What Do Forest Fires Really Cost?

Dennis L. Lynch

ABSTRACT

A seven-year quest to estimate forest fire costs in Colorado revealed a number of losses not usually considered. Catastrophic fires result in direct costs, rehabilitation costs, impact costs, and special value losses. They are wildfire events that imperil public health, safety, or welfare and result in significant degradation of the environment, substantial loss of property, and often death or injury of people. While each fire is unique, a series of large fire case studies, primarily in ponderosa pine forests, are used to develop a progression of cost estimates. The author concludes that damages to forest watershed values in the arid West may ultimately result in the most serious, long-term costs of large fires. A contrasting case study where fire has been a regular component of the forest ecosystem is used to question the tacit acceptance of very costly, extremely damaging catastrophic fires as natural events.

Keywords: wildfire; forest fire; forest fire costs; fire cost accounting

Media reports of catastrophic forest fires usually present video or photographs of extreme fire behavior and then dazzle us with huge estimated suppression costs and property losses. Once the smoke clears, estimates of land rehabilitation project costs may be used to give legs to the story. Later we often see reports about the aftermath of a fire, focusing on devastation, flooding, and other damages. Then the story quietly ends as the media moves on to different, more exciting news. However, this is far from the end of a wildfire story. What did the fire suppression, property loss, rehabilitation, impacts on local government, and subsequent flooding really cost, who had to pay, and how did people cope?

This article describes a quest I began in 1997 to track costs of large wildfires in Colorado. I wanted to compare actual wildfire costs with fire mitigation costs for forest thinning and prescribed fire introduction that are essential to forest restoration and wildfire alleviation (Lynch et al. 2000, Lynch and Mackes 2003). Initially I turned to national fire data compiled in a study by the USDA Forest Service (Fire and Aviation Management 1995). The study had been prompted by the 1994 fire season, one of the most severe in history. In that season, 14,426 fires occurred, the highest number since 1940. Many fire managers indicated that 1994 fire behavior was the most extreme they had seen in their 20–30 year careers. Emergency fire suppression costs were the highest in the history of the USDA Forest Service. Suppression costs had been increasing since 1977 by $17.4 million per year, but the 1994 costs were 174% higher than 1988, the year of the Yellowstone fires. The study also found that from 1977 to 1994 there had been a total of 181,050 USDA Forest Service fires that burned 6,899,254 acres at a GDP-adjusted cost to 1994 of $4,214,700,000. Average cost per acre was $611 with a range from $316 to $1,253. These costs included all fires occurring in a wide variety of grasslands, shrublands, and forest fuel types with a myriad of terrain and burning conditions.

This information whetted my interest. What had been the situation in Colorado? State and Private Forestry in Region 2 of the USDA Forest Service furnished me with a summary of wildfire data for Colorado during the period 1991–96. During that time, 2,140 wildfires burned 40,882 national forest acres at a total cost of $21,472,607 or an average cost of $525 per acre. An unpublished study

by the Rocky Mountain Research Station for fires during 1996–97 in the West that were larger than 5,000 acres listed a range of costs from $30 per acre up to $2,900 per acre (RMRS 2002).

In 1994, Colorado mirrored the national fire season with record costs and losses. Lynn Young, public information officer for the USDA Forest Service Region 2, estimated that $20 million had been spent suppressing 1,697 fires that charred 49,518 acres on all landownerships across the state. This was an average cost of $404 per acre. The State of Colorado's share of the multi-agency total exceeded $1.49 million and was $375,000 over the state's emergency fund budget. The deaths of 14 firefighters on Storm King Mountain July 6 left the state in shock and made that fire season the deadliest in Colorado history.

Initial Case Studies

I began to wonder just what was the total cost of these fires. So my quest moved on, not to just the suppression costs but property losses and other costs local agencies and private individuals experienced. The quest formed into a series of case studies to determine the scope, extent, and dollar amount of fire costs and related losses. Digging back into Colorado fire history, I found that the 1989 Black Tiger fire had been well documented in a case study prepared by the National Fire Protection Association (1990). A person burning trash in a ponderosa pine forest west of Boulder, Colorado on July 9 reportedly started it. A total of 44 homes burned, and property losses were estimated at $10 million. Suppression costs amounted to $830,298 for 2,100 acres burned, an average cost of $395 per acre. The report carefully examined fire behavior and conditions that made buildings susceptible to loss or damage. Unfortunately, however, other losses evident in photographs of the fire aftermath were not collected or documented. My quest for detailed cost data was late and wanting.

Similarly, the Hourglass fire, which burned through the Pingree Park forestry camp of Colorado State University, was partially documented (CSU 1995). The fire started by lightning on July 1,1994 and burned 1,275 acres of lodgepole pine forest, 13 buildings, and damaged 2 others. Suppression costs totaled $1.5 million, and structure loss was $2.4 million. The fire required 602 firefighters, 4 helicopters, 9 air tankers, and 15 engines to achieve control on July 5. Over 170 people were evacuated from the camp, and approximately another 150 were required to leave an adjacent church camp and subdivision. Again, fire weather, fuels, and firefighting tactics were well documented, but associated costs were not. Suppression costs averaged $1,176 per acre, and the building damages, when computed on an acreage basis, were $1,882 per acre. But what were the costs associated with evacuation, law enforcement, and resource damage?

Introduction to Catastrophic Fires

The Buffalo Creek fire started on May 18, 1996, apparently by some schoolchildren building a campfire. This fire was recent enough to allow me to expand my quest and follow some costs through time. Working with Chuck Dennis, forester for the Denver Water Board, we were able to capture some of the costs before the ashes on our quest-trail cooled. The fire burned 11,900 acres of the Pike National Forest and into the settlement of Buffalo Creek west of Denver. Unfortunately, the area burned by the fire is a key watershed for the City of Denver and is just above Strontia Springs reservoir, which delivers 75% of Denver's water and a significant portion of the City of Aurora's water supply. Fire suppression costs for the USDA Forest Service, Colorado State Forest Service and Jefferson County totaled $2.65 million or $223 per acre. Private insured property losses amounted to $1,036,918 or $87 per acre. The USDA Forest Service conducted rehabilitation efforts to reduce erosion by placing log barriers along contours, straw bale dikes in drainages, and planting 80,000 lbs of white oats to initiate revegetation. In total, about $1.6 million was spent on rehabilitation or $134 per acre.

However, the real impact of the fire came when severely burned soils, which had become hydrophobic, began to repel thunderstorm rains like a tin roof. The result was flash flooding. The first flood on July 12 roared down tiny Buffalo Creek and Spring Creek at an estimated volume of 7,000 cubic feet per second, wiping out the settlement's water system, fire station, community center, and damaging roads, bridges, private homes, and buildings. One person drowned trying to outrun the water.

An estimated 15–20 tons of soil per acre, along with nearly all of the erosion control materials, were washed down stream. Public property flood loss was $1,483,773 or $125 per acre, and private flood losses were $1,125,988 or $95 per acre. Much of the flood sediment and debris were washed into Strontia Springs reservoir where water quality and cleanup costs amounted to $903,743 or $76 per acre. Despite all-out efforts by the water board to maintain water quality, they watched in horror as smoky-tasting water disseminated through Den-

ver's water system.

By 1997, estimated costs totaled nearly $17 million or $1,403 per acre. With every succeeding storm, erosion continued. Before the fire, the total amount of sediment deposited in the reservoir amounted to approximately 12,000 cubic yards per year. The flood deposited 160,000 cubic yards in 1 day, and future sediment transfer is estimated at 200,000 cubic yards per year until the watershed is revegetated and stabilized. At present, the reservoir has become so sediment-clogged that full-scale dredging must occur. This will necessitate construction of a pipeline to transport sediment from the reservoir to a place where it can be stockpiled. The estimate is for another expenditure of $15–20 million on dredging and pipeline construction. When this occurs, it will put the final fire cost between $2,600 and $3,100 per acre. Part of the quest ends right here with the mucking out of this reservoir to keep the City of Denver neighborhoods supplied with water.

Yet, the quest moves on. Despite all of our cost collection efforts, we were unable to capture every cost associated with the fire. For example, we lacked information on uninsured losses, tax losses to counties, and important impact costs. Will I ever get to the bottom line? Have I entered the Slough of Despond that another questor, John Bunyan, identified in his Pilgrims Progress?

By 2000, I felt better equipped to fully track costs associated with a large fire. The Bobcat Gulch fire, started by an illegal campfire on June 12 in the Roosevelt National Forest, was only miles west of my home. It burned 10,599 acres and destroyed 22 homes and outbuildings. Its location allowed me to become fully engaged in cost collection during and immediately following the fire. I divided fire costs into (1) Direct Costs occurring during the fire, (2) Rehabilitation Costs of erosion control projects, and (3) Impact Costs, which occurred as a result of but incidental to the fire. Table 1 contains a summary of these costs. Even though the quest trail was hot, I was not able to document uninsured structure losses or personal property losses (automobiles or camp trailers for example). Then too, the Roosevelt National Forest did not estimate resource damages, but surely timber, wildlife, recreation, and watershed losses occurred. The rehabilitation costs related only to erosion control and did not include tree planting. Actually, to date no plans have been made to replant National Forest lands, but some private landowners have apparently planted trees on their property. In addition, I was not able to value volunteer efforts associated with cleanup.

Under impact costs, I was not able to obtain costs for destroyed telephone facilities, administrative costs for workers who had to devote energies to the fire while neglecting their primary jobs, or business losses or wages lost by people evacuated from their homes.

Even so, I felt I had come closer to the goal of fully documenting the real costs of the fire. The quest was not over but I was out of the slough. Since the fire, there were a series of flood events that continued even through the dry summer of 2003. As these events occurred, I recognized the need to follow costs into subsequent years to more completely identify a fire's true impact.

The 2002 Fire Season and Colorado's Largest Fire in History

The 2002 fire season proved to be another record, with 2,012 fires burning more than 502,000 acres and destroying 384 homes and 624 other structures. One hundred forty two subdivisions with 81,435 residents were evacuated. Tragically, nine firefighters lost their lives. Total suppression costs exceeded $152 million (Colorado Division of Forestry 2002, Hackett 2003). Smoke blanketed Colorado for weeks, and the Governor was quoted as saying "Colorado is on fire" in the national media. Summer tourism losses were estimated at $1.7 billion by Dr. Bob Aukermann of Colorado State University (Benson 2002). It was during this season that Colorado experienced its largest fire in state history. Suddenly my quest took the form of a huge fireball, an angry howling firestorm that sucked up money and manpower like a vortex from hell.

The Hayman fire was started by arson on June 8 and controlled on July 18, after burning 137,759 acres of ponderosa pine forest in four counties within the Pike National Forest. Congressional Representative Mark Udall from Colorado wrote the Chief of the USDA Forest Service suggesting that a full analysis of the fire be conducted. In response, five review teams were established in Aug. 2002. I cooperated with the social/economic team (Kent et al. 2003) by sharing costs and contacts I had developed as well as serving as a reviewer for their report. Table 2 includes 2002 and 2003 data collected to date.

Direct costs include federal suppression costs and state and county costs partially reimbursed by the Federal Emergency Management Agency (FEMA). Unreimbursed costs are those that do not meet FEMA criteria and must be absorbed by local governments. Insured property losses include homes, adjacent structures, and personal property covered under individual policies. These losses were aggregated by Rocky Mountain Insurance Association for all insurance agencies. Some businesses, homes, and personal property were not insured. Those who experienced uninsured losses could file with FEMA for grants or with the Small Business Administration (SBA) for loans. For the first time, I was able to account for these losses as well as damage to electric transmission facilities, which are self-insured.

USDA Forest Service recreation facilities burned, and forest resources such as timber, wildlife, range, and watersheds were consumed by the fire monster. Timber value was estimated in two different ways that produced drastically different results. Families evacuated or those not allowed to return to their homes were cared for in shelters run by the American Red Cross (ARC). The fire season was so widespread in Colorado that evacuation costs were not recorded for each fire. I used the gross expenditure by ARC divided by the burned acres for all fires evacuated to develop the aid to evacuated cost for this fire. Tragically, the fire engulfed the watershed above

Table 1. Bobcat Gulch fire.[a]

Fire information:	
Location:	Roosevelt National Forest (Larimer County, CO)
Date:	June 12–24, 2000
Cause:	Illegal campfire
Acres burned:	10,599
Direct costs (during fire):	
Suppression cost	$3,840,319 ($362.33/acre)
Insured property loss (22 homes and out buildings)	$5,087,500
Uninsured losses	$????
Law enforcement (Larimer County) (does not include Sheriff's posse/volunteers)	$46,634
American Red Cross aid (does not include donated food or other items)	$7,023
Rehabilitation costs (does not include volunteers): (contour felling, straw wattles, seeding, mulching)	
USDA Forest Service	$656,166 (1,545 acres +15 mile road drainage)
Natural Resources Conservation Service	$167,687.50 (state and private lands)
Impact costs:	
USDA Forest Service landline re-establishment	$147,000
Homeowners: Fish kill and pond cleanup	$15,000
Larimer County:	
Noxious weed control	$11,000
Road repairs	$37,099.53
Lost tax revenues	$36,450
City of Loveland:	
Flood warning system	$14,600 (maintenance cost $600/year)
Water treatment costs – loss of water passing headgate (Hg+Mn may require $ additions to treatment plant)	$15,074.38
Division of Wildlife	$750 (monitoring run-off)
Poudre Valley REA	$15,000 (replace poles & line)
Qwest Telephone	$????
Business losses (Sylvan Dale Ranch)	$13,200
Property value losses	$????
Administrative costs	$????
Total all costs:	$10,110,503.41 ($953.91/acre)

[a]*Costs collected by Dennis L. Lynch.*

Cheesman Reservoir, another key link in Denver's water system. Rehabilitation costs in Table 2 are essentially erosion control project costs for federal and private lands. It is doubtful that significant areas of the fire will be replanted with trees. However, 2003 costs include some tree-planting efforts on Denver Water Board land and on private lands by the Coalition for the Upper South Platte.

Impact costs include tax revenue losses incurred by counties when dwellings were destroyed. If a property was totally destroyed, the insurance company covered the loss to the owner. The county, however, no longer receives tax revenue for the dwelling that burned. In addition, tax revenues are lost from partially burned properties. County assessors from the four counties in the fire devised a method of reducing taxes on partially burned properties. They concluded that all properties in burn areas whether damaged or not would receive a 10% "stigma adjustment." In addition, properties with low damage received an additional 20% reduction. Moderately burned property values were reduced another 40%, and severely burned properties were reduced by an additional 60%. Thus assessed values were reduced between 10 and 70% for partially burned properties.

In some ways, people who suffered partial damage to their homes may be worse off than those who lost entire structures. For example, many were left surrounded by nuclear winter with lingering smoke odor, blowing ash, and the threat of flash flooding. Consider the financial impact on a property owner who has a 75% mortgage but has just realized a 30% or more loss of property value. His equity has been lost along with a sizable amount of value that supported the mortgage. A condition mortgage lenders ironically refer to as a "mortgage underwater." Realtors I contacted were skeptical about the salability of such properties. One can only hope that, in time, some measure of the value lost will return as revegetation occurs.

We are confident that sales tax losses also occurred. However, only a few businesses were directly within or immediately adjacent to the fire zone. Given the slow down in tourism associated with the 9/11 tragedy and the 2002 fire season publicity, the extent of sales tax loss has been impossible to determine. The USDA Forest Service Social/Economic Report (Kent 2003) actually found that food and beverage sales held steady or increased in the general region during the fire period, but businesses that enjoyed prosperity were apparently far outside the fire area.

In the impact cost section, unreimbursed loss-of-business costs are identified for firms and organizations. Some reimbursement for loss of business is in-

Table 2. 2002 Hayman Fire costs.[a]

Fire information:	
Fire started:	June 6, 2002
Controlled:	July 18, 2002
Cause:	Arson
Location:	Pike National Forest, Teller, Park, Jefferson, Douglas Counties.
Total acres burned:	137,759 (includes 20,819 state and private lands)
Direct costs (during fire):	
Federal suppression cost (approximately $34.93 million direct federal cost plus $7.35 million state and counties cost reimbursed by FEMA)	$42,279,000 ($307/acre)
Unreimbursed suppression costs of state and counties	$1,015,741.66
Insured property loss (600 structures)	$38,700,000 ($280.92/acre)
Uninsured private property losses:	
FEMA grants	$851,552
SBA loans	$4,000,000
Excel Energy power lines	$230,000
Intermountain REA power lines	$650,000
USDA Forest Service recreation facilities lost	$56,600
Estimated National Forest resource losses (The timber portion included in this estimate is $3.7 million. Another estimate places the timber loss alone at $34.3 million.)	$47,000,000
Aid to evacuated people:	
American Red Cross aid	$765,940[b] ($5.56/ac.)
Direct cost subtotal	$135,548,834
Rehabilitation costs (2002 erosion control projects):	
USDA Forest Service emergency rehab.	$23,710,000
Denver Water Board land	$2,230,000 estimated
US Geological Service mapping	$240,000
Natural Resources Conservation Service state and private lands	$10,800,000
USDA Forest Service Restoration Team (12 staff plus aids) per year	$2,950,000
Rehabilitation cost subtotal	$39,930,000
Impact costs (costs related to the fire):	
2002 tax revenue losses:	
Teller County	$127,351
2002 sales tax losses:	Not able to document in this case
2002 business losses:	
Lost Valley Guest Ranch	$1,900,000
Youth camps	$222,000
Campground concessionaires	$382,000
USDA Forest Service recreation fees	$60,250
Reduction of values of surviving structures within fire area	–10% to –70%
Impact cost subtotal	$2,691,601
Subtotal of costs	$178,170,435 ($1,293/acre)
Special value losses:	
Deaths of 5 firefighters and an asthma victim	$18,000,000
Respiratory illnesses from smoke	$????
Loss of wilderness and roadless values on severe and moderately burned areas	$679,614 plus 10.6 jobs
Loss of 47% of endangered butterfly habitat	$10,850,000 annually
Special value losses subtotal	$29,529,614
Total costs and values lost estimate:	$207,700,049 ($1,508/acre)

[a] *Final 2002–03 estimate compiled by Dennis L. Lynch, and includes work by the USDA Forest Service Hayma Fire Social-Economic Analysis Team.*

[b] *American Red Cross cost is prorated from a consolidated statewide cost.*

fied for firms and organizations. Some reimbursement for loss of business is included in the FEMA and SBA grants and loans under direct costs. In addition, some businesses found that their insurance companies would not pay for loss of business that occurred after the fire was declared controlled. However, in many cases, the area was deemed unsafe or not suitable for re-entry and potential clientele could not obtain access for weeks after control. Campground concessionaires lost business while National Forest campgrounds were closed during the fire. Because the USDA Forest Service receives revenues from the concessionaires, they lost money as well.

The quest took a new turn and I added a section for this fire designated Special Values because of possible smoke impacts on respiratory health, deaths associated with the fire, and losses connected with roadless, wilderness, and endangered species habitat.

Vedal and Dutton studied smoke from the fire in relation to respiratory illnesses and deaths in Denver (S. Vedal and S. Dutton, Colorado Department of Health, Jan. 13, 2004). They noted that hourly increases in particulate matter (PM) air pollution peaked on June 9 and June 18 when smoke from the fire drifted directly over Denver. In examining respiratory illness connections, they reviewed cardiovascular emergency room (CER) visit data at an inner city hospital and a large community hospital. They also conducted a panel study of 22 adults during a 21-day period of the fire. They found that the largest number of CER visits for the month occurred on June 19 following the June 18 smoke episode. However, they were unable to definitively link CER visits with the dramatic short-term increases of PM concentrations. In the panel study, however, they concluded that wildfire smoke caused dramatic increases in fine particle concentrations, and such short-term increases are associated with increased respiratory symptoms in patients with chronic obstructive pulmonary disease. In their subsequent study on mortality, they determined that daily deaths in June 2002 were comparable to those in June 2001 when no wildfire smoke drifted over Denver. It is useful to note that the population of Denver and suburbs were well informed about the fire, and people with respiratory illnesses were cautioned to stay indoors during smoky days. Vedal and Dutton were not able to collect data in the greater Denver area on patient visits to their primary physicians for respiratory assistance during this period. While the results are mixed, the studies are useful in examining impacts on the health of populations exposed to wildfire smoke and potential costs related to such episodes.

Table 3. 2003 costs related to the Hayman Fire.

Property tax revenue losses to counties:	
Teller County	$127,351
Douglas County	$97,826
Park County	$11,638
Jefferson County	$312,100
Subtotal	$548,915
Land rehabilitation costs:	
USDA Forest Service Rehabilitation Team (2003)	$2,500,000
USDA Forest Service long-term rehab.	$3,313,522
Denver Water Board	$1,620,000
State lands	$46,250
Coalition for Upper South Platte (expenditures and value of volunteer time)	$518,200
Subtotal	$7,997,972
Flood damages to public property:	
Douglas County	$446,000
Teller County	$35,031
Park County	$5,000
Jefferson County	$74,577
Colorado Dept. of Transportation (Some USDA Forest Service campgrounds may be permanently closed due to fire and flooding.)	$250,000
Subtotal	$810,608
Flood damages to private property:	
Youth camp	$180,000
Church camp	$150,000
Private landowner	$400,000
Subtotal	$730,000
Loss of business:	
Guest Ranch	$314,000
Fishing business	$100,000
Subtotal	$414,000
Total of 2003 costs:	$10,501,495 ($76.23/acre)
Special values losses:	
Loss of South Platte trout fishery value	–25% to –50%
Loss of endangered butterfly habitat value	$10,850,000
Loss of wilderness and roadless area values	$679,613
Subtotal of special values losses	$11,529,613
Total costs and values lost estimate:	$22,031,108 ($159.92/acre)

Quests are not immune to human tragedies, and unfortunately deaths related to the fire did occur. One death of an asthma patient occurred when she was trying to escape the fire zone. She died in the arms of her husband on their front porch engulfed in dense smoke (Herdy 2003). Five contract firefighters died in a highway accident on their way to the fire. In my previous quest, I had turned aside and avoided estimating this ultimate cost. Having fought fires for a good portion of my career, I simply could not bring myself

to attempt to place dollar values on the life of another firefighter. In one respect, insurance companies and Congress did that for me. Survivors of contract firefighters who die in the line of duty receive a death benefit of $10,000 plus an annuity that depends on the wage rate of the firefighter and the expected longevity of dependents. The amount of that annuity is confidential. In the case of a full-time public safety officer's death, the one-time death benefit is at least $267,494 as set by the Hometown Heroes Survivors Benefit Act (S.459) signed into law Dec. 15, 2003, plus any federal life insurance amounts and service annuities to survivors.

These are death benefits. They do not measure the special value of a life fully lived. While we recognize that the value of the life of a family member or friend is infinite and beyond measure, there have been attempts to estimate this special value loss. Viscusi (1993) presented a summary of value of life studies based on wage-risk tradeoff. These studies were largely based on the nature of the risk, the component of monetary tradeoff, and the average income level of the worker to estimate the implicit value of life. He concluded that the majority of life value estimates were in the $3 million to $7 million range. In this study, I have simply chosen to use the conservative estimate of $3 million as an estimate of this special value without further investigation into the variables.

Other special values relate to wilderness, roadless areas, and threatened species. Obviously value existed prior to the fire, but now these special resources may be lost for centuries, if not forever. These losses, while very real, are not quantifiable in hard dollar costs as presented in previous sections. My quest now ventured into the realm of what some regard as intangibles.

The fire burned through 33,785 acres of designated roadless areas and the Lost Creek wilderness. Loomis and Richardson (2000) estimated the economic values of protecting primitive, roadless areas and wilderness in a study prepared for The Wilderness Society and Heritage Forests Campaign. He recognized recreation benefits, community effects, and passive-use benefits in protecting such areas. Using USDA Forest Service geographic information systems data provided by Nallick (2003) on acreage and burn severity, I used the Loomis research to estimate special value losses caused by the Hayman fire. Note that these values are annual losses that presumably will end only when the area recovers sufficiently to exhibit acceptable wilderness and roadless benefits.

The fire also destroyed 47% of the habitat of the threatened Pawnee Montane Skipper butterfly. Questors, what is the value of butterfly habitat? Loomis and White (1996) estimated values for 18 rare and endangered species using contingent valuation surveys of households. They found that annual willingness to pay ranged from a low of $6 per household for fish such as the striped shiner to a high of $95 per household for the northern spotted owl and its habitat. Loomis and Caban (1998) found that average willingness to pay to reduce catastrophic fire on 2,570 acres of old-growth forest habitat for the spotted owl was $56 per household. Neither of these research papers identified values associated with threatened butterflies. However, it is clear that value existed prior to the fire that is now lost. Supposing that $6 per household, the lowest value found by Loomis and White, is applicable to the butterfly, the value loss amounts to $10.85 million annually. If the butterfly habitat is, say, half as valuable as that of the spotted owl, the value lost is $50.6 million. I chose, therefore, to use the conservative value of $10.85 million as an indicator of special value lost in this case. Note that these are annual value losses that will continue into 2003 and beyond if the butterfly can exist on the remaining 53% of its habitat.

Unfortunately, costs for the Hayman fire did not end in 2002, and costs are likely to continue into the foreseeable future. I summarize in Table 3 documented 2003 costs that occurred in the fire aftermath. Is a quest like this ever really over?

Land rehabilitation costs continued into 2003 with ongoing erosion control projects on public and private lands. Hydrophobic soil conditions created by the fire resulted in significant flood damages. Bob Jarrett, hydrologist with the US Geological Service in Denver, observed runoff discharges 300 times greater in burned areas than in unburned areas of the Hayman fire (B. Jarrett, US Geological Service, Jan. 13, 2004). He stated that even "garden variety" thunderstorms are producing 100-year flood discharges. However, due to the random nature of thunderstorm activity over the fire area, not all areas experienced such events (J. Stednick, Colorado State University, Jan. 15, 2004). Flood damages are divided into public and private property losses. It is significant that none of these losses are covered by flood insurance. Flooding in these arid mountains is so unusual that flood insurance is seldom considered necessary by homeowners. Reviewing the 2003 experience, one can only speculate on what flood impacts are going to be when the drought breaks and more frequent high-intensity thunderstorms return to this area.

Counties complained that firefighting reimbursement checks from FEMA took 18 months to arrive. That put them in tight financial situations and they lost interest on their money during that time. Tax revenue losses continued in 2003 and are likely to continue in 2004 to some degree.

Removal of hazard trees along roads began in 2003, and organizations report that they will be paying as much as $150,000 in 2004 to reduce such hazards on their properties. Business losses continued within the fire area as well as for businesses in streamside flood zones.

Another Kind of Wildfire

In my quest, I learned about another kind of fire, a concluding and contrasting case study that merits consideration by those who accept catastrophic fires as simply natural events. The Doe Canyon fire occurred in southwestern Colorado and was reported to me in 1997 by Scott Steinberg, fire management officer on the San Juan National Forest. The fire occurred in an area known as Five Pine Canyon or Doe Canyon. That area had experienced wildfire frequencies over the past 30 years similar to frequencies before the turn of the century when

fire was a regular component of the forest ecosystem (Grissino-Mayer et al. 2004). The Doe Canyon fire burned 600 acres of ponderosa pine forest that had some open glades, areas that had been thinned, and terrain that was fairly level. The wind was not erratic. The fire report described the fire as being of low intensity with some small pine occasionally torching out, but it "burned like a prescribed fire." Control consisted of burning out from roads. The suppression cost was $7,500 or $12.50 per acre. This appears to be a more classic fire, typical of historic ponderosa pine forest conditions than the conflagrations we are now experiencing. Is there a lesson here that might be repeated in other forests? Could forest management lead us into "natural" fire regimes with lower fire costs? Quests are nourished by nagging questions.

Conclusions

I am impressed with the diversity of people and organizations touched by forest fires and their aftermath. The real cost of any fire is an enigma; separable and unique to each fire situation. Cost collection on large fires has proved to be a time-consuming and tedious task where only a few data sources remain consistent from fire to fire. With each new study comes the realization and frustration that costs were probably missed or overlooked in previous case studies and it is too late to recover them. I recognize that in several cases I have been unable to get definitive costs because people are just indifferent or unwilling to reveal them.

Much of the interest in fire prevention and suppression has been focused on defending and saving structures. While structural losses can be enormous and devastating, buildings can be replaced rather quickly if an owner is determined to rebuild. However, 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. In Colorado, most cities and towns are at risk of losing municipal watersheds and, consequently, their water supply if catastrophic fires continue. Many areas are being burned so severely that the forests we knew prior to the fires are not likely to naturally return to anything approximating their structure and protective ability for perhaps centuries. This loss of habitat, solitude, beauty, and forest productivity is compelling.

In my opinion, the mythology about a forest "renewing itself" after fire has been oversold. That "greening up" may well be a cover of noxious plants and another set of costs. It's time to tell the truth. Catastrophic fires are not normal and they endanger life, property, as well as ecosystems in ways that are beyond repair.

My quest for the real costs of wildfires revealed some questions we could begin to address now. For example, why should local governments and individuals be left with the continuing cost burden of a federal catastrophic fire?

Or, why are we not replanting major portions of burned areas?

At this pause in the quest, I am certain of at least one thing. Catastrophic fire costs are just that. Costs. Nothing lasting comes from spending all this money. We should at least be clear that these are not investments in future forests or watersheds that will leave our children and grandchildren with a legacy.

A lot of blame has been assigned to our predecessors for adopting fire suppression policies that supposedly left us where we are today. That is a way too easy cop out. Remember, they also planted a lot of trees, healed some badly abused watersheds, and, unlike other parts of the world, left us with forests. Forests that need management, to be sure, and not as pristine as some might like, but still not a bad inheritance. Can we improve on their ethic and turn catastrophic fire costs into a forest investment stream for the future?

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Dennis L. Lynch (denny@cnr.colostate.edu) is professor emeritus of forest sciences, Department of Forest, Rangeland, and Watershed Stewardship, Colorado State University, Fort Collins, CO 80523.