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GAO

Report to Congressional Requesters

June 2004

WILDLAND FIRES

Forest Service and BLM Need Better Information and a Systematic Approach for Assessing the Risks of Environmental Effects

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GAO-04-705

June 2004

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Highlights

Highlights of GAO-04-705, a report to congressional requesters

WILDLAND FIRES

Forest Service and BLM Need Better Information and a Systematic Approach for Assessing the Risks of Environmental Effects

Why GAO Did This Study

Decades of fire suppression, as well as changing land management practices, have caused vegetation to accumulate and become altered on federal lands. Concerns about the effects of wildland fires have increased efforts to reduce fuels on federal lands. These efforts also have environmental effects. The requesters asked GAO to (1) describe effects from fires on the environment, (2) assess the information gathered by the Forest Service and Bureau of Land Management (BLM) on such effects, and (3) assess the agencies' approaches to environmental risks associated with reducing fuels.

What GAO Recommends

This report recommends that the Secretaries of Agriculture and the Interior (1) develop a plan to implement the agencies' monitoring framework, (2) develop guidance that formalizes the assessment of landscape-level risks to ecosystems, and (3) clarify existing guidance, working with the Council on Environmental Quality (CEQ), to assess the risks of environmental effects from reducing fuels.

Commenting on the draft report, Agriculture and Interior agreed that more data are needed and prioritization of fuels work can be improved, but had concerns about developing guidance on a risk-based approach. CEQ commented that its guidance is not intended to address risk analysis.

www.gao.gov/cgi-bin/getrpt?GAO-04-705.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Barry T. Hill at (202) 512-9775 or hillbt@gao.gov.

What GAO Found

Wildland fires can have dramatic effects on environmental resources and ecosystems, including production of large amounts of smoke, loss of trees, and erosion of soil into streams and lakes. However, fires can also benefit resources by recycling soil nutrients, renewing vegetation growth, and adding gravel to streams, which improves spawning habitat for fish. The 20 wildland fires that we surveyed burned over 158,000 acres of federal land and had complex, wide-ranging, and sometimes contradictory, effects on both individual resources, such as trees and streams, and ecosystems. For example, the short-term effects of the Missionary Ridge fire in Colorado that burned almost 50,000 acres of trees and other vegetation included increased debris and sediment that affected water quality in some areas. However, in other areas, officials said even dramatic changes to streams would not be detrimental in the long term.

The Forest Service and BLM gather specific information on the environmental effects of individual wildland fires, such as soil erosion. The agencies do not, however, gather comprehensive data on the severity of wildland fire effects on broad landscapes and ecosystems—that is, large areas that may involve one or more fires. The agencies recently developed a monitoring framework to gather severity data for fires, but they have not yet implemented it. These data are needed to monitor the progress of the agencies' actions to restore and maintain resilient fire-adapted ecosystems, a goal of the National Fire Plan.

The National Fire Plan directs the Forest Service and BLM to target their fuel reduction activities with the purpose of lowering the risk of environmental effects from wildland fires in areas that face the greatest losses. However, the agencies do not systematically assess the risks across landscapes that fires pose to different environmental resources or ecosystems or the risks of taking no action on fuel reduction projects. At the landscape level, the Forest Service and BLM do not have a formal framework for systematically assessing the risk of fire to resources and ecosystems, although some of the forests and BLM field offices have developed risk assessments on their own or in collaboration with regional, state, or local efforts. At the project level, while the agencies recognize the need to better analyze the risk of acting to reduce fuels versus not doing so, neither fire planning guidance nor National Environmental Policy Act guidance specify how to do this. Opportunities exist to clarify how the agencies should analyze the effects of not taking action to reduce fuels. The agencies can clarify interim guidance to implement the Healthy Forests Restoration Act, and the agencies can, in conjunction with CEQ, further develop the lessons learned from a CEQ demonstration program carried out in 2003. Without a risk-based approach, these agencies cannot target their fuel reduction projects across landscapes or make fully informed decisions about which effects and project alternatives are more desirable.

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Abbreviations

BAER	Burned Area Emergency Response
BLM	Bureau of Land Management
CEQ	Council on Environmental Quality
ESR	Emergency Stabilization and Rehabilitation
FRCC	Fire Regime Condition Class
HFRA	Healthy Forests Restoration Act
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
NOAA	National Oceanic and Atmospheric Administration

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Congressional Requesters

Decades of fire suppression, in conjunction with land management activities that have excluded fire from the nation's forests and rangelands,[1] such as roads and trails, grazing, and development near public land, have caused the accumulation of brush, small trees, and other vegetation on federal and other lands. Recent fire seasons have shown that these land management practices have had unforeseen consequences. The accumulation and alteration of vegetation, in combination with an extended drought that has covered much of the country, has caused wildland fires to burn more intensely than they would under more natural or historical vegetation conditions. In response to changing views of wildland fire, the Federal Wildland Fire Management Policy developed by the Departments of Agriculture and the Interior in 1995 recognized the natural role of wildland fire and the potential for "catastrophic" fires to occur in areas of accumulated vegetation. In 2000, federal scientists and land managers estimated that 182 million acres of land in the United States had accumulations of vegetation that were highly altered from more historical conditions.

Under historical conditions, many forest and rangeland ecosystems—which are different ecological units distinguished by physical characteristics such as mountains, plains, and river basins, as well as their associated plant and animal communities—have adapted to wildland fire, surviving and regenerating after fires occur. Under these conditions, wildland fire can often have beneficial effects for resources and ecosystems, such as recycling soil nutrients, renewing vegetation growth, and sustaining ecological functions. However, federal scientists and land managers believe that the adverse effects of wildland fires are exacerbated in ecosystems with uncharacteristic vegetation conditions, that is, in which vegetation has accumulated or been altered by fire exclusion. Adverse effects of wildland fire on individual resources include reduced air and water quality, soil loss, and loss of threatened and endangered species and their habitat. In addition, wildland fires that cover broad landscapes can adversely affect all or parts of forest or rangeland ecosystems. In particular, scientists and land managers are concerned that, after years of fire exclusion, in dry forest ecosystems the large old trees that used to survive

[1] We use the term rangelands to refer to grasslands and shrublands.

fires now burn and die, and will not be replaced for over 100 years, eliminating sources of seeds and turning forests into shrubfields. Scientists and land managers are also concerned that the natural occurrence of wildland fire in grassland ecosystems has been altered by invasive species, such as cheatgrass, that have replaced native vegetation. Furthermore, communities in the interface of wildland areas that develop into areas where there are uncharacteristic fuel accumulations may experience exacerbated effects of wildland fires.

In 2001, in response to one of the worst fire seasons in over 50 years, the Departments of Agriculture and the Interior reiterated the principles in the Federal Wildland Fire Management Policy and began working with state and local agencies and tribal governments to develop an interagency National Fire Plan to coordinate federal, state, local, and tribal efforts. Together, the policy and plan offer a new approach to wildland fires by broadening the emphasis to include reducing vegetation, or fuels, and reintroducing fire, where possible, to restore ecosystems to more resilient fire-adapted conditions. The reintroduction of fire to certain federal lands does not mean, however, that all fires will be allowed to burn without management. Currently, there are two approaches to wildland fire management. First, all unplanned wildland fires are suppressed or are managed—given favorable weather conditions—to achieve beneficial effects to resources. Second, wildland fire management activities also include the reduction of fuels to protect communities and maintain or improve ecological conditions of the land. Fuel reduction activities include mechanical methods such as chainsaws, chippers, mulchers, and bulldozers, and prescribed burns. Prescribed burns may be set to restore or maintain desired vegetation conditions.

The degree to which fire can be reintroduced to different forest and rangeland ecosystems depends on the risk fire poses to environmental resources and ecosystems. Under the National Fire Plan, land managers are to identify ways to reduce the risk to communities and ecosystems from wildland fire. Risk, according to the National Academy of Sciences, involves hazardous events or conditions and the potential loss of or damage to something of value because of the hazard. In the case of wildland fires, the hazard involved is not only the fire, but also the excess vegetation, or fuel, that has accumulated or been altered on federal lands. A primary way to lower risks involves reducing the amount, type, or continuity of vegetation available to burn. The National Fire Plan applies to several federal agencies that manage public lands and wildland fires, including the Forest Service within the Department of Agriculture and the

Bureau of Land Management, National Park Service, Bureau of Indian Affairs, and the Fish and Wildlife Service within the Department of the Interior. These agencies are all members of the Wildland Fire Leadership Council, formed in 2002 to support and coordinate implementation of the National Fire Plan and Federal Wildland Fire Management Policy. Two of these agencies—the Forest Service and the Bureau of Land Management (BLM)—manage approximately 450 million acres or 60 percent of the nation's federal land.

In managing the effects of wildland fires, the Forest Service and BLM face a second type of risk—that the actions they take to reduce fuels and to restore ecosystems may damage additional resources such as species, habitat, or water, whereas if they do not take action, the effects of a future fire may be exacerbated. Consequently, the agencies' assessment of the potential effects of their activities involves weighing the risk of action to reduce fuels against the risk of doing nothing. Under the National Environmental Policy Act (NEPA) of 1969, agencies generally evaluate the likely environmental effects of projects they are proposing using a relatively brief environmental assessment, or, if the action would be likely to significantly affect the environment, a more detailed environmental impact statement.[2] One purpose of this analysis is to ensure that agencies have available detailed information concerning potentially significant environmental impacts to inform their decision making. The Forest Service and BLM typically conduct such analyses at two levels: the entire national forest or BLM land unit, which can encompass several broad landscapes, and the more specific project level, which addresses smaller areas within the landscape.

[2]In determining the significance of a proposed action, agencies must consider a variety of factors, including the action's geographic scope, potential for controversy, and the degree to which the proposed action threatens to violate federal, state, or local law. A significant effect may exist even if the federal agency believes on balance that the effect will be beneficial. When it is uncertain whether the proposed action would have significant environmental effects, agencies use environmental assessments to determine whether the proposed action would have such effects and therefore whether an environmental impact statement is necessary.

Concerns about the severity of recent wildland fires and their environmental effects have led to increased efforts to reduce fuels on federal lands, which culminated in the enactment of the Healthy Forests Restoration Act (HFRA) in December 2003.[3] There has been considerable disagreement over the extent of environmental effects of wildland fire on federal lands, and what, if anything, to do about them. The timber industry and other groups advocated increasing the use of mechanical tree thinning and timber sales to reduce the vegetation accumulating on the nation's forests and rangelands. Critics of this approach, which included environmental groups, cited its potentially detrimental effects on environmental resources, particularly large old trees. Both the advocates and the critics generally agreed on the actions needed to address risk to communities; however, there is little agreement as to what steps, if any, should be taken to reduce the risk posed to ecosystems. In this context, you asked us to (1) describe the effects wildland fires have on environmental resources and ecosystems, (2) assess the information the Forest Service and BLM gather on the extent of environmental effects of wildland fires, and (3) assess the approaches the Forest Service and BLM take to assess the risk to environmental resources from wildland fires and the vegetation that has accumulated or been altered on federal lands.

[3]Pub. L. No. 108-148 (2003). One of the main purposes of the act is to reduce wildfire risk to communities, municipal water supplies, and other at-risk federal land through a collaborative process of planning, prioritizing, and implementing hazardous fuel reduction projects.

To describe the effects that wildland fires have on environmental resources and ecosystems and assess the information the Forest Service and BLM gather on the extent of these effects, we designed a survey of local federal land managers who maintain this data. Our survey contained questions about 20 wildland fires that we randomly selected from a universe of 614 wildland fires. Some of the questions required that the land managers provide their opinions of conditions or make predictions about the future effects of a wildland fire rather than providing data about effects that had already occurred, and therefore there is a greater amount of uncertainty regarding the accuracy of these responses. We identified the 614 fires through Forest Service and BLM reports completed in fiscal years 2000 through 2002 on the emergency actions needed to stabilize areas burned in the fires. We used these reports to identify our sample because the reports are developed for wildland fires that the agencies determined are likely to have had considerable environmental effects. We conducted a random sample of these 614 fires to ensure that we had a range of small, medium, and large wildland fires.[4] To gather information on the approaches the Forest Service and BLM use to assess the risks to environmental resources posed by wildland fire, we reviewed federal wildland fire policies, the National Fire Plan, and agency guidance and planning and project documents. We also interviewed federal and state agency officials, scientists from several of the Forest Service's research stations, and university experts on fire and fire effects. We attended two national conferences on fire issues and visited national forests and BLM state offices in eight western states that had experienced large fires. We conducted our review from April 2003 through April 2004 in accordance with generally accepted government auditing standards. Appendix I provides further details about the scope and methodology of our review.

Results in Brief

The 20 wildland fires that we surveyed burned over 158,000 acres of federal land and had complex, wide-ranging, and sometimes contradictory, effects on both individual resources, such as trees and streams, and ecosystems. For example, the Missionary Ridge fire in Colorado burned almost 50,000 acres. The loss of trees and vegetation in some of the burned areas, as well as chemical and physical changes in the soil, has caused increased flooding and debris flows in local streams, which has affected water quality in the short term. However, in the long term, land managers indicated that even

[4] To ensure that all sizes were represented, we conducted a systematic random sample. In this method, the fires were ordered by size and then fires were selected at regular intervals.

dramatic changes to streams in other burned areas would not be detrimental. Of the 20 wildland fires in our survey, the land managers viewed the effects of the wildland fires as adverse, neutral, or beneficial, depending on a number of factors, including the short- and long-term time frames in which the effects were described, and the type and condition of the vegetation that had existed in the burned area. The managers also reported that the 20 fires had effects across broad landscapes and that these effects varied in severity.

The Forest Service and BLM gather specific information and data on the effects of some individual wildland fires on environmental resources, such as soil erosion or acres of trees burned, for the purpose of stabilizing burned areas. However, they do not gather comprehensive data on the long-term severity of wildland fire effects on broad landscapes and ecosystems—that is, on large areas that may involve one or more burns—because they do not have a monitoring plan to gather landscape data across fires. Wildland fires can have varying effects over time and space, and, as a result, it is important that the agencies have comprehensive data to monitor the progress of the their actions to restore fire-adapted ecosystems, a goal of the National Fire Plan. The agencies recently developed a monitoring framework that includes fire severity, but this plan has not yet been implemented. Data on severity would help the agencies to assess whether, over time, fires in forest and rangeland ecosystems are burning with more or less severe effects and whether the ecosystems are being restored to more fire-adapted, or resilient, conditions. Without the ability to identify the broad landscape effects of fire on vegetation conditions as fires occur, the agencies will have difficulty showing whether they have met their identified desired conditions and whether different ecosystems are becoming more or less resilient to fire.

The Forest Service and BLM, when planning fuel reduction activities, do not have a systematic approach that allows them to assess the risks of environmental effects from wildland fires at the landscape level or the specific project level. As a result, the agencies do not systematically assess the risks that fires pose to different environmental resources or ecosystems or the risks of taking no action on fuel reduction projects, although the National Fire Plan directs them to target their fuel reduction activities in areas that face the greatest losses. At the landscape level, the Forest Service and BLM do not have a common framework for assessing the risk of fire to environmental resources and ecosystems as part of their fuel reduction efforts because they and the Congress have placed high priority on assessing areas that threaten communities. The agencies have not focused exclusively on communities, as several of their field offices have begun efforts to assess the risks of environmental and ecosystem effects in planning their fuel reduction activities. Without a systematic approach to assessing risk to ecosystems at the landscape level, the agencies cannot effectively target their fuel reduction activities to protect areas that face the greatest losses, or, conversely, identify areas that can benefit from the reintroduction of fire. To formalize a common framework for such risk assessments, the Forest Service and BLM could use the experience of other agencies that conduct risk assessments, such as the Federal Emergency Management Agency or the Environmental Protection Agency, as well as the experience of those field offices that have independently conducted such assessments. In assessing the risks associated with individual projects, the Forest Service and BLM have in some instances assessed, under NEPA, the risk of acting to reduce fuels versus the risk of not doing so. We reviewed 10 of the agencies' assessments and determined the agencies did not systematically assess the risks of taking or not taking action to reduce fuels. Agency guidance is not specific about how this assessment should be performed and whether these analyses should be contained in NEPA documentation. The agencies have opportunities to specify how the risks of not reducing fuels should be assessed and where this assessment should be documented. The agencies have developed interim guidance for implementing the Healthy Forests Restoration Act, but the guidance does not go far enough in describing the analysis needed for showing the effects of not reducing fuels. Also, the agencies and the Council on Environmental Quality (CEQ) are developing model environmental assessments and lessons learned from a demonstration program developing model environmental assessments for fuel reduction projects, in which the agencies participated. Without a risk-based approach at the project level, the agencies cannot make fully informed decisions about which effects and project alternatives are more desirable.

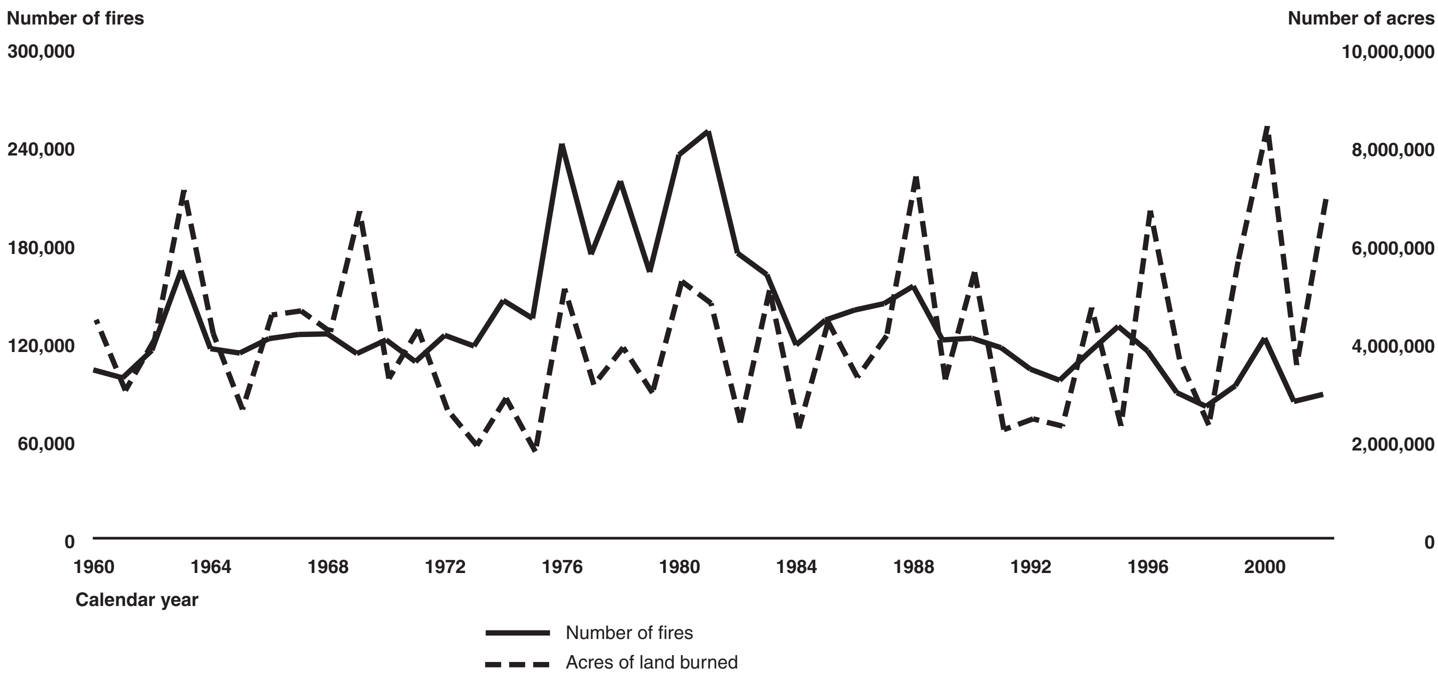
We are making recommendations to the Secretaries of Agriculture and the Interior to help ensure that the Forest Service and BLM develop (1) the information needed to better understand the full extent of environmental and ecosystem effects from wildland fires, (2) a systematic framework for the assessment of risks at the landscape level to target where fuel reduction activities need to occur, and (3) specific guidance on a risk-based approach to make trade-offs among the environmental effects of acting to reduce fuels or doing nothing.

In commenting on a draft of this report, the Departments of Agriculture and the Interior stated that the report provided a thorough analysis of a complex set of issues. They agreed that information on the long-term effects of fire is needed and noted that on May 18, 2004, they approved a monitoring framework that includes such information. They also agreed that prioritization of fuel reduction projects can be improved but expressed a number of concerns about our recommendation that they develop a systematic risk-based approach to help prioritize projects. Finally, they did not agree with our recommendation that they provide specific guidance on the assessment of the effects of not taking action to reduce fuels. CEQ also provided comments on this recommendation, stating that we should not imply that CEQ's guidance to help develop fuel reduction projects was meant to discuss risk analysis and the risks of not taking action to reduce fuels. While we made modifications to our report to address these concerns and to clarify our recommendations, we continue to believe that our recommendations are warranted.

Background

Wildland fire is an inevitable natural ecological disturbance that has helped to shape ecosystems over time. Fires are driven by climate and weather conditions, topography, and fuels—including trees, brush, grasses, dead leaves and needles, and other material that will burn. Thousands of fires are started each year by natural causes, such as lightning, or human causes, such as arson. These fires burn millions of acres of state and federally owned land (see fig. 1).

Figure 1: Number of Fires and Acres Burned, 1960-2002



Sources: National Interagency Fire Center (data); GAO (analysis).

Although fire is a natural component of many ecosystems, and although humans have used fire for land and resource management purposes for thousands of years—such as creating improved pasture for animals and improved land for agriculture—fire can be unpredictable and potentially destructive. The potential destructiveness of fire is a particular concern for the growing number of communities on the fringe of wildland areas that are prone to fire. These communities create a wildland-urban interface, where houses and other infrastructure are in or near wildland fuels. Because fires can have dramatic social, economic, and environmental effects, land management agencies and federal land managers have sought to suppress fires for much of the twentieth century. In particular, large, intense fires in 1910 focused federal policy on suppression to prevent damage to ecological resources. Suppression, in combination with land management activities such as building roads and trails, grazing, and increasing development near public lands, has excluded fire from ecosystems and caused the uncharacteristic accumulation of vegetation in some forest and grassland ecosystems. In 2000, the Forest Service and BLM completed a national study of fuel conditions called the Coarse-Scale Analysis, which estimated that 182 million acres of the nation's land have an uncharacteristic buildup of fuels.[5] The analysis produced categories of vegetation conditions ranked as low, medium, and high. The categories, called fire regime condition classes, represent the increasing accumulation and alteration of vegetation conditions and the potential for uncharacteristic wildland fire and its effects. (See app. II for a detailed description of the analysis.) In 2002, the agencies updated the analysis for the western states, estimating that almost 183 million acres in western states alone have highly altered vegetation. Based on additional analysis, the agencies estimated that the amount of highly altered vegetation nationwide could vary from 90 to 200 million acres. In the 2002 analysis, the agencies estimated that 99 million acres of Forest Service and BLM lands in western states have highly altered vegetation. Refinement of the analysis for the nation is expected to be completed in 2005.

[5] Kirsten M. Schmidt, James P. Menakis, Colin C. Hardy, Wendel J. Hann, and David L. Bunnell, *Development of Coarse-Scale Spatial Data for Wildland Fire and Fuel Management*, GTR RMRS-87 (Fort Collins, Colorado, U.S. Department of Agriculture, Forest Service Rocky Mountain Research Station: April 2002).

The National Fire Plan[6] recognizes the need for restoring historic, or characteristic, vegetation conditions as an important way to reduce the risks of wildland fire and its effects. Under historic conditions, each vegetation type has a characteristic fire "regime," in which the vegetation and species have adapted to, and benefit from, the kind of fires that occur there. Fires that occur in a given fire regime display similar fire behavior, which refers to how frequently fires burn, how intensely they burn, and how large they grow. Furthermore, the effects of fires in different fire regimes can be more or less severe, depending on the types of fires that typically burn there. For example, ecosystems such as ponderosa pine forests benefit from and are sustained by the frequent occurrence of less intense fires to remove brush and small trees, which allows the large trees to survive and grow. The severity of effects of these fires on resources and the ecosystem are usually low or moderate. On the other hand, other ecosystems, such as lodgepole pine forests, rely on less frequent but more intense fires to remove all the trees and regenerate a new stand from seeds dropped by fire-adapted cones. These fires are typically intense, but they are characteristic of the ecosystem and are needed to sustain it.

In 2001 and 2002, as part of the National Fire Plan, the federal agencies, states, and others involved in wildland fire management developed a 10-year strategy and implementation plan to reduce the risks of wildland fire to communities and ecosystems. The strategy established four broad goals for wildland fire management: (1) improving fire prevention and suppression for those areas that need it; (2) reducing hazardous fuels, using both natural and managed fire or mechanical means; (3) restoring fire-adapted ecosystems, both by reducing fuels and rehabilitating burned areas; and (4) promoting community assistance to help conduct all these fire management activities. The implementation plan established specific measures for showing progress toward each of the goals.[7]

[6]While the Federal Wildland Fire Management Policy and the National Fire Plan are distinct efforts, they are complementary. The policy, updated in 2001, provides broad policy for federal agencies, while the National Fire Plan focuses on implementing interagency plans.

[7]To deal with the need for fuel reduction and restoring fire-adapted ecosystems, the departments have drafted a joint fuel reduction policy entitled *Protecting People and Natural Resources: A Cohesive Fuel Treatment Strategy.* The cohesive strategy, although first drafted in 2002, had not been released as of June 2004. It identifies the federal agencies' strategy for dealing with fuel reduction and restoring fire-adapted ecosystems.

Reducing hazardous fuels is one of the key tools for reducing the risks of wildland fires. Evidence from fires, such as that shown in figure 2, encourages managers and scientists to believe that areas treated to reduce vegetation can help to slow down the progress of wildland fires that occur; in addition, the evidence leads managers to believe that treated areas do not suffer as severe effects from burning as they would without the treatment.[8] In addition, researchers have conducted modeling that indicates strategically placed fuel reduction areas can slow the spread of wildland fire across a landscape. Empirical confirmation is needed, although some forests, such as the forests in the Sierra Nevada, are working to apply these ideas in their fuel reduction treatments. Debate continues not only over the effectiveness of treatments, but over the extent and duration of treatments needed. These are areas that federal and university researchers continue to pursue through the Joint Fire Science Program[9] and other research programs. Despite uncertainties related to the effectiveness of fuel reduction treatments, federal and other wildland fire managers believe that they know enough to proceed with treatments in particular areas while research is completed.

[8]See Graham, Russell, et al., *Scientific Basis for Changing Forest Structure to Modify Wildfire Behavior and Severity*, RMRS-GTR-120 (Ogden, Utah, U.S. Department of Agriculture, Forest Service Rocky Mountain Research Station: April 2004).

[9]The Congress established the Joint Fire Science Program in 1998 for the Forest Service and the Department of the Interior to conduct and sponsor research projects aimed at better understanding accumulated fuels and ways to reduce them.

Figure 2: Effects of Wildland Fire in Treated and Untreated Areas Burned by Wildland Fire

Photo (A)

Location 1. shows an aerial view of an area that had been treated with a prescribed burn prior to the Hayman fire in Colorado. The treated area decreased the local intensity of the fire.

Locations 2. and 3. show surrounding aerial views of areas that were untreated prior to the Hayman fire and burned with greater intensity.

Photo (B)

Shows an area at ground-level that was mechanically treated prior to the Hayman fire. Because of the treatment the area burned with low intensity.

(Note: Photos (A) and (B) were taken in September, a few months later after the fire.)

Sources: Forest Service (photos); GAO (presentation).

The Federal Wildland Fire Management Policy requires that federal lands with burnable vegetation have a fire management plan. Of the 750 million acres managed by the Departments of Agriculture and the Interior, the Forest Service and BLM manage 453 million acres of forest and rangeland. Although the Forest Service manages most of the federal forested land in the nation—about 192 million acres—about 55 million acres of BLM's 261 million acres are forested, while the remainder contain grass and shrublands.[10] A fire management plan produced by each forest or BLM field office establishes the objectives, strategies, and resources needed to carry

[10]BLM's lands include about 11 million acres of forested land, which is determined to have commercially viable species, and almost 44 million acres of woodlands, which are determined to be covered in tree species that are not considered commercially viable, such as juniper trees.

out the fire program for that office. The plan divides a forest or BLM field office into smaller fire management units for which fire management strategies, including suppression, prescribed fire, wildland fire use, and nonfire fuel treatments, are coordinated. The forests and BLM offices—in conjunction with other federal agencies—have been directed to complete updated fire plans in 2004.

The Federal Wildland Fire Management Policy also states that each forest and BLM field office should base its fire plan on its land management plan. Both the Forest Service and BLM manage their lands for multiple uses, including timber production, wildlife, recreation, and wilderness uses. Under the National Forest Management Act (NFMA), the law that directs the planning of national forests in the Forest Service, all of the 155 national forests have land and resource management plans for the lands they manage.[11] Generally, these plans divide a forest into smaller management units with specific desired conditions to meet the agency's objectives for the different resources in that area. Similarly, BLM field offices, which are organized under state offices in 12 western states, develop resource management plans under the Federal Land Management Policy Act for the lands they manage. Similar to the national forests' plans, these plans identify the specific desired conditions that will meet the agency's objectives in that area. During the next 8 years, over half of the forests will be updating their land and resource management plans; BLM offices are also in the process of updating their resource management plans. Although many of the existing plans included little or no discussion of wildland fire and its effects, vegetation and fuel conditions, or the tools for managing wildland fire, the new plans will discuss these as appropriate. Currently, each agency's regulations require an environmental impact statement to accompany a plan revision.[12]

[11]Because some forests are grouped with others in administrative units, these forests develop one combined plan. For this reason, 123 forests will revise their resource management plans.

[12]In proposed amendments to its NFMA regulations, the Forest Service would not require the preparation of an environmental impact statement for every plan revision. The agency asserts that it may comply with NEPA by preparing an environmental assessment for plan revisions under some circumstances, or by categorically excluding certain plan revisions from NEPA analysis because not all plan revisions will have significant environmental effects. An environmental group has indicated it will challenge the new planning rule in court. According to the Forest Service, regardless of whether it prepares an environmental impact statement to accompany a forest plan revision, it will conduct environmental analyses for these revisions.

To implement their land and resource management plans, the agencies carry out specific projects—addressing, for example, fuel reduction, timber sales, grazing, habitat improvement, and recreation. Because these projects may cause environmental effects, the agencies generally carry out either an environmental assessment, which is a less detailed analysis, or an environmental impact statement for their proposed projects. These analyses may consider different approaches for carrying out a project—called action alternatives. The agencies may also consider an alternative that involves taking no action—called the no-action alternative. In developing their analyses, the agencies are required to disclose the potential environmental effects of alternatives.

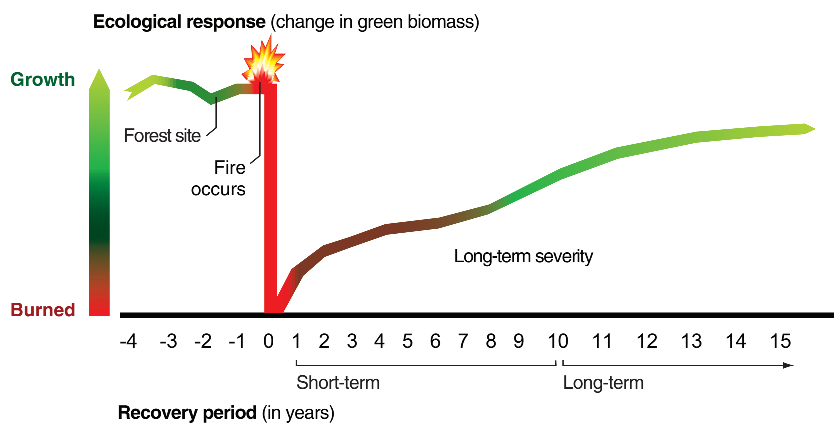
Wildland Fires Have Wide-Ranging Effects on Environmental Resources and Ecosystems, Depending on a Range of Factors

While they burn and afterward, wildland fires have dramatic effects on environmental resources and ecosystems, including the production of large amounts of smoke, the burning of trees and other vegetation, and the erosion of soil into streams and lakes. However, fires can also benefit resources by recycling soil nutrients, renewing vegetation growth, and adding material to streams that improves spawning habitat for fish. The 20 fires included in our survey highlighted the complex, wide-ranging—and sometimes contradictory—effects of fire on both individual resources, such as trees and streams, and ecosystems. For the 20 wildland fires in our survey, the land managers viewed the effects of the wildland fires as adverse, neutral, or beneficial, depending on a number of factors, including when the effects were described—in the short term or the long term—and the type and condition of the vegetation in the area that burned. The managers also reported that the 20 fires had effects across broad landscapes and that these effects varied in severity. The wildland fires in our survey burned over 158,000 acres of federal land in 10 states: Arizona, California, Colorado, Idaho, Louisiana, Montana, Nevada, Oregon, Utah, and Wyoming, with as few as 243 acres and as many as almost 50,000 acres burning in one fire. (See app. III for the definition of severity used in our survey and app. IV for a detailed description of our survey results.)

Fire Effects on Individual Resources Vary in the Short and Long Term

Fire effects can be considered as adverse, neutral, or beneficial depending, in part, on which resource is evaluated and the time frame over which the effects are considered. Fire effects are often described at three times: (1) immediately after the fire; (2) in the short term, which lasts from 1 to less than 10 years after the fire; and (3) in the long term, which lasts 10 years or more after a fire.[13] Unlike fire damage to homes, ecological damages from fire are more difficult to determine immediately after the fire because burned areas look devastated, even when these conditions are part of the natural, fire-adapted cycle. For example, although large, intense fires can kill vegetation in the burned area and generate substantial smoke, some vegetation, such as aspen and native grasses, regrows quickly from root systems. Also, although fires can kill individual animals in the short term, in the long term, many species are attracted to burned areas because of increases in food sources from new plant growth, increased numbers of insects and other prey, or because of increased denning or nesting habitat that dead trees provide. Figure 3 shows, conceptually, the effects and recovery of vegetation after a high-severity wildland fire over the short and long term.

Figure 3: Conceptual Short- and Long-Term Effects on Vegetation After a High-Severity Wildland Fire



Sources: Forest Service (graph); GAO (presentation).

[13]We used the Forest Service's Fire Effects Information System to define short-term effects as those lasting less than 10 years and long-term effects as those lasting 10 or more years.

When we surveyed Forest Service and BLM officials about the effects of the 20 fires that occurred on federal lands, land managers consistently responded that fire effects would be less adverse in the long term than in the short term for each ecological resource, even though their responses differed across resources. Officials identified whether the fire had an adverse, neutral, or beneficial effect on each of several resources in both the short and long term. As shown in table 1, while many land managers in our survey indicated these fires would have adverse effects on individual resources in the short term, fewer responded that the effects would be adverse in the long term. A discussion of the effects on each of the individual resources follows the table.

Table 1: Assessment of Overall Effects on Individual Resources in the Short and Long Term

Resource and time period	Beneficial	Neither beneficial nor adverse	Adverse	No basis to judge, not applicable, or not answered
Air				
Short term	1	7	9	3
Long term	1	1	2	16
Threatened and endangered species habitat				
Short term	4	3	3	10
Long term	3	8	1	8
Other species' habitat				
Short term	5	5	10	0
Long term	9	6	4	1
Soil				
Short term	5	5	10	0
Long term	4	9	7	0
Vegetation				
Short term	10	0	10	0
Long term	8	4	6	2
Water and watersheds				
Short term	11	0	9	0
Long term	6	9	5	0

Source: GAO survey of Forest Service and BLM land managers.

Notes: Because the officials provided answers about the effects of a fire on each resource, the columns do not add to 20.

The responses are based on the opinions of land managers.

Effects on air: Although officials reported that nine fires in our sample had adverse short-term effects on the air, only two expected long-term adverse effects on air quality, while many did not indicate what long-term effects these fires had on the air. For example, although the Pony Express II fire in Nevada released an estimated 54 tons of particulate matter into the air when it burned, BLM officials did not expect any long-term effects from this fire on air quality because the burned area is far from homes or towns and there are no nearby sources of air pollution that might have a cumulative effect.

Effects on threatened and endangered species habitat: Agency officials reported that 10 of the fires in our sample had no identifiable effect on threatened and endangered species habitat in the short term. Similarly, the majority of the fires had either no identifiable long-term effect on the habitat of these species or had a neutral effect. Eight threatened and endangered species inhabited the areas covered by 5 fires in our sample, including the Canada lynx and the Northern spotted owl. (See table 10 in app. IV.) Officials indicated that although none of the fires in our sample posed a threat to the survival and recovery of a threatened or endangered species population in the short term, these 5 fires had at least some local impact on a threatened or endangered species or its habitat. Fires have complex effects within and among populations of endangered species because their effects on habitat can both negatively and positively influence their chances of survival. For example, a nearly 2,500 acre fire in Louisiana's Kisatchie National Forest had a negative effect on the red-cockaded woodpecker's nesting habitat, while improving its foraging habitat by thinning vegetation—a factor the Forest Service official reported is likely to aid in its recovery. During site visits, Forest Service officials in Montana told us that the effect of a wildland fire on endangered fish, such as the bull trout, depends more on whether the affected streams are contiguous to other streams than on the fire itself. Locally, some fish may be killed, but if streams are well connected, other fish can find refuge by migrating away until the fire is over and then returning to recolonize burned areas. On the other hand, isolated fish populations living in an environment without these critical stream linkages are likely to be very vulnerable to fire. For example, in Arizona after the Aspen fire in 2003, the Fish and Wildlife Service removed the endangered fish, the Gila chub, from isolated reaches of Sabino Creek near Tucson to prevent it from being killed by potential runoff from burned lands.

Effects on other species' habitats: Agency officials reported that 10 fires had adverse effects on other species' habitat in the short term, while 5 fires had beneficial effects. In some cases, officials indicated that the loss of vegetation caused a loss of cover and habitat for species such as the sage grouse, which is a species that concerns land managers. However, officials stated that fires had beneficial effects on grasses by increasing their productivity, in turn providing forage for grazing animals. In the long term, officials reported that 9 fires had a beneficial effect on species' habitat, while 6 had neutral effects. For example, officials stated that although short-term effects may be adverse, the return to a historic fire regime increased the diversity of vegetation and would ultimately help species like the snowshoe hare.

Effects on soil: While officials reported that 10 fires had adverse effects on soil in the short term, they reported that 9 fires had neutral effects in the long term. For example, officials indicated that the short-term loss of vegetation cover after the Horse Creek fire would cause soil erosion and loss. In the long term, officials reported that most effects on soil would diminish, although an official reported that soil erosion after the Pony Express II fire would decrease soil productivity in intensely burned areas, and another official indicated that soil productivity would be increased because of increased organic matter released in the Sheep Mountain fire.

Effects on vegetation: Officials reported that, in the short term, 10 fires had beneficial effects on vegetation, while 10 fires had adverse effects. For example, BLM officials described the mix of burned and unburned areas within the perimeter of the Sheep Mountain fire in Wyoming as beneficial because it created a mosaic of vegetation types of different ages, with more grasses growing in burned areas. After another fire, however, officials stated that the fire had removed native vegetation and allowed the spread of cheat grass. In the long term, officials viewed 8 fires as having beneficial effects, while 6 had adverse effects. For example, officials described the Missionary Ridge fire as helping to return the long-term balance of different vegetation. Officials indicated that other fires would increase the chance of invasive species to spread.

Effects on watersheds: Nine of the fires in our sample had adverse effects on water and watersheds in the short term, while 11 had beneficial effects. In the long term, officials reported that 9 fires will have neutral effects and 5 fires will likely cause adverse effects to water and watersheds. Of the 20 fires, 3 severely burned 10 watersheds that supply domestic water to municipalities or towns, and in two cases, officials said the fires had a negative effect on water quality that lasted from 3 to 5 years. In areas burned by 8 fires, floods, debris flows, or landslides occurred within the fire perimeter, yet the long-term effects of fire on water and watersheds are expected to be more neutral as these effects subside. For example, although the Horse Creek fire in Oregon resulted in a short-term increase in the sediment in stream channels, BLM officials reported that the sedimentation will decline as vegetation recovers and sediment deposited into the channels will be moved downstream by natural stream flows in the long term.

Effects of Wildland Fire Vary Depending on Topography, Climate and Weather, and Vegetation Conditions

Researchers and land managers describe fire effects using levels of severity: low severity, moderate severity, and high severity. (See app. III for the definition of severity used in our survey.)[14] The severity of effects depends on the intensity of the fire—the amount of heat released in a fire—and its duration in relation to the historic fire regime. The intensity of a fire depends on its topography, climate and weather, and vegetation or fuels. First, topography includes locally unique site properties, such as the slope of the terrain, the direction in which the ground slopes, and the soil moisture, each of which affect how intensely a fire burns. For example, fires burn faster and more intensely on steep slopes, which allow a fire to move uphill driven by winds, and on south-facing slopes, which are drier than north-facing slopes. Second, climate and seasonal weather conditions such as drought cycles and high winds also determine how a fire will burn and how severe the effects of burning will be. Climate and weather also determine the extent to which storms occur after a fire; stronger and more frequent storms can result in increased erosion and landslides. Finally, the type and condition of vegetation in an area determines how much "fuel" is available to burn and thus how intense a fire will be and how severe its effects may be. For example, rangelands have less vegetation, and therefore lower amounts of fuel to burn, than forested areas. Furthermore, areas with accumulated vegetation have more fuels to burn than they would under more natural conditions.

Whether or not the environmental effects of a wildland fire are considered as adverse, neutral, or beneficial depends on the degree to which vegetation conditions have been changed from the historic fire regime in an area. For example, a fire that burns in a high- elevation forest filled with spruce and fir trees—a fire regime that historically has fewer but more

[14]Fire or burn severity is a term that qualitatively describes how fire affects vegetation and soil. It is a term that refers to how much of the vegetation or soil is consumed in the fire rather than a term that describes the beneficial or adverse nature of the effects.

intense fires, with more severe effects—is less likely to have adverse effects to the environment and that ecosystem than an uncharacteristically intense wildfire that burns in an ecosystem in which frequent, low-intensity fires occurred historically, such as ponderosa pine. Forest Service and BLM scientists and land managers describe areas in which vegetation has accumulated abnormally or has been altered as having uncharacteristic vegetation and fuel conditions and areas in which vegetation has accumulated at normal levels or not been altered as having characteristic vegetation and fuel conditions. Likewise, they describe fires that are similar to those that occurred under an area's historic fire regime as characteristic and those that are not similar to the historic fire regime as uncharacteristic. Characteristic fires tend to have effects on the environment and ecosystems that are appropriately severe for that vegetation type and fire regime, and which are therefore not considered negative, whereas uncharacteristic fires usually have unexpectedly severe environmental effects, which are often considered negative. Of the 20 fires included in our survey, 10 burned with predominantly characteristic effects, 3 burned with a mix of characteristic and uncharacteristic effects, and 7 burned with predominantly uncharacteristic effects. Table 2 shows that of the 10 fires with predominantly characteristic effects, 6 occurred in areas in which vegetation conditions experienced low levels of alteration or accumulation, and the remaining 4 occurred in areas with moderate levels of vegetation alteration or accumulation. Fires that resulted in both mixed and uncharacteristic effects occurred only in areas in which vegetation conditions were moderately or highly altered or accumulated (see table 2).

Table 2: Description of Characteristic and Uncharacteristic Fire Effects and Vegetation Conditions

Fire	Federal acres burned	Vegetation conditions, amount of alteration: Low	Medium	High	Characteristic (+) Mixed (+/-) Uncharacteristic (-)
Sheep Mountain (Wyoming)	21,370	x			+
Burgdorf Junction (Idaho)	17,207	x			+
Elko 13/#3 (Nevada)	12,544		x		+
Abert (Oregon)	10,100		x		+
Stables (California)	4,162	x			+
Horse Creek (Oregon)	1,839	x			+
Pony Express II (Nevada)	1,806	x			+
Crusoe (Nevada)	1,386	x			+
Elk Mountain (Montana)	667		x		+
Y-Mountain (Utah)	437		x		+
Missionary Ridge (Colorado)	49,990			x	+/-
Rough Diamonds (Idaho)	7,268		x		+/-
Springer (Arizona)	666		x		+/-
Crimson Clover (Idaho)	14,466		x		-
Boulder Hills (Montana)	5,400			x	-
Cow Hollow (Oregon)	3,022			x	-
Longleaf Vista (Louisiana)	2,497			x	-
Tipton Ranch (Nevada)	2,025			x	-
Hyampom (California)	1,053			x	-

(Continued From Previous Page)

Fire	Federal acres burned	Vegetation conditions, amount of alteration: Low	Medium	High	Characteristic (+) Mixed (+/-) Uncharacteristic (-)
Horse (Idaho)	243		x		-
Total acres	**158,148**				

Source: GAO survey of Forest Service and BLM land managers.

Notes: This sample cannot be projected to all wildland fires.

The responses are based on the opinions of land managers.

As table 2 shows, the third largest fire in our sample, the Burgdorf Junction fire in Idaho, had characteristic effects. For this reason, Forest Service officials considered the majority of the effects from this fire to be beneficial, even though the fire burned more than 17,000 acres of federal land, including areas that provided habitat for several threatened and endangered species. Overall, the officials considered the fire effects to support processes for maintaining the ecosystem, which includes lodgepole pine and Douglas fir forests. For example, officials stated that the debris flows from the fire introduced gravel into streams, providing new spawning grounds for fish. In addition, officials stated that burned areas of the lodgepole forest were turned into more open stands of brush and grasses, improving gray wolf and lynx habitat.

Of the three fires that officials identified as having a mix of characteristic and uncharacteristic effects, one—the Missionary Ridge fire in Colorado—was the largest fire included in our sample. Forest Service officials noted that the adverse effects of the fire in the short term included numerous floods and debris flows, which affected the water quality of streams supplying water to surrounding municipalities. They also indicated that in areas where the fire burned uncharacteristically, long-term adverse effects on streams included destabilized banks and loss of riparian area. On the other hand, the officials noted that in areas where the fire burned characteristically, changes to the streambed and riparian areas would not be adverse over the long term.

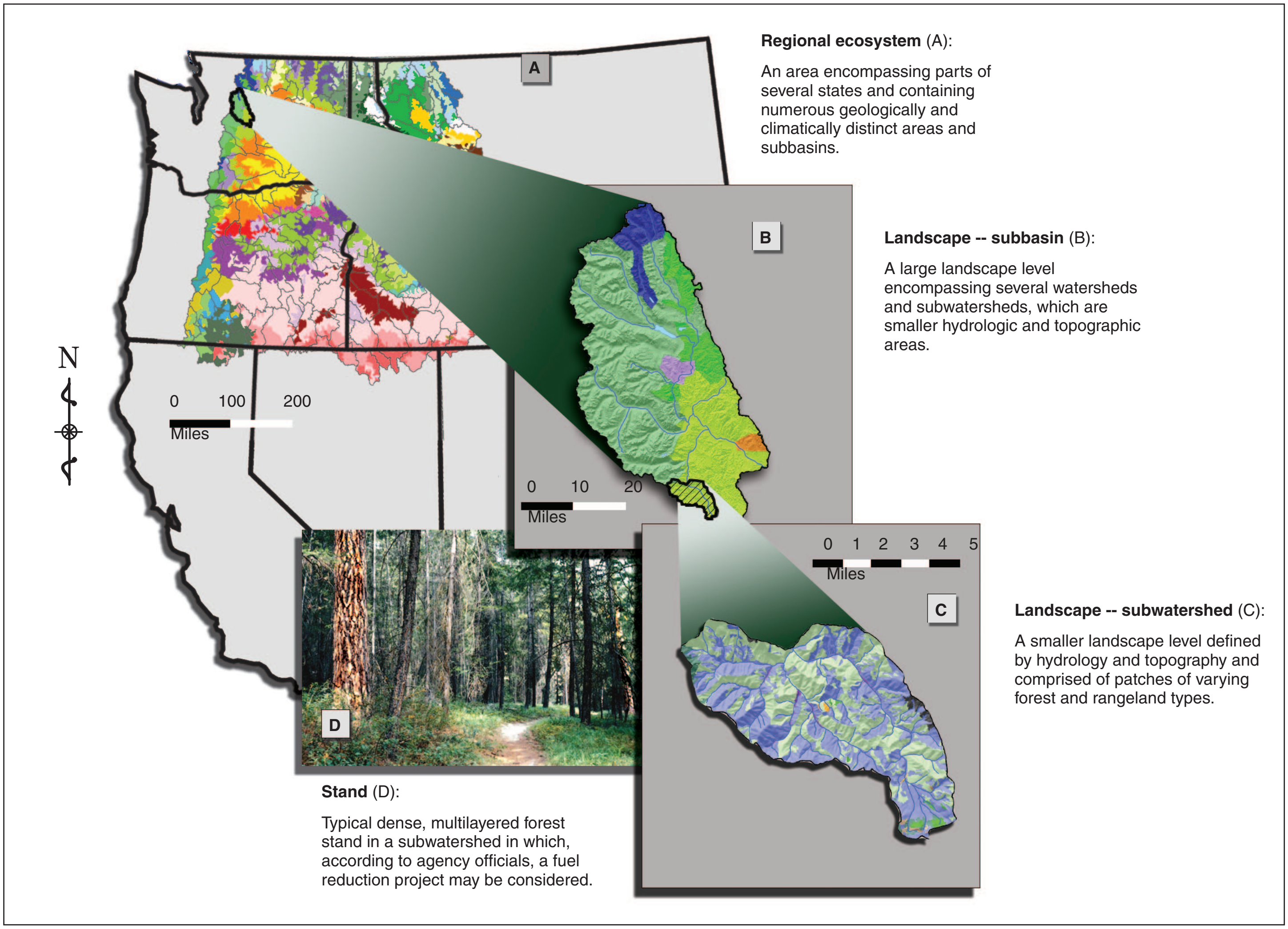
Of the seven fires with uncharacteristic effects, Forest Service officials identified the smallest fire in our sample—the Horse fire of 243 acres—as having adverse effects on resources. A Forest Service official reported that this fire in Idaho's Salmon-Challis National Forest had immediate adverse effects on the vegetation because of the size of the severely burned area, although he believed that in the long term, fire-killed trees might benefit the

Canada lynx by providing denning areas. Similarly, BLM officials viewed the 2,025-acre Tipton Ranch fire in Nevada as having adverse effects on vegetation because the fire exacerbated the conversion of native plant species such as grass and sage brush to invasive grasses such as cheat grass. Our survey showed that the number of acres vulnerable to population by noxious and invasive plant species such as cheat grass—which competes with native vegetation and alters the historic fire regime—after the 20 fires increased from about 32,130 acres to about 58,800 acres (83 percent). Several officials raised concerns about the spread of such invasive species as cheat grass into sagebrush-grass and pinyon-juniper vegetation types because it is highly flammable, and areas dominated by it may burn frequently. More frequent fires in such ecosystems may eliminate the native plants such as sage brush, which is important habitat for sage grouse.

Fires Have Broad Landscape Effects

In addition to its effects on individual resources such as soil, water, and air, fire creates landscape patterns to the extent that it burns large areas and leaves other areas lightly burned or unburned. As shown in figure 4, landscapes are geographic areas of varying sizes, encompassing tens of thousands of acres or more, that may contain smaller landscapes and interacting and interconnected ecosystems that are defined by geological, soil, climate, and other physical factors. Landscapes are separated by natural features, including watersheds, such as the example in figure 4 from the Interior Columbia Basin, and encompass different stands of trees and, in some ecosystems, patches of open areas among the stands of trees. Landscapes may include a mix of government and private lands and may cross state boundaries.

Figure 4: Relationship of Ecosystem and Landscape Levels

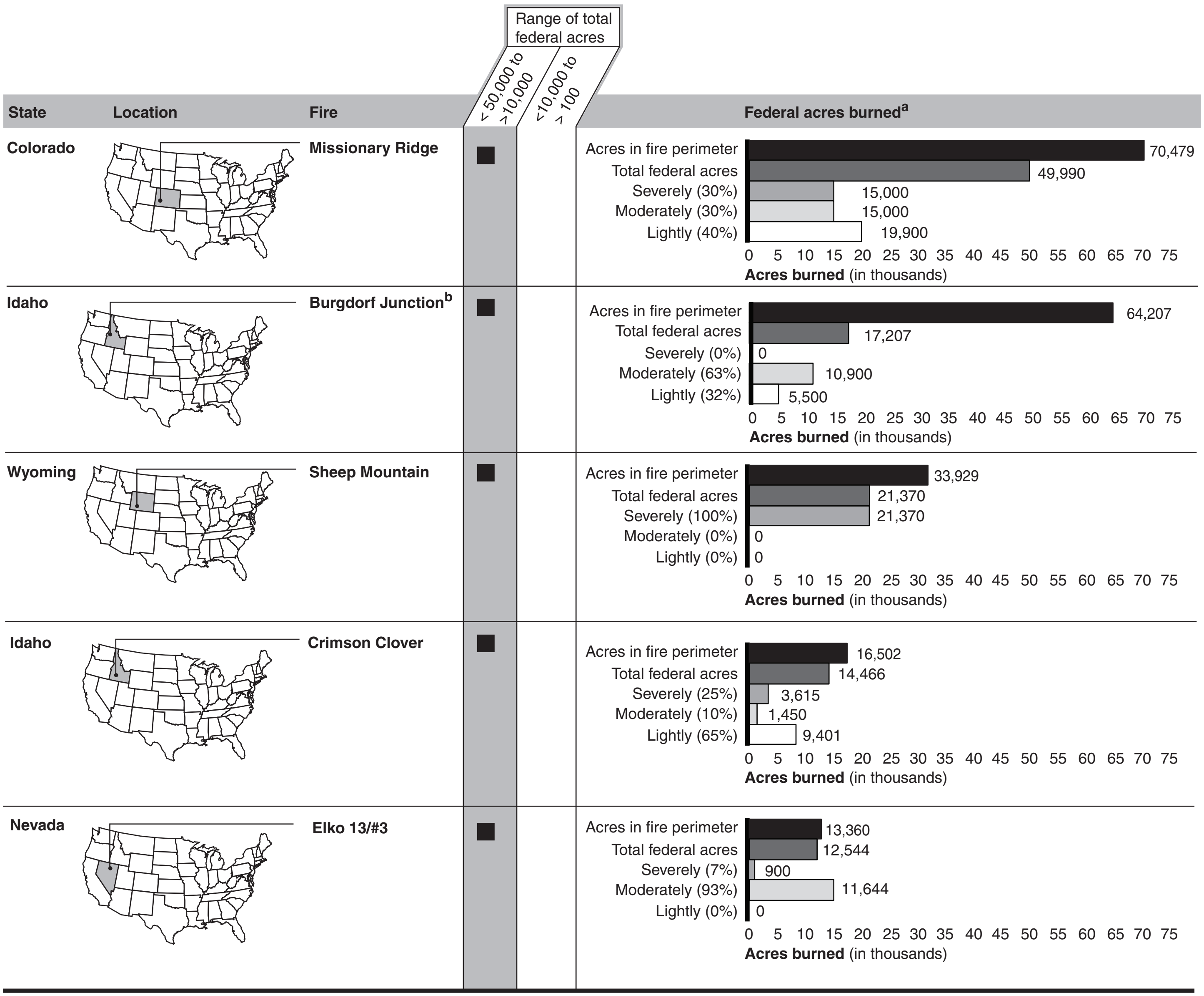


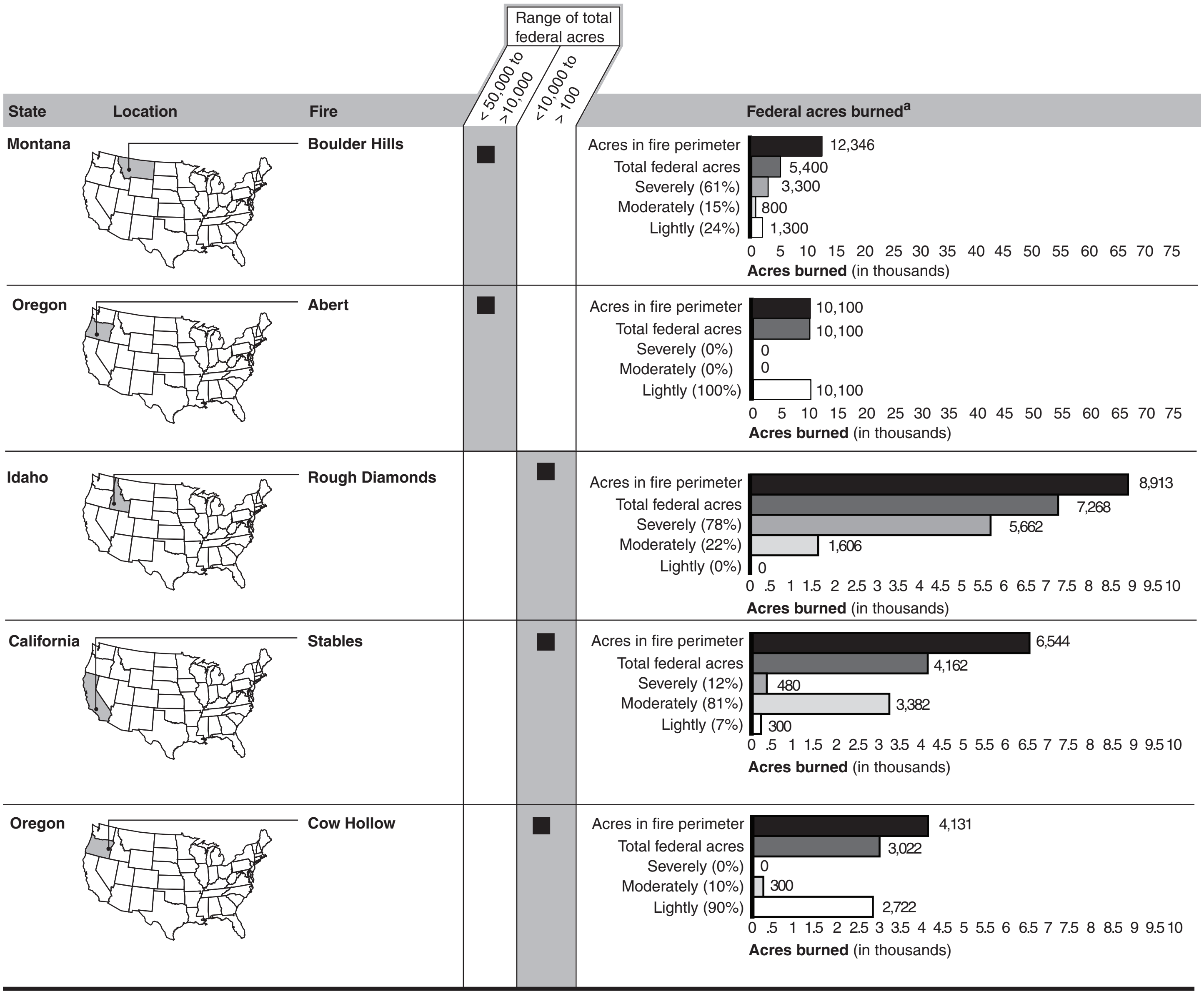
Sources: Forest Service, Pacific Northwest Research Station, Wenatchee Forestry Sciences Laboratory (graphic); GAO (adaptation).

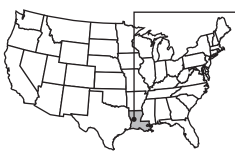
The landscape effects of fire include the patterns, or patches, of vegetation that are burned with varying degrees of severity, including some that are not burned at all. Under natural conditions, when fires burn some areas severely and other areas lightly or not at all, they create irregularly sized openings in vegetation layers, changing the size, shape, and age of the vegetation in those patches. These landscape effects, which reflect the degree of environmental change from burning and affect other environmental resources accordingly, can be described as being of low, moderate, or high severity. Under natural conditions, fires with low-severity effects are those that kill the least amount of vegetation; some burned areas may appear much like the unburned forest. Fires with moderate-severity effects are those in which vegetation is killed but some trees remain standing; the regeneration that occurs after the fire results in stands of trees of different ages. Fires with high-severity effects are those in which most of the trees and vegetation are killed over large areas, leaving open areas in which the tree stands that regenerate will be the same age. Ecosystems in which vegetation and fire are characteristic, or fire-adapted, are resilient, and the landscape reflects the functioning of interdependent plant and animal communities. In ecosystems in which vegetation and fire are uncharacteristic, fire severity can exceed the capacity of the ecosystem to regenerate, and the landscape reflects changes to the plant and animal communities that used to exist there.

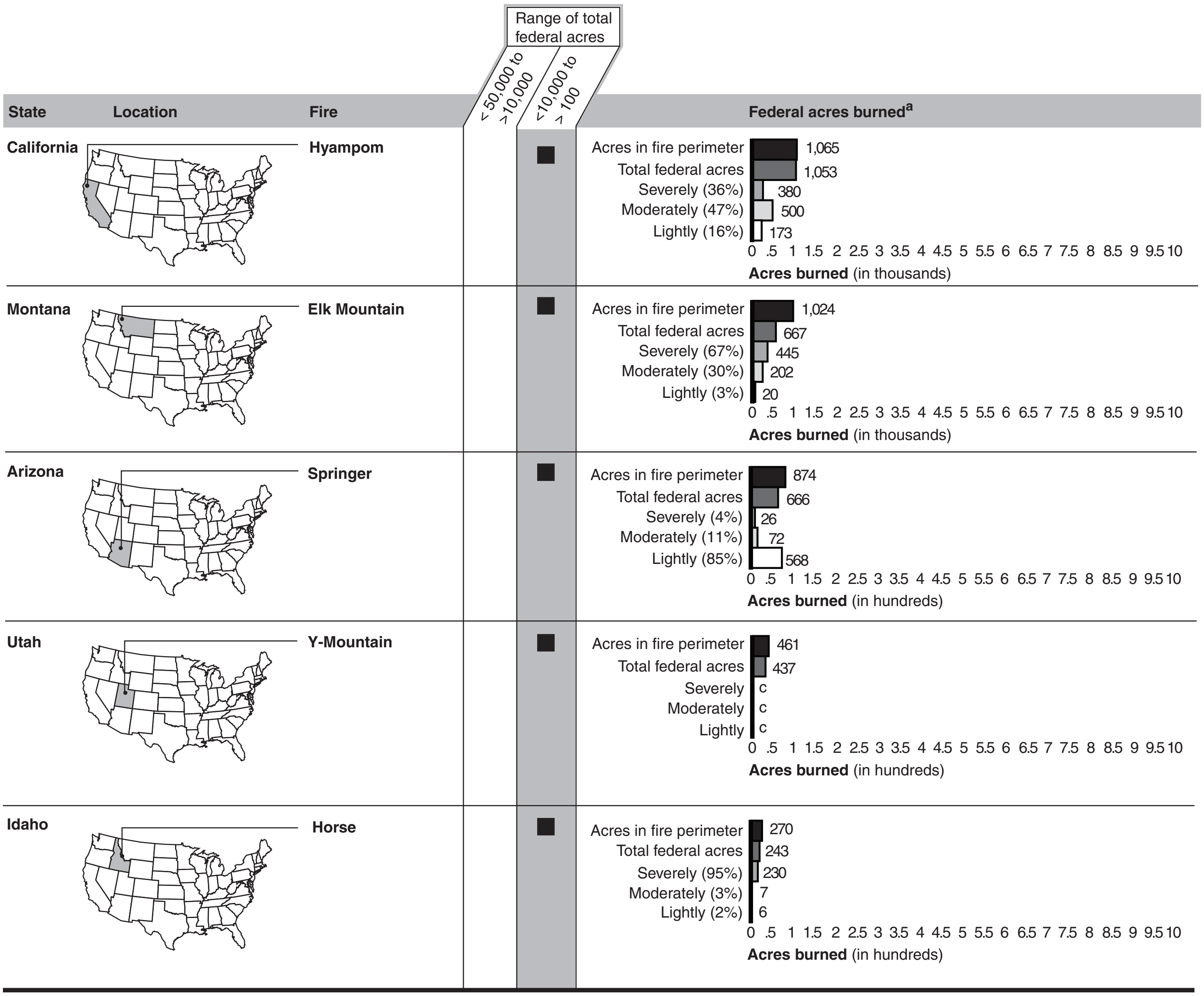
Figure 5 shows the range of burn severity patterns attributed to our sample of 20 fires. Of the 7 fires with uncharacteristic effects in our survey, the most frequent reason officials cited for a fire to be considered uncharacteristic was not the size of the fire, but the size of the patches the fire had burned severely. The fires demonstrate a wide variety of burn severity patterns within two extremes. While Wyoming's Sheep Mountain fire severely burned 100 percent of the federal lands within its perimeter, all of the federal acreage burned by Oregon's Abert fire burned at low severity.

Figure 5: Acres of Vegetation Burned Lightly, Moderately, and Severely in 20 Sample Fires




Range of total federal acres
< 50,000 to >10,000
<10,000 to > 100
State
Location
Fire
Federal acres burned[a]
Montana
Boulder Hills
Acres in fire perimeter 12,346
Total federal acres 5,400
Severely (61%) 3,300
Moderately (15%) 800
Lightly (24%) 1,300
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
Acres burned (in thousands)
Oregon
Abert
Acres in fire perimeter 10,100
Total federal acres 10,100
Severely (0%) 0
Moderately (0%) 0
Lightly (100%) 10,100
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
Acres burned (in thousands)
Idaho
Rough Diamonds
Acres in fire perimeter 8,913
Total federal acres 7,268
Severely (78%) 5,662
Moderately (22%) 1,606
Lightly (0%) 0
0 .5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10
Acres burned (in thousands)
California
Stables
Acres in fire perimeter 6,544
Total federal acres 4,162
Severely (12%) 480
Moderately (81%) 3,382
Lightly (7%) 300
0 .5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10
Acres burned (in thousands)
Oregon
Cow Hollow
Acres in fire perimeter 4,131
Total federal acres 3,022
Severely (0%) 0
Moderately (10%) 300
Lightly (90%) 2,722
0 .5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10
Acres burned (in thousands)

State	Location	Fire	Range of total federal acres: < 50,000 to >10,000	Range of total federal acres: <10,000 to > 100	Federal acres burned[a]
Oregon		Horse Creek		■	Acres in fire perimeter: 3,763 Total federal acres: 1,839 Severely (49%): 900 Moderately (51%): 939 Lightly (0%): 0 Acres burned (in thousands)
Louisiana		Longleaf Vista		■	Acres in fire perimeter: 2,500 Total federal acres: 2,497 Severely (56%): 1,400 Moderately (38%): 950 Lightly (6%): 147 Acres burned (in thousands)
Nevada		Tipton Ranch		■	Acres in fire perimeter: 2,031 Total federal acres: 2,025 Severely (0%): 0 Moderately (90%): 1,825 Lightly (10%): 200 Acres burned (in thousands)
Nevada		Pony Express II		■	Acres in fire perimeter: 1,806 Total federal acres: 1,806 Severely (64): 1,151 Moderately (0%): 0 Lightly (36%): 655 Acres burned (in thousands)
Nevada		Crusoe		■	Acres in fire perimeter: 1,386 Total federal acres: 1,386 Severely (30%): 415 Moderately (66%): 921 Lightly (4%): 50 Acres burned (in thousands)



Source: GAO survey of Forest Service and BLM officials.

[a]Percentages may not add to 100 because of rounding.

[b]Percentages do not add to 100 because the method used to measure burn severity did not always distinguish unburned acres. Acres in the fire perimeter include only federal acres.

[c]Survey respondent indicated these values are unknown.

Forest Service and BLM Do Not Gather Comprehensive Information on the Varied Effects of Wildland Fires on Ecosystems and Landscapes

Although the National Fire Plan established a goal of restoring forest and rangeland ecosystems to conditions that are more fire-adapted, and therefore more resilient to fire, land managers do not have comprehensive data on the broad landscape effects of wildland fire to help them monitor these effects over time. While the Forest Service and BLM gather information on the severity of environmental effects from individual wildland fires, they do not gather data that captures the long-term severity of fires across landscapes. Through emergency stabilization programs, the forests and BLM field offices gather information on the effects on soils and watersheds to estimate the likelihood that soil disturbances caused by individual fires will result in flooding and landslides. However, while the agencies' data collection efforts include fire histories—that is, the occurrence, location, and size of fires—they do not have a monitoring plan to gather landscape data across fires and they do not yet consistently map the long-term, landscape-level severity of wildland fires. This data would help the agencies to assess whether, over time, fires in forest and rangeland ecosystems are burning with more or less severe effects and whether they are being restored to more resilient, or fire-adapted, conditions.

Forest Service and BLM Collect Data on the Environmental Effects of Individual Fires to Help Them Restore and Rehabilitate Burned Lands

Although the Forest Service and BLM are generally not required to gather environmental data on the effects of wildland fires, the agencies' field offices do collect data that indicate the potential for flooding, erosion, and landslides to occur in the short term after a fire for the purpose of treating areas that need emergency stabilization. Both the Forest Service and BLM use multidisciplinary teams of experts, such as ecologists and soil scientists, to gather and review data on individual fires that have altered conditions enough to warrant the emergency stabilization. These teams—called Burned Area Emergency Response (BAER) teams by the Forest Service and Emergency Stabilization and Rehabilitation (ESR) teams by BLM—gather data on vegetation, soils, and stream channels and evaluate burn severity and erosion hazard potential in areas affected by fire. Both agencies use this evaluation process to assess the potential emergency and identify appropriate treatments to stabilize areas and to protect homes and other values at risk, such as roads. The data are reported and maintained in fire-specific files in the forest and BLM field offices.

Although the BAER and ESR reports do not address the long-term effects of fires, the Forest Service and BLM generally collect more extensive data on the effects of large fires affecting areas where they plan to conduct rehabilitation or restoration work.[15] The Forest Service uses a variety of funds, including funds raised from salvaging dead and damaged trees, to pay for rehabilitation work. When the forest staff identify fire-damaged areas that they wish to rehabilitate, they gather data on environmental resources for the purpose of developing an environmental assessment or environmental impact statement for a salvage sale and associated rehabilitation or restoration projects. For example, the staff at Bitterroot and Sequoia National Forests determined that they would conduct rehabilitation projects for very large fires that occurred on their lands in 2000—the Bitterroot fires and the McNally fire. In the case of the Bitterroot fires, the forest staff collected extensive data, including detailed information on soil and watershed characteristics, vegetation, wildlife and wildlife habitat, and noxious weeds. During and after the McNally fire in central California, the Sequoia National Forest staff gathered similar data on the fire's effects and measured the smoke output from the fire and its effect on air quality. Because the rehabilitation of rangelands that have burned often involves seeding the burned sites with fast-growing grasses to retain soils and forage for wildlife, BLM receives funding to pay for such work. Field office staff collect data on these rehabilitation needs as part of their rehabilitation efforts; the data collected under this program includes data on topography, soils, native and non-native plants, wildlife habitat, and threatened and endangered species that inhabit the project area.

Furthermore, some forest and BLM staff, after years in which numerous fires have occurred, have developed special reports on the effects of the different fires across the region. For example, the Intermountain and Northern Regions of the Forest Service[16] assessed the extent and effects of the large wildland fires these areas experienced during 2000. They collected data on the (1) number of air quality advisories to communities affected by the many fires involved; (2) flooding and sediment in streams

[15]The Forest Service and BLM typically conduct emergency treatments in the first year after a fire. Within the first 3 years after a fire, the agencies conduct rehabilitation work, and after the third year, the agencies conduct restoration work.

[16]These regions include Idaho, Montana, Nevada, North Dakota, Utah, and portions of South Dakota and Wyoming. U.S. Department of Agriculture Forest Service, *A Preliminary Assessment of the Extent and Effects of the 2000 Fires* (Intermountain and Northern Regions, 2000).

with native fish species, such as cutthroat and bull trout; and (3) adverse effects to sage grouse habitat. In addition, after a number of fires in 1999 burned about 1.7 million acres in portions of four states that comprise the Great Basin—Idaho, Nevada, Oregon, and Utah—BLM issued[17] a general report on the fires' combined effects on this large geographic area. As part of this effort, BLM assessed the role wildland fire has played over time in the Great Basin—changing some healthy rangeland ecosystems populated by native plants into systems dominated by annual weeds, such as cheatgrass. According to the report, because this annual grass provides little or no cover or food for wildlife, sage grouse populations had decreased by more than one-third, a factor in the grouse's possible consideration for listing as a threatened and endangered species.

Agencies' Data Collection Does Not Address Long-Term Landscape Severity of Wildland Fire Effects

Over the long term, as the National Fire Plan and its activities are implemented, the Forest Service and BLM will need landscape data on wildland fire effects, including fire severity, to monitor whether they are restoring and maintaining fire-adapted ecosystems. Because wildland fires and the severity of their effects vary across different landscapes and ecosystems, land managers and scientists need data on the severity of effects to understand whether the severity of fires is changing, and therefore whether vegetation conditions need to be managed differently. A monitoring plan would provide the means for gathering consistent and comprehensive data over the long term on fire trends and severity. The agencies have started to develop systems and methods to gather the needed data including: (1) vegetation data, (2) historical fire and severity data, and (3) current severity data. However, they do not yet have the full capability to gather and use these data. When these data are integrated and assessed, they will provide the Forest Service and BLM with information on the historical fire regime that occurred in a given area and the expected fire severity. With such data, the agencies will have a baseline to determine whether fire severity is changing because of vegetation and fuel conditions.

While the Forest Service and BLM use several different methods to gather information on vegetation conditions, they are working to develop a system of protocols and procedures to gather consistent nationwide data. Satellite images are currently used to provide data for individual forests and BLM offices to use in assessing their vegetation conditions. However, the Forest

[17] Bureau of Land Management, National Office of Fire and Aviation, *Out of the Ashes, an Opportunity* (Boise, Idaho, 1999).

Service and BLM, as part of an interagency effort to gather consistent national data on vegetation conditions and related fuel conditions, are developing a database and related modeling tools called LANDFIRE to gather satellite data, interpret it, and compare and validate the data with data from actual sites on the ground. Satellite images capture data on thousands of acres or more, providing a landscape-level view of the resources for land managers. (See app. V for a discussion of the recording and use of satellite data.) When it is completed, LANDFIRE is expected to provide land management agencies with maps of their vegetation that, when combined with data on the physical conditions of the same areas, will show the natural vegetation cover type that should exist on the areas. The Departments of Agriculture and the Interior funded the implementation of the system in 2004 and expect it to be completed for western states in 2006, for eastern states in 2008, and for the entire nation in 2009. In the interim, the agencies will use data that are already available.

In addition to vegetation data, historical fire and severity data are important for the agencies to understand the landscape severity of current fires. While the national forest and BLM field office staff collect historical fire data, including the occurrence, location, and size of wildland fires that have burned across a landscape, they do not consistently collect this data or data on the severity of effects for individual fires. Of the 13 forests and BLM offices we visited during our review, most were collecting severity data for large fires, but only one office had these data in a geographic information system database. A national database of fire history and severity data would help the agencies identify and monitor the actual effects of fire on vegetation and ecosystem conditions. While the Wildland Fire Leadership Council adopted a monitoring framework that includes fire severity in May 2004, it has not yet been implemented. The agencies are currently developing cost estimates and specific plans for implementing the framework.

Finally, while the forest and BLM field offices gather some data on severity of fires that burn on their lands, the agencies do not consistently collect data on burn severity that reflect the long-term effects of fires. The agencies use a mix of ground, aerial, and satellite data to measure the burn severity of different fires; however, the satellite data that they typically gather are better suited to show the short-term effects of wildland fire. The Forest Service and BLM generally compile satellite images taken a year before the fire and immediately after it to help them estimate the emergency stabilization needs of the area. In contrast, another approach to measuring severity involves comparing one satellite image taken immediately before a fire and another about a year after to more accurately estimate the long-term ecological effects of the fire. This approach, developed by the National Park Service in an effort to measure the long-term effects of fire, includes factors that affect the recovery of an area over the long term, such as the number of seeds that remain in the soil, the proximity of seed sources from unburned areas, slope, soil moisture, and the amount of erosion that may occur. Although this approach has been used successfully on Park Service lands and by some forests and BLM offices, its use in evaluating Forest Service and BLM lands has not been widely tested. One of the applications that is still being developed and tested is the ability to update vegetation maps from the severity maps. This application could be useful in updating vegetation maps, including those that will be created by the LANDFIRE system once it is completed. If it is implemented as planned, LANDFIRE's vegetation maps will be available to the forests and BLM offices about every 5 years. According to the National Park Service, this approach has been used to update some of the parks' vegetation maps, thereby maintaining their usefulness in tracking progress in managing vegetation conditions and planning management activities.

The Forest Service and BLM Do Not Systematically Assess the Risks to Environmental Resources and Ecosystems to Target and Conduct Fuel Reduction Activities

Although the National Fire Plan identifies the need to reduce the risk of environmental and ecosystem effects from wildland fires by targeting fuel reduction activities to the areas that face the greatest potential losses, the Forest Service and BLM do not systematically assess the risks to resources and ecosystems for the purpose of targeting fuel reduction projects. Because wildland fires affect both large landscapes and individual resources at specific sites, it is important to assess risk at both the broad landscape level and the more specific project-planning level. At the landscape level, the Forest Service and BLM do not have a common framework that includes the three elements for assessing risks: hazard, risk, and values. At the project level, although the agencies have recognized the need to better analyze the relative risks of undertaking fuel reduction activities versus not doing so, they do not have a systematic approach to assess these risks. Because they lack a systematic risk-based approach for targeting their fuel reduction projects across a landscape and within a project area, the agencies cannot ensure that they are reducing fuels in areas of highest risk to environmental resources and ecosystems.

A Risk Assessment Framework Would Systematically Analyze Hazard, Risk, and Values

In general, risk assessment is a process for evaluating a natural hazard, such as wildland fire, as well as the probability of the hazardous event occurring and the consequences or potential losses that would result if the event did occur. According to the National Academy of Public Administration, a systematic approach to risk assessment involves three elements:

Hazard: A hazard is the potential event, such as a wildland fire, hurricane, or earthquake, and the conditions that cause it. In the case of wildland fire, both the fuel conditions that exist and the fire itself are the hazard. According to scientists and land managers, the increased vegetation in different ecosystems around the country has become more continuous and dense, resulting in larger fires that burn more intensely. For example, the Tyee fire burned 140,000 acres in Washington in 1994, in part because excess vegetation had grown into areas that, under natural conditions, would have less vegetation to act as fuel for the fire.

Risk: Risk is the probability that an event such as a wildland fire will occur. By mapping the number and location of fires, scientists have discovered that some areas are more prone to fires than others. For example, Florida and the western states are more likely to experience wildland fire than the states along the East Coast and in the Midwest. Wildland fire ignites either because of lightning strikes, which occur along storm paths and prominent landscape features, such as mountain ridges, or because of human activities, such as camping, logging, agricultural burning, and careless smoking.

Values: In general, values are the things that might be lost or damaged because of a hazard. In the case of wildland fire, social values that might be lost include the lives of both civilians and firefighters, cultural and historical resources, and artifacts and sacred sites. Economic values that might be lost include property and other infrastructure, resources such as timber and water, and recreation and tourism opportunities. In the case of environmental values, however, wildland fire can both damage and improve different environmental resources and ecosystems. The values that might be affected include ecosystems, species and their habitat, air and water quality, and soil and vegetation.

To prioritize areas needing fuel reduction, all three elements—hazard, risk, and value—need to be considered and ranked because, for example, an area with high vegetation hazard may or may not be in an area where fires are likely to occur, making it a lower priority for treatment. Furthermore, a high hazard area may not be close to something of value that would be lost or damaged in a fire, also making it a lower priority for treatment. The National Fire Plan calls for the Forest Service and BLM to collaborate with state, local, and tribal entities in making decisions about what specific areas are in need of fuel reduction treatment. An assessment of hazard, risk, and values can form the basis for informing this collaborative approach.

According to the National Academy of Sciences' National Research Council, a risk assessment supports decisions that need to be made.[18] For this reason, a framework for assessing the risks of effects from wildland fires would also identify the types of decisions that need to be made at different organizational levels—the national, landscape, and project levels—and the risk information required to make the decisions. For example, in the case of fuel reduction activities, the types of decisions that need to be made at the national level include how many resources to allocate per year to reduce risk. Landscape-level decisions include determining which parts of the landscape are at the greatest risk of wildland fire and its potential effects. Project-level decisions include making tradeoffs among alternatives and their different effects.

Forest Service and BLM Lack a Framework for Assessing Risks to Ecosystems Across Landscapes to Target Fuel Reduction Activities

The Forest Service and BLM have not adopted a framework to systematically assess the risks of environmental effects of fires to support their fuel reduction efforts. Without addressing the three elements of a risk assessment—hazard, risk, and value—the agencies do not have a systematic way to target their fuel reduction activities across a landscape. The Forest Service and BLM nationwide assessment of vegetation, or fuel, conditions, conducted in 2000 and updated in 2002, addressed only one element of a risk assessment—hazard. Because of the need to prioritize their fuel reduction efforts, some Forest Service and BLM field offices have conducted assessments that include one or more elements of a risk assessment. However, these efforts are informal, incomplete or uncoordinated and therefore do not systematically address the need to identify and reduce ecosystem risks.

[18] Paul C. Stern and Harvey V. Fineberg, eds., *Understanding Risk: Informing Decisions in a Democratic Society* (Washington, D.C.: National Research Council, 1996).

Nationwide Assessment of Vegetation Conditions Considered Only Hazard Information, Not Risks and Values

In 2002, the Forest Service and BLM updated the national assessment of fuel conditions that estimated that about 99 million acres of the agencies' land in 11 western states were highly altered from historic vegetation conditions.[19] While the assessment also identified and collected data on fire occurrence, a factor in determining the probability that a fire will occur, the researchers did not include these risk data in the assessment because they were incomplete or inconsistent. In addition, although the assessment indicated which ecosystems might burn uncharacteristically and experience uncharacteristically severe effects from fire, it did not consider other values at risk, such as threatened and endangered species habitat that might be damaged or lost. A complete risk assessment—one that includes risk and values—could give national leaders a better idea of (1) the amount of fuel reduction that needs to be done per year to reduce the risks of wildland fires at the national level and (2) the amount of funding that needs to be allocated to reduce risks. For example, in 2002, a group of researchers involved in developing the national assessment conducted an independent study of options for reducing risks of effects from wildland fire through fuel reduction projects across landscapes and nationally.[20] The study, which included information on the probability of fire occurring and the values at risk, concluded that reducing risks would require more work and funding than was allocated in 2002. While the study results have not been officially confirmed by the multiple agencies and organizations involved in conducting fuel reduction activities, it is an example of the risk-based approach needed to target fuel reduction activities and funding.

In late 2003, recognizing the need for some direction in how to conduct risk assessments, the Forest Service and BLM issued guidance in conjunction with the National Association of State Foresters. The guidance states that there are a number of valid assessment processes available for the agencies to use, including one approach that involves mapping data on four factors: (1) fire occurrence, (2) hazard, (3) values to be protected, and (4) protection capabilities. This guidance, however, focuses on communities and does not discuss how the risks to the environmental resources and

[19]The national assessment was a one-time effort. The agencies expect the LANDFIRE system to provide periodic assessments of fuel conditions similar to this assessment. Like the national assessment, LANDFIRE will be based on hazard conditions and will not include risk and values at risk.

[20]W. Hann, M. Beighley, P. Teensma, T. Sexton, and M. Hilbruner, "A Cohesive Strategy for Protecting People and Sustaining Natural Resources: Predicting Outcomes for Program Options," (Paper presented at "Fire, Fuel Treatments, and Ecological Restoration Conference," April 16-18, 2002).

ecosystems that the agencies are responsible for managing are to be assessed. It is important that the risks to environmental resources and ecosystems be assessed in considering fuel reduction across landscapes because different approaches are needed to manage environmental resources and ecosystems in different fire regimes. For example, it can be more difficult to treat forests and rangelands that burn with low frequency and high intensity, such as lodgepole pine forests, as opposed to areas that burn with high frequency and low intensity, such as ponderosa pine forests.

The Forest Service's Rocky Mountain Research Station has developed a modeling protocol to assess the risks, as well as the benefits, of fire by considering three factors: (1) the probability of fire occurrence; (2) the expected severity of a fire; and (3) the ecological, social, and economic value ascribed to an area.[21] Other agencies have developed risk assessment frameworks, tailored to their particular needs, that include hazard, risk, and values and identify the organizational levels that should conduct the risk assessment. For example, the Federal Emergency Management Agency provides funding to state and local governments for hazard mitigation on the basis of their assessment of (1) the natural hazard and the probability of future hazardous events, (2) state and local vulnerability to the hazards, and (3) the potential losses from the hazardous event. In addition, the Environmental Protection Agency has developed an ecological risk assessment framework that defines the values at risk on the basis of desired environmental conditions and can be applied at different organizational levels depending on the risk problem.

Some Forest Service and BLM Offices Have Conducted Independent Risk Assessments

To identify the areas with the highest levels of risk at the landscape level, some forests and BLM field offices, in conjunction with state and local governments, have applied their own approaches to assessing fuel conditions and risks. We reviewed fire planning processes and documents at 13 forest and BLM offices and found that several offices had applied risk assessment frameworks that they had either developed themselves or contributed to developing. Table 3 shows the forest and BLM offices that we visited and describes the type of assessment they conducted, including the elements of a risk assessment that were addressed.

[21] C. Miller, P. Landres, and P. Alaback, "Evaluating Risks and Benefits of Wildland Fire at Landscape Scales," in L.F. Neuenschwander and K.C. Ryan, eds. *Joint Fire Sciences Conference and Workshop: Proceedings*, June 15-17, 2001: 78-87.

Table 3: Forest Service and BLM Office Assessments and the Risk Elements Addressed

National forest	Assessment conducted and elements addressed
Arapaho-Roosevelt (Region 2, Colorado)	Joint effort with state and other federal agencies included hazard, risk, and communities at risk. Subsequent land management plan included environmental values, such as threatened and endangered species and old-growth vegetation.
Pike San Isabel (Region 2, Colorado)	Joint effort with state and other federal agencies included hazard, risk, and communities at risk. Land management plan is being revised starting in 2004 and will include environmental values such as threatened and endangered species and watersheds.
Bitterroot (Region 1, Montana)	Region conducted an assessment of hazard, risk, and values, including environmental values such as threatened and endangered species, water quality, air quality, and soil condition. The forest's land management plan is being revised, and the forest will add some of this information.
Sequoia (Region 5, California)	Joint effort with other forests and federal agencies included hazard, risk, and communities at risk. Data on environmental values have been collected.
Wenatchee (Region 6, Washington)	An assessment of fire regime and vegetation conditions began in 2004.
Payette (Region 4, Idaho)	Joint effort with two other forests included hazard and risk. Another assessment identified watersheds of concern.
Coronado (Region 3, Arizona)	Assessment of fire regime and vegetation conditions began in 2004.
BLM office	**Assessment conducted and elements addressed**
Colorado	Joint effort with the state of Colorado included hazard, risk, and values at risk, including environmental values such as threatened and endangered species.
California	Assessment of fire regime and vegetation conditions began in 2004.
Nevada	Joint effort with other federal and state agencies will assess hazard, risk, and communities at risk. BLM began its assessment of fire regime and vegetation conditions in 2004.
Oregon/Washington	Assessment of fire regime and vegetation conditions began in 2004.
Idaho	Joint effort with state and other federal agencies to assess hazard, risk, and values, including environmental values such as threatened and endangered species, water quality, air quality, and soil.
Arizona	Assessment of fire regime and vegetation conditions completed in 2003.

Source: GAO.

Although the forests and BLM offices have undertaken independent efforts, some similarities exist in their approaches. Specifically, several of the units have attempted to include environment and ecosystem values in their mapping efforts. For example, Region 1 of the Forest Service assembled data on species habitat, water quality, soils, erosion potential, airsheds, and vegetation. The data are mapped, which provides managers with the location of important resources as they plan their fuel reduction activities. This team developed a computer program called the Multi-Resource Information Tool that uses the hazard, risk, and values information to rank different watersheds by different risk categories. In a similar way, some of the BLM offices identified the values present in different management areas, including environmental resource values. Other BLM offices use a computer program called the Risk Assessment and Mitigation System to model the protection afforded these values from their chosen fuel reduction programs.

The purpose of conducting risk assessments at the forest and BLM field office level is to support decisions about where to target fuel reduction efforts and where naturally caused fires can be managed and controlled to achieve resource benefits. The forests and BLM field offices are required to identify in their fire management plans the areas in which they will continue suppressing fires, those in which they will conduct fuel reduction projects, and those in which they can allow wildland fires to burn to reduce fuels and provide resource benefits. A risk assessment would help the offices identify these areas. For example, officials at some of the forests we visited stated that they wanted to increase their use of wildland fires to achieve resource benefits. Using wildland fire in this way not only provides resource benefits, but may also help to limit the overall costs of suppressing fires. For example, if the Forest Service had been able to let the Burgdorf Junction fire in Idaho burn, the fire would have benefited most resources and the agency would have spent much less than the $26 million used to suppress the fire. The fire, which occurred in an area identified as having low accumulations of fuel that could have benefited from a fire to maintain its conditions, was suppressed to protect a nearby community—a community that would have been protected by a $1 million fuel reduction project that was considered lower priority, given funding and the assessment of vegetation conditions.

Although a framework for conducting risk assessments to support the agencies' landscape-level fuel reduction activities would identify the organizational level at which the assessment should be conducted, agency guidance issued in 2002 and 2003 does not direct the forests or BLM field offices to conduct risk assessments to support their landscape-level fuel reduction plans. Specifically, guidance issued in April 2002 directs the Forest Service and BLM to collaborate with other agencies, including state, local, and tribal agencies responsible for managing wildland fire and fuels, in planning treatments across landscapes. This guidance recommends that landscape plans be developed; however, it does not require a formal risk assessment to support a plan. In addition, guidance issued in February and March 2003 directs the forests and BLM field offices to use the methods from the national assessment of fuel conditions to classify their local lands and fuel reduction projects according to their alteration from historic fire regimes. The purpose for classifying projects, in the short term, is to determine if the agencies are making progress toward reducing the number of acres of land they manage that have high accumulations of vegetation. In the long term, the guidance directs that the methods be used as part of land management planning.

Forest Service and BLM Also Lack a Systematic Approach to Assess the Risks of Environmental Effects Associated with Fuel Reduction Projects

The Forest Service and BLM also do not have a systematic approach for assessing the risks of environmental effects associated with fuel reduction projects. Because the agencies generally assess the environmental effects of fuel reduction projects in NEPA documents, we reviewed 10 environmental assessments for such projects. Although the agencies' assessments were for projects that would mitigate or avoid the effects of wildland fire, the assessments did not systematically assess the hazard, risks, or values associated with the projects. This is because the agencies lack clear guidance on how to assess the risks of environmental effects of projects and where to document the assessment and effects—in environmental assessments or in other documents. Interim guidance issued for the Healthy Forests Restoration Act partially addresses the need for documentation of the effects of not taking action to reduce fuels, but is not yet complete or final. CEQ guidance on developing model environmental assessments for fuel reduction projects, issued in 2002, does not address the risks of environmental effects from reducing fuels or not because the purpose of the guidance was to facilitate the development of concise environmental assessment documentation. Guidance on how to do such assessments and where to document them is important if the agencies are to effectively use fuel reduction projects to address the risks of environmental effects from wildland fires.

Some Environmental Assessments Did Not Systematically Assess the Risks of Not Reducing Fuels

Our review of 10 environmental assessments of fuel reduction projects—6 prepared by the Forest Service and 4 by BLM—revealed that some of these assessments did not systematically assess the risks of the likely environmental effects from not implementing fuel reduction projects. Forest Service and BLM officials recognize that taking no action to reduce fuels while continuing to suppress fires will contribute to continued accumulation and alteration of vegetation, perpetuating hazardous conditions that can create severe fire effects. At the same time, fuel reduction projects themselves can pose risks to environmental resources. For these reasons, it is important that the agencies, in developing fuel reduction projects, discuss the hazard, risk, and values at risk associated with project alternatives. It is also important that the agencies analyze a project's environmental effects. We reviewed the environmental assessments prepared by the Forest Service and BLM to determine the extent to which they (1) included a discussion of, or referred to, other documents that discussed hazard, risk, and value in assessing project alternatives and (2) presented information and data on the environmental effects of the no-action alternative. We did not determine whether the assessments complied with NEPA.

Generally, the agencies analyze the environmental effects of a fuel reduction project in an environmental assessment, which is an analysis conducted under NEPA regulations and guidance to discusses such effects. In general, fuel reduction projects can range in size from a few hundred acres to several thousand acres. In developing a project, forest and BLM staff determine the purpose and need for the project and design one or more alternatives. Although NEPA regulations do not require the agencies to consider a no-action alternative and its effects in an environmental assessment, the agencies often do develop a no-action alternative and consider its effects. The agencies can use several different models of fire effects and fire behavior to show how different vegetation will burn in different conditions, such as weather. (See app. VI for a discussion of models.) Through this modeling, agency staff can show that reducing vegetation can reduce the risk of a fire becoming uncharacteristically large and intense and the risk of associated adverse effects.

Furthermore, in analyzing the effects of a fuel reduction project, the agencies are also to consider whether the project meets the requirements of several environmental laws, including the Clean Water Act, the Clean Air Act, and the Endangered Species Act. In analyzing water quality effects, for example, forest and BLM staff estimate what effects fuel reduction activities such as mechanical thinning—which can involve heavy equipment that compacts soils—will have on soils and sedimentation of local streams. In analyzing air quality effects, forest and BLM staff estimate the amount of smoke that a prescribed burn may produce. Finally, in analyzing the effects of a project on threatened and endangered species—such as the Northern spotted owl or the Canada lynx—the agencies may be required to develop biological assessments of the effects on species population and habitat. In consulting with the Fish and Wildlife Service and National Oceanic and Atmospheric Administration (NOAA) Fisheries, the agencies use these biological assessments to determine what risks the alternatives pose for species and their continued existence and survival.[22]

[22]In December 2003, the administration promulgated regulations authorizing the Forest Service and BLM to determine that a fuel reduction project carried out pursuant to the National Fire Plan would not likely adversely affect a listed species without consulting Fish and Wildlife Service or NOAA Fisheries. Formal consultation would still be required if the action agency determined that a project would be likely to have an adverse effect. In March, 2004, an environmental group filed a notice of intent to sue the administration, contending that the new regulations violate the consultation requirements of section 7 of the Endangered Species Act.

Table 4 shows the results of our review of the 10 environmental assessments.

Table 4: Results of GAO's Review of 10 Fuel Reduction Project Environmental Assessments

Project name	Hazard, risk, and values included?	Discussion of environmental effects specifically for not reducing fuels?
Rogue	Yes	Yes
Horsethief	No	Yes
Weaver Mountain	No	Yes
Pine Valley	No	Yes
Last Chance	Yes	Yes
Sheafman	Yes	Yes
Deer Point	Yes	Yes
Pinaleno	No	Yes
Cache la Poudre	No	Yes
Ely	No	Yes

Sources: Forest Service and BLM (documents); GAO (analysis).

Of the 10 assessments we reviewed, 4—3 from the Forest Service and 1 from BLM—used the hazard, risk, and value framework for a risk assessment to discuss the action and no-action alternatives. In one case, for example, the BLM's Rogue assessment estimated the number of days per year that intense fires would reach the crowns of trees—known as crown fire—and kill whole trees. The assessment also estimated how much of the project area contained environmental resources at risk. The Forest Service's Sheafman project assessment described the risk of fire on the basis of a recent trend toward large fires in the project area. However, 6 of the 10 assessments did not use a hazard, risk, and value framework to discuss the risk of environmental effects. Existing guidance does not specifically require this or describe how the assessment should be done.

Each of the 10 assessments included some level of discussion of the environmental effects of the no-action alternative (see table 4). The level of detail about the effects varied from a minimal description of some effects to a detailed discussion of effects that was comparable to the discussion provided in other alternatives. For example, one of the assessments only described the general effects of no action as "increasing risk of damage to water resources." On the other hand, another of the 10 assessments used extensive tables comparing the specific effects on a wide range of environmental resources that could result from taking or not taking action to reduce fuels.

Although each of the 10 assessments we reviewed contained some effects of not reducing fuels, the effects were not described systematically in all of the assessments. According to forest and BLM staff, as well as biologists from the Fish and Wildlife Service and NOAA Fisheries, predicting the environmental effects of the no-action alternative is difficult. This difficulty stems from having to predict the occurrence of wildland fires, which are random events. The staff noted that such an analysis would need to be based on the assumption that a particular fire would occur and on estimates of the environmental effects of that assumed fire—a process they said might be considered "speculative." For example, to project the potential effects of wildland fire in a project area on a threatened or endangered species—such as the Northern spotted owl or Canada lynx—a wildlife specialist would take data produced by fire models to determine what habitat and food sources would be affected under anticipated fire conditions. While some say that this cannot be done, according to agency and CEQ officials, NEPA involves making reasonable forecasts of effects, and models can provide a reasonable basis on which to make such forecasts.

Guidance Is Unclear About How to Assess and Document the Risks of Environmental Effects of Fuel Reduction Projects

The varied use of risk assessment at the project level is a result of the fact that the agencies do not have clear guidance about the systematic assessment of the risks of environmental effects from wildland fire from fuel reduction projects. Guidance would describe how relevant hazards, risks, and values would be assessed for fuel reduction projects and where such information would be documented. Such guidance could be expected to appear in the agencies' fire planning or NEPA guidance. However, Forest Service and BLM fire planning guidance does not provide clear direction on how to conduct and document an assessment of risk of environmental effects at the project level, although the agencies recognize the importance of reducing fuels to mitigate or avoid the environmental effects of wildland fires. As described above, the agencies' fire planning guidance refers to assessing the risks to communities at the landscape level and to assessing the condition of vegetation at the project level. Just as the guidance does not address the assessment of hazard, risk, and values at risk at the landscape level, it does not discuss the assessment of hazard, risk, and value at the project level.

Similarly, NEPA guidance does not describe how to conduct or document an assessment of the risks of environmental effects associated with fuel reduction project alternatives. In terms of describing how to conduct such an assessment, although NEPA guidance requires the description of an alternative's environmental effects, it does not discuss an explicit risk assessment approach involving the assessment of hazard, risk, and value. In terms of documenting the environmental effects of a project, NEPA does not explicitly require the discussion of the effects of the no-action alternative in an environmental assessment. Analysis and documentation of the effects of a no-action alternative in relation to the effects of action alternatives facilitates the comparison of the relative risks of taking action or not to reduce fuels at the project level. While NEPA requires environmental impact statements to discuss a no-action alternative for a proposed project, it does not require this of environmental assessments. In 2002, CEQ issued NEPA guidance for a demonstration program to develop examples of model environmental assessments for fuel reduction projects. The demonstration program sought to make environmental documents more concise by removing unnecessary information. While the CEQ guidance stated that the agencies may compare the impact of the proposed action and alternatives with the current condition and expected future condition in the absence of the project, it did not address the no-action alternative or its effects in environmental assessments of fuel reduction projects.

The agencies have opportunities to clarify the analysis and documentation of the risks of environmental effects from not taking action to reduce fuels. In February 2004, the agencies issued interim guidance on the Healthy Forests Restoration Act (HFRA).[23] This guidance, which does not clearly state when a no-action alternative should be developed, states that the effects of not reducing fuels should be documented in a project's files. It also identifies some effects that may be analyzed as part of the

[23]HFRA, enacted in December 2003, states that the Forest Service and BLM should study, develop, and describe both an action and a no-action alternative for fuel reduction projects covered by the act that take place outside the wildland-urban interface. Projects authorized under the act include those implemented in accordance with the10-year implementation plan on federal lands (1) in the wildland-urban interface, (2) with highly altered fuels (fire regime condition class 3) near a municipal water supply system; (3) with moderately altered fuels (fire regime condition class 2) near a municipal water supply system; (4) with trees blown down by winds or storms or killed by insects; or (5) that contain threatened and endangered species habitat, where, among other things, the project would provide enhanced fire protection to the species or its habitat. No more than 20 million acres may be treated under the act.

documentation. However, the guidance does not include the range of environmental resources that may be affected by wildland fire nor does it state clearly what analyses should be done. In addition, the agencies and CEQ met in March 2004 to evaluate the lessons learned from the demonstration program, which CEQ used to develop examples. The agencies are compiling lessons learned from the demonstration program that they intend to use in future environmental assessments. Through these evaluations, CEQ and the agencies have another opportunity to clarify how the agencies will address the risks of environmental effects associated with fuel reduction projects and whether or not the discussion of the effects of taking no action should be included in environmental documents for projects.

Conclusions

The Forest Service and BLM, in conjunction with the other federal, state, local, and tribal land management agencies, face important and complex challenges in managing wildland fires, and, in particular, minimizing risks from future fires, including the effects of fires on environmental resources and ecosystems. The primary challenge that relates to these effects is, over the long term, balancing the risks of adverse effects caused by wildland fires with the benefits that such fires offer to restoring resources and ecosystems. The agencies will not be able to find such a balance without understanding the range of environmental and ecosystem effects created by wildland fire, including the adverse, neutral, and beneficial effects, and without gathering data and information to monitor and support their decision making about fire management. The range and variety of effects complicates their data-gathering efforts, which makes it important that the agencies select the right effects to monitor and that the agencies test and adopt new tools that can help them capture the range of effects of wildland fire. Without collecting landscape data on wildland fire effects as the National Fire Plan and its activities are implemented, the Forest Service and BLM—as well as the other fire management agencies—will not have information and data to give them a better understanding of how fires are affecting environmental resources and ecosystems over the long term. With such data, the agencies would be in a better position to answer the question whether fires are burning with more than normal severity because of vegetation and fuel conditions or as a result of other factors. For these reasons, it is important that the agencies, and more broadly the Wildland Fire Leadership Council, follow through on their commitment to implement the monitoring framework passed in May 2004.

A second challenge is that the agencies will not be able to stop all fires, nor will they be able to reduce fuels on all lands. Without a risk-based approach, the agencies cannot adequately determine where they will take deliberate action to reduce fuels and the risks of potential fire effects and where they will take the risk of fire occurring. Successful risk management is grounded in risk identification and assessment. Until the agencies formalize a framework for assessing the elements of risk at appropriate organizational levels, they will not have a systematic process for assessing the risks to environmental resources and ecosystems posed by wildland fires and will not be able to coordinate their efforts to ensure that they succeed in reducing these risks. A framework should incorporate and build on the data that are to be generated by LANDFIRE, as well as fire and other models. At the landscape level, a framework would clarify what elements will be included in agency risk assessments, what decisions will be supported by risk assessments, who will do the assessments, and when they will be done. This is particularly important as state and local agencies are moving ahead with risk assessments and the federal agencies will need to coordinate and collaborate with them.

In carrying out fuel reduction projects, it is important that the agencies consider the risk of not taking action to reduce fuels and the long-term risk of wildland fire effects. In fact, HFRA now specifically requires the agencies to develop a no-action alternative for fuels reduction projects covered by the act. However, the agencies must also assess the risks of effects from their actions to reduce fuels to ensure that they will not exacerbate existing resource problems or create new problems. Such decisions require information on the potential environmental effects of all project alternatives and the ability to make clear comparisons among project alternatives and their potential effects. Without clear guidance on the complicated analysis and comparisons that seem warranted to adequately address the effects of taking action or not to reduce fuels, the agencies lack the ability to make informed decisions to conduct fuel reduction projects, and as a result, these projects could face challenges and delay rather than proceeding more quickly in the face of increased risks. The agencies' guidance needs to be more specific about (1) how the assessment of hazard, risk, and values at risk should be done at the project level and (2) where the assessment of such risks should be documented. Both the HFRA guidance and the lessons learned from the CEQ demonstration program provide an opportunity for the agencies and CEQ to clarify appropriate guidance.

Recommendations for Executive Action

To improve the agencies' ability to identify and manage the actual and potential effects of wildland fires on the environment, we recommend that the Secretaries of Agriculture and the Interior, after consulting with the Wildland Fire Leadership Council, direct the Forest Service and BLM to

- develop a monitoring plan to implement the agencies' framework approved in May 2004 and include a pilot program for testing on Forest Service and BLM lands the applicability of, and resource needs associated with, the burn severity mapping and data tool developed by the National Park Service;
- develop and issue guidance, in consultation with experts inside and outside the agencies, that formalizes a framework for systematically assessing landscape-level risks to ecosystems from wildland fires; and
- clarify existing guidance, working with CEQ and taking into account any lessons learned from the CEQ demonstration program, on the assessment and documentation of the risks of environmental effects associated with not conducting fuel reduction projects.

Agency Comments and Our Evaluation

We provided a draft of this report to the Secretaries of Agriculture and the Interior and the Chairman of CEQ for review and comment. The departments provided a consolidated written response to our draft, which is included in appendix VII of this report. CEQ provided written comments, which are included in appendix VIII.

The departments stated that the draft was well prepared and provided a thorough analysis of a complex set of issues. In commenting on our recommendation to develop a monitoring plan and pilot project to test a tool for mapping the long-term effects of wildand fires, the departments said they presently have several methods for assessing such effects. Specifically, the departments said that the Forest Service and BLM work with the U.S. Geological Survey to assess the burn severity of large or severe fires and that, at the field level, the agencies collect site-specific data on wildland fires to support their land management plans and postfire rehabilitation plans. Furthermore, the departments mentioned that in May 2004, the Wildland Fire Leadership Council approved a nationwide monitoring framework for wildland fire data, including fire severity data. We agree that the agencies have various methods for assessing the effects of wildland fire, and we identified several of these in the report. We are also encouraged by the recent development of a nationwide monitoring framework. However, this framework does not address the part of our recommendation that calls for a pilot program for testing a different tool for measuring burn severity. The pilot program would allow the agencies to determine the extent to which the National Park Service tool is applicable for assessing the environmental and ecosystem effects from wildland fires that start on the agencies' lands. Furthermore, since the framework has just been approved, no plan for its implementation has been developed. Accordingly, we are recommending that such a plan be developed. We modified the report text and recommendation to reflect the recent approval of a monitoring framework.

In commenting on our second recommendation that the agencies develop and adopt a framework that supports systematic assessment of the landscape-level risks to ecosystems from wildland fire and issue guidance implementing that framework, the departments had several concerns. First, the departments stated that the Forest Service and BLM are designing and refining a number of analytical tools to assess project and landscape-level risk. Specifically, the departments noted that the Fireshed Assessment process is a promising approach for evaluating fuel treatment effectiveness across landscapes and that LANDFIRE will provide nationally consistent data to be used in landscape-level risk assessments. Second, the departments stated that the agencies already include a significant amount of risk assessment in their fuels programs. The departments said that national fuel reduction priorities represent a judgment about risk; the classification of wildland-urban interface areas into high, medium, and low priorities represents another judgment about risk; and the emphasis on treating lands in different fire regimes and condition classes represents yet another judgment about risk. The departments also stated that the relative value of resources is decided through the collaborative project selection and prioritization process developed with states for the implementation of the 10-Year Comprehensive Strategy, as directed by the Congress, and that community wildfire protection plans called for in HFRA include an assessment of risks associated with high-priority areas and values identified by the communities. Third, while the departments agree that prioritization of fuel reduction treatments can be improved and in their technical comments they agree that they do not have a single, consistent risk-based approach, they do not believe that a model or methodology that assesses the risks associated with fuel reduction treatments across time and at the landscape and project scales can be developed. Finally, the departments said that it is misleading to assert that the Forest Service and

BLM have focused on the wildland-urban interface, preventing them from developing a systematic approach to ecosystem risk assessment.

Our recommendation is based on our belief that to systematically identify fuel reduction projects, the agencies should support a single common approach or framework for assessing risk. We recognize that the agencies are developing a number of analytical tools useful for assessing landscape-level risk. We note several of these in our report and believe that they can serve as good examples for the agencies in developing an overall risk assessment framework. However, a common approach will allow the agencies to prioritize projects systematically. In addition, we recommended that the agencies seek the assistance of external and internal experts, which would allow them to identify the best tools for conducting risk assessments and would leverage the experience of the field offices in developing and using different risk tools, such as the Fireshed Assessment process the departments mention. In addition to Fireshed, several other worthwhile efforts that are being implemented in the field could serve as examples.

Regarding the departments' views that they already carry out a significant amount of risk assessment, it is our view that the results of these assessments are too broad to target fuel reduction projects at the landscape or project levels. Given the level of fuel reduction needs (90-200 million acres) identified in the Coarse-Scale Analysis and the emphasis of the 10-Year Comprehensive Strategy and Implementation Plan on reducing risks to the wildland-urban interface and environment, the agencies need a systematic way to further target their projects to areas of high risk and to demonstrate to decision makers and to the public how the decisions have been made and what results have been achieved with the use of public funds. The departments state that the collaborative process will identify relative values and priorities and that community wildfire protection plans will include assessment of the risks to community-defined values. Recognizing that the 10-Year Comprehensive Implementation Plan does not change existing agency statutory and regulatory responsibilities, we do not disagree. However, we believe that a formalized, common risk assessment framework would better inform the collaborative efforts under way, as well as future community efforts, by providing the groups involved with consistent hazard and risk information and allowing them to identify values at risk. We did not, as the departments' comments state, suggest they develop a single, all-encompassing model or methodology to assess risks associated with fuel reduction treatments across multiple time frames and geographic scales. Rather, our recommendation is directed at ensuring that the agencies develop a common approach to assessing landscape-level risks to environmental resources and ecosystems from wildland fires. We modified our report text and recommendation language to clarify that we mean a formalized, common approach to assessing risks.

Furthermore, we did not criticize the agencies' emphasis on addressing threats within the wildland-urban interface. We merely observed that the agencies have not made the same degree of progress in developing an approach for assessing the risks from wildland fire to ecosystems and environmental resources as they have for areas within the wildland-urban interface. We concur with the agencies' statements in the 10-Year Comprehensive Strategy and Implementation Plan that threats outside the wildland-urban interface also need to be addressed, and our recommendation is directed at that need. We did not mean to imply that communities should not be a high priority for fuel reduction, and we modified our report text accordingly.

Lastly, the departments disagree with our recommendation that the agencies develop and issue guidance to clarify the assessment and documentation of risks of environmental effects associated with taking or not taking action to reduce fuels. They said that current NEPA guidance is sufficient and that additional guidance on conducting risk assessments would be inconsistent with new CEQ guidance, which calls for short concise environmental assessments. Furthermore, the departments said that existing direction is generally adequate for implementing the lessons learned from the CEQ demonstration program. We did not state that CEQ's guidance fails to meet the intent of NEPA, nor did we recommend any amendments to that guidance. The purpose of our recommendation is to help ensure that the agencies have a sound scientific basis for the prioritization decisions that they will need to make to implement fuels reduction projects as effectively as possible, not to enhance agency compliance with NEPA. In fact, interim guidance issued by the agencies for HFRA partially addresses the need to document the risks associated with not taking action to reduce fuels. Specifically, the interim guidance says that "it is important that the specialists' report retained in the project files document the anticipated short- and long-term effects of proposed HFRA treatments." We believe, however, that if the agencies agree that the documentation of risks and effects is important, this guidance should specifically require the need for such documentation and should clarify how the environmental assessment should refer to the effects of the no-action alternative documented in the project files. Accordingly, we continue to believe that clear guidance for helping agency personnel determine the appropriate form and content of the risk assessment associated with not taking action would improve the agencies' fuel reduction efforts. We modified our report text and our recommendation language to reflect the fact that the agencies' interim guidance provides another opportunity to clarify the analysis of risks of not reducing fuels.

CEQ provided us written comments on the aspects of the report that reflect CEQ policies. CEQ stated that our draft should not imply that CEQ's guidance for its demonstration program could, or was intended to, describe "how to" assess the risks of environmental effects of taking action to reduce fuels against those of not taking action. CEQ stated that the purpose of this guidance was to provide a framework to support the development of environmental assessments that are "concise" and "public" documents that better serve their core function: briefly describing sufficient evidence and analysis to support a decision about whether or not to prepare an environmental impact statement and to assist agency NEPA compliance. We did not intend to imply that CEQ's guidance should discuss risk assessment methods, and we directed our recommendation to the agencies to clarify their guidance and methodology. We referred to the CEQ guidance in our discussion of risk assessments for conducting or not conducting fuel reduction projects only to demonstrate that such guidance does not exist.

CEQ also said that our draft incorrectly states that CEQ and the agencies plan to finalize a report on the "lessons learned" from the demonstration program. Rather, CEQ said that it has issued examples of completed environmental assessments on the Internet and that the agencies have drafted a document on these lessons. We deleted the reference to CEQ being a participant with the Forest Service and BLM in documenting the lessons learned from the program.

The Departments of Agriculture and the Interior and CEQ made other technical comments, which we addressed as appropriate in the report.

As arranged with your offices, unless you publicly announce the contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies of this report to other interested congressional committees. We will also send copies of this report to the Secretaries of Agriculture and the Interior, the Chief of the Forest Service, the Director of BLM, and the Chairman, CEQ. We will make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have questions about this report, please contact me at (202) 512-3841. Key contributors to this report are listed in appendix IX.

Barry T. Hill
Director, Natural Resources
and Environment

List of Requesters

The Honorable Pete V. Domenici
Chairman, Committee on Energy and Natural Resources
United States Senate

The Honorable Larry E. Craig
Chairman, Subcommittee on Public Lands and Forests
Committee on Energy and Natural Resources
United States Senate

The Honorable Mike Crapo
Chairman, Subcommittee on Fisheries, Wildlife, and Water
Committee on Environment and Public Works
United States Senate

The Honorable Kit Bond
United States Senate

The Honorable Conrad Burns
United States Senate

The Honorable Ben Nighthorse Campbell
United States Senate

The Honorable John Ensign
United States Senate

The Honorable Jon Kyl
United States Senate

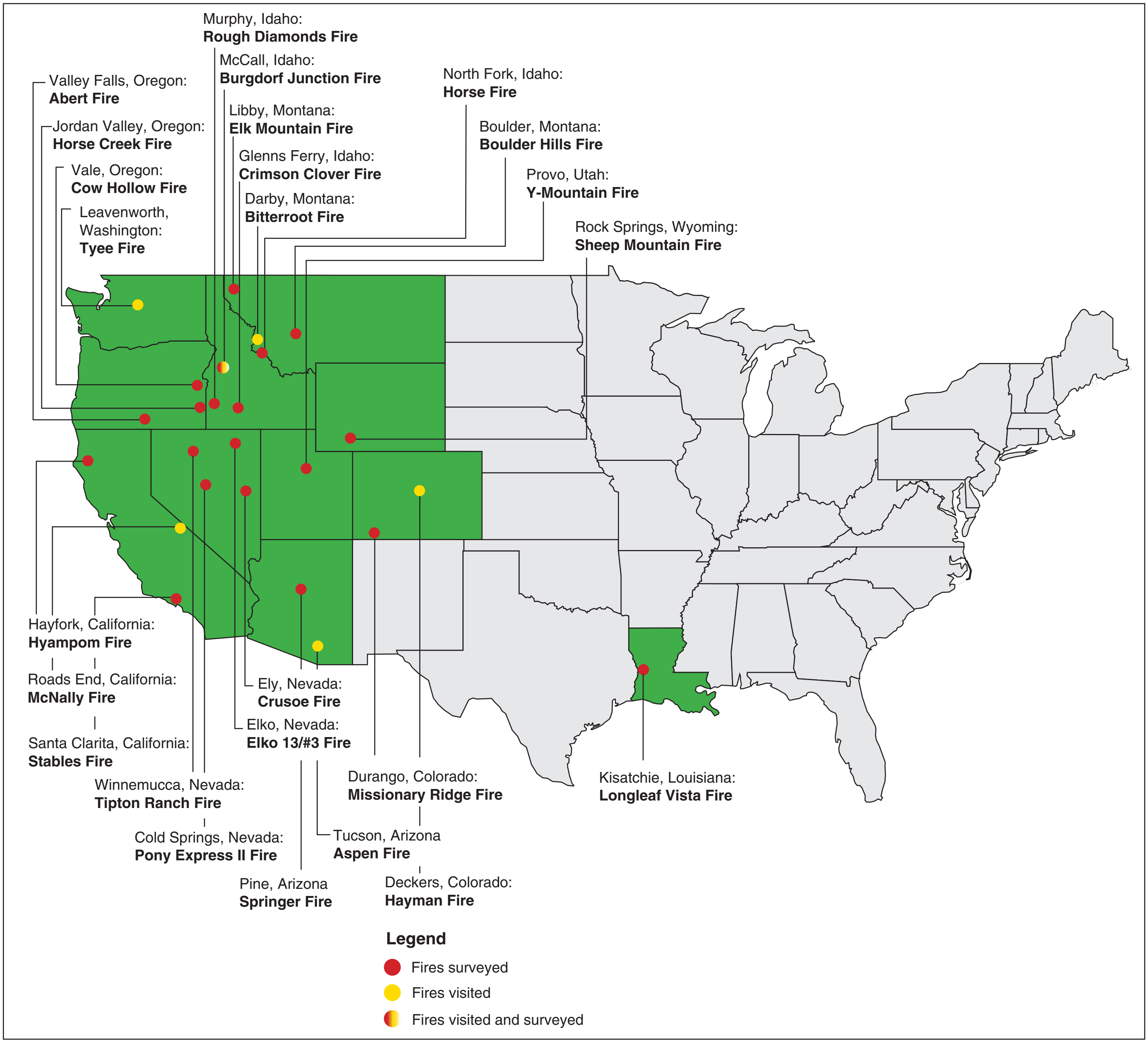
The Honorable Gordon H. Smith
United States Senate

Objectives, Scope, and Methodology

This appendix presents the scope and methodology we used to gather information on the environmental effects of wildland fire and to understand the data collected on these effects by the Forest Service and the Bureau of Land Management. It also addresses how we identified the approaches that these agencies use to assess the risk posed to environmental resources by wildland fire and the relative risks of undertaking and not undertaking fuel reduction activities.

To describe the environmental effects of wildland fire and assess the information the Forest Service and BLM gather on these effects, we randomly selected a sample of 20 fires from a universe of 614 wildland fires to include in a survey. The fires we selected ranged in size from hundreds to tens of thousands of acres in diverse geographic locations. To identify the universe of wildland fires, we created a database from two separate lists of Forest Service Burned Area Emergency Response (BAER) reports and BLM Emergency Stabilization and Rehabilitation (ESR) reports completed in 2000, 2001, and 2002. We requested these lists of BAER and ESR reports because the agencies' official lists of wildland fires did not contain information on the environmental effects of these fires. Both Forest Service and BLM officials indicated that BAER and ESR reports contain data on the environmental effects of fire because they are prepared for the purpose of requesting emergency stabilization funds to aid in the recovery of the burned areas. We assessed the lists of these reports for completeness and accuracy and found them to be reliable for the purpose of selecting a sample of wildland fires. We also visited the locations of 6 western fires and discussed the data collected on their environmental effects with local Forest Service and BLM officials. Figure 6 shows the fires we included in our survey sample, as well as the fire locations we visited in eight western states.

Figure 6: Location of Forest Service and BLM Wildland Fires Visited and Surveyed



Source: Forest Service and Bureau of Land Management (data); GAO (presentation).

To develop survey questions for the sample of 20 wildland fires and better understand the data that the Forest Service and BLM collect on the environmental effects of these fires, we (1) conducted a literature review and read reports and scientific studies on this topic; (2) reviewed federal fire policy documents, handbooks, BAER and ESR reports, and other reports; and (3) interviewed Forest Service and BLM officials in national, regional, and state offices, as well as local land units. Information gathered from the agencies on the environmental effects of wildland fire allowed us to develop a series of questions for our survey about the size and extent of a wildland fire and how it affected individual resources, such as soil, vegetation, air, watersheds, and threatened and endangered species over the short and long term. Our survey also contained questions on short-term (defined as less than 10 years), long-term (defined as greater than 10 years), and cumulative effects of the sample fire on the landscape or ecosystem. Some of these questions requested that the land managers make predictions about the future effects of a wildland fire rather than providing data about effects that had already occurred. Therefore, there is a greater degree of uncertainty regarding the accuracy of responses to these questions than to questions about observed effects.

Once we developed the survey questions, we pretested the content and format of the survey with BAER and ESR team leaders and other agency staff, as well as with two scientific and technical experts at the University of Arizona and the University of Washington. We conducted pretests with agency officials located in Colorado, Montana, Nevada, Washington, and Washington, D.C. During pretesting, we simulated the actual survey experience by asking the individual to complete the survey, and then we conducted a semistructured interview to determine whether (1) the questions were clear, (2) the terms used were precise, and (3) how long it took individuals to answer the questions. In mid-November 2003, we electronically mailed the survey to staff the agencies identified as knowledgeable about each fire and instructed them to return the survey by electronic mail. We obtained a 100 percent response rate from staff at all 20 field locations.

To identify the approaches the Forest Service and BLM take to assess the risk to environmental resources from wildland fire and the risks associated with undertaking and not undertaking fuel reduction projects, we reviewed National Fire Plan policies, National Environmental Policy Act regulations, and the December 2001 report[1] prepared by the National Academy of Public Administration on risk assessment and its application to the National Fire Plan. We also obtained agency guidance and selected planning and project documents to see how they addressed the potential environmental effects of future fires. To obtain specific information on the agencies' risk assessment practices, we interviewed Forest Service and BLM officials representing seven national forests and six BLM field offices and reviewed their land and resource management plans, in addition to their fire management plans. We also examined existing and proposed risk assessment approaches discussed in research papers and governmental and nongovernmental publications, and we interviewed some of the authors. During 2003, we attended two national conferences on wildland fire and risk assessment decisions held in Denver, Colorado, and Portland, Oregon. We also contacted the National Park Service, professors from five universities, and scientists from the Forest Service's research stations in California, Montana, and Colorado, including those who participated in developing the national assessment of fuel conditions and LANDFIRE.

To identify how the Forest Service and BLM evaluate the relative risks of undertaking or not undertaking projects to reduce fuels, we reviewed 10 environmental assessments of fuel reduction projects in eight western states: Arizona, California, Colorado, Montana, Nevada, Oregon, Utah, and Washington. We selected 6 environmental assessments prepared by the Forest Service and 4 prepared by BLM for analysis. Of the assessments we selected, 5 were part of a Council on Environmental Quality (CEQ) demonstration program for developing model environmental assessments and 5 were not. We also interviewed officials at Forest Service and BLM headquarters and staff members at CEQ to obtain information on agency guidance to field offices and CEQ program guidance to agencies. Finally, we interviewed headquarters and regional staff from NOAA Fisheries and the Fish and Wildlife Service to obtain information on how agency biologists could compare the short-term effects of fuel reduction projects on threatened and endangered species with the long-term effects of a future wildland fire in their environmental assessments.

We conducted our work from April 2003 through April 2004 in accordance with generally accepted government auditing standards.

[1]National Academy of Public Administration, *Managing Wildland Fire: Enhancing Capacity to Implement the Federal Interagency Policy* (Washington, D.C., 2001).

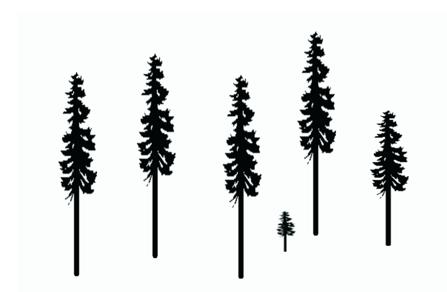
Fire Regime Condition Class Analysis

Wildland fire managers have recognized for several years the need to reduce excessive vegetation levels that have accumulated and been altered after decades of excluding fire from different ecosystems. Until 2000, managers did not have national-level data that could be used to distinguish and prioritize the different ecosystems that are more affected than others by fire exclusion. To accomplish such a prioritization, land managers need data on the current conditions of vegetation and fuels. In 2000, the staff of the Forest Service's Fire Sciences Laboratory at the Rocky Mountain Research Station produced an assessment of spatial data for wildland fire and fuel management called the Coarse-Scale Analysis.[1] The staff gathered and analyzed national-level data from several sources to create vegetation maps and from that assessed the condition of this vegetation to act as fuel for wildland fire. The assessment resulted in a national map of vegetation and fuel conditions. The assessment was based on "coarse-scale" or coarse resolution data that are not, and were never intended to be, applicable for site-level use.

The assessment identified three categories of fuel conditions, called fire regime condition classes (FRCC), using estimates of the historical fire regimes—the frequency and intensity of fires typical for different vegetation types—and estimates of the alteration in current vegetation. Figure 7 shows the three categories of hazard and the levels of alteration from historic conditions (hazard) that they represent.

[1]Kirsten M. Schmidt, James P. Menakis, Colin C. Hardy, Wendel J. Hann, and David L. Bunnell, *Development of Coarse-Scale Spatial Data for Wildland Fire and Fuel Management*, GTR RMRS-87 (Fort Collins, Colorado, U.S. Department of Agriculture, Forest Service Rocky Mountain Research Station: April 2002).

Figure 7: Wildland Fire Hazard

High Hazard. The probability of damage to soil, vegetation, and water quality from fire is high. In forests, there are excess levels of fuels buildup, and on rangelands, nonnative species are predominant. Vegetation composition, structure, and diversity have been significantly altered. Consequently, these lands have the greatest probability of catastrophic, destructive wildland fires. To restore their historic fire patterns–before prescribed fire can be utilized–these lands may require multiple mechanical thinning projects, or reseeding.	
Moderate Hazard. The role of fire in the ecosystem has been altered, allowing fires to occur less frequently than they did historically. In forests, there are moderate levels of fuels buildup, and on rangelands, nonnative species have replaced some native species. A moderate probability of damage to soil, vegetation, and water quality has been identified on these lands. To restore their historic fire patterns, these lands may require some prescribed burns, mechanical thinning, and the subsequent reintroduction of native plants.	
Low Hazard. For the most part, fires occur at frequencies and severities similar to historic patterns. In forests, vegetation has not accumulated beyond historic levels, and on rangelands, native species are predominant. Thus, the probability of damage to soil, vegetation, and water quality from fire remains relatively low. Maintenance such as prescribed burns, mechanical thinning, or preventing the invasion of nonnative weeds is required to prevent these lands from becoming degraded.	

Source: GAO analysis of Forest Service and Department of the Interior data.

The original assessment estimated that wildland fire could cause severe effects on about 182 million acres of land in the United States. Of that land, an estimated 75 million acres of federal land, including land managed by the Department of the Interior and the Forest Service within the Department of Agriculture, could suffer from severe effects as a result of wildland fire. In 2002, the original assessment was updated to more thoroughly examine grassland vegetation and to make corrections from more specific data gathered through samples on the ground. This update focused on 11 western states, reporting that 183 million acres across the west were highly altered from historical conditions and would experience severe effects from wildland fire. Based on additional analysis, the agencies estimated that the amount of highly altered vegetation nationwide could vary from 90 to 200 million acres.

Federal land management agencies and the National Fire Plan have adopted the FRCC categories as an indicator of whether forest and grassland ecosystems are in good condition. The National Fire Plan, under its goal for achieving fire-adapted ecosystems, tracks the acres of land that are in the second and third FRCC categories for which fuels are reduced and conditions changed to a lower category—either the first or second category. The agencies' field offices, which plan and implement all projects to reduce fuels, are responsible for monitoring their progress through a new national reporting system, which tracks National Fire Plan goals and performance measures.

Because the national-scale data is based on coarse resolution data, the data cannot be used to identify the areas on the ground that need to have fuel reduction activities—it can only be used at a Forest Service regional level or summarized to several western states. To help the field offices identify which acres need fuel reduction treatment projects, the Forest Service and the Department of the Interior are developing a project-level analysis tool. This tool, which the Forest Service and the Department of the Interior began to implement in spring 2004, requires the field office staff to conduct a field visit to examine vegetation conditions, to consider them in context of past and current fire regimes, and to estimate the alteration of fire regimes and fire intensity if a fire were to burn in the current conditions.

The FRCC concept has been incorporated into LANDFIRE, which is a data system that, when completed, will provide periodic updates of national vegetation maps at a higher resolution than the original assessment provided in 2000. LANDFIRE is also expected to provide FRCC maps and will contain computer models to help fire planners and land managers estimate how wildland fire might behave in the estimated fuel conditions. Full implementation of LANDFIRE was approved in 2003 and funded by the Forest Service and the Department of the Interior in 2004. The system is expected to be completed for application across the nation in 2009. In the interim, the agencies will use the FRCC assessment and project tool to track progress in reducing high levels of fuels across the nation.

Definition of Fire/Burn Severity

Table 5 presents the definitions of fire/burn severity as it relates to effects on soils and vegetation. We asked Forest Service and BLM officials to use this table in responding to questions about the specific fires and their effects on soil and vegetation for the 20 wildland fires in our sample.

Table 5: Classes of Fire Severity for Soils and Vegetation

Class	Soil substrate—litter/duff	Vegetation—understory/brush/herbs
Unburned	Not burned	Not burned
Scorched	Litter partially blackened; duff nearly unchanged; wood/leaf structures unchanged	Foliage scorched and attached to supporting twigs
Lightly burned	Litter charred to partially consumed; upper duff layer burned; wood/leaf structures charred, but recognizable	Foliage and smaller twigs partially to completely consumed
Moderately burned	Litter mostly to entirely consumed, leaving coarse, light-colored ash; duff deeply burned; wood/leaf structures unrecognizable	Foliage, twigs, and small stems consumed
Heavily burned	Litter and duff consumed, leaving fine, white ash; mineral soil visibly altered, often reddish	All plant parts consumed, leaving some or no major stems/trunks
Not applicable	Inorganic	Not present

Source: U.S. Fish and Wildlife Service.

Note: The definition appears in the National Wildlife Coordinating Group Fire Use Working Team, National Interagency Fire Center, *Fire Effects Guide* (NFES 2394), (Boise, Idaho: June 2001), citing *Fuel and Fire Effects Monitoring Guide*, U.S. Fish and Wildlife Service, June 2001.

Selected Wildland Fire Survey Results

This appendix provides selected results from our survey of Forest Service and BLM officials on the environmental effects of 20 sample wildland fires (app. I). Tables 6 and 7 present general information about each fire and the fire location. Tables 8 through 13 provide information on the generally short-term effects that these fires had on individual environmental resources such as streams and watersheds, threatened and endangered species and their habitats, air, soils, and vegetation.

Table 6 lists each wildland fire by size according to the total number of federal and nonfederal acres of land burned. It also presents information on federal and nonfederal acreage within the fire perimeter but not burned by fire.

Table 6: Acres Burned by Fire, Land Ownership, and Percent of Forest and BLM Field Office Land Base

Fire name	Total acres burned	Federal acres burned	Nonfederal acres burned	Federal acres unburned	Nonfederal acres unburned	Percent of forest or BLM office land base affected by fire
Missionary Ridge (Colorado)	57,935	49,990	7,945	11,929	615	3.80
Sheep Mountain (Wyoming)	27,574	21,370	6,204	5,102	1,253	0.59
Burgdorf Junction (Idaho)	17,207[a]	17,207	D/K	47,000	D/K	2.90
Crimson Clover (Idaho)	16,172	14,466	1,706	330	0	1.00
Elko 13/#3 (Nevada)	13,104	12,544	560	256	0	<.01
Boulder Hills (Montana)	11,394	5,400	5,994	287	665	2.00
Abert (Oregon)	10,100	10,100	0	0	0	0.30
Rough Diamonds (Idaho)	8,467	7,268	1,199	383	63	0.04
Stables (California)	6,349	4,162	2,187	115	80	0.67
Horse Creek (Oregon)	3,763	1,839	1924	0	0	<.01
Cow Hollow (Oregon)	3,718	3,022	696	336	77	0.20
Longleaf Vista (Louisiana)	2,500	2,497	3	0	0	0.40

(Continued From Previous Page)

Fire name	Total acres burned	Federal acres burned	Nonfederal acres burned	Federal acres unburned	Nonfederal acres unburned	Percent of forest or BLM office and base affected by fire
Tipton Ranch (Nevada)	2,031	2,025	6	0	0	<.01
Pony Express II (Nevada)	1,806	1,806	0	0	0	0.50
Crusoe (Nevada)	1,386	1,386	0	0	0	<.01
Hyampom (California)	1,065	1,053	12	0	0	1.00
Elk Mountain (Montana)	1,024	667	357	0	0	<.01
Springer (Arizona)	666	666	N/A	208	N/A	0.20
Y-Mountain (Utah)	461	437	24	0	0	0.05
Horse (Idaho)	243	243	0	27	0	<.01
Total	**186,965**	**158,148**	**28,817**	**65,973**	**2,753**	

Source: GAO survey of Forest Service and BLM officials.

Note: D/K = did not know; N/A = not applicable.

[a]Total acres burned include only federal acres.

Table 7 presents information on the major types and uses of federal land affected by each wildland fire.

Table 7: Types and Uses of Federal Land within Fire Perimeters

Fire name	Woodland acres	Rangeland acres	Number of acres permitted for grazing	Forested or timbered acres	Number of acres permitted for timber harvest	Congressionally or administratively designated acres[a]
Missionary Ridge (Colorado)	0	3,167	36,752	46,431	7,134	5,712
Sheep Mountain (Wyoming)	8,382	12,297	21,370	691	0	0
Burgdorf Junction (Idaho)	0	0	0	17,207	0	17,207
Crimson Clover (Idaho)	0	14,466	14,466	0	0	0
Elko 13/#3 (Nevada)	0	12,544	12,544	0	0	0
Boulder Hills (Montana)	2,170	1,867	3,650	1,363	0	1,750
Abert (Oregon)	0	10,100	10,100	0	0	0
Rough Diamonds (Idaho)	3,556	3,556	7,268	156	0	0
Stables (California)	70	4,092	0	0	0	0
Horse Creek (Oregon)	0	1,839	1,839	0	0	0
Cow Hollow (Oregon)	0	3,022	3,022	0	0	0
Longleaf Vista (Louisiana)	0	0	0	2,497	310	2,187
Tipton Ranch (Nevada)	0	2,025	2,025	0	0	0
Pony Express II (Nevada)	1,806	0	6	0	0	1,800
Crusoe (Nevada)	277	1,109	1,386	0	0	0
Hyampom (California)	133	0	0	920	815	238
Elk Mountain (Montana)	0	0	422	667	245	0
Springer (Arizona)	0	7	333	659	333	0
Y-Mountain (Utah)	326	41	0	70	0	0
Horse (Idaho)	0	0	0	243	30	213
Total	**16,720**	**70,132**	**115,183**	**70,904**	**8,867**	**29,107**

Source: GAO survey of Forest Service and BLM officials.

Note: Data do not include land managed by federal agencies other than the Forest Service or the BLM or lands not owned by the federal government. Uses in this table are mutually exclusive.

[a]Includes wilderness, recommended wilderness, wilderness study areas, research natural areas, wild and scenic rivers, and inventoried roadless areas.

Table 8 presents information on the size and extent of each wildland fire's effects on streams and watersheds.

Table 8: Miles of Perennial Streams and Number of Floods, Debris Flows, or Landslides within Fire Perimeters

Fire name	Miles of perennial streams within fire perimeter	Percent of perennial stream miles in forest or field office within fire perimeter	Number of floods, debris flows or landslides within fire perimeter
Missionary Ridge (Colorado)	84.00	4	60
Sheep Mountain (Wyoming)	34.00	6	1
Burgdorf Junction (Idaho)	107.00	2	1
Crimson Clover (Idaho)	N/A	N/A	0
Elko 13/#3 (Nevada)	5.00	0	2
Boulder Hills (Montana)	3.00	2	3
Abert (Oregon)	0.00	0	N/A
Rough Diamonds (Idaho)	0.00	N/A	0
Stables (California)	0.10	0	1
Horse Creek (Oregon)	7.00	0	0
Cow Hollow (Oregon)	0.00	0	0
Longleaf Vista (Louisiana)	2.00	1	0
Tipton Ranch (Nevada)	0.00	N/A	0
Pony Express II (Nevada)	3.00	1	0
Crusoe (Nevada)	0.00	0	0
Hyampom (California)	11.00	1	11
Elk Mountain (Montana)	1.00	0	0
Springer (Arizona)	0.00	0	0
Y-Mountain (Utah)	0.00	0	1
Horse (Idaho)	1.00	0	D/K
Total	**258.10**		**80**

Source: GAO survey of Forest Service and BLM officials.

Note: D/K = did not know; N/A = not applicable.

Table 9 presents the three wildland fires that severely burned municipal watersheds and affected water quality.

Table 9: Municipal Watersheds within Severely Burned Areas

Fire name	Number of municipal watersheds within severely burned area	Locations affected by fire	Number of months water quality degraded
Missionary Ridge (Colorado)	3	Durango, Bayfield, Ignacio, Colorado	60
Stables (California)	2	Santa Clarita, California	Not degraded
Hyampom (California)	5	Hayfork, California	36
Total	**10**		

Source: GAO survey of Forest Service and BLM officials.

Note: A municipality may be served by more than one watershed.

Table 10 presents the five wildland fires that affected federally listed threatened or endangered species or their habitats.

Table 10: Fires Affecting Threatened and Endangered Species Populations and Habitats

Fire name	Threatened or endangered species	Percent of species' range burned	Did fire adversely affect species population?
Missionary Ridge (Colorado)	Canada lynx	1.8	no
Missionary Ridge (Colorado)	Bald eagle	<.01	yes
Missionary Ridge (Colorado)	Southwestern willow fly catcher	<.01	D/K
Missionary Ridge (Colorado)	Colorado pikeminnow	N/A[a]	yes[b]
Missionary Ridge (Colorado)	Razorback sucker	N/A[a]	yes[b]
Longleaf Vista (Louisiana)	Red-cockaded woodpecker	2.0	yes[c]
Hyampom (California)	Bald eagle	N/A[d]	no
Hyampom (California)	Northern spotted owl	<.01	no
Springer (Arizona)	Mexican spotted owl	<.01	no
Horse (Idaho)	Canada lynx	<.01	no

Source: GAO survey of Forest Service and BLM officials.

Note: D/K = did not know; N/A = not applicable.

[a]Species located downstream of fire, not within fire perimeter.

[b]These fish species were not directly affected by the fire but by stream depletions during suppression of the fire.

[c]Respondent also indicated the fire beneficially affected the species population.

[d]The area burned by the fire is potential transitory habitat for this species, not forage habitat.

Table 11 presents the volume of air pollutants each wildland fire released and relates the impact of the particulate matter emissions to a national air quality standard.

Table 11: Air Emissions by Fire

Fire name	Tons of total particulate matter (PM)	Tons of carbon monoxide (CO)	Tons of carbon dioxide (CO^2)	Number of days air quality exceeded PM 2.5 standards[a]
Missionary Ridge (Colorado)	D/K	D/K	D/K	5.00
Sheep Mountain (Wyoming)	3,845.00	22,511.00	423,351.00	D/K
Burgdorf Junction (Idaho)	8,250.00	D/K	D/K	D/K
Crimson Clover (Idaho)	D/K	D/K	D/K	D/K
Elko 13/#3 (Nevada)	184.00	694.00	29,706.00	0.00
Boulder Hills (Montana)	902.00	4,056.00	72,967.00	D/K
Abert (Oregon)	1,190.00	6,126.00	82,058.00	1.00
Rough Diamonds (Idaho)	D/K	D/K	D/K	D/K
Stables (California)	3,500.00	15,200.00	317,700.00	8.00
Horse Creek (Oregon)	165.50	570.00	11,758.50	0.00
Cow Hollow (Oregon)	37.18	128.06	2,641.36	D/K
Longleaf Vista (Louisiana)	261.00	1,172.00	21,087.00	D/K
Tipton Ranch (Nevada)	0.60	0.16	0.32	0.50
Pony Express II (Nevada)	54.00	443.00	7,923.00	D/K
Crusoe (Nevada)	193.00	912.00	14,625.00	D/K
Hyampom (California)	D/K	D/K	D/K	8.00
Elk Mountain (Montana)	286.00	1,978.00	31,016.00	8.00
Springer (Arizona)	197.00	889.00	15,994.00	D/K
Y-Mountain (Utah)	15.60	91.30	1,652.10	0
Horse (Idaho)	105.00	528.00	7,191.00	0
Total	**19,185.88**	**55,298.52**	**1,039,670.28**	**30.50**

Source: GAO survey of Forest Service and BLM officials.

Note: D/K = did not know.

[a]The Environmental Protection Agency defines PM 2.5 as fine particles measuring 2.5 microns or less in diameter. When these solid particles mix with liquid droplets in the air, they form a common air pollutant known as particulate matter.

Table 12 identifies two significant effects the wildland fires had on soils located on federal lands. The first three columns identify the acres on which the fire burned but had beneficial effects, grouped by (1) severely burned acres, (2) moderately burned acres, and (3) lightly burned acres. The last column shows the percentage of acres burned by the fire that may experience the adverse effects of soil erosion.

Table 12: Fire Effects on Soils by Burn Severity and Erosion Potential

Fire name	Percent of severely burned federal acres with beneficial effects on soils	Percent of moderately burned federal acres with beneficial effects on soils	Percent of lightly burned federal acres with beneficial effects on soils	Percent of acres with high potential erosion hazard
Missionary Ridge (Colorado)	0	0	0	40
Sheep Mountain (Wyoming)	0	30	100	56
Burgdorf Junction (Idaho)	N/A	100	100	43
Crimson Clover (Idaho)	0	0	50	4
Elko 13/#3 (Nevada)	11	60	0	12
Boulder Hills (Montana)	0	20	20	84
Abert (Oregon)	0	0	100	0
Rough Diamonds (Idaho)	0	34	0	81
Stables (California)	0	0	0	91
Horse Creek (Oregon)	11	43	0	0
Cow Hollow (Oregon)	0	0	0	0
Longleaf Vista (Louisiana)	0	0	0	72
Tipton Ranch (Nevada)	0	0	0	0
Pony Express II (Nevada)	61	0	100	D/K
Crusoe (Nevada)	50	0	100	0
Hyampom (California)	0	0	82	47
Elk Mountain (Montana)	0	0	0	0
Springer (Arizona)	0	0	100	6
Y-Mountain (Utah)	0	0	0	34
Horse (Idaho)	0	50	100	8

Source: GAO survey of Forest Service and BLM officials.

Note: D/K = did not know; N/A = not applicable.

Table 13 identifies three significant effects the wildland fires had on vegetation. The first three columns identify the percentage of federal acres burned and the severity with which the vegetation burned. The fourth and fifth columns identify the federal acres that experienced stand-replacing fire and the number of acres in which this fire behavior is characteristic of the historic fire regime. The last two columns show the number of acres populated by noxious or invasive weeds prior to the fire, as well as the number of these acres vulnerable to weeds after the fire.

Table 13: Fire Effects on Vegetation

Fire name	Percent of federal acres severely burned with beneficial effects on vegetation	Percent of federal acres moderately burned with beneficial effects on vegetation	Percent of federal acres lightly burned with beneficial effects on vegetation	Federal acres of trees burned in stand-replacing fire[a]	Federal acres of trees in which stand-replacing fire is characteristic	Federal acres with weeds prior to fire	Federal acres vulnerable to weeds after fire
Missionary Ridge (Colorado)	0	N/R	100	6,500	1,950	D/K	D/K
Sheep Mountain (Wyoming)	100	0	0	9,000	9,000	1,000	5,000
Burgdorf Junction (Idaho)	0	100	100	10,900	10,900	20	9,900
Crimson Clover (Idaho)	0	0	69	N/A	N/A	10,120	14,466
Elko 13/#3 (Nevada)	22	60	0	20	15	6,272	10,000
Boulder Hills (Montana)	50	50	100	2300	800	500	1,800
Abert (Oregon)	0	0	100	0	0	0	0
Rough Diamonds (Idaho)	63	100	0	4,096	4,096	618	1,000
Stables (California)	0	35	90	0	N/R	3,800	4,000
Horse Creek (Oregon)	11	43	0	0	N/R	100	900
Cow Hollow (Oregon)	0	0	0	0	0	3,058	3,358
Longleaf Vista (Louisiana)	0	100	100	100	100	1,875	1,875
Tipton Ranch (Nevada)	0	0	0	NA	100	2,025	2,025
Pony Express II (Nevada)	9	0	100	705	705	D/K	705
Crusoe (Nevada)	60	100	100	277	277	1,386	1,386
Hyampom (California)	0	100	100	380	50	1,053	1,053
Elk Mountain (Montana)	55	100	100	445	290	0	1,024

(Continued From Previous Page)

Fire name	Percent of federal acres severely burned with beneficial effects on vegetation	Percent of federal acres moderately burned with beneficial effects on vegetation	Percent of federal acres lightly burned with beneficial effects on vegetation	Federal acres of trees burned in stand-replacing fire[a]	Federal acres of trees in which stand-replacing fire is characteristic	Federal acres with weeds prior to fire	Federal acres vulnerable to weeds after fire
Springer (Arizona)	0	50	100	26	0	26	26
Y-Mountain (Utah)	D/K	D/K	D/K	D/K	0	280	380
Horse (Idaho)	40	100	100	230	81	0	0
Total				**34,979**	**28,364**	**32,133**	**58,898**

Source: GAO survey of Forest Service and BLM officials.

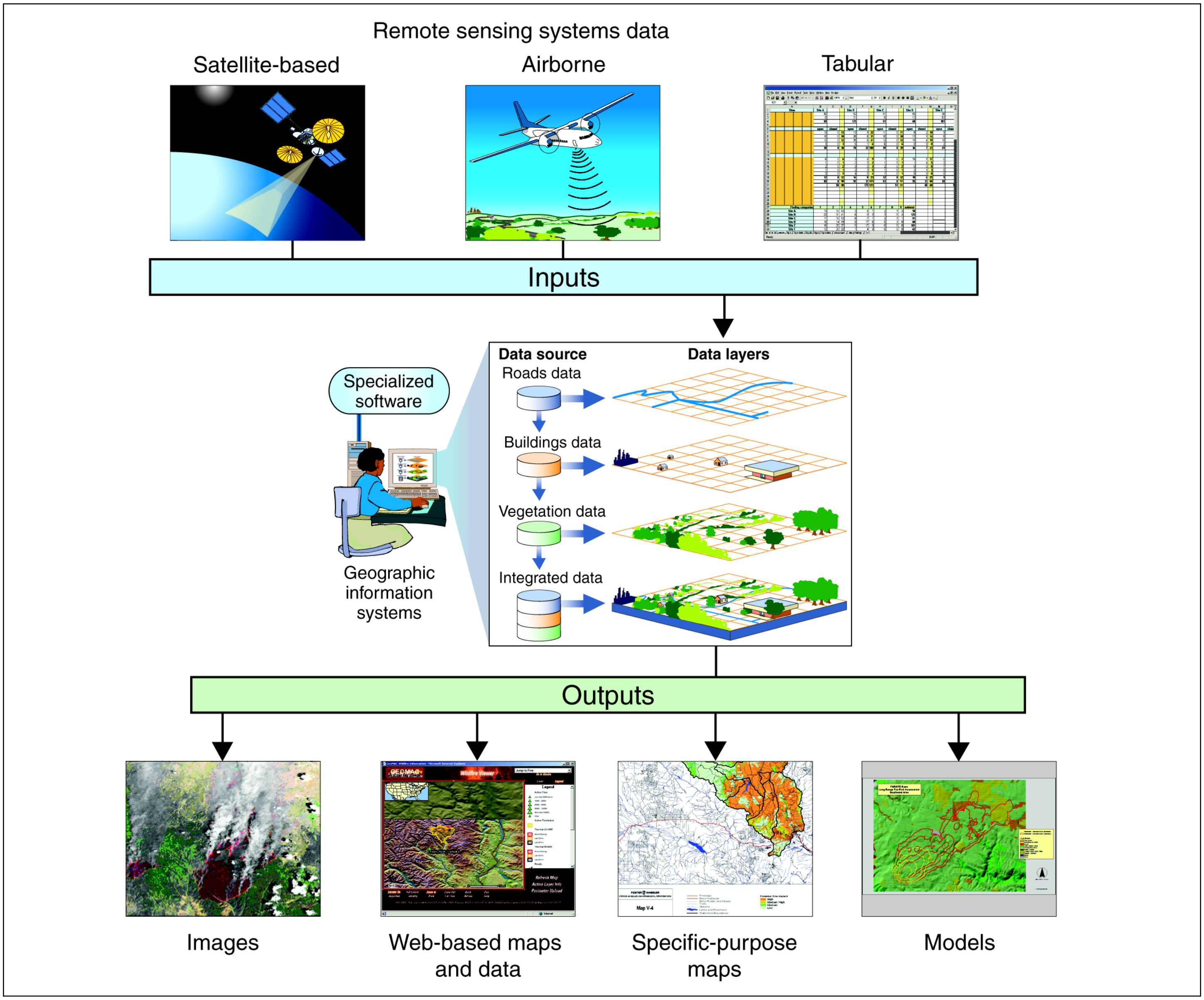
Note: D/K = did not know; N/A = not applicable; N/R = no response.

[a]Stand-replacing fire refers to a fire that burns 80 percent or more of the vegetation.

Remote Sensing Data and Systems

To gather data on features of the earth, land management agencies use remote sensing technologies and data. Remote sensing means that different technologies are used to gather data from some distance away from the earth—that is, remotely. As shown in figure 8, the technologies used to collect data can be based on satellites, airplanes, or towers of some kind. These platforms carry sensors that collect data through spectral images, or wavelengths that reflect off objects. Different objects on the earth reflect light differently, and the images can be filtered and analyzed to identify the objects. For example, the amount of greenness reflecting back from burned acres varies depending on the amount of vegetation burned, which gives land managers an idea of how severely different areas have been affected by fire.

Figure 8: Remote Sensing Technologies and the Data Produced

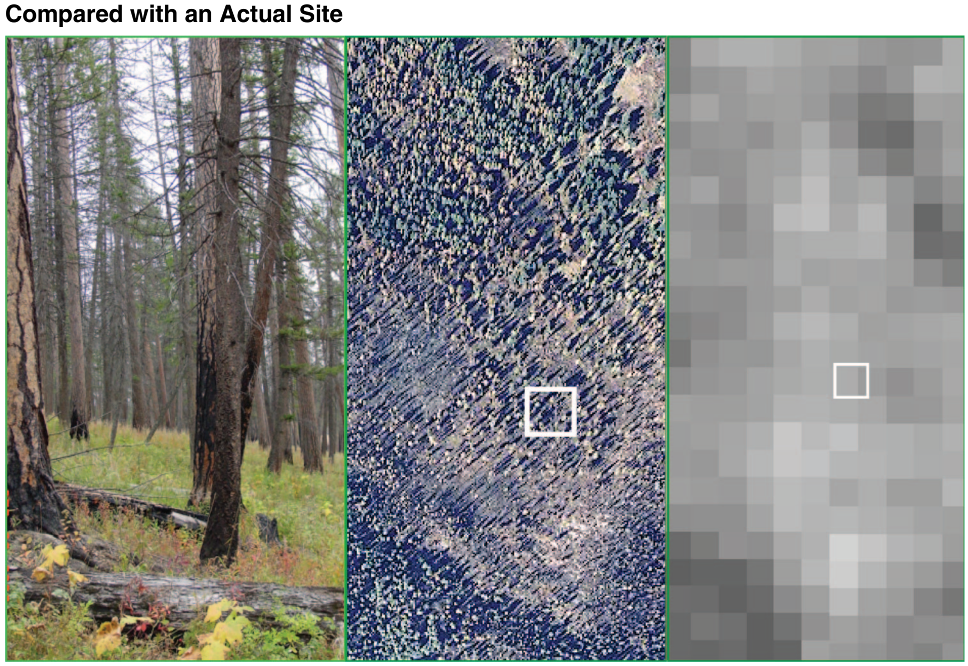


Sources: GAO, Art Explosion, U.S. Geological Survey, Forest Service.

Remote sensing data is analyzed using geographic information system tools. Through these computer systems, the image data can be integrated and analyzed with other spatially referenced data, such as topography, weather, and soils.

Depending on the resolution of the images that are taken, the data gathered through remote sensing systems are more or less detailed. For example, a resolution commonly used for gathering information on natural resources is 1 kilometer by 1 kilometer (250 acres), which refers to the size of the area of ground that is recorded in 1 pixel—that is, 1 point of remote sensing data. A more specific resolution is 30 meters by 30 meters, which is equivalent to about one-quarter acre. Figure 9 compares an actual site, on the left, with the site represented through two remote-sensing methods. The center photograph represents the view taken from an airplane (the square outlines the actual site from the photograph on the left), and the photograph on the right depicts 30-meter by 30-meter data captured by a satellite-based sensor (the square outlines the actual site from the photograph on the left).

Figure 9: Images and Data Collected Using Aerial and Satellite Technology Compared with an Actual Site



Sources: National Park Service (pictures); GAO (presentation).

Examples of Models for Assessing Wildland Fires and Fuels

Fire ecologists and researchers have been studying wildland fire for many years and through this process have developed models, databases, and other tools that are helpful for land and fire managers in planning and managing fires and their effects. Not only does the Forest Service maintain a system of laboratories that conduct research on many aspects of wildland fire, including wildland fire behavior, fire effects, air quality, and more, but the Bureau of Land Management maintains an agreement with the Desert Research Institute to study fire, atmosphere, and ecological effects. In addition, universities and nonprofit organizations are studying different aspects of fire and its effects. The Joint Fire Science Program is a key source of funding for fire researchers, providing almost $16 million in 2002 to study (1) fire effects and fuel treatments; (2) planning and preparedness; (3) air quality, smoke management, and climate; (4) social and economic impacts; (5) fire and invasive plant species; (6) remote sensing; (7) demonstration projects; and (8) local and other projects. Some of the important tools that have been developed to model fire and its effects are described below.

BehavePlus: This is a modeling system that uses vegetation information to predict a number of different factors that describe a wildland fire for the purposes of planning a prescribed fire or predicting the behavior of a potential wildland fire. The factors that describe fire behavior include the rate of spread of fire, length of flames the vegetation would produce, size of the fire that would burn, distance that embers would fly to unburned areas, and amount of trees and other vegetation that would die from the fire, among others.

FARSITE: This is a fire growth simulation model that computes fire behavior and growth over a long period of time across a geographic area. Using fire behavior models integrated with spatial vegetation data, terrain data, and weather data, the model projects where and how fast a fire will spread across a landscape with variable vegetation, and how hot or intense the fire will be.

Fire and Fuels Extension-Forest Vegetation Simulator (FFE-FVS): This is a model originally developed to simulate forest growth and yield, which has been adapted to provide information for fuels reduction projects. It uses data on specific stands of trees and “grows” the trees to show stand development over time. It also simulates accumulation and decay of surface fuels due to litter, tree mortality, and fuel reduction resulting from treatments. Expected fire behavior and effects if a wildland fire should occur are also shown over the simulation period. This information is used by fuels planners to assess the need for fuel treatment.

Vegetation Dynamics Development Tool (VDDT): This model uses "state in transition" models or box and arrow diagrams to show how vegetation is changing and will change.

NEXUS: This is a model that estimates surface, transition, and crown fire behavior, which occurs in the forest canopy. The model shows the conditions that may cause a crown fire in an area with particular combinations of surface and canopy fuels and fuel moisture conditions. The wind speed at which crown fire can occur is computed based on the potential for crown fire in the stand. This information can be used to evaluate alternatives for treating fuels to reduce the risk of crown fire.

FlamMap: This software creates geographic information system maps (raster maps) of potential fire behavior characteristics, including rate of spread, flame length, crown fire, and others, as well as environmental factors such as fuel moistures and wind speeds. It does not simulate fire growth but uses spatial information on topography and fuels to calculate fire behavior factors at a point in time.

Simulating Vegetative Patterns and Processes at Landscape Scales (SIMPPLLE): This simulation model shows the succession of vegetation after fire or other disturbance has been introduced. It is spatially explicit, meaning that the results are mapped in a geographic information system. It also models the change in vegetation over time. Planners can use it to explore how fire will affect a landscape and how their fuel reduction treatments can change the outcome.

Multi-Resource Analysis and Geographic Information System (MAGIS): MAGIS is an optimization model that schedules fuel reduction treatments across a landscape. It is a spatial model that considers land management objectives for deciding which projects are optimal and also functions under user-imposed resource constraints.

First-Order Fire Effects Model (FOFEM): This model estimates the first-order effects of a fire in a particular area based on a set of fuel loadings provided by the users. First-order effects include those effects that result directly from the fire: fuel consumption, tree mortality, smoke, and soil heating. Second-order effects refer to the indirect effects of fire: erosion, soil loss, and species or habitat loss.

Fire Effects Information System (FEIS): This system provides literature reviews for about 900 plant species, 100 animal species, and 16 plant communities (as defined by Kuchler in North America). The reviews, called "species summaries," are online at www.fs.fed.us/database/feis. The objective of each summary is to synthesize information on fire and its effects on the species, but background information on taxonomy, distribution, basic biology, and ecology is also provided. Summaries are documented and each contains a complete bibliography.

LANDFIRE: This system consists of a database and models that will provide nationwide data on vegetation conditions and departure from fire regimes. The data and system will be used by forests and BLM field offices to identify how much vegetation has accumulated beyond historical conditions for purposes of reducing fuels.

Fuel Characteristic Classification System (FCCS): This is a database of different fuelbeds that can exist around the country. A fuelbed is a unit of land on a landscape that contains relatively homogenous fuel conditions in the form of different vegetation. The fuelbeds are created by classifying the amount and type of vegetation—which acts as fuel—in six different strata—canopy, shrub, low vegetation, woody fuel, mosses, and ground fuels.

Fuel Photo Series: The series contains a collection of photos showing a range of natural vegetation conditions in the field and their related fuel conditions. The photos can be compared to actual conditions on the ground for fire and land managers to use in running fire effects models and to plan fuel reduction projects.

Bluesky: This smoke-dispersion model simulates the cumulative impacts from wildland fires, prescribed fires, and agricultural burn activities. The model can be used by air quality regulators and land managers who are planning prescribed burns for purposes of minimizing the effects of smoke on communities and other areas with impaired air quality.

Ventilation Climate Information System (VCIS): This is a national climate model that predicts localized inversions that can hold in smoke, causing impaired air quality. Fire and land managers can use the model to plan prescribed burns to minimize their effect on air quality.

CONSUME: CONSUME is an interactive model of fuel consumption that estimates the amount of fuels consumed during prescribed and wildland fires. It predicts the amount of smoke and pollutants emitted from a particular fire based on weather data, the amount of fuel, fuel moisture, and other factors. Land managers use the model to plan for prescribed burns.

Fire Emissions Production Simulator (FEPS): This model estimates the rate of gas, heat, and particle emissions from a fire. It calculates total fuel consumption and determines short-term and long-term smoldering and consumption. Land managers use this to plan a response to smoke emissions from a wildland fire.

Fire Effects Tradeoff Model (FETM): This model simulates changes in vegetation composition over time—1 to 300 years—and shows the different outcomes from alternative land management practices over the selected time frame. It does not display these spatially but summarizes the landscape composition in various categories, such as density classes, acres disturbed, and fire emissions. It can be used by managers when planning a number of activities over a large area—over 1 million acres.

National Fire Danger Rating System (NFDRS): The system combines weather, climate, and fuels information to predict the potential for wildland fires to occur on a daily basis. Land managers use the system to plan the timing of prescribed burns and to anticipate when wildland fires might occur.

Consolidated Comments from the Departments of Agriculture and the Interior

WASHINGTON

THE DEPARTMENT OF AGRICULTURE

THE DEPARTMENT OF THE INTERIOR

June 9, 2004

Barry T. Hill, Director
Natural Resources and Environment
United States General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Director Hill:

Thank you for giving us the opportunity to review the draft report, Wildland Fires*: Forest Service and BLM Need Better Information and a Systematic Approach for Assessing the Risks of Environmental Effects* (GAO-04-705). The report is a well-prepared document that provides a thorough analysis of a complex set of issues.

We agree with GAO that systematic data collection and analysis is a way to better inform the selection of fuels treatment projects. We are presently doing so. The Wildland Fire Leadership Council has endorsed an accelerated schedule to complete the LANDFIRE project which will provide nationally consistent data sets to aid in the selection of fuels treatments. At its May 2004 meeting WFLC approved a nationwide monitoring program. Our efforts to uniformly gather and analyze information across the nation will enable us to better track changes as well as help provide standardized information in support of decision-making at local levels where both the Administration and Congress center prioritization.

GAO calls for risk assessments but we note that the agencies already do a significant amount of risk assessment within the fuels program, indeed it is an inherent part of the entire effort locally and nationally. The Implementation Plan for the 10-Year Comprehensive Strategy calls for identification and prioritization of hazardous fuels treatments by agency field offices in collaboration with state, tribal, and local representatives. These decisions flow from assessments of risks, hazards, and values to be protected. National priorities likewise rest on assessments regarding risk. Administration and congressional emphasis on wildland urban interface (WUI) areas represent a judgment on risk. The classification of WUI areas into high, medium, and low priorities using the National Association of State Foresters guidance includes an assessment of risk. Outside the WUI the emphasis on treating lands in Fire Regimes I, II, and III that are in Condition Classes 2 and 3 is also an assessment of risk.

Finally, the development of community wildfire protection plans, as provided in Title I of the Healthy Forests Reforestation Act of 2003, includes an assessment of risk associated with high priority areas and values identified by communities as a basis for sequencing fuels reduction activities.

GAO appears to suggest that, absent development of a calculus producing systematic assessments of the fire-related risks to ecosystems, natural resources, and societal values associated with treating fuels and not treating fuels at both project and landscape scales fuels treatment priorities cannot be properly developed. Prioritization can be improved and we are working to do so. The emergence of models or a methodology, however, that meaningfully assesses the risks associated with treating fuels or not treating fuels across time and at multiple spatial scales seems unlikely. It would have to identify and integrate all the impacts of doing fuels treatments and not doing fuels treatments on species, natural resources, constantly changing ecosystems, and on the myriad of values people place on landscape components. We do not agree that such a calculus can be developed and instead believe that current methods, especially as additional information becomes available, provide the best approach to balancing multiple considerations in execution of the federal hazardous fuels program.

The report notes that the National Fire Plan directs the agencies to conduct fuel reduction activities in areas that face the greatest losses and also says that the agencies do not have a systematic method for assessing the risk of fire to environmental resources because the agency has placed a higher priority on assessing areas that threaten communities. The assertion that the Forest Service's and Bureau of Land Management's focus on the WUI has kept it from developing a systematic approach to ecosystem risk evaluation is misleading. It is important to put these statements in their proper context. The agencies have been directed by Congress to give priority to areas that threaten communities, specifically, the WUI. The focus on the WUI is in response to specific direction by Congress to meet a strong public demand. Congress and the public have determined that these areas face the greatest potential loss and, while protecting environmental resources are also important, protecting people and communities must be the highest priority. However, the efforts to develop consistent methods to evaluate wildland fire potential and risk at the landscape scale have continued.

In reference to GAO's specific recommendations:

- *Develop a monitoring plan for gathering consistent and comprehensive data on the long-term effects of wildland fires, including a pilot program for testing, on Forest Service and BLM lands, the applicability and resource needs associated with the burn severity mapping and data tool developed by the National Park Service.*

    Presently the agencies have several methods for assessing the long-term effects of wildland fires. The Forest Service and the Department of the Interior, U.S. Geological Survey cooperate to conduct consistent assessments of burn severity of large or severe wildland fires. At the field office level, agencies have also collected site specific or watershed specific data in support of their land and resource management plans, as well as part of the post-fire rehabilitation plans.

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At its May 2004 meeting the Wildland Fire Leadership Council (WFLC) approved a monitoring framework that addresses burn severity to assure the consistency of data across the landscape. This new monitoring effort will link field and satellite data with output from the LANDFIRE project, such as long-term trends of fire effects, vegetation condition and other landscape characteristics.

- *Develop and adopt, in consultation with experts inside and outside the agencies, a framework that supports the systematic assessment of the landscape level risks to ecosystems from wildland fires, and issue guidance directing the agencies to use the framework.*

The agencies are designing and refining a number of analytical tools to assess project and landscape-level risk. Specifically, the agencies are testing several new GIS-based, landscape risk assessment frameworks. One that appears promising for national implementation is the Fireshed Assessment process; an integrated, interdisciplinary approach to evaluating fuel treatment effectiveness at reducing fire spread across landscapes. This process evaluates fuel treatment location, the degree of fuel reduction within treatments, and the percentage of land treated, and projects the resulting effects on landscape fire spread and size.

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Since a spatially explicit fire spread modeling system is used, tradeoffs resulting from adding, deleting, or moving fuel treatments to avoid critical habitat or riparian areas, as well as the effects of different intensities of treatment, can be evaluated. This assessment process can also be used to evaluate the combined risk to locally determined natural resource and social values from both the likelihood of an ignition in the area, plus the risk associated with fire spreading from an ignition in an adjacent area.

Nationally consistent data required to implement these tools is being collected in the LANDFIRE project, a collaborative effort chartered by the WFLC. Less sophisticated analytical tools with lower resolution data are currently in use by the agencies to assess hazard and risk. Meanwhile, the relative value of resources is decided through the collaborative project selection and prioritization process developed with the States for the implementation plan of the 10-Year Comprehensive Strategy, as directed by the Congress.

- *Develop and issue guidance, working with CEQ and taking into account any lessons learned from the CEQ demonstration program, to clarify the assessment and documentation of the risks of environmental effects associated both with conducting and not conducting fuel reduction activities.*

  We believe the guidance on preparation of environmental assessments for fuels treatments provided by the Council on Environmental Quality (CEQ) in December 2002 fully meets the intent of the National Environmental Policy Act. Supplementary guidance calling for the preparation of more detailed and extensive risk assessments, thus potentially adding to the length and complexity of environmental assessments would be inconsistent with the original purpose of the new guidance which was to return environmental assessments to what CEQ's regulations originally intended them to be: short, concise statements resulting in a finding that either the action will have no significant impact or there was not enough information currently available to make significance determination so an environmental impact statement is needed.

  The agencies have reviewed the lessons learned from the CEQ demonstration program and determined that existing direction is generally adequate for implementing these lessons. Risks associated with not taking action to reduce fuels (the no action alternative) are assessed as appropriate and generally documented in the project analysis file.

Additional technical comments are included in the attachment.

We appreciate the opportunity to review the draft report, Wildland Fires*: Forest Service and BLM Need Better Information and a Systematic Approach for Assessing the Risks of Environmental Effects* (GAO-04-705) and look forward to working with GAO on future reports.

Mark Rey
Under Secretary
Natural Resources and the Environment
U.S. Department of Agriculture

P. Lynn Scarlett
Assistant Secretary
Policy, Management and Budget
U.S. Department of the Interior

Attachment 1: Additional technical comments (18 pp.)

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Comments from the Council on Environmental Quality

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL ON ENVIRONMENTAL QUALITY
WASHINGTON, D.C. 20503

CHAIRMAN

June 14, 2004

Barry T. Hill
Director, Natural Resources
and Environment
United States General Accounting Office
441 G Street, N.W.
Washington, DC 20548

Dear Director Hill:

Thank you for the opportunity to comment on your proposed report entitled "Wildland Fires: Forest Service and BLM Need Better Information and a Systematic Approach to Assessing the Risks of Environmental Effects" (GAO-04-705). The following comments of the Council on Environmental Quality ("CEQ") are limited to aspects of the report that characterize CEQ policies and actions taken in response to the President's direction to make administrative improvements that ensure more timely decisions, greater efficiency, and better results in projects that reduce the risk of catastrophic wildfires and restore forest and rangeland health. The Departments of Agriculture and the Interior are separately providing joint comments that address the bulk of the proposed report.

For purposes of greater accuracy, CEQ believes that it would be helpful for you to distinguish your assessment of projects and events that predate the implementation of the President's direction from those that reflect the Healthy Forests Initiative . CEQ notes that GAO's selection of 20 fires and 10 environmental assessments (EAs) for analysis relies on assessments performed prior to the administrative improvements that the Departments have adopted to help reduce threats to community safety, better protect wildlife and ecosystems, and improve water and air quality. The report should make clear that only five of the ten EAs that GAO selected for review were among the twelve EAs that the Forest Service and the Bureau of Land Management developed to demonstrate the application of CEQ guidance.

Second, your current draft implies that CEQ's EA guidance could, or was intended to, describe "how to" assess the risks of environmental effects from reducing fuels or not. GAO-04-705 draft at 37, 41. GAO should not imply that CEQ EA guidance should address risk assessment methodologies. Consistent with CEQ NEPA regulations governing EAs, the purpose of CEQ's EA guidance is to provide a framework to assist the development of EAs that are "concise" and "public" documents that better serve their core function: briefly describing sufficient evidence and analysis to support a decision whether or not to prepare an environmental impact statement and assist agency NEPA compliance. 40 CFR 1501.4, 1508.9. CEQ assisted the Forest Service and BLM in their development of twelve EAs that reflected agency environmental analysis in a clear and concise manner, but CEQ lacks the resources and technical expertise to advise the land management agencies "how to" conduct that analysis. The agencies sought to tailor their description of environmental impacts, including risks, to the complexity and potential significance of the issues raised by each proposal for agency action. Your draft report suggests that, though they were not required to do so, these EAs should have been written according to a specific risk assessment methodology. In our view, the demonstration EAs reflect the agencies' assessment of hazard, risk and values with a level of detail that is appropriate to each proposal for agency action, even if they did not precisely track the risk assessment methodology that GAO recommends.

Finally, the GAO incorrectly states, at draft page 43, that we plan to finalize a "lessons learned" document and issue a report. In issuing the EA guidance, CEQ stated that "we will provide examples of completed EAs to be used as models and may develop more substantive protocols." The examples of completed EAs have been provided on the internet and are currently being used by the agencies in NEPA training activities. See, e.g., http://www.fire.blm.gov/ea_sites/index.htm;
http://www.fs.fed.us/emc/hfieaguide/projects/index.html;
http://www.fireplan.gov/content/success_stories; www.ntc.blm.gov.
The land management agencies have also drafted a "lessons learned" document that describes various perspectives on the EA development processes used by the agencies in their implementation of the CEQ guidance. CEQ is considering possible follow-up actions to build on the experience gained in the implementation of CEQ guidance, but has not concluded that a formal report is necessary.

Thank you for your consideration of CEQ views regarding your draft report. We appreciate the opportunity to consider your evaluation as we continue to seek improvements in the Federal land management agencies' assessment and response to wildfire risks.

Sincerely,

James L. Connaughton

Cc: The Honorable Gale Norton
The Honorable Ann Veneman

GAO Contacts and Staff Acknowledgments

GAO Contacts

Barry T. Hill, (202) 512-3841
Roy Judy, (202) 512-3482

Staff Acknowledgments

In addition to those named above, Nancy Crothers, Sandy Davis, Susan Iott, Rich Johnson, and Ches Joy made key contributions to this report. Mark Braza, Jean McSween, Kim Raheb, Jena Sinkfield, and Joan Vogel made important methodological and graphic contributions to the report.

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