Order Code RL30755

CRS Report for Congress

Received through the CRS Web

Forest Fire Protection

December 5, 2000

Ross W. Gorte
Natural Resource Economist and Senior Policy Analyst
Resources, Science, and Industry Division

Forest Fire Protection

Summary

The 2000 fire season was, by most standards, one of the worst in the past half century. National attention began to focus on wildfires when a prescribed burn in May escaped control and burned 235 homes in Los Alamos, NM. In September, the Clinton Administration proposed an additional $1.6 billion for wildfire management, and Congress enacted much of this proposal in the FY2001 Interior Appropriations Act (P.L. 106-291). However, Congress still faces questions about forestry practices, continued funding, and the federal role in wildland fire protection.

Many factors contribute to the threat of wildfire damages; two major factors are the decline in forest and rangeland health and the expansion of residential areas into wildlands — the urban-wildland interface. Over the past century, aggressive wildfire suppression, as well as past grazing and logging practices, have altered many ecosystems, especially those where light, surface fires were frequent. Many areas now have unnaturally high fuel loads (*e.g.*, dead trees and dense thickets) and an historically unnatural mix of plant species (*e.g.*, exotic invaders).

Fuel treatments have been proposed to reduce the wildfire threats. Prescribed burning — setting fires under identified conditions — can reduce the fine fuels that spread wildfires, but can escape and become catastrophic wildfires, especially if fuel "ladders" and wind spread the fire into the forest canopy. Commercial timber harvesting is often proposed, and can reduce heavy fuels and fuel ladders, but can increase the threat unless the slash (tree tops and limbs) is properly disposed of. Other mechanical treatments (*e.g.*, precommercial thinning, pruning) can reduce fuel ladders, but also temporarily increase fuels on the ground. Treatments can often be more effective if combined (*e.g.*, prescribed burning after thinning). However, some fuel treatments are very expensive, and the benefit of treatments for reducing wildfire threats depend on many factors.

It should also be recognized that, as long as there is biomass, drought, and high winds, catastrophic wildfires will occur. Only about 1% of wildfires become conflagrations, but which fires will "blow up" into catastrophic wildfires is unpredictable. It seems likely that management practices and policies, including fuel treatments, affect the likelihood of such events. However, past experience with wildfires are of limited value for building predictive models, and research on fire behavior under various circumstances is difficult, at best. Thus, predictive tools for fire protection and control are often based on expert opinion and anecdotes, rather than on research evidence.

Individuals who choose to build homes in the urban-wildland interface face some risk of loss from wildfires, but can take steps to protect their homes. Federal, state, and local governments can and do assist by protecting their own lands, by providing financial and technical assistance, and by providing relief after the fire.

Contents

List of Tables

Forest Fire Protection

The spread of housing into forests and other wildlands[1], combined with various ecosystem health problems, has substantially increased the risks to life and property from wildfire. Wildfires seem more common than in the past, with severe fire seasons in 1988, 1990, 1996, 1999, and 2000.[2] Prescribed fires are often used to reduce woody debris that serve as fuel for fires and to protect natural resources and structures, but occasionally prescribed fires escape containment and cause serious damages. One such escaped prescribed fire was the Cerro Grande fire that burned 235 houses in Los Alamos, NM, in May 2000. Wildfire-related issues for Congress include funding for the various options to treat fuels; federal roles and responsibilities for wildfire damages; and oversight of the agencies' prescribed burning programs, of other fire management activities, and of other wildland management practices that have altered fuel loads over time.

Many of the discussions over wildfire protection focus on the several federal agencies that manage lands and receive funds to prepare for and to control wildfires. The Forest Service, in the Department of Agriculture, is the "big brother" among federal wildfire fighting agencies. The Forest Service is the oldest of the federal land management agencies, having been created in 1905 with fire control as a principal purpose; the Forest Service also administers more forestland in the 48 coterminous states than any other federal agency; the Forest Service receives more than two-thirds of federal fire funding; and the Forest Service created the well-known symbol of fire prevention, Smokey Bear. The Department of the Interior contains several land managing agencies, including the Bureau of Land Management (BLM), the National Park Service, the U.S. Fish and Wildlife Service, and the Bureau of Indian Affairs, with fire protection programs coordinated through the BLM. Despite the substantial attention given to the Forest Service and to other federal agencies, the majority of wildlands appear to be privately owned, and the states are responsible for fire protection for these lands, as well as for their own lands.[3]

---

[1] Wildlands is a term commonly used for undeveloped areas — forests, grasslands, brush fields, wetlands, deserts, *etc.* It excludes agricultural lands and pastures, residential areas, and other, relatively intensively developed areas.

[2] These are the five most recent years with more than 5 million acres burned nationally. The severity of fire seasons is commonly assessed by acreage burned, but larger fires may not be "worse" if they burn less intensely, because their damages may be lower. However, fire intensity and damages are not measured for each wildfire, and thus cannot be used to gauge the severity of fire seasons. It is uncertain whether acreage burned might be a reasonable approximation of severity.

[3] U.S. Dept. of the Interior and Dept. of Agriculture, National Interagency Fire Center, *Wildland Fire Statistics*, at [http://www.nifc.gov/stats/wildlandfirestats.html]

This report provides historical background on wildfires, and describes concerns about the "Urban-Wildland interface" and about forest and rangeland health. The report discusses fuel management, fire control, and fire effects. The report then examines federal, state, and landowner roles and responsibilities in protecting lands and resources from wildfires, and concludes by discussing current issues over federal wildfire management.

Historical Background

Wildfire has existed in North America for millennia. Many fires were started by lightning, although Native Americans also used wildland fire for various purposes. Wildfires were a problem for early settlers. Major forest fires occurred in New England and the Lake States in the late 1800s, largely fueled by the tree tops and limbs (slash) left after extensive logging. One devastating fire obliterated the town of Peshtigo and killed 1,500 people in Wisconsin in 1871. Large fires in cut-over areas and the subsequent downstream flooding were principal reasons for Congress authorizing the President in 1891 to establish forest reserves (now national forests).

Federal Fire Policy Evolution. The nascent Forest Service focused strongly on halting wildfires in the national forests following several large fires that burned nearly 5 million acres in Montana and Idaho in 1910. The desire to control wildfires was founded on a belief that fast, aggressive control efforts were efficient, because fires that were stopped while small would not become the large, destructive conflagrations that are so expensive to control. In 1926, the agency developed its "10-acre policy" — that all wildfires should be controlled before they reached 10 acres in size. This was clearly aimed at keeping wildfires small. Then in 1935, the Forest Service added its "10:00 a.m. policy" — that, for fires exceeding 10 acres, efforts should focus on control before the next burning period began (at 10:00 a.m.). These policies were seen as the most efficient and effective way to control large wildfires.[4]

In the 1970s, these aggressive Forest Service fire control policies began to be questioned. Research had documented that, in some situations, wildfires brought ecological benefits to the burned areas — aiding regeneration of native flora, improving the habitat of native fauna, and reducing infestations of pests and of exotic and invasive species. In recognition of these benefits, the Forest Service and the National Park Service initiated policies titled "prescribed natural fire," colloquially known as "let-burn" policies. Under these policies, fires burning within prescribed areas (such as in wilderness areas) would be monitored, rather than actively suppressed; if weather or other conditions changed or the wildfire threatened to escape the specified area, it would then be suppressed. These policies remained in effect until the 1988 wildfires in Yellowstone National Park. Because at least one of the major fires in Yellowstone was an escaped prescribed natural fire, the agencies temporarily ended the use of the policy. Today, unplanned fire ignitions (by lightning or humans) that occur within site and weather conditions established in fire

---

[4] See: Julie K. Gorte and Ross W. Gorte, *Application of Economic Techniques to Fire Management – A Status Review and Evaluation*, Gen. Tech. Rept. INT-53 (Ogden, UT: USDA Forest Service, June 1979).

management plans are identified as wildland fires for resource benefit, and are part of the agencies' fire use programs.[5]

Aggressive fire control policies were ultimately abandoned for federal wildfire planning in the late 1970s. The Office of Management and Budget challenged as excessive proposed budget increases based on these policies and a subsequent study documented that the fire control policies would increase expenditures beyond efficient levels.[6]

Concerns about unnatural fuel loads were being raised in the 1990s. Following the 1988 fires in Yellowstone, Congress established the National Commission on Wildfire Disasters, whose 1994 report described a situation of dangerously high fuel accumulations.[7] This report was issued shortly after a major conference examining the health of forest ecosystems in the intermountain west.[8] The summer of 1994 was another severe fire season, leading to more calls for action to prevent future severe fire seasons. The Clinton Administration developed a Western Forest Health Initiative,[9] and organized a review of federal fire policy, because of concerns that federal firefighting resources had been diverted to protecting nearby private residences and communities at a cost to federal lands and resources.[10] In December 1995, the agencies released the new *Federal Wildland Fire Management Policy & Program Review: Final Report*, which altered federal fire policy from priority for private property to equal priority for private property and federal resources, based on values at risk. (Protecting human life is the first priority in firefighting.)

Concerns about historically unnatural fuel loads and their threat to communities persist. In 1998 and 1999, the General Accounting Office (GAO) testified on these continuing threats three times,[11] and issued two reports recommending a cohesive

---

[5] U.S. Dept. of the Interior and Dept. of Agriculture, *Federal Wildland Fire Management Policy & Program Review: Final Report* (Washington, DC: Dec. 18, 1995).

[6] Stephen J. Pyne, *Fire In America: A Cultural History of Wildland and Rural Fire* (Princeton NJ: Princeton Univ. Press, 1982), pp. 293-294.

[7] R. Neil Sampson, chair, *Report of the National Commission on Wildfire Disasters* (Washington, DC: 1994), 29 p.

[8] See: R. Neil Sampson and David L. Adams, eds., *Assessing Forest Ecosystem Health in the Inland West: Papers from the American Forests Workshop, November 14th – 20th, 1993, Sun Valley, Idaho* (New York, NY: Food Products Press, 1994). Hereafter referred to as *Assessing Forest Ecosystem Health in the Inland West*.

[9] U.S. Dept. of Agriculture, Forest Service, State and Private Forestry, *Western Forest Health Initiative* (Washington, DC: Oct. 31, 1994), 66 p.

[10] Bob Armstrong, Assistant Secretary for Lands and Minerals Management, U.S. Dept. of the Interior, "Statement," *Fire Policy and Related Forest Health Issues*, joint oversight hearing, House Committees on Resources and on Agriculture, Oct 4, 1994 (Washington, DC: U.S. Govt. Print. Off., 1995), p. 9. Serials No. 103-119 (Committee on Resources) and 103-82 (Committee on Agriculture).

[11] U.S. General Accounting Office, *Western National Forests: Catastrophic Wildfires*
(continued...)

wildfire protection strategy for the Forest Service and a combined strategy for the Forest Service and BLM to address certain firefighting weaknesses.[12] The Forest Service responded to the GAO recommendations, but its draft report was not released to the public.[13] The Clinton Administration then developed a program and supplemental budget request to respond to the severe 2000 fire season, as discussed in more detail in the last section of this report. In the FY2001 Interior Appropriations Act (P.L. 106-291), Congress enacted the additional funding, and required the agency to publish the cohesive strategy.

Efficacy of Fire Protection. The Forest Service fire control programs appeared to be quite successful until the 1980s. For example, fewer than 600,000 acres of Forest Service protected land[14] burned each year from 1935 through 1986, after *averaging* 1.2 million acres burned annually during the 1910s. As shown in table 1, the average annual acreage of Forest Service protected land burned declined nearly every decade until the 1970s, but has risen substantially in the past two decades, concurrent with the shift from fire control to fire management. Furthermore, the acreage of Forest Service protected land burned did not exceed a million acres annually between 1920 and 1986; since then, more than a million acres of Forest Service protected land have burned in each of five years — 1987, 1988, 1994, 1996, and 2000.

In contrast, the acreage burned of wildlands protected by state or other federal agencies has declined substantially since the 1930s, and has continued at a relatively modest level for the past 40 years, as shown in table 1. There are still occasional severe fire seasons, with more than six million acres burned five times since 1960 — 1963, 1969, 1988, 1996, and 2000. Nonetheless, the severe 2000 fire season is below the average annual total acres burned in the 1950s.

It should also be recognized that only a small fraction of wildfires become catastrophic. In 2000, through October 17th, there had been 83,887 fires on all lands,

---

[11] (...continued)
Threaten Resources and Communities, GAO/T-RCED-98-273 (Washington, DC: Sept. 28, 1998), 23 p.; *Western National Forests: Nearby Communities Are Increasingly Threatened by Catastrophic Wildfires*, GAO/T-RCED-99-79 (Washington, DC: Feb. 9, 1999), 21 p.; and *Western National Forests: Status of Forest Service's Efforts to Reduce Catastrophic Wildfire Threats,* GAO/T-RCED-99-241 (Washington, DC: June 29, 1999), 6 p.

[12] U.S. General Accounting Office, *Western National Forests: A Cohesive Strategy is Needed to Address Catastrophic Wildfire Threats*, GAO/RCED-99-65 (Washington, DC: April 1999), 60 p.; and *Federal Wildfire Activities: Current Strategy and Issues Needing Attention,* GAO/RCED-99-233 (Washington, DC: Aug. 1999), 35 p.

[13] U.S. Dept. of Agriculture, Forest Service, *Protecting People and Sustaining Resources in Fire-Adapted Ecosystems: A Cohesive Strategy. The Forest Service Management Response to the General Accounting Office Report GAO/RCED-99-65, May 31, 2000,* unpublished report (Washington, DC: 2000), 89 p.

[14] Under several cooperative agreements, developed to improve protection efficiency, the Forest Service protects some nonfederal lands, while other organizations protect some national forest lands; the total acres protected by the Forest Service roughly equals the acres in the National Forest System.

but only 913 of those wildfires (1%) were more than 100 acres; these 913 large wildfires accounted for 6.49 million acres (93%) of the reported 6.96 million acres burned through October 17th.[15] This is consistent with data reported elsewhere.[16] Thus, a small percentage of the fires account for the vast majority of the acres burned, and probably an even larger share of the damages and control costs, since the large fires (conflagrations) burn more intensely than smaller fires and suppression costs (per acre) are higher for conflagrations because of overhead management costs and the substantial cost of aircraft used in fighting conflagrations.

Table 1. Average Annual Acreage Burned by Decade Since 1910
(in acres burned annually)

Decade	Average Annual Acres Burned, Forest Service Protected Lands	Average Annual Acres Burned, Non-FS Federal and Nonfederal Lands
1910-1919	1,243,572 acres	not available
1920-1929	616,834 acres	25,387,733 acres
1930-1939	343,013 acres	38,800,182 acres
1940-1949	269,644 acres	22,650,254 acres
1950-1959	261,264 acres	9,154,532 acres
1960-1969	196,221 acres	4,375,034 acres
1970-1979	242,962 acres	2,951,459 acres
1980-1989	488,023 acres	3,748,206 acres
1990-1999	554,577 acres	3,093,020 acres

Sources:

U.S. Dept. of Agriculture, Forest Service, *Forest Service Historical Fire Statistics*, unpublished table (Washington, DC), 1 p.

U.S. Dept. of the Interior and Dept. of Agriculture, National Interagency Fire Center, *Wildland Fire Statistics*, at [http://www.nifc.gov/stats/wildlandfirestats.html], with Forest Service acres burned deducted.

[15] Personal communication with Lorraine Buck, Information Officer, Office of External Affairs, National Interagency Fire Center, Boise, ID, on Oct. 17, 2000.

[16] Neuenschwander, Leon F., *et al.*, "Indexing Colorado Watersheds to Risk of Wildfire," *Mapping Wildfire Hazards and Risks*, R. Neil Sampson, R. Dwight Atkinson, and Joe W. Lewis, eds. (New York, NY: Food Products Press, 2000), pp. 35-55.

Concerns and Problems

Wildfires can stir a primeval fear and fascination in most of us. Many have long been concerned about the loss of valuable timber to fire and about the effects of fire on soils, watersheds, water quality, and wildlife. In addition, the loss of houses and other structures adds to wildfire damages. Historically, wildfires were considered a major threat to people and houses primarily in the brushy hillsides of southern California. However, people have increasingly been building their houses and subdivisions in forests and other wildlands, and this expanding "urban-wildland interface" has increased the wildfire threat to people and houses. Also, a century of using wildlands and suppressing wildfires has significantly increased fuel loads and led to historically unnatural vegetative species and structures; many believe that these forest and rangeland "health" problems have exacerbated wildfire threats.[17]

Urban-Wildland Interface. The urban-wildland interface has been defined as the area "where combustible homes meet combustible vegetation."[18] This interface includes a wide variety of situations, ranging from individual houses and isolated structures to subdivisions and rural communities surrounded by wildlands. While this situation has always existed to some extent, subdivisions in wildland settings appear to have grown significantly over the past two decades. However, there are no standard definitions or measures of the interface, making it difficult to quantify the magnitude of the situation, or how much and where it has grown.

One particular aspect is that the growth of the interface has also increased the number of roads into wildland settings. Increased road access has both benefits and costs for protecting resources and people from wildfires. Increased human access generally increases the frequency of wildfire ignitions — 88% of the fires from 1988-1997 were caused by humans, with only 12% caused by lightning. While human-caused fires can be catastrophic, they are typically in accessible areas, and thus can often be controlled more quickly; for example, only 48% of the acres burned from 1988-1997 were in human-caused fires. If the roads are mapped and marked (so that fire crews can find their way) and are sufficiently wide for fire-fighting equipment, increased access can allow for faster control efforts, and probably reduces the risk of a structure being burned. However, poorly marked or unmarked, narrow, twisting roads exist in some wildland subdivisions, in part because homeowners want to minimize non-local traffic in and through the subdivision.[19] In such situations, the poor access may exacerbate the wildfire threat to homeowners.

---

[17] For example, see R. Neil Sampson, David L. Adams, Stanley S. Hamilton, Stephen P. Mealey, Robert Steele, and Dave Van De Graaff, "Assessing Forest Ecosystem Health in the Inland West: Overview," *Assessing Forest Ecosystem Health in the Inland West*, pp. 3-10.

[18] *Wildfire Strikes Home! The Report of the National Wildland/Urban Fire Protection Conference*, sponsored by the USDA, Forest Service; the National Fire Protection Association; and the FEMA, U.S. Fire Administration (Jan. 1987), p. 2.

[19] Anecdotes have described this problem in particular situations, but the extent and severity of the problem are uncertain.

Forest and Rangeland Health. The increasing extent of wildfires in the national forests in the past two decades has been widely attributed to deteriorating forest and rangeland health, resulting in at least some cases directly from federal forest and rangeland management practices. Wildland ecological health in many areas, particularly in the intermountain west (the Rocky Mountains through the Cascades and Sierra Nevadas), has been altered by various activities. Beginning more than a century ago, livestock overgrazing affected ecosystems by reducing the amount of grass and changing the plant species mix in forests and on rangelands. This reduced the fine fuels that carried surface fires (allowed them to spread), encouraged trees to invade traditionally open grasslands and meadows, and allowed non-native species to become established, all of which experts believe induce less frequent but more intense wildfires.[20] In addition, first to support mining and railroad development and later to support the wood products industry, logging of the large pines that characterized many areas has led to regeneration of smaller, less fire-resistant trees in some areas.[21] In mixed conifer stands, the regeneration has been dominated by Douglas-fir and the true firs, which are more susceptible than the pines to drought and insect and disease infestations as well as being less commercially desirable. Roads that provide access for logging, grazing, and recreation have also been implicated in spreading non-native species.[22]

It is widely recognized that fire suppression has greatly exacerbated these ecological problems. Most grass ecosystems and many forest ecosystems (such as the southern yellow pines and Ponderosa (western yellow) pine) evolved with frequent surface fires that burned grasses, pine needles, and other small fuels every 5 to 25 years, depending on the site and plant species.[23] Surface fires reduce fuel loads by

---

[20] W.W. Covington and M.M. Moore, "Postsettlement Changes in Natural Fire Regimes and Forest Structure: Ecological Restoration of Old-Growth Ponderosa Pine Forests," *Assessing Forest Ecosystem Health in the Inland West*, pp. 153-181.

Some allege that grazing still contributes to these unnatural situations, but it is unclear whether today's lower grazing levels are still a problem.

[21] Jay O'Laughlin, "Assessing Forest Health Conditions in Idaho with Forest Inventory Data," *Assessing Forest Ecosystem Health in the Inland West*, pp. 221-247.

[22] Federal Interagency Committee for the Management of Noxious and Exotic Weeds, *Invasive Plants: Changing the Landscape of America* (Washington, DC: 1998), pp. 23-24.

[23] Not all forest ecosystems evolved with frequent surface fires. Some areas, such as near the Pacific Coast and in the east, have relatively high humidity (with moderate temperatures) during much of the year, and woody materials and other plant debris rot quickly, thus eliminating the fine fuels that carry surface fires. Other tree species — *e.g.*, jack pine in the Lake States and Canada, giant sequoia in the Sierra Nevada, lodgepole pine in much of the west, and aspen nearly everywhere — evolved to regenerate following intense fires that kill all or most of the trees in the stand (called stand replacement fires). The conifers developed "serotinous" cones, that open and disperse seeds only after exposure to intense heat. Aspen regenerates primarily from root suckers that can survive the most intense wildfires. In these ecosystems, stand replacement fires at intervals of less than 100 years (for aspen) to more than 1,000 years (for giant sequoia) have been part of the natural cycle. A few ecosystems (such as giant sequoia) experienced both frequent surface fires and periodic stand replacement fires. For more information, see: T.T. Kozlowski and C.E. Ahlgren, eds., *Fire and*

(continued...)

mineralizing biomass in typically dry areas that may take decades for the biomass to rot, and thus provide a flush of nutrients to stimulate new plant growth. Historically, many surface fires were started by lightning, although Native Americans used fires to clear grasslands of encroaching trees, to stimulate seed production, and to reduce undergrowth and small trees that provide habitat for undesirable insects (*e.g.*, ticks and chiggers) and inhibit mobility and visibility when hunting.[24]

Eliminating frequent surface fires through effective fire suppression and other activities has led to unnaturally high fuel loads, by historic standards, in many western and southern ecosystems. The nature of this fuels problem varies, depending on the ecosystem and the history of the site. In rangelands, the problem is likely to be invasion by non-native species (*e.g.*, cheat grass or spotted knapweed) or by shrubs and small trees (*e.g.*, salt cedar or juniper). In some areas (*e.g.*, western hemlock, Douglas-fir, and larch stands), the problem may be widespread dead trees due to drought and/or insect or disease infestations. In others (*e.g.*, southern pines and western mixed conifers), the problem may be dense undergrowth of different plant species (*e.g.*, palmetto in the south and firs in the west). In still others (*e.g.*, Ponderosa pine stands) the problem is more likely to be stand stagnation — too many little green trees, because intra-species competition rarely kills Ponderosa pines.

The historically unnatural fuel loads in forest ecosystems can lead to stand replacement fires in ecosystems adapted to frequent surface fires ("frequent-fire ecosystems"). In particular, small trees and dense undergrowth can create a "fuel ladder" that allows surface fires to spread upward into the forest canopy. In these ecosystems, the frequent surface fires had historically eliminated much of the understory before it got large enough to create fuel ladders. Stand replacement fires in frequent-fire ecosystems could regenerate new versions of the original surface-fire adapted ecosystems, but there has been concern that some of these ecosystems could be replaced with a different forest that doesn't contain the big old Ponderosa pines, giant sequoias, and other traditional species of these areas.

Some uncertainty exists over the extent of forest and rangeland health problems and how various management practices can exacerbate or alleviate the problems. Despite a decade of debate on forest health, much of the evidence on the nature and extent of the problems is still anecdotal, although quantitative assessments are being developed. Some observers have suggested that the problem is high timber mortality on western federal lands. The published forest inventory data[25] show that timber mortality has risen on national forest lands in the west over the past two decades, but timber mortality has risen for most landowners and in most regions. Per acre and as

---

[23] (...continued)
Ecosystems (New York, NY: Academic Press, 1974).

[24] James K. Agee, *Fire Ecology of Pacific Northwest Forests* (Washington, DC: Island Press, 1993), pp. 54-57. Hereafter referred to as Agee, *Fire Ecology of PNW Forests*.

[25] U.S. Dept. of Agriculture, Forest Service, *Forest Statistics of the United States, 1997*, Draft – 10/15/99 (Washington, DC) at: [http://www.srsfia.usfs.msstate.edu/wo/RPA_TABLES.PDF], June 14, 2000.

a percent of inventory, western federal timber mortality has not risen faster or farther than timber mortality in other regions or in other landownership classes.[26]

Weak comparative evidence of excessive western federal timber mortality does not necessarily mean that there is no forest health problem on federal lands. The Forest Service inventories lands relatively infrequently, with a goal of inventorying all forestlands once a decade. Thus, a sudden rise in timber mortality might not be reflected in published inventory data until several years later. The data also might not reflect other forest health concerns. For example, shifting species composition in mixed conifer stands could not be seen, because the inventory data on species composition do not distinguish among stand types. Stand stagnation (too many small green trees) and other biomass fuel buildups are not shown, because timber volume (*i.e.*, fuel load) data only include trees of at least $5^1/_2$ inches in diameter. Similarly, a build-up of undergrowth fuels is not shown, because non-tree species are not reported in many areas. Therefore, there could be forest health problems, as suggested by volumes of anecdotes and widespread professional agreement, despite the weak evidence in the published inventory data.

In 1995, the Forest Service estimated that 39 million acres in the National Forest System (NFS) were at high risk of catastrophic wildfire, and thus needed some form of fuel treatment.[27] This encompasses more than 20% of NFS lands nationwide, and about 30% of NFS lands in the interior west.

More recently, the Forest Service has classified lands by historical fire regime (fire frequency and severity) and condition (risk of fire-caused loss of key ecosystem elements).[28] The agency estimated that 29 million National Forest System acres of frequent-fire forest ecosystems (37%) were at high risk and another 31 million acres (40%) were at moderate risk of significant losses without treatment. More than half the high-risk lands are in California, Oregon, and Washington, while more than half the moderate-risk lands are in the central and southern Rockies. (Nearly 72% of the low-risk frequent-fire forest ecosystems are in the South.) The agency similarly examined non-Forest Service lands (other federal lands, non-federal government lands, and industry and non-industrial private lands), and found 53 million acres of frequent-fire forest ecosystems (17%) at high risk and another 119 million acres (37%) at moderate risk of significant losses without treatment.[29]

Rangelands face a similar situation. Some observers have concluded that rangelands are currently in better condition than at any time since the 1930s, when the

---

[26] CRS calculations from data in *Forest Statistics of the United States, 1997*.

[27] Enoch Bell, David Cleaves, Harry Croft, Susan Husari, Ervin Schuster, and Dennis Truesdale, *Fire Economics Assessment Report*, unpublished report submitted to Fire and Aviation Management, USDA Forest Service, on Sept. 1, 1995.

[28] U.S. Dept. of Agriculture, Forest Service, Fire Sciences Lab and Fire Modeling Institute, *Historic Fire Regimes by Current Condition Class* (Missoula, MT: Feb. 15, 2000), at [http://www. fs.fed.us/fire/fuelman/data_tables.pdf], Oct. 6, 2000. Hereafter referred to as USDA Forest Service, *Historic Fire Regimes by Current Condition Class*.

[29] The report does not provide geographic information on non-Forest Service lands.

Taylor Grazing Act was enacted, and that they continue to improve.[30] Others contend that the condition of rangelands is less clear:

> Although most observers agree that rangeland degradation was widespread on overgrazed and drought-plagued rangelands at the turn of the century, the present state of health of U.S. rangelands is a matter of sharp debate.
>
> ...
>
> The lack of a national-level inventorying and monitoring system is a major impediment to the nation's ability to assess the health of federal and nonfederal rangelands ... [31]

The Forest Service has estimated that 10 million acres of the National Forest System grasslands and other non-forest frequent-fire ecosystems (59%) were at moderate risk of significant losses without fuel treatment; 97% of these lands were in the central and southern Rockies. Of the non-forest frequent-fire ecosystems on non-Forest Service lands, 8 million acres (2%) were estimated at high risk and another 153 million acres (41%) were at moderate risk of significant losses.[32]

Fuel Management

Fuel management is a collection of activities intended to reduce the threat of significant damages by wildfires. The Forest Service began its fuel management program in the 1960s. By the late 1970s, earlier agency policies of aggressive suppression of all wildfires had been modified, in recognition of the enormous cost of organizing to achieve this goal and of the ecological benefits that can result from some fires. These understandings have in particular led to an expanded prescribed burning program.

The relatively recent recognition of historically unnatural fuel loads from dead trees, dense understories of trees and other vegetation, and non-native species has spurred a renewed interest in fuel management activities. The presumption is that lower fuel loads and a lack of fuel ladders will reduce the extent of wildfires, the damages they cause, and the cost of controlling them. Substantial anecdotal evidence supports this belief. However, research in southern California chaparral has shown that fuel treatments had no measurable effect on the extent of wildfires driven through the brush by high winds.[33] The authors are careful to note that these results might not be applicable to other wildfires, although it should also be recognized that many severe wildfires (*e.g.*, the Cerro Grande fire near Los Alamos, NM) are substantially

---

[30] Council for Agricultural Science and Technology, *Grazing on Public Lands*, Task Force Report No. 129 (Ames, IA: Dec. 1996).

[31] National Research Council, Board on Agriculture, Committee on Rangeland Classifica-tion, *Rangeland Health: New Methods to Classify, Inventory, and Monitor Rangelands* (Washington, DC: National Academy Press, 1994), pp. 1, 12.

[32] USDA Forest Service, *Historic Fire Regimes by Current Condition Class*.

[33] Jon E. Keeley, C.J. Fotheringham, and Marco Morais, "Reexamining Fire Suppression Impacts on Brushland Fire Regimes," *Science*, v. 284 (June 11, 1999): 1829-1832.

wind-driven. The extent to which fuel management might reduce the extent, damage, and control costs of wildfires has not been precisely quantified.

Before examining fuel management tools, a brief description of fuels may be helpful.[34] As mentioned above, wildfires are typically spread by fine fuels[35] — pine needles, leaves, grass, *etc*. — both on the surface and in the tree crowns (in a stand-replacement crown fire); these are known as 1-hour time lag fuels, because they dry out (lose two-thirds of their moisture content) in about an hour. Small fuels, known as 10-hour time lag fuels, are woody twigs and branches, up to1 inch in diameter; these fuels also help spread wildfires because they ignite and burn quickly. Larger fuels — particularly the 1000-hour time lag fuels (more than 3 inches in diameter) — may contribute to the intensity and thus to the damage fires cause, but contribute little to the rate of spread, because they are slow to ignite. One researcher noted that only 5% of large tree stems and 10% of tree branches were consumed in high intensity fires, while 100% of the foliage and 75% of the understory vegetation was consumed.[36] Finally, "ladders" of fine and small fuels between the surface and the tree crowns can spread surface fires into the canopy, thus turning a surface fire into a stand-replacement fire.

Prescribed Burning. Fire has been used as a tool for a long time.[37] Native Americans lit fires for various purposes, such as to reduce brush and stimulate grass growth. Settlers used fires to clear woody debris in creating agricultural fields. In forestry, in large part because of severe wildfires in logging debris in the Northeast and Lake States more than a century ago, fire has been used to eliminate logging debris, by burning brush piles and by broadcast burning harvested sites to prepare them for reforestation.[38]

Prescribed burning has been used increasingly over the past 40 years to reduce fuel loads on federal lands. In FY1998 and FY1999, Forest Service prescribed burning totaled 1.4 million acres each year; as recently as FY1995, the prescribed burning acreage was less than 500,000 acres annually. (Comparable data on BLM

---

[34] See: Arthur A. Brown and Kenneth P. Davis, "Chapter 4: Forest Fuels," *Forest Fire Control and Use* (New York, NY: McGraw-Hill Book Co., 1973), pp. 79-110.

[35] Robert E. Martin and Arthur P. Brackebusch, "Fire Hazard and Conflagration Prevention," *Environmental Effects of Forest Residues Management in the Pacific Northwest: A State-of-Knowledge Compendium* (Owen P. Cramer, ed.), Gen. Tech. Rept. PNW-24 (Portland, OR: USDA Forest Service, 1974).

[36] Agee, *Fire Ecology of PNW Forests*, p. 42. It is also important to recognize that the percentage of biomass in 1-hour, 10-hour, 100-hour, and 1000-hour fuels depends largely on tree diameter, with the *percentage* in large fuels increasing as diameter increases.

[37] Historical evidence indicates that current levels of burning through prescribed burns and wildfires represent levels perhaps 10–30% of pre-industrial burning levels from natural and Native-set fires. See: Bill Leenhouts, "Assessment of Biomass Burning in the Conterminous United States," *Conservation Ecology* 2(1), 1998, at [http://www.consecol.org/vol2/iss1/art1]. (Hereafter referred to as Leenhouts, "Assessment of Biomass Burning.")

[38] David M. Smith, *The Practice of Silviculture,* 7th ed. (New York, NY: John Wiley & Sons, 1962), pp. 317-321.

prescribed burning are not published.) However, nearly two-thirds of prescribed burning is in the Forest Service's Southern Region, and thus prescribed burning in the intermountain west is still at relatively modest levels.

Typically, areas to be burned are identified in agency plans, and fire lines (essentially dirt paths) are created around the perimeter. The fires are lit when the weather conditions permit (*i.e.*, when the burning "prescription" is fulfilled) — when the humidity is low enough to get the fuels to burn, but not when the humidity is so low or wind speed so high that the burning cannot be contained. (This, of course, presumes accurate knowledge of existing and expected weather and wind conditions, as well as sufficient fire control crews with adequate training on the site.) When the fire reaches the perimeter limits, the crews "mop up" the burn area to assure that no hot embers remain to start a wildfire after everyone is gone.

Prescribed burning is widely used for fuel management because it reduces biomass (the fuels) to ashes (minerals). It is particularly effective at reducing the smaller fuels, especially in the arid west where deterioration by decomposers (insects, fungi, *etc.*) is often very slow. In fact, it is the only human treatment that directly reduces the fine and small fuels that carry fires. However, prescribed fires are not particularly effective at reducing larger-diameter fuels or thinning stands to desired densities and diameters.[39]

There are several limitations in using prescribed fire. The most obvious is that prescribed fires can be risky — fire is not a "controlled tool;" rather, it is a self-sustaining chemical reaction that, once ignited, continues until the fuel supply is exhausted.[40] Fire control (for both wildfires and prescribed fires) thus focuses on removing the continuous fuel supply by creating a fire line dug down to mineral soil. The line must be wide enough to prevent the spread of fire by radiation (*i.e.*, the heat from the flames must decline sufficiently across the space that the biomass outside the fire line does not reach combustion temperature, about 550^{o} F.) Minor variations in wind and in fuel loads adjacent to the fire line can lead to fires jumping the fire line, causing the fire to escape from control. Winds can also lift burning embers across fire lines, causing spot fires outside the fire line which can grow into major wildfires under certain conditions (such as occurred near Los Alamos, NM, in May 2000). Even when general weather conditions — temperature, humidity, and especially winds — are within the limits identified for prescribed fires, localized variations in the site (*e.g.*, slope, aspect,[41] and fuel load) and in weather (*e.g.*, humidity and wind) can be problematic. Thus, prescribed fires inherently carry some degree of risk, especially

---

[39] See Arthur A. Brown and Kenneth P. Davis, *Forest Fire Control and Use*, 2nd Ed. (New York, NY: McGraw-Hill Book Co., 1973), pp. 560-572.

[40] Fire can also be halted by eliminating the supply of oxygen, as occurs when fire retardant ("slurry") is spread on forest fires from airplanes ("slurry bombers"). However, reducing oxygen supply usually can only occur in a limited area, because of the cost to spread the fire retardant.

[41] Aspect is the term used for the direction which the slope is facing; in the northern hemisphere, south-facing slopes (south aspects) get more radiant energy from the sun than north aspects, and thus are inherently warmer and drier, and hence are at greater risk of more intense wildfires.

in ecosystems adapted to stand-replacement fires and in areas where the understory and undergrowth have created fuel ladders.

Another concern is that prescribed fires generate substantial quantities of smoke — air pollution with high concentrations of carbon monoxide, hydrocarbons, and especially particulates that degrade visibility. Some assert that prescribed fires merely shift the timing of air pollution from wildfires. Others note that smoke from pre-industrial wildland fires was at least three times more than from current levels from prescribed burning and wildfire.[42] The Clean Air Act requires regulations to preserve air quality, and regulations governing particulate emissions and regional haze have been of concern to land managers who want to expand prescribed burning programs. Proposed legislation (H.R. 236, 106th Congress) would have exempted Forest Service prescribed burning from air quality regulations for 10 years, to demonstrate that an aggressive prescribed burning program will reduce total particulate emissions from prescribed burning and wildfires. However, owners and operators of other particulate emitters (*e.g.*, diesel vehicles and fossil fuel power plants) generally object to such exemptions, arguing that their emissions would likely be regulated more stringently, even though wildland fires are one of the largest sources of particulates.[43]

Salvage and Other Timber Harvesting.[44] Another tool commonly proposed for fuel treatment is traditional timber harvesting, including salvaging dead and dying trees before they rot or succumb to disease, commercially thinning dense stands, *etc.* In areas where the forest health problems include large numbers of dead and dying trees, a shift toward an inappropriate or undesirable tree species mix, or a dense understory of commercially usable trees, timber harvesting can be used to improve forest health and remove woody biomass from the forest. Nonetheless, some interest groups object to using salvage and other timber harvests to improve forest health.[45] Currently, timber generally may only be removed from federal forests under timber sale contracts. Because the contracts have to be bought, they generally must include the removal of merchantable trees, which some argue could compromise reducing fuel loads or achieving desired forest conditions. Timber harvests remove heavy fuels that contribute to fire intensity, and can break fuel ladders, but the remaining limbs and tree tops ("slash") substantially increase fuel loads on the ground, at least in the short term, until the slash is removed or disposed of through burning, and get in the way of

---

[42] Leenhouts, "Assessment of Biomass Burning."

[43] See, for example, U.S. Congress, House Committee on Resources, *Hearing on the Use of Fire as a Management Tool and Its Risks and Benefits for Forest Health and Air Quality*, Hearing on Sept. 30, 1997 (Washington, DC: U.S. Govt. Print. Off., 1997), Serial No. 105-45, 141 p.

[44] Timber harvesting has a variety of proponents and opponents for reasons beyond fuel management. Some interests object to timber harvesting on a variety of grounds, including the poor financial performance of Forest Service timber sales and the degradation of water quality and certain wildlife habitats that follows some timber harvesting. Others defend timber sales for the employment and income provided in isolated, resource-dependent communities as well as for increasing water yields and available habitat for other wildlife species. The arguments supporting and opposing timber harvests generally have often been raised in discussions about fire protection.

[45] See CRS Report 95-364 ENR, *Salvage Timber Sales and Forest Health*.

controlling future fires. "Slash is a fire hazard mainly because it represents an unusually large volume of fuel distributed in such a way that it is a dangerous impediment in the construction of fire lines" (*i.e.*, in suppressing fires).[46]

If logging slash is treated, as has long been a standard practice following timber harvesting, the increased fire danger from higher fuel loads that follow timber harvesting can be alleviated. Various slash treatments are used to reduce the fire hazard, including lop-and-scatter, pile-and-burn, and chipping.[47] Lop-and-scatter consists of cutting the tops and limbs so that they lie close to the ground, thereby hastening decomposition and possibly preparing the material for broadcast burning (essentially, prescribed burning of the timber harvest site). Pile-and-burn is exactly that, piling the slash (by hand or more typically by bulldozer) and burning the piles when conditions are appropriate (dry enough, but not too dry, and with little or no wind). Chipping is feeding the slash through a chipper, a machine that reduces the slash to particles about the size of a silver dollar. and scattering the chips to allow them to decompose. Thorough slash disposal can significantly reduce fuel loads, particularly on sites with large amounts of noncommercial biomass (*e.g.*, undergrowth and unusable tree species) and if combined with some type of prescribed burning. However, data on the actual extent of various slash disposal methods and on needed slash disposal appear to be available only for a few areas.

Other Fuel Management Tools. The other principal tool for fuel management is mechanical treatment of the fuels.[48] One common method is precommercial thinning — cutting down many of the small (less than $4^1/_2$-inch diameter) trees that have little or no current market value. Other treatments include pruning and mechanical release of seedlings (principally by cutting down or mowing competing vegetation). Mechanical treatments are generally most effective at eliminating fuel ladders, but as with timber cutting, do not reduce the fine fuels on the sites without additional treatment (*e.g.*, without prescribed burning). Thus, mechanical fuel treatments alone tend to increase fine fuels on the ground in the short term.

Some critics have suggested using traditionally unused biomass, such as slash and thinning debris, in new industrial ways, such as using the wood for paper or particleboard or burning the biomass to generate electricity.[49] Research has indicated that harvesting small diameter timber may be economically feasible.[50] However, collecting and hauling chipped slash and other biomass for products or energy have

---

[46] Smith, *The Practice of Silviculture*, p. 312.

[47] Smith, *The Practice of Silviculture*, pp. 312-317.

[48] Chemical treatments (herbicides) are also used in forestry, mostly on unwanted vegetation, but they are not included here as a fuel treatment tool, because they are used primarily to kill live biomass rather than to reduce biomass levels on a site. Biological treatments (*e.g.*, using goats to eat the small diameter material) are feasible, but are rarely used.

[49] Robert Nelson, Univ. of Maryland, cited in: Rocky Barker, "Wildfires Creating Odd Bedfellows," *The Idaho Statesman* (Aug. 14, 2000): 1A, 7A.

[50] Henry Spelter, Rong Wang, and Peter Ince, *Economic Feasibility of Products From Inland West Small Diameter Timber*, FPL-GTR-92 (Madison, WI: USDA Forest Service, May 1996), 17 p.

apparently not been seen as economically viable thus far, given that such woody materials are currently left on the harvest sites.[51]

Another possibility is to significantly change the traditional approach to timber sales and removal. Stewardship contracting, in various forms, has been and is being tested in various national forests.[52] This approach typically takes one of two forms. Sometimes, the stewardship contract (payment and performance) is based on the condition of the stand after the treatment, rather than on the volume harvested; this is also known as end-results contracting. A variation on this theme, that has been discussed sporadically for more than 30 years, is to separate the forest treatment from the sale of the wood.[53] The other common form is essentially the use of commercial timber to pay for other treatments; that is, the contractor removes the specified commercial timber and is required to perform other activities, such as precommercial thinning of a specified area. Some observers believe that such alternative approaches could lead to development of an industry based on small diameter wood, and thus significantly reduce the cost of fuel management.[54]

Fuel Management Funding. Direct federal funding for prescribed burning and other fuel treatments (typically titled "hazardous fuels" or "fuel management") has, since FY1996, been in Forest Service and BLM appropriations for "Wildfire Operations." For FY1998 and FY1999, the Forest Service reported expenditures of $50 million and $65 million, respectively. (Comparable data on BLM fuel treatment funding are not published.) The Forest Service fuel treatment expenditures are four times the expenditures just 5 years earlier. The average Forest Service cost of fuel treatment was $34 per acre in FY1998 and $46 per acre in FY1999. However, these average treatment costs are relatively low largely due to the low cost of prescribed burning in the Southern Region, which accounts for the majority of Forest Service fuel treatment acreage; in other areas, with substantially higher fuel loads, costs can range as high as $1,500 per acre.[55]

Appropriations for agency wildfire operations include the direct funding of fuel treatments. However, funds appropriated for other purposes can also provide fuel treatment benefits. As noted above, salvage and other commercial timber sales can be used to reduce fuels in some circumstances. Forest Service funding for timber sale

---

[51] Research documenting the economics of slash use (in contrast to small diameter trees) is lacking. However, this seems a reasonable conclusion, given that the slash is left on the site by the timber purchaser (who could remove and sell the material) and that the agencies and various interest groups have been trying to develop alternatives to the traditional contracts (*e.g.*, stewardship contracts) to remove thinning slash and other biomass fuels.

[52] See: V. Alaric Sample and Anthony A. DiNicola, *Land Stewardship Contracts: Issues and Opportunities* (Washington, DC: Forest Policy Center, Dec. 6, 1994), 25 p.

[53] See CRS Report 95-1077 ENR, *Forest Service Timber Sale Practices and Procedures: Analysis of Alternative Systems*.

[54] Personal communication with Robert H. Nelson, Professor of Public Policy, Univ. of Maryland, College Park, MD, on Nov. 13, 2000.

[55] Personal communication with Denny Truesdale, Assistant Director of Fire Operations, Fire and Aviation Management, USDA Forest Service, Washington, DC, on July 28, 2000.

planning, preparation, and administration, from annual appropriations plus the salvage sale and timber pipeline special funds, has been relatively stable over the past 5 years (about $365 million annually). BLM timber sale funding has similarly been relatively stable (at nearly $35 million). The extent to which timber sales provide fuel treatment benefits, however, depends substantially on the sale design and the subsequent slash disposal.

The Forest Service and BLM also have appropriations for other activities that can reduce fuel loads. Various accounts fund reforestation, stand improvement, resource mitigation, and other activities. Reforestation and resource mitigation efforts generally do not reduce fuels, but stand improvement includes precommercial thinning, pruning, and other mechanical vegetative treatments included in "other fuel management tools" described above, as well as herbicide use and other treatments that do not reduce fuels.

The Forest Service has four accounts that fund stand improvement and other activities that can reduce fuel loads:

- Annual appropriations for forest vegetation management (stand improvement and reforestation). The annual appropriations have averaged $58 million since FY1996; funds for reforestation are not distinguished from funds for stand improvement.

- Brush disposal, a permanent special account to treat logging slash (*i.e.*, for fuel treatment). The program level has averaged $21 million annually since FY1996.

- The Reforestation Trust Fund, a permanent account to address the backlog of needed reforestation and stand improvement. Funding is limited to $30 million annually, with no distinction between reforestation and stand improvement funding.

- The Knutson-Vandenberg (K-V) Fund, a permanent trust fund for reforestation, stand improvement, and other resource mitigation and enhancement in timber sale areas. The program level has averaged $162 million annually since FY1996; for FY1994– FY1997 (the last year such information was available), 15% of the funds were spent on stand improvement.

The BLM also receives money, in annual appropriations and the permanent Forest Ecosystem Health Restoration Fund, which funds other fuel treatments, but these funds are not distinguished from timber sale funds in BLM appropriations.

In summary, the Forest Service and BLM receive funds for fuel treatment directly under fire operations appropriations, and indirectly for various programs that reduce fuels in the course of achieving other purposes. However, the total funding available for fuel treatment is unclear, because direct funding is not regularly distinguished from other fire operations funding and indirect funding does not distinguish between treatments that reduce fuel loads and treatments that do not.

Fire Control

Wildfire Management Funding. Over the past 8 fiscal years (FY1994–FY2001), the Forest Service has received 70% of the $10.5 billion appropriated by Congress for wildfire preparedness, fire operations, and emergency supplemental funds. (See table 2.) The BLM coordinates wildfire management funding for the land managing agencies of the Interior Department (BLM, the National Park Service, U.S. Fish and Wildlife Service, and Bureau of Indian Affairs), and has received about 60% of the Interior Department funding for wildfire activities.

Annual appropriations for wildfire management on federal lands (including the fuel treatment discussed above) are provided in two lines: wildfire preparedness and fire operations. Preparedness includes planning, preventing fires and educating the public, detecting fires (*e.g.*, from lookouts and aerial surveillance), acquiring the needed equipment, and hiring, training, and paying the fire organization personnel. Appropriations for these tasks have averaged $498 million annually over the past 8 years.

Appropriations for fire operations cover suppression costs (above the regular fire organization salaries), and in recent years, hazardous fuels reduction. Total appropriations have averaged $348

Table 2. Federal Wildfire Management Funding, FY1994-FY2001
(in millions of dollars)

Table 2a. Forest Service

FY	Fire Preparedness	Wildfire Operations	Supplemental	Total
2001	$612.5	$226.6	$1,045.3	$1,884.4
2000	$408.8	$209.2	$380.0	$998.0
1999	$374.8	$245.6	$202.0	$822.4
1998	$319.2	$265.4	$252.0	$836.6
1997	$319.3	$210.7	$300.0	$830.0
1996	$295.3	$90.2	$100.0	$485.5
1995	$160.0	$225.6	$200.0	$585.6
1994	$186.1	$378.2	$188.0	$752.3

Sources: Forest Service annual budget justifications, and H.Rept. 106-914, *Conference Report to Accompany H.R. 4578, Making Appropriations for the Department of the Interior and Related Agencies for FY2001.*

Table 2b. Department of the Interior

FY	Fire Preparedness	Wildfire Operations	Supplemental	Total
2001	$315.4	$110.1	$553.7	$979.2
2000	$175.8	$115.1	$300.0	$590.9
1999	$156.9	$129.9	$50.0	$336.8
1998	$156.7	$126.0	$ 0.0	$282.7
1997	$144.2	$107.7	$ 0.0	$251.9
1996	$130.7	$104.9	$51.2	$286.8
1995	$114.8	$121.0	$ 0.0	$235.8
1994	$117.1	$116.7	$ 0.0	$233.8

Sources: BLM annual budget justifications and H.Rept. 106-914, *Conference Report to Accompany H.R. 4578, Making Appropriations for the Department of the* million per year over the past 8 years. The Forest Service (in recent years) and BLM (in FY2001) have also received contingency appropriations, which are only available after appropriations have been ex-hausted and the President has declared that an emergency exists. In addition, agencies have the authority to borrow from their unobligated funds (typically from their permanently appropriated accounts) to cover the suppression costs. Borrowed funds are generally repaid in subsequent emergency supplemental appropriations. The total contingency and emergency appropriations have averaged $452 million annually over the past 8 years, including $1.6 billion for FY2001. (In addition to the emergency supplemental funds for firefighting, the FY2001 Military Construction Appropriations Act (P.L. 106-246) enacted the Cerro Grande Fire Assistance Act, providing $661 million in disaster relief for homes burned in Los Alamos, NM, in May 2000.)

The cost of federal fire management is high, and seems to be rising, although the FY2001 appropriations amount could be a temporary phenomenon. One critic has observed that the emergency supplemental appropriation process is viewed by agency employees as "free money" and has suggested that this has led to wasting federal firefighting funds, which he calls "fire boondoggles."[56]

Fire Control Policies. Federal fire management policy was revised in 1995, after severe fires in 1994 and the deaths of several firefighters. Current federal wildfire policy is to protect human life first, and then to protect property and natural resources from wildfires.[57] This policy includes viewing fire as a natural process in ecosystems where and when fires can be allowed to burn with reasonable safety. But when wildfires threaten life, property, and resources, the agencies act to suppress those fires.

Despite control efforts, some wildfires clearly become the kind of conflagration (stand replacement fire or crown fire) that gets media attention. As noted above, relatively few wildfires become conflagrations; it is unknown how many wildfires might become conflagrations in the absence of fire suppression.

A wide array of factors determine whether a wildfire will blow up into a conflagration. Some factors are inherent in the site: slope (fires burn faster up steep slopes); aspect (south-facing slopes are warmer and drier than north-facing slopes); and ecology (some plant species are adapted to periodic stand replacement fires). Other factors are transient, changing over time (from hours to years): moisture levels (current and recent humidity; long-term drought); wind (ranging from gentle breezes to gale force winds in some thunderstorms); and fuel load and spatial distribution (more biomass and fuel ladders make conflagrations more likely).

Whether a wildfire becomes a conflagration can also be influenced by land management practices and policies. Historic grazing and logging practices (by

---

[56] Robert H. Nelson, *A Burning Issue: A Case for Abolishing the U.S. Forest Service* (Lanham, MD: Rowman & Littlefield Publishers, Inc., 2000), pp. 15-43. Hereafter referred to as Nelson, *A Burning Issue*.

[57] U.S. Dept. of the Interior and Dept. of Agriculture, *Federal Wildland Fire Management Policy and Program Review: Final Report* (Washington, DC: Dec. 18, 1995), 45 p.

encouraging growth of many small trees), and especially fire suppression over the past century, appear to have contributed to unprecedented fuel loads in many areas. Fuel treatments can reduce fuel loads, and thus probably reduce the likelihood and severity of catastrophic wildfires; however, some policies and decisions may restrict fuel treatment — *e.g.*, air quality protection that limits prescribed burning or wilderness designation that prevents mechanical fuel reduction. Other practices and policies are more problematic. For example, timber harvesting can reduce fuel loads, if accompanied by effective slash disposal, but data on the extent and need for slash disposal are not available. Similarly, road construction into previously unroaded areas can increase access, and thus facilitate fuel treatment and fire suppression; conversely, roadless area protection and even road obliteration[58] can impede fuel treatment, but may reduce the likelihood of a wildfire starting, because human-caused wildfires are more common along roads.

Once a wildfire becomes a conflagration, halting its spread is exceedingly difficult, if not impossible. Dropping water from helicopters or fire retardant ("slurry") from airplanes ("slurry bombers") can occasionally return a crown fire to the surface, where firefighters can control it, and can be used to protect individually valuable sites (*e.g.*, structures). Setting backfires — lighting fires from a fire line to burn toward the conflagration — can eliminate the fuel ahead of the conflagration, thus halting its spread, but can be dangerous, because the backfire sometimes becomes part of the conflagration. Most firefighters recognize the futility of some firefighting efforts, acknowledging that some conflagrations will burn until they run out of fuel (move into an ecosystem or an area where the fuel is insufficient to support the conflagration) or the weather changes (the wind dies or it begins raining or snowing).

Wildfire Effects

Wildfires cause damages, killing some plants and occasionally animals.[59] Firefighters have been injured or killed, and structures can be damaged or destroyed. The loss of plants can heighten the risk of significant erosion and landslides. Some observers have reported soil "glassification," where the silica in the soils has been melted and fused, forming an impermeable layer in the soil; however, research has yet to document the extent and frequency of this condition, and the soil and burning conditions under which it occurs.

Damages are almost certainly greater from stand replacement fires than from surface fires. Stand replacement fires burn more fuel, and thus burn hotter (more intensely) than surface fires. Stand replacement fires kill many plants in the burned area, making natural recovery slower and increasing the potential for erosion and landslides. Also, because they burn hotter, stand replacement fires are generally more difficult to suppress, raising risks to firefighters and to structures. Finally, stand

---

[58] Road obliteration is closing the road and returning the roadbed to near-natural conditions.

[59] For a thorough discussion of these effects, see: L. Jack Lyon, Mark H. Huff, Robert G. Hooper, Edmund S. Telfer, David Scott Schreiner, and Jane Kapler Smith, *Wildland Fire in Ecosystems: Effects of Fire on Fauna*, Gen. Tech. Rept. RMRS-GTR-42-vol. 1 (Ogden, UT: USDA Forest Service, Jan. 2000).

replacement fires generate substantial quantities of smoke, which can directly affect people's health and well-being.

Wildfires, especially conflagrations, can also have significant local economic effects, both short-term and long-term, with larger fires generally having greater and longer-term impacts. Wildfires, and even extreme fire danger, may directly curtail recreation and tourism in and near the fires. Extensive fire damage to trees can significantly alter the timber supply, both through a short-term glut from timber salvage and a longer-term decline while the trees regrow. Water supplies can be degraded by post-fire erosion and stream sedimentation. If an area's aesthetics are impaired, local property values can decline. However, federal fire management includes substantial expenditures, and fire-fighting jobs are considered financially desirable in many areas.[60]

Ecological damages from fires are more difficult to determine, and may well be overstated, for several reasons. First, burned areas look devastated immediately following the fire, even when recovery is likely; for example, conifers with as much as 60% of the crown scorched are likely to survive.[61] Second, even the most intense stand replacement fires do not burn 100% of the biomass within the burn's perimeter — fires are patchy. For example, in the 1988 fires in Yellowstone, nearly 30% of the area within the fire perimeters was unburned, and another 15–20% burned lightly (a surface fire); 50–55% of the area burned as a stand replacement fire.[62] Finally, traditional damage appraisals apply a standard value-per-acre for all acres burned to estimate losses, but the values have not been determined by the on-site resource changes that resulted from the fires.

Emergency rehabilitation is common following large fires. This is typically justified by the need for controlling erosion and preventing landslides, and may be particularly important for fire lines (dug to mineral soil) that go up steep slopes and could become gullies or ravines without treatment. Sometimes, the rehabilitation includes salvaging dead and damaged trees, because the wood's quality and value deteriorate following the fire. Emergency rehabilitation often involves seeding the sites with fast-growing grasses. While helpful for erosion control, such efforts might inhibit natural restoration if the grasses are not native species or if they inhibit tree seed germination or seedling survival.

Finally, as mentioned above, wildfires can also generate benefits. Many plants regrow quickly following wildfires, because fire converts organic matter to available mineral nutrients. Some plant species, such as aspen and especially many native perennial grasses, also regrow from root systems that are typically undamaged by wildfire. Other plant species, such as lodgepole pine and jack pine, have evolved to depend on stand replacement fires for their regeneration; fire is required to open their cones and spread their seeds. One author identified research reporting various

---

[60] Nelson, *A Burning Issue*, pp. 37-38.

[61] See: Ross W. Gorte, *Fire Effects Appraisal: The Wisconsin DNR Example*, Ph.D. dissertation (East Lansing, MI: Michigan State Univ., June 1981).

[62] See: Lyon, *et al.*, *Effects of Fire on Fauna*, p. 44.

significant ecosystems threatened by fire exclusion — including aspen, whitebark pine, and Ponderosa pine (western montane ecosystems), longleaf pine, pitch pine, and oak savannah (southern and eastern ecosystems), and the tallgrass prairie.[63] Other researchers found that, of the 146 rare, threatened, or endangered plants in the coterminous 48 states for which there is conclusive information on fire effects, 135 species (92%) benefit from fire or are found in fire-adapted ecosystems.[64]

Animals, as well as plants, can benefit from fire. Some individual animals may be killed, especially by catastrophic fires, but populations and communities are rarely threatened. Many species are attracted to burned areas following fires — some even during or immediately after the fire. Species can be attracted by the newly available minerals or the reduced vegetation allowing them to see and catch prey. Others are attracted in the weeks to months (even a few years) following, to the new plant growth (including fresh and available seeds and berries), for insects and other prey, or for habitat (*e.g.*, snags for woodpeckers and other cavity nesters). A few may be highly dependent on fire; the endangered Kirtland's warbler, for example, only nests under young jack pine that was regenerated by fire, because only fire-regenerated jack pine stands are dense enough to protect it from predators.

In summary, many of the ecological benefits of wildfire that have become more widely recognized over the past 30 years are generally associated with light surface fires in frequent-fire ecosystems. This is clearly one of the justifications given for fuel treatments that include prescribed burning. Damage is likely to be greater from stand replacement fires, especially in frequent-fire ecosystems, but even crown fires produce benefits in some situations (*e.g.*, for the jack pine regeneration needed for successful Kirtland's warbler nesting).

Roles and Responsibilities

Landowner Responsibilities. Individuals who choose to build their homes and other structures in the urban-wildland interface face some risk of loss from wildfires. As noted above, catastrophic fires occur, despite our best efforts, and can threaten houses and other buildings. However, landowners can take steps, individually and collectively, to reduce the threat to their structures.

Research has documented that "home ignitability" — the likelihood of a house catching fire and burning down — depends substantially on the characteristics of the structure and its immediate surroundings.[65] Flammable exteriors — *e.g.*, untreated

---

[63] Leenhouts, "Assessment of Biomass Burning."

[64] Amy Hessl and Susan Spackman, *Effects of Fire on Threatened and Endangered Plants: An Annotated Bibliography*, Information and Technical Report 2 (Fort Collins, CO: U.S. Dept. of the Interior, National Biological Service, n.d.).

[65] See: Jack D. Cohen, "Reducing the Wildland Fire Threat to Homes: Where and How Much? *Proceedings of the Symposium on Fire Economics, Planning, and Policy: Bottom Lines* (San Diego, CA: April 5-9, 1999), Gen. Tech. Rept. PSW-GTR-173 (Berkeley, CA: USDA Forest Service, Dec. 1999), pp. 189-195. (Hereafter referred to as: Cohen, "Reducing the Wildland

(continued...)

wood siding and shingles — increase the chances that a structure will ignite by radiation (heat from the surrounding burning forest) or from firebrands (burning materials carried aloft by wind or convection and falling ahead of the fire). Alternate materials and protective treatments can reduce the risk. In addition, the probability of a home igniting by radiation depends on its distance from the flames. Researchers found that 85–95% of structures with nonflammable roofs survived two major California fires (in 1961 and 1990) when there were clearances of 10 meters (33 feet) or more between the homes and surrounding vegetation.[66] Thus, using fire resistant materials and treatments and clearing flammable materials — vegetation, firewood piles, *etc.* — from around structures reduces their chances of burning.

In addition, landowners can cooperate in protecting their homes in wildland subdivisions. Fuel reduction within and around the subdivision can reduce the risk, and economies of scale suggest that treatment costs for a subdivision might be lower than for an individual (especially if volunteer labor is contributed). In addition, as noted above, narrow and unmarked roads can hinder fire crews from reaching wildfires. Assuring adequate roads that are clearly marked and mapped can help firefighters to protect subdivisions. Finally, communal water sources, such as ponds and cisterns, may improve the protection of structures and subdivisions.

State and Local Government Roles and Responsibilities. In general, the states are responsible for fire protection on nonfederal lands, although cooperative agreements with the federal agencies may shift those responsibilities. Typically, local governments are responsible for putting out structure fires. Maintaining some separation between suppressing structural fires and wildfires may be appropriate, because the suppression techniques and firefighter hazards differ. Nonetheless, cooperation and some overlapping responsibilities are also warranted, simply because of the locations of federal, state, and local firefighting forces.

In addition, state and local governments have other responsibilities that affect wildfire threats to homes. For example, zoning codes — what can be built where — and building codes — permissible construction standards and materials — are typically regulated locally. These codes could (and some undoubtedly do) include restrictions, standards, or guidelines for improving fire protection in the urban-wildland interface.

The insurance industry, and home fire insurance requirements, are generally regulated by states. State regulators could work with the industry to assure that wildfire protection and home defensibility are considered in homeowners' insurance, substantially without reliance on federal disaster relief funding. Road construction and road maintenance are often both state and local responsibilities, depending on the road; these roads are usually designed and identified in ways that are useful for fire suppression crews. State and local governments could further assist home protection from wildfires by supporting programs to inform residents, especially those in the urban-wildland interface, of ways that they can protect their homes.

---

[65] (...continued)
Fire Threat to Homes.")

[66] Reported in Cohen, "Reducing the Wildland Fire Threat to Homes."

Federal Roles and Responsibilities. The federal government has several roles in protecting lands and resources from wildfire, including protecting federal lands, assisting protection by states and local governments, and assisting public and private landowners in the aftermath of a disaster.

Federal Land Protection. The federal government clearly is responsible for fire protection on federal lands. Federal responsibility to protect neighboring non-federal lands, resources, and structures, however, is less clear. This issue was raised following several 1994 fires, where the federal officials observed that firefighting resources were diverted to protecting nearby private residences and communities at a cost to federal lands and resources.[67] In December 1995, the agencies released the new *Federal Wildland Fire Management Policy & Program Review: Final Report*, which altered federal fire policy from priority for private property to equal priority for private property and federal resources, based on values at risk. (Protecting human life is the first priority in firefighting.)

Cooperative Assistance. The federal government also provides assistance for fire protection. Federal emphasis on wildfire protection assistance has been through the Forest Service, but the Federal Emergency Management Agency (FEMA) also has a program to assist in protecting communities from disasters (including wildfire).

The Forest Service efforts are operated through a cooperative fire protection program within its State and Private Forestry (S&PF) branch. This program includes financial and technical assistance to states and to volunteer fire departments. The funding provides a nationwide fire prevention program and equipment acquisition and transfer (the Federal Excess Personal Property program) as well as training and other assistance for state and local fire organizations.

---

[67] Bob Armstrong, Assistant Secretary for Lands and Minerals Management, U.S. Dept. of the Interior, "Statement," *Fire Policy and Related Forest Health Issues*, joint oversight hearing, House Committees on Resources and on Agriculture, Oct 4, 1994 (Washington, DC: U.S. Govt. Print. Off., 1995), p. 9. Serials No. 103-119 (Committee on Resources) and 103-82 (Committee on Agriculture).

As shown in table 3, state fire assistance funding averaged $19 million annually, and volunteer fire assistance funding averaged $2.5 million annually, from FY1994–FY2000. The Interior Appropriations Act for FY2001 (P.L. 106-291) increased these two programs considerably ($25 million and $5 million, respectively) in the regular (Title II) line item appropriation and in Wildland Fire Emergency Appropriations (Title IV) of the Act (an additional $50.5 million and $8.3 million, respectively). This contrasts with several earlier proposals by the Reagan, Bush, and Clinton Administrations to substantially reduce the annual state fire assistance funding (to less than $5 million).

Table 3. Forest Service Cooperative Fire Protection Funding, FY1994-FY2001
(in millions of dollars)

Fiscal Year	State Fire Assistance	Volunteer Fire Asst.[a]
2001	$ 75.49	$13.28
2000	$ 23.93	$ 3.24
1999	$ 20.87	$ 2.00
1998	$ 20.14	$ 2.00
1997	$ 18.00	$ 1.28
1996	$ 17.00	$ 2.00
1995	$ 13.69	$ 3.40
1994	$ 17.15	$ 3.50

[a] Prior to FY1999, this was called Rural Community Fire Assistance, and was funded through the Rural Housing Service of the U.S. Department of Agriculture.

Sources: Forest Service and USDA annual budget justifications, and H.Rept. 106-941 (Conference Report on Appropriations for Interior and Related Agencies for FY2001.)

FEMA has three programs to assist fire protection efforts.[68] One is "Project Impact," a program to reduce damages from natural disasters (wildfires, floods, storms, etc.) by helping communities to prevent disasters and to minimize damages when disasters strike. The program is not explicitly authorized, but Congress has appropriated funds for these efforts for several years. The second FEMA program is fire suppression grants under the Stafford Act (the Disaster Relief and Emergency Assistance Act, P.L. 93-288; 42 U.S.C. 5187). These are grants to states to assist in suppressing wildfires that threaten to become major disasters. Finally, the U.S. Fire Administration is a FEMA directorate whose purpose is to reduce deaths, injuries, and property losses from fires; agency programs include data collection, public education, training, and technology development.[69]

The federal government has one other program that supports federal and state wildfire protection efforts — the National Interagency Fire Center (NIFC). The center was established by the BLM and the Forest Service in Boise, ID, in 1965 to coordinate fire protection efforts (especially aviation support) in the intermountain west. The early successes led to the inclusion of the National Weather Service (in the National Oceanic and Atmospheric Administration of the U.S. Department of

---

[68] The annual funding for these three programs is not distinguished in the agency's annual budget justification, and thus is not included in this report. See CRS Report RL30460, *FEMA Funding: Budget Information for the Federal Emergency Management Agency.*

[69] See CRS Report RS20071, *United States Fire Administration: An Overview.*

Commerce) and of the other Interior agencies with fire suppression responsibilities (the National Park Service, Fish and Wildlife Service, Bureau of Indian Affairs, and Office of Aircraft Services). (FEMA is not included in the NIFC.) NIFC also coordinates with the National Association of State Foresters, to assist in the efficient use of federal, state, and local firefighting resources in areas where wildfires are burning.

Disaster Relief. The federal government also provides relief following many disasters, to assist recovery by state and local governments and especially the private sector (including the insurance industry). The federal land management agencies generally do not provide disaster relief.[70] However, wildfire operations funding includes money for emergency rehabilitation, to reduce the possibility of significant erosion, stream sedimentation, and mass soil movement (landslides) from burned areas. While not direct relief for affected communities, such efforts may prevent flooding and debris flows that can exacerbate local economic and social problems caused by catastrophic fires.

FEMA is the principal federal agency that provides relief following declared disasters, although local, state, and other federal agencies (*e.g.*, the Farm Service Agency and the Small Business Administration) also have emergency assistance programs.[71] The Stafford Act established a process for Governors to request the President to declare a disaster, and public and individual assistance programs for disaster victims.[72]

If the risk of catastrophic fires destroying homes and communities continues to increase, as some have suggested, requests for wildfire disaster relief are also likely to rise. This might lead some to argue that a federal insurance mechanism might be a more efficient and equitable system for sharing the risk. Federal crop insurance and national flood insurance have existed for many years, while federal insurance for other catastrophic risks (*e.g.*, hurricanes, tornados, earthquakes, volcanoes) has also been debated.[73] An analysis of these alternative systems is beyond the scope of this report, but these might provide alternative structures that could be adapted for federal

---

[70] The FY2001 Interior Appropriations Act (P.L. 106-291) included $35 million in Title IV (Wildland Fire Emergency Appropriations) for the Forest Service to provide "assistance to non-federal entities most affected by fire using all existing authorities under the State and Private Forestry appropriation" which includes economic assistance to rural communities.

[71] For information on related legislation, see CRS Report RL30543, *Disaster Mitigation Assistance Bills in the 106th Congress: Comparison of Provisions*.

[72] Annual disaster assistance funding fluctuates widely, depending on the number and nature of natural disasters that occur.

[73] For more on current insurance issues and concerns, see CRS Report IB10033, *Federal Crop Insurance: Issues in the 106th Congress*; and CRS Report RS20481, *Major Insurance Legislation in the 106th Congress*. For background information, see CRS Report 94-195 ENR, *A Descriptive Analysis of Federal Relief, Insurance, and Loss Reduction Programs for Natural Hazards*.

wildfire insurance, if such insurance were seen as appropriate. Some observers, however, object to compensating landowners for building in unsafe areas.[74]

Current Issues

The 2000 fire season has raised many wildfire issues for Congress and the public. With 7.3 million acres burned through November 30, and fires still burning, the 2000 fire season could surpass 1988 (with 7.4 million acres burned) as the "worst," or most extensive fire season in the United States in half a century. The 2000 fire season began making headlines in May, when a prescribed fire at Bandelier National Monument escaped control and burned 235 homes in the town of Los Alamos, NM, and threatened the Los Alamos National Laboratory, one of the U.S. Department of Energy nuclear weapons labs. Later, numerous large fires in Idaho and Montana attracted national attention when they threatened communities and their extensive smoke caused widespread visibility and health problems.

There has been spirited discussion about the effects of land management practices, especially timber sales, on fuel loads. A significant range of opinion exists on this issue, but most observers generally accept that current fuel loads reflect the aggressive, effective fire suppression of the past century as well as historic logging and grazing practices. Some argue that catastrophic wildfires are nature's way of rejuvenating forests that have been mismanaged in extracting timber, and that the fires should be allowed to burn to restore the natural conditions.[75] Others argue that the catastrophic fires are due to increased fuel loads that have resulted from reduced logging in the national forests over the past decade, and that more logging could contribute significantly to reducing fuel loads and thus to protecting homes and communities.[76] However, the extent to which timber harvests affect the extent and severity of current and future wildfires cannot be determined from available data.[77] One critic suggests that historic mismanagement (excessive fire suppression and past logging and grazing practices) by the Forest Service warrants wholesale decentralization of the management authority governing the National Forest System.[78]

Research information on causative factors and on the complex circumstances surrounding wildfire is limited. The value of wildfires as case studies for building predictive models is restricted, because the *a priori* situation (*e.g.*, fuel loads and distribution) and burning conditions (*e.g.*, wind and moisture levels, patterns, and

---

[74] Personal communication with Tim Hermach, Founder and President, Native Forest Council, Eugene, OR, on October 18, 2000.

[75] Personal communication with Tim Hermach, Founder and President, Native Forest Council, Eugene, OR, on Sept. 26, 2000.

[76] William N. Dennison, Plumas County Supervisor, District 3, "Statement," *Hearing on the Use of Fire as a Management Tool and Its Risks and Benefits for Forest Health and Air Quality*, Hearing before the House Committee on Resources, Sept. 30, 1997 (Washington, DC: U.S. Govt. Print. Off., 1997), pp. 107-116. Serial No. 105-45.

[77] See CRS congressional distribution memorandum, *Forest Fires and Forest Management* (by Ross W. Gorte), Sept. 20, 2000.

[78] Nelson, *A Burning Issue*.

variations) are generally not well studied. Experimental fires in the wild would be more useful, but are dangerous and generally unacceptable to the public. Prescribed fires could be used, but the burning conditions are necessarily restricted. Fires in the laboratory are feasible, but often cannot duplicate the complexity and variability of field conditions. Thus, research on fire protection and control is challenging, and predictive tools for fire protection and control are often based substantially on expert opinion and anecdotes, rather than on documented research evidence.[79]

Concerns over forest and rangeland health, particularly related to fuel loads, have been discussed for a decade; a major conference on forest ecosystem health was held in Idaho in 1993.[80] Significant funding to address these concerns, however, was not proposed by the Bush Administration or by the Clinton Administration until September 2000. In October, Congress included substantially higher funding for fire protection in the FY2001 Interior Appropriations Act (P.L. 106-291). Table 4 summarizes the FY2000 funding, the original FY2001 budget request, the September 2000 Administration proposal, and the appropriations for FY2001.[81] (The figures include the Forest Service and Department of the Interior.) The FY2001 funding to reduce fuel loads through fuel treatment, as proposed by the Administration in September and as enacted by Congress in October, is substantially higher — more than triple — than FY2000 funding.

Table 4. Recent Federal Fire Protection Funding (Forest Service and Department of the Interior)

(in millions of dollars)

	FY2000 Appropriations	FY2001 Budget Request	Sept. 2000 Proposal	FY2001 Appropriations
Fire Preparedness	$584.6	$586.4	$922.8	$927.9
Fire Suppression + Contingency	$497.5	$354.4	$1,099.8	$1,134.5
Fire Operations: Fuels Reduction	$116.5	$126.7	$365.0	$401.0
Emergency Rehabilitation	(included in fire suppression)	(included in fire suppression)	$150.0	$227.0
Other (Assistance, *etc.*)	$27.2	$32.5	$140.8	$208.3
Total	$1,225.8	$1,100.1	$2,678.5	$2,898.7

[79] Fire experts typically believe (and must believe, to do their jobs effectively) that catastrophic wildfires can and should be controlled; thus, their opinions may be biased, overstating the effectiveness and efficiency of control efforts.

[80] *Assessing Forest Ecosystem Health in the Inland West: November 14th – 20th, 1993*. See *infra* Note 7.

[81] Details on how and where the additional funds will be spend are not currently available.

Sources:

Executive Office of the President, *Managing the Impact of Wildfires on Communities and the Environment: A Report to the President in Response to the Wildfires*, at [http://www.whitehouse.gov], Sept. 11, 2000.

U.S. Congress, House, Committee on Appropriations, *Hearings, Department of the Interior and Related Agencies Appropriations for 2001, Part 1, Justification of the Budget Estimates: Bureau of Land Management* (Washington, DC: U.S. Govt. Print. Off., 2000), pp. 214-253.

________, *Part 3, Justification of Budget Estimates: Forest Service*, pp. 182-192.

U.S. Congress, House, *Conference Report [To accompany H.R. 4578], Making Appropriations for the Department of the Interior and Related Agencies for the Fiscal Year Ending September 30, 2001, and For Other Purposes* (H.Rept. 106-914), pp. 113-119, 160-167, 192-196.

A remaining question is whether this additional funding is sufficient to adequately reduce fuel loads. The General Accounting Office has estimated that it would cost $725 million *annually* — nearly $12 billion by 2015 — to treat fuels using traditional treatment methods on the 39 million acres that the Forest Service had estimated were at high risk of catastrophic wildfire.[82] This would be more than double the significantly increased FY2001 appropriations for Forest Service fuel treatment, and would need to be continued for at least 15 years to treat fuel loads on just the high-risk acres of the national forests, assuming that no lands became high-risk through additional fuel accumulations in the intervening 15 years.

Several factors suggest that the GAO estimate of $12 billion over 16 years may be low. First, in frequent-fire ecosystems, retreatment would be needed on the 5-35 year fire cycle (depending on the ecosystem), suggesting that fuel management costs would need to be continued after the end of the 16-year program. Forest Service estimates of high-risk acreage have increased — from 39 million acres to 48 million acres of Forest Service land, plus 22 million high-risk acres of other federal land and 97 million high-risk acres of nonfederal land — since the GAO report. Finally, one might anticipate more careful federal prescribed burning operations after the May 2000 fire in Los Alamos; more carefully prescribed burns will likely have higher unit costs than GAO estimated, although there may be an overall savings if unanticipated damages from escaped prescribed burns can be avoided.

Perhaps the most significant question is: would it work? The answer depends, in part, on how one defines successful fire protection. Fuel treatments might help restore forests and rangelands to pre-European-influenced conditions; this seems likely to yield some significant benefits (*e.g.*, improved water quality, more habitat for fire-dependent animal species), although this restoration goal is opposed by those whose uses and values might be constrained. Reducing fuel loads might reduce acreage burned and the severity and damages of the wildfires that occur. Research is needed to document and quantify the relationships among fuel loads and damages and the probability of catastrophic wildfires, to examine whether the cost of fuel reduction is justified by the lower fire risk and damage. However, it should also be recognized that, regardless of the extent of fuel treatment and other fire protection efforts, as long as there is biomass for burning, severe weather conditions (drought

---

[82] U.S. General Accounting Office, *Western National Forests: A Cohesive Strategy is Needed to Address Catastrophic Wildfire Threats*, GAO/RCED-99-65 (Washington, DC: April 1999).

and high wind) will occasionally lead to catastrophic wildfires, with the attendant damages to resources, destruction of nearby homes, other economic and social impacts, and potential loss of life.

References

Agee, James K. *Fire Ecology of Pacific Northwest Forests*. Washington, DC: Island Press, 1993. 493 p.

Brown, Arthur A. and Kenneth P. Davis. *Forest Fire Control and Use*. 2nd ed. New York, NY: McGraw-Hill Book company, 1973. 686 p.

Gonzalez-Caban, Armando and Philip N. Omi, technical coordinators. *Proceedings of the Symposium on Fire Economics, Planning, and Policy: Bottom Lines*. General Technical Report PSW-GTR-173. Berkeley, CA: USDA Forest Service, Pacific Southwest Research Station, Dec. 1999. 332 p.

Kozlowski, T.T. and C.E. Ahlgren, eds. *Fire and Ecosystems*. New York, NY: Academic Press, 1974. 542 p.

Nelson, Robert H. *A Burning Issue: A Case for Abolishing the U.S. Forest Service*. Lanham, MD: Rowman & Littlefield Publishers, Inc., 2000. 191 p.

Pyne, Stephen J. *Fire in America: A Cultural History of Wildland and Rural Fire*. Princeton, NJ: Princeton University Press, 1982. 654 p.

Pyne, Stephen J., Patricia L. Andrews, and Richard D. Laven. *Introduction to Wildland Fire*, 2nd ed. New York, NY: John Wiley & Sons, Inc., 1996. 769 p.

Sampson, R. Neil and David L. Adams, eds. *Assessing Forest Ecosystem Health in the Inland West: Papers from the American Forests Workshop, November 14th – 20th, 1993, Sun Valley, Idaho*. New York, NY: Food Products Press, 1994. 461 p.

Sampson, R. Neil, R. Dwight Atkinson, and Joe Lewis, eds. *Mapping Wildfire Hazards and Risks*. New York, NY: Food Products Press, 2000. 343 p.

Wright, Henry A. and Arthur W. Bailey. *Fire Ecology: United States and Southern Canada*. New York, NY: John Wiley & Sons, 1982. 501 p

A forest fire is an uncontrolled fire that occurs in nature. Climatic conditions have an important impact on the severity of forest fires with particular high risks during long dry spells. Weather conditions such as precipitation and wind, vegetation, the layout of the terrain as well as forest management practices are important factors that determine the dimensions of the forest fire.Â The European Union Civil Protection Mechanism helps to coordinate rapid support for an onset crisis. Forestâ€“protection policy is an essential part of social policy, and modern forestry is gradually shifting its focus to public fire-prevention education. Hong (2005) explored the relationship between forest fire prevention and fire-prevention promotion using the Dapu utility district in the Chiayi forest area, determined the optimal fire prevention promotional method, and established the optimal fire prevention promotion model.