Fire Management *today*

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Managing Fire in Areas Without Roads

United States Department of Agriculture
Forest Service

Fire Management in Roadless Areas

In October 1999, President Clinton asked the USDA Forest Service to develop, and propose for public comment, regulations to provide appropriate long-term protection for inventoried roadless areas on National Forest System lands. That request sparked a robust public debate, raising two key fire management questions:

- Are roads always needed to effectively suppress wildland fires?
- Do fire managers absolutely need roads to complete fire hazard reduction work?

Events in the summer of 2000 brought these questions into sharp focus, especially when the Cerro Grande Fire burned through portions of inventoried roadless areas near Los Alamos, NM, and when large wildland fires scorched millions of acres in the Western United States.

In this special issue of *Fire Management Today*, authors from the public and private sectors address these key fire management questions. We purposely solicited authors with divergent interests in the environment and natural resource management. We asked them to write candidly, with the understanding that we might not agree with what they had to say.

Forest Service Chief Mike Dombeck has welcomed the high degree of public involvement and healthy debate associated with the proposed Roadless Area Conservation rule. This issue of *Fire Management Today* reflects some of the discussion. In these pages, you will find articles by a poet of ecology and the natural world; a retired Director of the Forest Service's Fire and Aviation Management; environmentalists from national organizations; and Federal fire managers from the Forest Service and National Park Service.

Long after the final Roadless Area Conservation Environmental Impact Statement is published, the debate will continue over roadbuilding and fire management. But this is as it should be, for as Harvard business professor Ronald Heifetz has said, "…conflict is the primary engine of creativity and innovation. People don't learn by staring into a mirror; people learn by encountering difference. So hand in hand with the courage to face reality comes the courage to surface and orchestrate conflicts" (*Fast Company*, June 1999).

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On the Cover:

An airtanker drops retardant on a fire in steep terrain. Since 1940, when smokejumpers first saw operational action, wildland fire managers have increasingly relied on helicopters, smokejumpers, helirappelers, and airtankers to suppress wildland fires in areas without roads. Today, thanks in good part to aerial resources, the vast majority of wildland fires in the United States—up to 98 percent—are successfully controlled at a small size. Photo: USDA Forest Service.

The FIRE 21 symbol (shown below and on the cover) stands for the safe and effective use of wildland fire, now and throughout the 21st century. Its shape represents the fire triangle (oxygen, heat, and fuel). The three outer red triangles represent the basic functions of wildland fire organizations (planning, operations, and aviation management), and the three critical aspects of wildland fire management (prevention, suppression, and prescription). The black interior represents land affected by fire; the emerging green points symbolize the growth, restoration, and sustainability associated with fire-adapted ecosystems. The flame represents fire itself as an ever-present force in nature. For more information on FIRE 21 and the science, research, and innovative thinking behind it, contact Mike Apicello, National Interagency Fire Center, 208-387-5460.

FIRE 21

Firefighter and public safety is our first priority.

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A National Fire Plan for Future Land Health*

Mike Dombeck

We can postpone the inevitable blazes, but—as the 2000 fire season showed—not indefinitely.

When people think of wildland fires, they tend to think of the USDA Forest Service. It's a tribute to the leading role the Forest Service plays nationwide in wildland fire management that so many people associate firefighting with the Forest Service. However, through the Forest Service, many people also associate wildland fires with our national forests and grasslands, not realizing that the vast majority of the acres burned each year are on State, private, and other Federal lands.

In the 1990's, less than 14 percent of the acres burned nationwide were on the national forests and grasslands. The 2000 fire season was exceptional: By late September, the proportion of acres burned on the National Forest System reached almost 32 percent. In fact, the 2000 fire season was the most severe on our national forests and grasslands in more than 80 years. By late September, fires had scorched almost 2.2 million acres (890,000 ha) on the National Forest System. The last time that more than 2 million acres (810,000 ha) burned on our national forests was in 1919 (fig. 1).

Postponed Fires

Historically, severe fire seasons all but ceased on the national forests after the 1920's. From 1930 to 1986, a period of 57 years, the number of acres burned on the national forests never again approached 1 million (405,000 ha) in any fire season, thanks to the growing effectiveness of our wildland firefighting force. Ineffectual before the 1930's, wildland fire suppression got a boost from the Depression-era Civilian Conservation Corps (Pyne 1982). For more than half a century, our cooperative fire programs grew ever better at suppressing wildland fires.

Then, in 1987, the large fires returned—with a vengeance. The 1987 and 1988 fire seasons saw 1.2 and 1.5 million acres (490,000 and 610,000 ha), respectively, burn on the national forests. More than a million acres burned again in 1994, and then again in 1996. The fires we managed to postpone for half a century would no longer wait. In drought years, 60 years or more of accumulated fuels exploded into flame, usually touched off by lightning. The 2000 fire season was the most severe yet in the new era of big blazes.

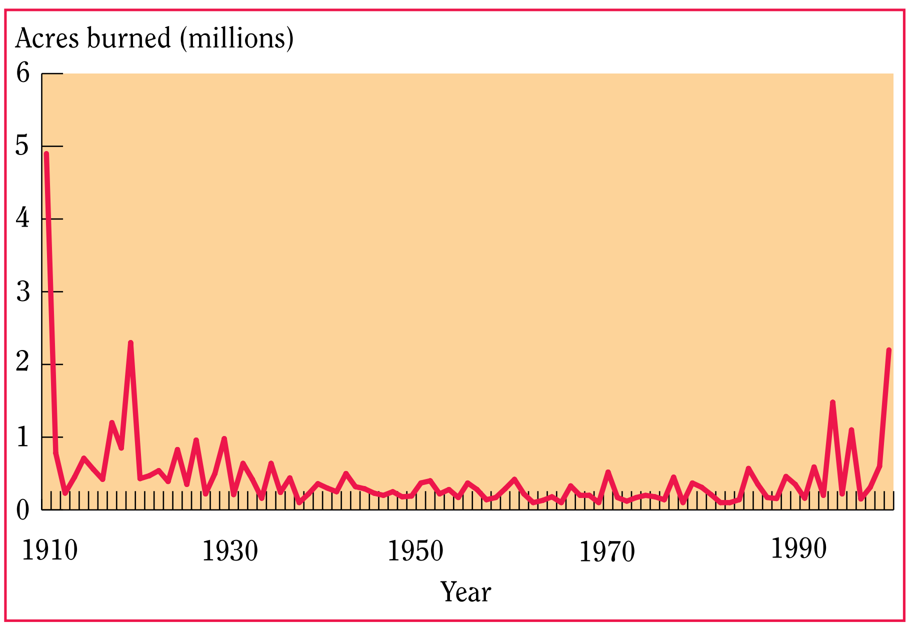

Figure 1—*Acres burned on the national forests and grasslands from 1910 to late September 2000 (USDA Forest Service 2000). Until the 1930's, wildland fires burned largely unimpeded, just as they had for millennia. From the 1930's to the 1980's, increasingly effective cooperative fire protection programs vastly reduced the number of acres burned. Beginning in the late 1980's, accumulated fuels fed a resurgence of fire in drought years. Illustration: Gene Hansen Creative Services, Inc., Annapolis, MD, 2000.*

Mike Dombeck is the Chief of the USDA Forest Service.

* This article is partly based on remarks made by USDA Forest Service Chief Mike Dombeck on October 5, 2000, at the Forest Service's National Leadership Conference in New Haven, CT.

> Fuel buildups are causing severe fires throughout the interior West, not just on the national forests.

Why, in the last 14 years, are we suddenly seeing a return of severe fire seasons on the national forests? The answer has to do with the character of our western forests. About three-quarters of the National Forest System—some 145 million acres (59 million ha)—lies in the West, mostly in the interior West. The years before effective fire suppression began might be considered a baseline for more natural fire regimes in the western forests. From 1910 to 1929, the average annual number of acres burned on the national forests was about 900,000 (360,000 ha); almost 5 million acres (2 million ha) burned in the exceptionally severe 1910 fire season, the year of the fabled Big Blowup in the northern Rocky Mountains.

The last 14 years of severe fire seasons on the national forests are well within the historical range of variability for our western fire seasons. Since 1987, the average annual number of acres burned on the national forests has been 750,000 (300,000 ha), less than the baseline; and the total of more than 2 million acres (810,000 ha) burned during the 2000 fire season lies well within the baseline range.

The recent surge in postponed fires is partly Mother Nature reasserting herself. In 2000, some two-thirds of the acres burned on our national forests by late September were in wilderness and roadless areas, mostly in remote locations at higher elevations. The forest types in these areas are often in the high-intensity, low-frequency fire regime; they typically burn in stand-replacing fires every 100 to 300 years. Today, after a century of learning about wildland fires, we know that nothing we do will prevent these forests from burning sooner or later. We can postpone the inevitable blazes, but—as the 2000 fire season showed—not indefinitely.

Forest Health Problem

However, our worst fire hazard has little to do with Mother Nature. At lower elevations, western forest types historically had frequent low-intensity fires that kept the number of trees per acre low. For example, the density of ponderosa pines on Arizona's Kaibab National Forest has been estimated at 56 per acre (22 per ha) in 1881 (GAO 1999). Large, severe fires were rare in our open, parklike western forests.

Beginning in the 1930's, our growing firefighting effectiveness excluded all fire from our forests, even surface fires. Small trees and brush, no longer kept out by fire, now built up in our lower elevation western forests. Dense coniferous thickets commonly added 200 to 2,000 small trees per acre in old-growth stands and 2,000 to 10,000 small trees per acre where the forest canopy had been removed through timber harvest (Arno [in press]).

When fires now occur, the dense fuels can make the fires so severe that they destroy entire forest stands. Some 24 million acres (10 million ha) of national forests in the interior West are at high risk of wildland fires that could compromise ecosystem integrity and human safety. An additional 32 million acres (13 million ha) are at moderate risk. That's 56 million acres (23 million ha) at risk, or about 29 percent of the land in our National Forest System.

Fuel buildups are causing severe fires throughout the interior West, not just on the national forests. As of late September 2000, comparable numbers of acres had burned on lands administered by the U.S. Department of the Interior (2.5 million acres [1 million ha]) and State and private managers (2.2 million acres [890,000 ha]). Unlike our national forestlands, most of these lands are at lower elevations, where wildland fire can threaten rural communities and homeowners in the wildland–urban interface.

By 1994, the number of large fires nationwide was plainly growing (fig. 2). Wildland firefighters paid a high price that year, with 134 entrapments and 35 fatalities, including 14 fallen firefighters on Storm King Mountain, CO. Afterward, the Federal wildland fire community joined together to address the fire problem. In 1995, we adopted the Federal Wildland Fire Management Policy and Program Review, which calls for integrating fire "as a critical natural process" into "land and resource management plans and activities on a landscape scale, across agency boundaries." Since 1994, the Forest Service and USDI Bureau of Land Management have increased our fuels treatments by almost 500 percent, to 2.4 million acres (10 million ha) per year.

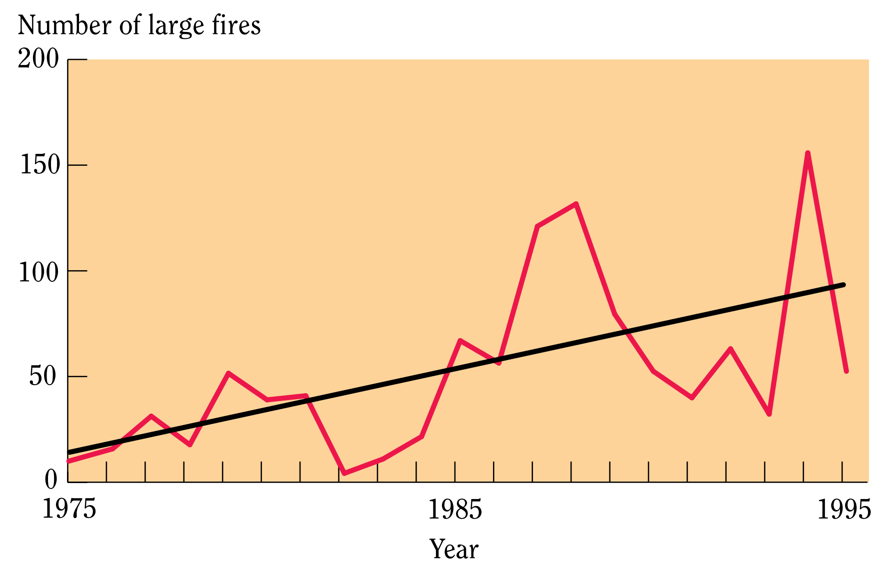

Figure 2—*The number of fires 1,000 acres (405 ha) or larger across the United States from 1975 to 1995. By the mid-1990's, large-fire occurrence was clearly rising. Illustration: Gene Hansen Creative Services, Inc., Annapolis, MD, 2000.*

National Fire Plan

We must do more. The relative severity of the 2000 fire season mobilized public opinion behind a large-scale program to reduce the fire hazard in our western forests. On September 8, 2000, the Secretaries of Agriculture and the Interior delivered a national plan to the President outlining steps we will take to better manage fire for the health of our communities and environment (see page 9). Congress appropriated funds to support the plan, including $1.1 billion for the Forest Service in fiscal year 2001.

Our National Fire Plan offers unprecedented opportunities for investing in the long-term health of the land. The growing consensus that we must restore our forests and protect our communities gives us the chance to build a constituency for active management based on ecologically conservative principals. In September 2000, the Forest Service's National Leadership Team approved principles for implementing the plan in an effective manner that minimizes controversy (see sidebar).

We need a sustained and increased level of funding to fix what ails our forests and rangelands. And money flows to things people want. Our priorities for restoration are:

- Protecting homes and communities,
- Protecting accessible municipal water supplies, and
- Protecting threatened and endangered species habitat.

We will not use funding for the National Fire Plan to put up new commercial timber sales. However, we will use existing timber sale funding, as appropriate, to help restore healthy forest ecosystems. We will use service contracts, volunteers, the Youth Conservation Corps, Forest Service work crews, and others to help accomplish our land health objectives. In the process, we will provide thousands of new jobs; new, locally based, sustainable stewardship industries; and wood fiber as a byproduct of accomplishing our land health objectives.

Our first priority will be to work with willing landowners through programs such as Firewise to reduce hazardous fuels and create defensible spaces around homes. The single most important thing homeowners can do to keep safe from wildland fire is to take such measures as clearing vegetation within 30 to 100 feet (9–30 m) from their homes. This is an arena where we can move quickly and without controversy to protect homes and private property.

Demonstrable Results

Congress and the American people will not support our efforts if we cannot provide demonstrable results. I expect every restoration project to:

- Take before-and-after pictures;
- Diligently monitor implementation and effectiveness; and
- Identify new research needs that will demonstrate which projects are most effective in accomplishing our community protection, land health, and water quality objectives.

We must be smart in how we spend the new appropriations. The surest way to lose future funding for the National Fire Plan is to propose projects that are certain to engender controversy and conflict. We must focus initial treatment on areas where risks to communities are greatest and where the risk of unintended adverse effects on wildland values is least. Restoration involving roadless areas, road construction, or old-growth forests will not be a priority unless it is determined that the land's condition places a community at risk of uncharacteristic fire effects.

We know that thinning can help reduce the risk of crown fires. We are not as certain about the effects of thinning and other mechanical

Forest Service Principles for Implementing the National Fire Plan

In September 2000, the Forest Service's National Leadership Team endorsed eight principles for implementing the National Fire Plan. The principles are intended to accomplish the most rehabilitation and restoration work with the least amount of controversy.

1. Help our State and local partners reduce the fire risk to homes and private property through programs such as Firewise.
2. Focus our rehabilitation efforts on restoring watershed function. That means protecting basic soil and water resources, conserving biological communities, and preventing the spread of invasive species.
3. Assign the highest priority for hazardous fuels reduction to communities at risk, readily accessible municipal watersheds, threatened and endangered species habitat, and other important local features where conditions favor uncharacteristic fire effects.
4. Restore healthy, diverse, and resilient ecosystems to minimize uncharacteristic fire effects. Our methods will include removing excess vegetation and dead fuels through thinning, prescribed fire, and other treatments.
5. Focus on achieving the desired future condition of the land, in collaboration with communities, interest groups, and State and Federal partners. That includes streamlining our process, maximizing our effectiveness, using an ecologically conservative approach, and minimizing controversy in accomplishing restoration projects.
6. Monitor results to evaluate the effectiveness of various treatments in reducing uncharacteristic fire effects and in restoring forest health and watershed function.
7. Encourage new stewardship industries in collaboration with local people, volunteers, the Youth Conservation Corps, service organizations, and others.
8. Focus our research on the long-term effectiveness of different restoration and rehabilitation methods to determine the best ways to protect and restore watershed function and forest health. That includes finding new uses and markets for the byproducts of our restoration work—the brush and small trees that currently have little or no market value.

Prescribed fire in pine litter. Prescribed fire, conducted safely and effectively, is a proven method for removing excess vegetation and dead fuels, major fire hazards in many of our western forests. Photo: USDA Forest Service.

treatments on forest values such as clean water, stable soils, and habitat for wildlife and fish. The fact is, we have a lot to learn. We do not have all the answers. We must temper the imperative of ramping up restoration activities with prudence. We all know of cases where well-intended stewardship projects produced unintended effects that further compromised land health.

In short, we must strike a balance between aggressive action and intelligent caution. We must make certain that we thoroughly document the results of our efforts and learn about what works, what doesn't, and why. We must tell Congress and the American people what we learn, even—perhaps especially—about projects that might not work as intended. This is our chance to perform, to put our best foot forward for the health of the lands we manage and the communities we serve.

Old-Growth Values

For too long, we have allowed the issues of old-growth forests and roadless areas to drain our resources and polarize the public. In the United States, most forests that are old growth, ancient, late successional—whatever your favorite moniker is—are found on national forests. We ought to celebrate the fact that national forests serve as a reservoir for old-growth forests and the values associated with these forests, values such as biodiversity. In the not-so-distant past, these old trees were viewed as "decadent." Today, we recognize the incredibly unique contribution of national forests to maintaining and expanding the habitat and values provided by old-growth forests.

Our management objectives within these forests should focus on maintaining and enhancing old-growth values and characteristics. I can anticipate what our critics might charge—that by protecting these forests, we are abandoning our commitment to multiple use and active management. In fact, the opposite is true. Through our National Fire Plan, we have a tremendous opportunity to demonstrate how active management—prescribed fire as well as thinning and other mechanical treatments—can enhance forest ecosystem health and resiliency in fire-adapted forests where fire has been excluded.

What we *do not* need to do to accomplish our restoration objectives is to harvest old-growth trees. In some cases, when old-growth resources and values are threatened by uncharacteristic fire effects, we might choose to carefully thin and burn understory vegetation while leaving older, larger trees intact. We will protect and enhance these ecologically sensitive areas and focus restoration on the already roaded and managed portions of the landscape, where present conditions might pose a risk to communities, accessible municipal watersheds, or threatened and endangered species habitat.

Opportunities for Healthier Lands

As my predecessor Jack Ward Thomas said, if we don't pay for fuels treatments now, we will pay in the future—in billions of dollars in fire damages each year, plus billions more in local, State, and Federal firefighting costs. The 2000 fire season showed how right Jack was.

Our Nation, the richest on Earth, has the resources—especially in these years of unprecedented prosperity—to solve our fire-related forest health problems. It will not happen overnight. It took decades of fuel buildups to endanger our forests; it will take more than a few years of treatments to reach fuel levels that are safe. Success will depend on a continued national commitment to sustain the programs under our National Fire Plan.

But it will be worth it. By working together across jurisdictions, we can do even more than solve our collective fuels problem: We can improve the long-term health of our lands while making our rural communities better places in which to live and work. It's a golden opportunity for our Nation.

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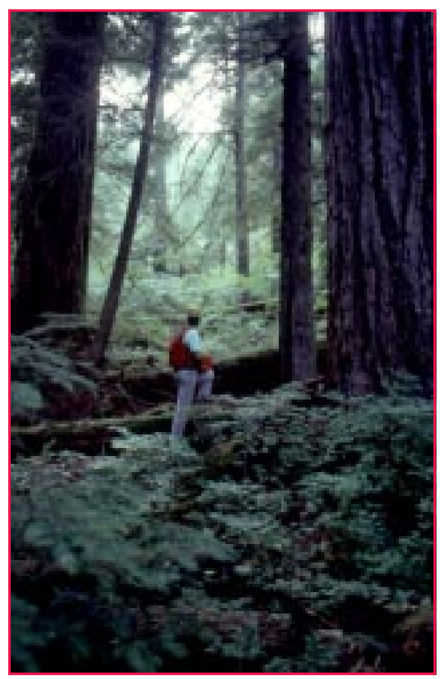


Old-growth forest ecosystem. Our national forests serve as a reservoir for rare, threatened, and endangered species associated with old-growth, interior-forest habitat. Photo: USDA Forest Service, 1991.

Managing the Impact of Wildfires on Communities and the Environment: A Report to the President in Response to the Wildfires of 2000 (Executive Summary)

Editor's note: On September 8, 2000, Secretary of Agriculture Dan Glickman and Secretary of the Interior Bruce Babbitt released "Managing the Impact of Wildfires on Communities and the Environment: A Report to the President in Response to the Wildfires of 2000." The executive summary is reprinted here, lightly edited. The full report was posted on the World Wide Web at <http://www.whitehouse.gov/CEQ/firereport.pdf>.

On August 8, 2000, President Clinton asked Secretaries Babbitt and Glickman to prepare a report that recommends how best to respond to this year's severe fires, reduce the impacts of these wildland fires on rural communities, and ensure sufficient firefighting resources in the future.

The President also asked for short-term actions that Federal agencies, in cooperation with States, local communities, and tribes, can take to reduce immediate hazards to communities in the wildland–urban interface and to ensure that land managers and firefighter personnel are prepared for extreme fire conditions in the future.

This report recommends a fiscal year (FY) 2001 budget for the wildland fire programs of the Departments of Agriculture and the Interior of $2.8 billion. Included within this total is an increase of nearly $1.6 billion above the President's FY 2001 budget request in support of the report's recommendations. This includes additional funding of about $340 million for fire preparedness resources, new funding of $88 million to increase cooperative programs in support of local communities, and approximately $390 million for fuels treatment and burned area restoration. The increase also includes about $770 million to replenish and enhance the Departments' fire suppression accounts, which have been depleted by this year's extraordinary costs, and to repay FY 2000 emergency transfers from other appropriations accounts.

> As a first priority, the Departments will continue to provide all necessary resources to ensure that firefighting efforts protect life and property.

A summary of the key points discussed in the body of the report:

1. Continue to make all necessary firefighting resources available. The wildfires of the summer of 2000 continue to burn. As conditions change, new fires will start as others are controlled or die out. As a first priority, the Departments will continue to provide all neces-

The Valley Complex Fire on Montana's Bitterroot National Forest. One of many large fires in the interior West during the 2000 fire season, the Valley Complex Fire burned for weeks and blackened more than 292,000 acres (118,000 ha). Photo: USDA Forest Service, 2000.

sary resources to ensure that firefighting efforts protect life and property. The Nation's wildland firefighting organization is the finest in the world and deserves our strong support.

Silt fence (above) helps prevent postfire erosion (below). Postfire rehabilitation, including watershed restoration and soil stabilization, is a prominent part of the National Fire Plan. Photos: USDA Forest Service.

2. Restore landscapes and rebuild communities. The Departments will invest in restoration of communities and landscapes impacted by the 2000 fires. Some communities already have suffered considerable economic losses as a result of the fires. These losses will likely grow unless immediate, emergency action is taken to reduce further resource damage to soils, watersheds, and burned-over landscapes. Key actions include:

- **Rebuilding communities and assessing economic needs.** Assess the economic needs of communities and, consistent with current authorities, commit the financial resources necessary to assist individuals and communities in rebuilding their homes, businesses, and neighborhoods. Existing loan and grant programs administered by the Federal Emergency Management Agency (FEMA), the Small Business Administration (SBA), and USDA's Forest Service and Rural Development programs should provide this assistance.
- **Restoring damaged landscapes.** Invest in landscape restoration efforts, such as tree planting, watershed restoration, and soil stabilization and revegetation. In so doing, priority should focus on efforts to protect:

Building on policies of the past 8 years, the Departments should establish a collaborative effort to expedite and expand landscape-level fuel treatments.

– Public health and safety (e.g., municipal watersheds);
– Unique natural and cultural resources (e.g., salmon and bull trout habitat) and burned-over lands that are susceptible to the introduction of nonnative invasive species; and
– Other environmentally sensitive areas where economic hardship may result from a lack of reinvestment in restoring damaged landscapes (e.g., water quality impacts on recreation and tourism).

3. Invest in projects to reduce fire risk. Addressing the problem of brush, small trees, and downed material that have accumulated in many forests because of past management activities, especially a century of suppressing wildland fires, will require significant investments to treat landscapes through thinning and prescribed fire. Since 1994, the Forest Service and the Bureau of Land Management have increased the number of acres treated to reduce fuel buildups from fewer than 500,000 acres [200,000 ha] in 1994 to more than 2.4 million acres [970,000 ha] this year. Building on the forest policies of the past 8 years, the wildland fire policy, and the concepts of ecosystem management, the Departments should establish a collaborative effort to expedite and expand landscape-level fuel treatments. Important dimensions of this effort include:

- **Developing a locally led, coordinated effort between the Departments of Agriculture, the Interior, and Commerce, and other appropriate agencies through the establishment of integrated fuels treatment teams at the regional and field levels.** The role of each team would be to identify and prioritize projects targeted at communities most at risk, coordinate environmental reviews and consultations, facilitate and encourage public participation, and monitor and evaluate project implementation. Each team will work closely with local communities to identify the best fit for each community.
- **Utilizing small-diameter material and other biomass.** Develop and expand markets for traditionally underutilized small-diameter wood and other biomass as a value-added outlet for excessive fuels that have been removed.
- **Allocating necessary project funds.** Commit resources to support planning, assessments, and project reviews to ensure that hazardous fuels management is accomplished expeditiously and in an environmentally sound manner.

4. Work directly with communities. Working with local communities is a critical element in restoring damaged landscapes and reducing fire hazards near homes and communities. To accomplish this, the Departments recommend:

- **Expanding community participation.** Expand the participation of local communities in efforts to reduce fire hazards and the use of local labor for fuels treatment and restoration work.
- **Increasing local capacity.** Improve local fire protection capabilities through financial and technical assistance to State, local, and volunteer firefighting efforts.
- **Learning from the public.** Encourage grassroots ideas and solutions best suited to local communities for reducing wildfire risk. Expand outreach and education to homeowners and communities about fire prevention through use of programs such as Firewise.

5. Be accountable. Establish a Cabinet-level coordinating team to ensure that the actions recommended by the Departments receive the highest priority. The Secretaries of Agriculture and the Interior should cochair this team. Integrated management teams in the region should take primary responsibility for implementing the fuels treatment, restoration, and preparedness program. The Secretaries should assess the progress made in implementing these action items and provide periodic reports to the President. ■

An Ecologically Based Strategy for Fire and Fuels Management in National Forest Roadless Areas

Dominick A. DellaSala and Evan Frost

During the challenging 2000 fire season, the local and national headlines trumpeted daily news about the "worst fires in recent memory." The media showered us with the latest statistics on wildland fires in the West: "More than 6 million acres charred in 13 Western States…more than 25,000 firefighters deployed…over 80 blazes raging out of control…hundreds of homes consumed."

Some individuals sought to increase logging on Federal lands, citing greatly reduced logging levels during the previous decade as the cause of the 2000 fires. The implication was that the USDA Forest Service's proposed policy for protecting roadless areas was akin to putting a lit match into a tinderbox.

Whereas conservationists advocated roadless area protection on the basis that roadless areas are the last remnants of formerly large and intact forests, logging proponents called for massive logging, roadbuilding, and a rash of prescribed fires as a quick fix for the previous 50 to 100 years of fire suppression. The rest of us pondered: Where is the science in all this? Is every acre doomed to "catastrophic" fire if not intensively managed? Is it appropriate to treat all forests the same, regardless of whether or not they contain existing road systems?

Dominick DellaSala is a forest ecologist and director of the Klamath–Siskiyou Regional Program for the World Wildlife Fund, Ashland, OR; and Evan Frost is an ecologist for Wildwood Environmental Consulting, Ashland, OR.

Scientists widely agree that protecting roadless areas will enhance biodiversity and ecosystem conservation.

After all the hyperbole—a combination of media hype and misinformation spread to promote special interests—it's time to take a sober look at the questions raised by the 2000 fire season. Specifically, what evidence exists on the relationship between wildland fire and timber management in roaded vs. roadless areas? What effects might silvicultural treatments and prescribed fire have on ecosystems in roadless areas? Is there an ecologically based strategy for identifying, on a case-by-case basis, where active management might be appropriate for maintaining fire-dependent forest ecosystems?

Fire and Roadless Areas

Level of Fire Hazard. Scientists widely agree that protecting roadless areas on the national forests from roadbuilding, commercial logging, and other forms of development will greatly enhance biodiversity and ecosystem conservation (Ercelawn 1999; Henjum and others 1994; Noss and Cooperider 1994; Strittholt and DellaSala [in press]). However, some critics of roadless area protection (Bernton 1999; Hansen 1999; Schlarbaum 1999) have repeatedly made two assertions:

- Roadbuilding prohibitions in roadless areas will restrict access for timber management, which in turn will increase the frequency of large, intense fires.
- Widespread silvicultural treatments (such as low thinning and crown thinning) in roadless areas will be necessary to reduce the fire hazard.

Does the relevant scientific literature support these claims?

Broad scientific assessments were completed in 1996 and 1997, respectively, for Federal lands in the Sierra Nevada in California and the Interior Columbia River Basin in portions of Idaho, Montana, Nevada, Oregon, Washington, and Wyoming. These studies provide the most comprehensive analysis to date for comparing fire, fuel, and vegetation conditions in intensively managed areas to conditions in roadless areas. Both assessments found the fire hazard to be significantly higher in intensively managed areas.

Tree plantation on the Mount Baker–Snoqualmie National Forest, WA. Intensively managed landscapes such as this hold some of the greatest wildfire risks. Tree plantations are particularly susceptible to fire because live fuels are often continuous, concentrations of flammable slash are often present from past logging, and small trees have little resistance to fire. In 2000, a large proportion of the lands that burned with uncharacteristically high intensity were intensively managed for timber production (Morrison and others 2000). Photo: Evan Frost, Ashland, OR, 1993.

According to the Sierra Nevada assessment, "Timber harvest, through its effects on forest structure, local microclimate and fuel accumulation, has increased fire severity more than any other recent human activity" (SNEP 1996). The Interior Columbia Basin assessment similarly concluded that "fires in unroaded areas are not as severe as in roaded areas because of less surface fuel….Many of the fires in the unroaded areas produce a forest structure that is consistent with the fire regime, while the fires in the roaded areas commonly produce a forest structure that is not in sync with the fire regime. Fires in the roaded areas are more intense, due to drier conditions, wind zones on the foothill/valley interface, high surface-fuel loading, and dense stands" (Hann and others 1997).

Even within the forest types most altered as a result of fire suppression (such as dry forests with a regime of frequent low-intensity fires), intensively managed forests on Federal lands in the Interior Columbia Basin are denser and carry higher fuel loads than do roadless areas. Accordingly, intensively managed lands were found to be at higher risk of tree mortality from fire, insects, disease, and other disturbance agents (Hann and others 1997).

Others have reported similar findings for portions of the interior West. In the Sierra Nevada, McKelvey and others (1996) and Weatherspoon (1996) identified timber harvest as the single most important factor responsible for an increase in potential fire severity. In the Klamath Mountains of northwestern California, Weatherspoon and Skinner (1995) found that partial-cut stands with fuels treatment (lop and scatter or broadcast burning) burned more intensely and suffered higher levels of tree mortality than adjacent areas left uncut and untreated. Fire and fuel models also suggest that mechanical treatments alone, including silvicultural thinning and biomass removal, are not likely to be effective at reducing fire severity in dense stands (van Wagtendonk 1996).

In eastern Oregon and Washington, Lehmkuhl and others (1995) and Huff and others (1995) reported a positive correlation between logging, on the one hand, and fuel loadings and predicted flame lengths, on the other. They attributed the increased fire hazard in intensively managed areas to leftover slash fuels from tree removal activities (including thinning) and to the creation of dense, early-successional stands through overstory removal. A postfire study of the effectiveness of fuels treatments (including thinning) on previously nonharvested lands on the Wenatchee National Forest in Washington found that harvest treatments likely exacerbated fire damage (USDA Forest Service 1995).

Overall, the scientific literature suggests that forests in areas without roads are less altered from historical conditions and present a lower fire hazard than forests in intensively managed areas, for three reasons:

1. Timber management activities often increase fuel loads and reduce a forest's resilience to fire.
2. Areas without roads have been less influenced by fire suppression than intensively managed lands.
3. Widespread road access associated with intensively managed lands raises the risk of human-caused ignitions.

As summarized in a recent review of national forest management organized by the Ecological Society of America, "There is no evidence to suggest that natural forests or reserves are more vulnerable to disturbances such as wildfire than intensively managed forest stands. Indeed, there is considerable evidence to the contrary, evidence that natural forests are actually more resistant to many types of both small- and large-scale disturbances" (Aber and others 2000). Assertions about increased wildland fire made by critics of roadless area protection are not based in fact; the evidence is clear that the forests most in need of fuels treatment are not roadless areas but areas that have already been roaded and logged, "where significant investments have already been made" (USDA/ USDI 1997).

Effectiveness of Fire Suppression. Some evidence exists that fire suppression activities have had a lower impact on roadless areas than on roaded portions of the national forests (Hann and others 1997; SNEP 1996). The lower impact may be attributable to limited access and steep terrain, which prevent the application of large, ground-based suppression strategies in roadless areas (Agee 1993; Fuller 1991; Pyne 1996; Schroeder and Buck 1970).

Fires in roadless areas tend to be more remote from human habitations than are fires on roaded lands. Accordingly, they are often the lowest priority for suppression during years when firefighting resources are in short supply. Although data are limited, findings from the Interior Columbia Basin assessment on this topic might apply to other regions as well. The assessment concluded that a "combination of past harvest practices and more effective fire suppression moved the roaded landscapes much further from their unaltered biophysical templates, as measured by dominant species, structures, and patterns, relative to unroaded areas….In general, all forests which show the most change from their historical condition are those that have been roaded and harvested" (Hann and others 1997). Furthermore, the forests that are most susceptible to moisture stress, insects, disease, and unnaturally intense fire tend to be at the lowest elevations, which typically border private, State, tribal, or other landownerships (Everett and others 1994).

Old-growth forest burning on the Mount Baker–Snoqualmie National Forest, WA. Scientific investigation has shown that, of all forest ages and conditions, unmanaged old growth is the least likely to burn catastrophically. The resistance of such forests to fire is related to a variety of factors, including their cool/moist microclimate and preponderance of large, fire-resistant trees. Expending large amounts of resources to extinguish such fires in areas without roads might not be fiscally sound or ecologically appropriate. Photo: Evan Frost, Ashland, OR, 1994.

Another reason why fire suppression has had less impact on forests in roadless areas is associated with differences in vegetation and fire regimes. A large proportion of roadless areas on the national forests, particularly in the interior West, are found at middle to high elevations (Beschta and others 1995; Henjum and others 1994; Merrill and others 1995). Some exceptions are in the Eastern United States, where elevational gradients are limited, and the Klamath–Siskiyou ecoregion in northwest California and southwest Oregon, where very steep slopes at lower elevations have limited road construction (Strittholt and DellaSala [in press]).

Higher elevations are cooler, receive more moisture, and have a shorter summer dry season than lower elevations. They are typically characterized by a regime of low-frequency, high-intensity fires (Agee 1993; Baker 1989; van Wagner 1983). Roadless areas are therefore less likely to have current fire regimes that are significantly different from historical conditions (Agee 1997; Beschta and others 1995).

For fires in high-elevation forests, weather rather than fuels is often the primary variable determining fire severity and extent (Agee 1997; Bessie and Johnson 1995; Flannigan and Harrington 1988; Johnson and Wowchuck 1993; Turner and others 1994). Under severe fire weather, the efficacy of fire suppression decreases dramatically in forest types characterized by high-intensity fires (Agee 1998; SNEP 1996). Even substantial investments of financial and human firefighting resources often fail to control large fires; they are extinguished only when the weather changes (Romme and Despain 1989).

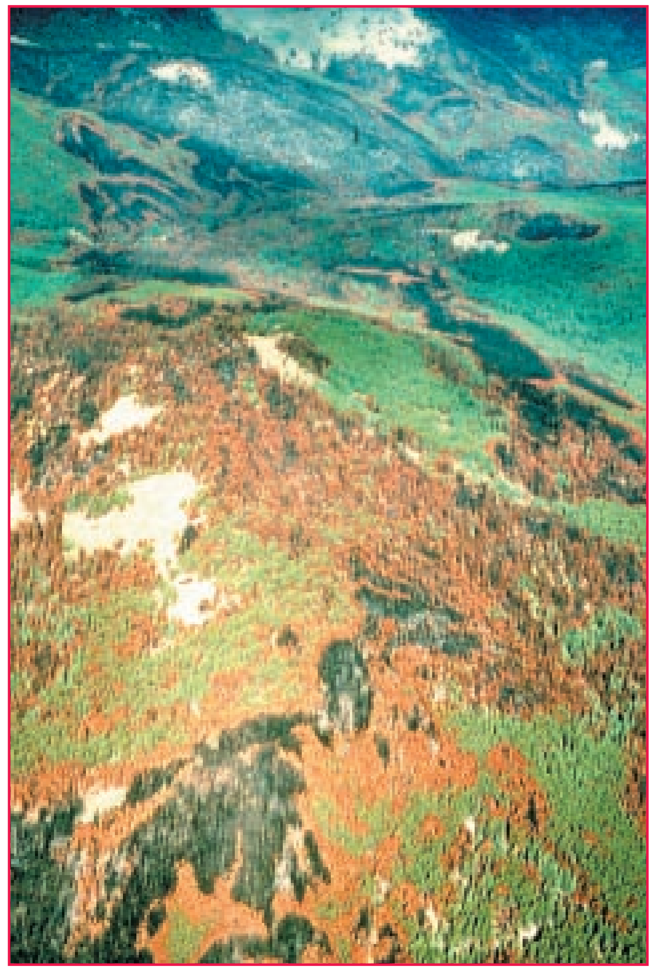
Risk of Human-Caused Ignitions. Roadless areas have a lower potential for high-intensity fires than roaded areas partly because they are less prone to human-caused ignitions (DellaSala and others 1995; USDA Forest Service 2000; Weatherspoon and Skinner 1996). Roads constructed for timber management and other activities provide unregulated motorized access to most national forestlands and are heavily used by the general public.

In the Western United States, most of the more than 378,000 miles (608,000 km) of national forest roads traverse heavily managed forests with the greatest potential for high-severity fire. According to the Forest Service, more than 90 percent of wildland fires are the result of human activity, and ignitions are almost twice as likely to occur in roaded areas as they are in roadless areas (USDA Forest Service 1998, 2000). Although it can be argued that roads improve access for fire suppression, this benefit is more than offset by much lower probabilities of fire starts in roadless areas.

The Case Against Mechanical Fuels Treatments in Roadless Areas

Some land managers and policy makers advocate the widespread use of silvicultural treatments (often mechanical thinning of merchantable trees) in western roadless areas to reduce fuel loads and tree stocking levels and thereby decrease the probability of large, intense fires. Although thinning has long been a part of intensive forest management, its efficacy as a tool for fire hazard reduction at the landscape scale is controversial and remains fundamentally experimental in nature (DellaSala and others 1995; FEMAT 1993; Henjum and others 1994; SNEP 1996; USDA Forest Service 2000).

Few empirical studies have tested the relationship, even on a limited basis, between thinning or other fuels treatments and fire behavior. These studies, supported by anecdotal information and the analysis of recent fires, suggest that thinning treatments have highly variable results. In some instances, thinning intended to reduce the fire hazard appeared to have the opposite effect (Huff and others 1995; van Wagtendonk 1996; Weatherspoon 1996). Thinning might reduce fuel loads, but it also allows more solar radiation and wind to reach the forest floor. The net effect is often reduced fuel moisture and increased flammability (Agee 1997; Countryman 1955).



Mosaic burn pattern left by the Thunder Mountain Fire on the Okanogan National Forest in north-central Washington in 1994. High-elevation forests, which comprise a large proportion of national forest roadless areas, are characterized by infrequent high-intensity fires that often burn large areas in patchwork patterns. The low-frequency, high-intensity fire regime remains largely unchanged by fire suppression and is often driven by extreme weather events. Photo: Peter Morrison, 1994.

Moreover, mechanical treatments fail to mimic the ecological effects of fire, such as soil heating, nutrient cycling, and altering forest community structure (Chang 1996; DellaSala and others 1995; Weatherspoon and Skinner 1999). In fact, according to the Sierra Nevada Ecosystem Project report, "although silvicultural treatments can mimic the effects of fire on structural patterns of woody vegetation, virtually no data exist on their ability to mimic the ecological functions of natural fire. Silvicultural treatments can create patterns of woody vegetation that appear similar to those that fire would create, but the consequences for nutrient cycling, hydrology, seed scarification, nonwoody vegetation response, plant diversity, disease and insect infestation, and genetic diversity are almost unknown" (SNEP 1996).

Although our current understanding of the ecological effects of thinning is incomplete, evidence indicates that mechanical treatments, even when carefully conducted, can have additional environmental impacts such as:

- Damage to soil integrity through increased erosion, compaction, and loss of litter layer (Harvey and others 1994; Meurisse and Geist 1994);
- Increased mortality of residual trees due to pathogens and mechanical damage to boles and roots (Filip 1994; Hagle and Schmitz 1993);
- Creation of sediment that might degrade streams (Beschta 1978; Grant and Wolff 1991);
- Increasing levels of fine fuels and near-term fire hazard (Fahnestock 1968; Huff and others 1995; Weatherspoon 1996; Wilson and Dell 1971);

> "Timber harvest, through its effects on forest structure, local microclimate and fuel accumulation, has increased fire severity more than any other recent human activity."
> *Sierra Nevada Ecosystem Project report, 1996*

- Disruption of mycorrhizal fungi–plant relationships that are important to ecosystem function and to shrubs and perennial native bunchgrasses involved in fungal linkages (Amaranthus and Perry 1994; Massicotte and others 1999; Southwort and Valentine 2000);
- Dependence on roads, which have numerous adverse effects of their own (Henjum and others 1994; Megahan and others 1994); and
- Reduced habitat quality for sensitive species associated with cool, moist microsites or closed-canopy forests (FEMAT 1993; Thomas and others 1993).

These adverse impacts of mechanical treatments should be of particular concern in managing roadless areas, where ecological values are especially high. Moreover, roadless areas are often in steep, unstable terrain that is highly sensitive to human disturbance (Henjum and others 1994; Wilderness Society 1993). According to the Forest Ecosystem Management Assessment Team, most existing roadless areas "are considered inoperable because timber harvest and road construction would result in irretrievable loss of soil productivity and other watershed values. These lands consist of erosion- and landslide-prone landforms such as inner gorges, unstable portions of slump earthflow deposits, deeply weathered and dissected weak rocks, and headwalls" (FEMAT 1993).

Similarly, the Interior Columbia Basin assessment found "a high risk to watershed capabilities from further road development in these [roadless] areas. In general, the effects of wildfires in these areas are much lower and do not result in the chronic sediment delivery hazards exhibited in areas that have been roaded. In contrast, the already roaded areas have high potential for restoration action" (USDA/USDI 1997). Given the potential for adverse impacts from silvicultural treatments in roadless areas, many scientists recommend limiting experimental treatments to previously managed lands already degraded by fire suppression and logging (Aber and others 2000; Beschta and others 1995; DellaSala and others 1995; Franklin and others 1997; Hann and others 1997; Henjum and others 1994; McKelvey and others 1996; Perry 1995).

In summary, scientific assessments of Federal lands in several western regions generally conclude that previously roaded and logged areas should be the highest priority for fuels reduction and forest restoration treatments (FEMAT 1993; Hann and others 1997; SNEP 1996). Silviculture has a role to play in a scientifically based approach to fire and fuels management on Federal lands, but current evidence indicates that widespread mechanical treatments in roadless areas would most likely increase rather than decrease ecosystem degradation. Therefore, experimentation with mechanical treatments for fire hazard reduction should proceed primarily in areas with road access and adjacent to private lands, where the ecological risks are lower and the threat of fire to human lives and property is far greater.

Roadless areas should be considered for mechanical treatment after other, higher priority areas are addressed and only if it can be demonstrated that such treatments will not degrade ecological values. Any experimental treatments in roadless areas should occur in small roadless areas (less than 5,000 acres [2,000 ha]) that have relatively good access, are near the wildland–rural interface, and exhibit high fire hazard due to past suppression. Only small trees (generally less than 12 inches [30 cm] in diameter) should be considered for removal, and under no circumstances should new or temporary roads be built to conduct mechanical treatments.

Roadless area along the Illinois River in southwest Oregon, part of the National Wild and Scenic Rivers System. Most roadless areas are on steep slopes presenting access problems for fire control. Well-managed fire use, particularly in the backcountry, is ecologically appropriate and often the most cost-effective way of safely handling fuel hazards in most roadless areas. Photo: Dominick DellaSala, Ashland, OR, 1999.

The Case for Prescribed Fire in Roadless Areas

The Forest Service should treat roadless areas primarily by reintroducing fire, both natural and prescribed. Restoration of ecological processes is key to ecosystem integrity and biological diversity (Samson and Knopf 1993), particularly in unroaded areas. Use of prescribed fire has been successful in restoring wildland fire regimes to many fire-adapted ecosystems (Wright and Bailey 1982), and a widespread consensus exists that additional burning is necessary (Arno 1996; Mutch 1994, 1997; USDA/USDI 1995; Walstad and others 1990).

Prescribed fire has important advantages over mechanical treatments in areas where ecological integrity and biodiversity conservation are important management objectives (Hann and others 1997; SNEP 1996; Weatherspoon and others 1992). Prescribed fire also appears to be the most effective treatment for reducing fire severity and rate of spread (Stephens 1998; van Wagtendonk 1996). In addition to reducing fuel loading and continuity, prescribed fire may decrease pest outbreaks, provide germination sites for shade-intolerant species, release nutrients, and create wildlife habitat (Agee 1993; Biswell 1999; Chang 1996; Walstad and others 1990).

Positive outcomes associated with prescribed fire are, of course, contingent on detailed site-specific planning, adequate budgetary support, and careful execution by trained personnel. In roadless areas with forests characterized by low-intensity, high-frequency fire regimes, repeated prescribed burns within a relatively short timeframe might be required to sufficiently reduce fuels and ensure that fire intensities remain within an acceptable range (Biswell 1999). After initial treatment, the frequency of prescribed burns can be designed to reflect the inherent disturbance regime and range of variability associated with particular forests. Data from the Sierra Nevada suggest that prescribed burning is likely to be considerably cheaper for treating fuels than either mechanical treatments or fire suppression (Husari and McKelvey 1996; see Deeming

[1990] for a summary of the literature on the cost-effectiveness of prescribed burning versus other fuel treatments).

In addition to prescribed fire, ecological benefits could flow from allowing some naturally ignited fires to burn in roadless areas under specific environmental conditions. Traditionally, the Forest Service has suppressed most wildland fires without adequately considering the potential resource benefits of a "confine-and-contain" strategy. However, Federal policies introduced in 1995 encourage careful management of naturally ignited wildland fires if they meet resource objectives and are consistent with inherent fire regimes (USDA/USDI 1995). Less than full control strategies for fire suppression could be employed, provided the strategy chosen is projected to incur the least cost of suppression and the least loss of resource values (McKelvey and others 1996).

Carefully planned wildland fire use should be fully considered for roadless areas, based on fire regime, expected fire behavior, and other variables, as an alternative to costly firefighting in large remote areas where there is little or no danger to lives and property. In 2000, the Forest Service spent more than $91 million fighting two large fires in Idaho, the Burgdorf Junction Fire and the Clear Creek Complex Fire. Together, the fires burned more than 280,000 acres (113,000 ha), mostly in remote roadless and wilderness areas (Morrison and others 2000; NIFC 2000a). On such fires, wildland fire is likely to be the most sensible as well as ecologically appropriate strategy.

Areas without roads have been less influenced by fire suppression activities than intensively managed lands.

Prioritizing Roadless Areas for Prescribed Fire

Management decisions on whether and where to apply prescribed fire in roadless areas should be based on site-specific analysis of current and historic forest conditions, landscape context, watershed integrity, the status of at-risk fish and wildlife populations, and other ecological values. However, the following criteria provide a general framework for prioritizing treatments to maximize potential benefits and minimize ecological risk.

The most credible efforts will initially apply prescribed fire in areas where:

- The dominant forest types are characterized by relatively frequent, low- and mixed-severity fire regimes (i.e., the forests have most likely been significantly altered from historical conditions).
- Reintroducing fire is operationally feasible with minimal risk of adverse impacts on soils, watersheds, wildlife, and other ecological values. Focusing fire treatments on such areas will help secure their high ecological integrity and resilience to fire, characteristics that might be lost if forest structure and composition are not maintained within their appropriate ranges. Subsequent restoration efforts should be designed to extend and/or connect high-integrity areas at the landscape level.
- The risk of losing key habitats (e.g., late-successional forests, aquatic refugia, critical habitat for at-risk species, or rare community types) due to uncharacteristic fire effects is especially high. This type of fire risk is often high where small and/or isolated roadless areas are embedded in landscapes that have been highly simplified and fragmented by intensive timber management. In many cases, the most effective way of protecting these areas without reducing the quality of key habitats will be to treat adjacent, already managed and roaded areas.
- Fire can be reintroduced at the landscape level (as opposed to the stand level), thereby allowing natural ecological processes to function again in shaping ecosystem structure and composition over time. Landscape-level treatments will also allow the most acres to be treated at the least cost.
- Prescribed fire treatments can be strategically located to break up the continuity of fuels at the landscape level, thereby reducing the risk of uncharacteristically large, severe wildland fires. Fuel discontinuities should be located in topographic settings where fire hazard conditions were most likely historically low (e.g., along major ridges or on south- and west-facing upper slopes).

Instead of suppression, many roadless areas could benefit from proactive fuels management using fire. Fire management in roadless areas should be based on (1) a standard set of guidelines for identifying and prioritizing roadless areas based on their fire hazard and risk at the national or regional level (see sidebar below); and (2) a subsequent step-down process for planning fire treatments at the local level, designed to allow fire to play a more important role while minimizing risks to ecological values.

Integrated Management Strategies Are Needed

Roadless areas do not exist in isolation from other land designations. It follows that an effective fire and fuels management strategy should be developed at the landscape scale. This means first identifying areas of highest priority for fire/fuels treatments, and then planning treatments that are consistent with management standards to ensure protection of soil, water, wildlife, and other ecological values. For roadless areas, high-priority treatment areas should first be identified at the national and regional scale. Then site-specific burn plans can be developed for individual landscapes or watersheds, by integrating spatial information on fire hazard (fuel load, fuel continuity, and topography); fire risk (ignition history and weather); and ecosystem values (old-growth forests, wildlife habitat, and sensitive watersheds) (Agee 1995; Bunting 1996; Crutzen and Goldhammer 1993; Johnson and others 1997; Weatherspoon and Skinner 1996). Through this kind of tiered prioritization, limited resources can be directed to areas that are most in need of fire and fuels reduction.

Over time, as fire is reintroduced into roadless areas—coupled with fire and other fuels treatments on adjacent, intensively managed lands—the occurrence of large, high-intensity wildland fires might become of less concern. In some cases, limited low thinning (removal of small understory trees) might be appropriate in roadless areas as a prerequisite for prescribed fire. However, more experimentation and research on the efficacy of mechanical treatments are needed in intensively managed forests before such treatments are broadly applied to roadless areas. Such a cautious approach is warranted, given that a mere 7 percent of roadless lands present a high fire hazard; the vast majority of areas at risk of uncharacteristically intense fire are in the intensively managed, roaded landscape (USDA Forest Service 2000).

Principles for Fire and Fuels Management

Land managers need a comprehensive, landscape-level strategy for fire/fuels management that takes into account the important values associated with roadless areas and directs treatments where they are needed the most. The strategy should be based on the following principles:

- Initially limit mechanical treatments to high-priority, low-risk areas, primarily roaded areas of dense, dry forest.
- Reduce the fire risk in the wildland–rural interface by treating areas immediately adjacent to rural settlements as a first line of defense. Provide homeowners with assistance grants to reduce the fire hazard on private land by creating a defensible space around homes.
- Conduct watershed or landscape-scale assessments that identify restoration priorities before widespread fire/fuel treatments are initiated.
- Eliminate commercial incentives for mechanical removal of merchantable trees by decoupling goods from services (that is, pay a fixed fee for tree removal services that is not tied to timber volume).
- Focus on removing small-diameter trees (e.g., trees less than 12 inches [30 cm] in diameter at breast height or intermediate and suppressed understory trees) where current forest stand densities are outside the historical range of variability.
- Minimize impacts to soils, below-ground processes and related species, accumulation of surface fuels from thinning, and exposure to solar radiation and reduction of soil moisture retention.
- Conduct mechanical treatments in high-priority, low-risk areas in compliance with all relevant environmental statutes (e.g., the National Environmental Policy Act, National Forest Management Act, and Endangered Species Act).

Although much can be done to reduce fire hazards, there is no "magic bullet" to reverse many decades of fire suppression and other management activities. Despite our best intentions, the fire situation might yet worsen as more homeowners build cabins deeper into fire-prone forests and climate change potentially produces hotter and drier conditions in some areas. Moreover, it is important to note that despite all the media hype, the 2000 fire season was relatively light by historical standards: In the 1930's, more than 39 million acres (16 million ha) burned on average each year (NIFC 2000b).

The strategy outlined here is consistent with recent Federal policy recommendations emphasizing treatment of the highest priority areas first in noncontroversial areas—the wildland–rural interface and designated municipal watersheds (Council on Environmental Quality 2000). To ensure that the current fire management policy avoids ecological risks associated with the logging of large trees and other ecosystem values, we recommend that thinning in priority areas target the removal of the small, noncommercial materials that have increased most dramatically as a result of fire exclusion and are of greatest concern for hazardous fuel reduction. Our recommendation is consistent with Forest Service Chief Mike Dombeck's letter to Senator Jeff Bingaman emphasizing that emergency appropriations be used to remove trees smaller in size than 12 inches (30 cm) in diameter at breast height from high-priority areas (Dombeck 2000).

In contrast, timber industry representatives such as Butch Bernhardt of the Western Wood Products Association insist that "cutting some larger trees" is "the incentive" needed to "markedly improve forest health" by allowing "more sunlight and nutrients to reach the remaining growth" (Associated Press 2000). Commercial harvest is designed for profit, not to address ecological need; the timber industry's claims to the contrary are inconsistent with the available science on fire and fuels management. Only through an integrated approach that emphasizes protection of roadless values and focuses treatment where it is most needed—in the roaded landscape—are we likely to make significant progress in restoring the resiliency of western forest ecosystems.

Adverse impacts of mechanical treatments should be of particular concern in managing roadless areas, where ecological values are especially high.

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Intensively managed area on the Idaho Panhandle National Forests. Logging contributes to fire risks in many ways, including accumulation of fine fuels (slash) on forest floors; removal of large, relatively fire-resistant trees; opening of understories to excessive drying and solar radiation; increase of flammable understory layers; and increase in the likelihood of human-caused ignitions associated with road access. Photo: Dominick DellaSala, Ashland, OR, 1995.

Scientific assessments of Federal lands generally conclude that previously roaded and logged areas should be the highest priority for fuels reduction and forest restoration treatments.

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Prescribed fire has important advantages over mechanical treatments in areas where ecological integrity and biodiversity conservation are high priorities.

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Restoring Fire to Wilderness: Sequoia and Kings Canyon National Parks

Jeffrey Manley, MaryBeth Keifer, Nathan Stephenson, and William Kaage

Sequoia and Kings Canyon National Parks, established in 1890, consist of 863,741 acres (349,551 ha) of Sierra Nevada foothills, mid-elevation conifer forest, and high-elevation alpine environment. The parks contain 36 giant sequoia (*Sequoiadendron giganteum*) groves, including the largest known tree, the General Sherman. Ninety-four percent of the parklands is in designated or proposed wilderness (fig. 1), with conditions resembling roadless areas in national forests.

Since 1969, prescribed fire and wildland fire use have been extensively applied to restore and maintain ecosystems in many areas of the parks. Controversy, on the parks and elsewhere, regarding the wisdom of reintroducing fire into altered forests without prior mechanical treatment has caused the parks to reevaluate the outcomes of the current fire management program.

Altered Ecosystems

Most of the parks' ecosystems have been shaped and driven by fire as a pervasive and important natural process over thousands of years. Euroamerican occupation of the parklands, beginning in the mid-1800's, seriously disrupted the natural fire regime through grazing, fire suppression, and some logging. As a result, large amounts of surface fuels accumulated and small trees increased in the understory, many of which would have otherwise been removed by frequent, naturally occurring fires.

Euroamerican occupation of the parklands seriously disrupted the natural fire regime of the giant sequoia–mixed conifer forest through grazing, fire suppression, and some logging.

In the giant sequoia–mixed conifer forest, fires before Euroamerican settlement burned at intervals ranging from 2 to 30 years, as

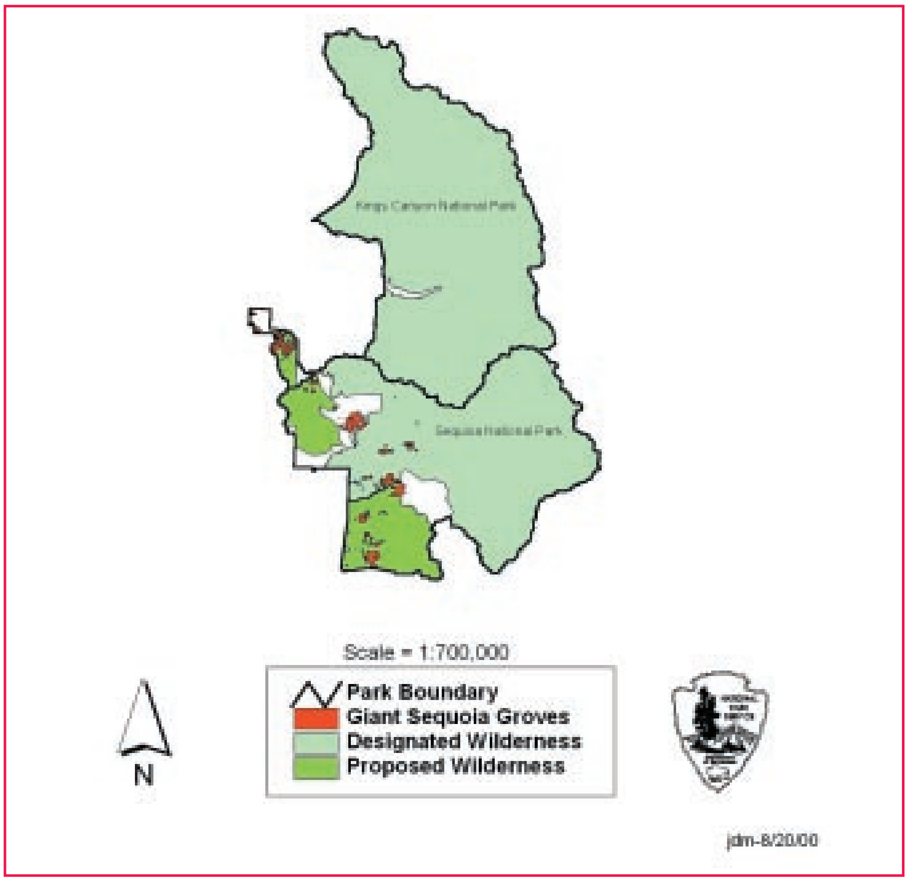

Figure 1—*Sequoia and Kings Canyon National Parks. Ninety-four percent of the area in the parks is congressionally designated or proposed wilderness. The parks contain 36 giant sequoia groves. Illustration: USDI National Park Service, Sequoia and Kings Canyon National Parks, Three Rivers, CA.*

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The parks' fire effects data show that prescribed burns consistently meet the objective of reducing total fuel loads by at least 60 to 80 percent in all conifer forest types.

evidenced by fire scars in the giant sequoia annual ring records dating back nearly 2,000 years (Kilgore and Taylor 1979; Swetnam 1993). Aggressive fire suppression beginning in the early 1900's almost completely halted fire in the parks' forests over the next 70 to 100 years. As a result, many areas missed from 5 to 16 natural fire events. Preburn fuel loads increased, reaching an average of 14 tons per acre (34 t/ha) in the giant sequoia–mixed conifer forests (Keifer 1998). Stand density, especially in the smaller size classes of shade-tolerant (and fire-intolerant) white fir (*Abies concolor*), increased dramatically during the century-long disruption of the fire regime. These changes are well documented by Kilgore (1972), Parsons (1978), Vankat and Major (1978), and others, as summarized in Stephenson (1996).

Because of the dramatically higher fuel loads and stand densities, some researchers believe that forest structure throughout the western forests, including those in the parks, should be mechanically restored before reintroducing fire (Bonnicksen and Stone 1985; Fulé and others 1997). These researchers believe that mechanical removal of fuels and understory trees prior to burning will minimize the potential for severe ecosystem disruption or other unnatural effects of high-intensity fires. Mechanical treatment, proponents argue, will increase the space between tree crowns and reduce the risk that subsequent fires will spread through the crowns.

The extensive use of mechanical means to thin forests in wilderness areas faces legal, social, ecological, and economic constraints. A different strategy for restoring forest structure that is more compatible with wilderness values and legislation is the application of prescribed fire without mechanical pretreatment.

Changing Program Focus

The Sequoia and Kings Canyon National Parks initiated an active prescribed fire program in 1969. Park staff concentrated on implementing fuel hazard reduction burns, partly due to an extensive imminent threat to park resources and human health and safety. The parks are analyzing data from the long-term fire effects monitoring program to see whether prescribed fire alone appears to be achieving not only fuel hazard reduction, but also forest structure restoration goals in the parks' wilderness ecosystems.

To determine whether prescribed fire is achieving the desired results, changes in fuel loads and forest structure are monitored in areas treated with prescribed fire. Research plots on some of the earliest prescribed burns continue to serve as sources of information on the long-term ecological outcomes of prescribed fire. A more comprehensive fire effects monitoring program began in 1982 to assess whether fire management objectives were being accomplished and to document changes in fuel and vegetation in burned areas.

The ongoing fire effects monitoring program has documented that prescribed burns consistently meet the objective of reducing total fuel loads by at least 60 to 80 percent in all conifer forest types (Keifer 1998; Keifer and Manley [in press]). The fire effects monitoring program also measured and recorded changes in stand structure following the initial fuel reduction burn. The information on changing forest structure has become more significant as the parks' fire management program shifts emphasis from reducing the fire hazard to restoring natural conditions.

Developing Restoration Goals

In 1997, park staff began to develop preliminary goals for structural conditions in all vegetation types where stand structure is likely to have been greatly altered by fire suppression over the previous century. As part of this effort, structural goals were developed for the giant sequoia–mixed conifer forest, based on information from various sources:

- Research results (e.g., Bonnicksen and Stone 1982; Stephenson 1994);
- Examination of written accounts (Bonnicksen and Stone 1978);
- Qualitative analysis of historic photos; and
- Expert opinion from USDI National Park Service, USDA Forest Service, and USDI U.S. Geological Survey scientists.

Park staff recognized that the climate in the Sierra Nevada has changed over time, affecting the natural fire regime (Graumlich

1993). Goals were developed to reflect the range of variability over the thousand-year time period prior to Euroamerican settlement, based on Stephenson (1996, 1999).

From age/diameter relationships, almost all trees 32 inches (80 cm) or larger in diameter at breast height (dbh) were thought to predate Euroamerican settlement (Finney and Stephenson 1999). Smaller trees were thought to have mostly recruited since settlement; the current high densities in this size class are presumably an artifact of postsettlement fire suppression. For the giant sequoia–mixed conifer forest, the stand-level structural goal is:

- Large trees (≥ 32 inches [80 cm] dbh): 4 to 30 per acre (10–75/ha)
- Small trees (< 32 inches [80 cm] dbh): 20 to 101 per acre (50–250/ha)
- All trees: 34 to 132 per acre (60–325/ha)

Target conditions are subject to amendment as new information emerges. Ongoing research includes the quantitative analysis of historical photographs and the examination of additional sources, both inside and outside the parks, for information on the density of large trees by species.

Comparing Goals to Outcomes

After structural goals were established, existing long-term fire effects monitoring data were examined to determine whether the prescribed fire program was making progress toward achieving restoration goals. Monitoring data from 27 quarter-acre (tenth-hectare) monitoring plots that burned in 17 different prescribed fires between 1982 and 1991 were compared to the target structural conditions. Figure 2 shows the results.

Prescribed fire can serve to reduce the potential for crown fire in giant sequoia–mixed conifer forests by thinning smaller trees and ladder fuels, with minimal effects on larger trees.

Preburn mean density for small trees was 253 per acre (625/ha), two and a half times the maximum target value (Keifer and others 2000). The preburn mean density of larger trees was 19 per acre (46/ha), already well within the target range.

One year after a single prescribed burn, tree density was reduced significantly, with a 53-percent mortality of smaller trees and a 4-percent mortality of trees in the larger size class. The density of the smaller trees remained somewhat higher than the target maximum of 101 per acre (250/ha), whereas large-tree density remained within the target range.

Five years after burning, additional tree mortality decreased the mean density of smaller trees to 90 per acre (222/ha), within the target range. The larger trees also experienced additional mortality, reducing large-tree density to 17 per acre (42/ha)—still well within the acceptable range.

Overall, most of the density reduction occurred in the smaller size class, confirming that prescribed fire can serve to reduce the potential for crown fire in giant sequoia–mixed conifer forests by thinning smaller trees and ladder fuels, with minimal effects on larger trees. It should be noted

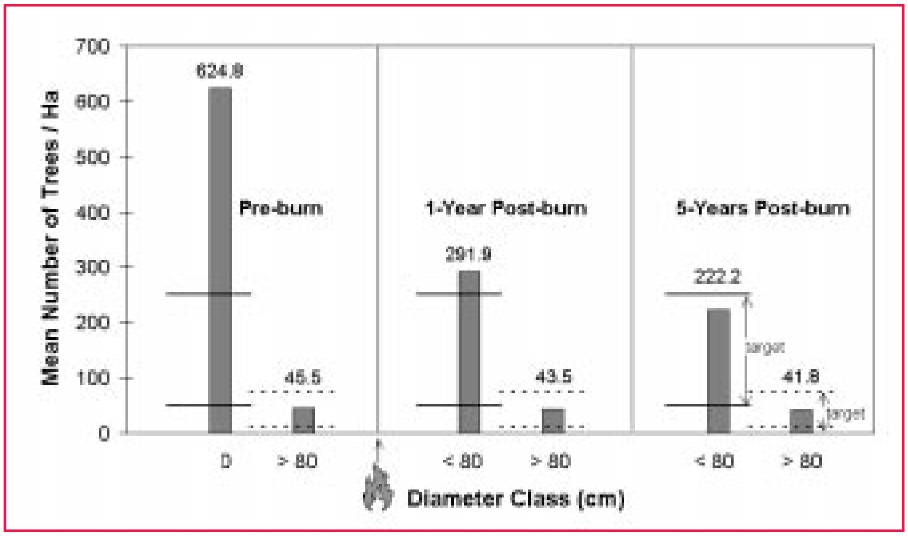

Figure 2—*Stand density (all species combined) by diameter class in the giant sequoia–mixed conifer forest before prescribed burning, 1 year after burning, and 5 years after burning on 27 monitoring plots. The target range for trees smaller than 32 inches (80 cm) is indicated by solid lines and for trees larger than 32 inches (80 cm) by dashed lines. Note that 5 years after the burn, numbers for both small and large trees are within target, suggesting that prescribed fire alone can achieve restoration goals. Illustration: USDI National Park Service, Sequoia and Kings Canyon National Parks, Three Rivers, CA.*

Postburn recruitment of important species such as giant sequoia suggests that prescribed fire alone—without mechanical pretreatments—can meet forest restoration goals.

that no mortality of large giant sequoia trees occurred within the 27 monitoring plots following prescribed burning. The results from this analysis clearly show that tree density targets by size class were met after a single prescribed burn.

Although park staff initially focused on total tree density to develop structural target conditions, they recognize that species composition is an important element of forest structure. Ten-year postburn data on species composition within the giant sequoia–mixed conifer forest show the postburn recruitment of important species such as giant sequoia (fig. 3), again suggesting that prescribed fire alone can meet forest restoration goals.

Prescribed Fire for Forest Restoration

Data from the Sequoia and Kings Canyon National Parks fire effects monitoring program, compared to the parks' quantitative fire management and structural restoration goals, show that prescribed fire alone—without thinning pretreatments—can be successfully used both to reduce fuel loads and to restore some elements of forest structure in the giant sequoia–mixed conifer forest (Keifer and others 2000; see also Stephenson 1996, 1999).

Whether forest structure can be restored as successfully in other vegetation communities using prescribed fire alone depends on many site-specific factors, including the number of fire return intervals missed and the history of other disturbances. Some vegetation communities might be so sensitive or so greatly altered that using prescribed fire without first mechanically mitigating the altered structural conditions might have unacceptable effects (Fulé and others 1997). In other communities, a series of conservative prescribed fires might be needed to reduce fuel loads and completely restore the presettlement forest structure before natural fire regimes can be returned.

Evidence from the Sequoia and Kings Canyon National Parks suggests that forest structure restoration using prescribed fire alone is possible in at least some forests altered by past fire suppression. Prescribed fire should be considered as a tool in forest restoration in other areas, particularly where mechanical treatments are inappropriate or impractical, such as in parks and wilderness areas. For more information, contact Jeffrey Manley at jeff_manley@nps.gov (e-mail).

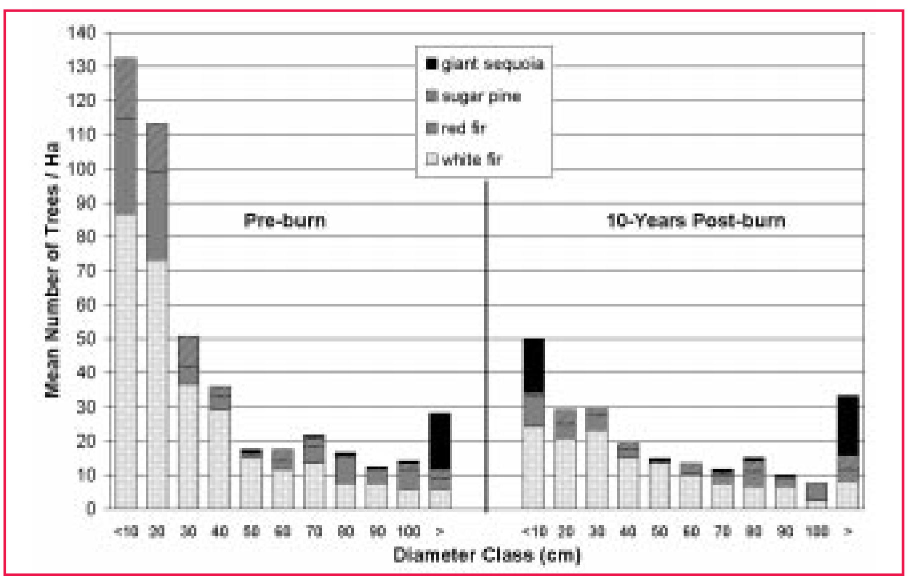

***Figure 3**—Preburn and 10-year postburn stand density, by species and diameter class, in the giant sequoia–mixed conifer forest on 12 monitoring plots. Note the increase in giant sequoia numbers in the smallest diameter class 10 years after the burn, suggesting that fire aids giant sequoia recruitment by creating advantageous conditions for seedlings. Illustration: USDI National Park Service, Sequoia and Kings Canyon National Parks, Three Rivers, CA.*

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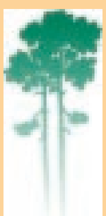
Websites on Fire*



Tall Timbers Research Station: E.V. Komarek Fire Ecology Database

The E.V. Komarek Fire Ecology Database was created in 1987 when Dr. E.V. Komarek donated his scientific fire ecology materials—collected after years of research and travel—to the Tall Timbers Research Station in Tallahassee, FL. Believing in the importance of providing convenient and permanent access to a wide range of fire ecology materials, Tall Timbers continuously updates the data base to provide information both historical and current. The data base provides a unique resource for locating a broad range of fire-related information, including literature about controlling wildland fires, prescribed burning applications, fire ecology, and fire histories and case studies. Although international in scope, the data base emphasizes North America, particularly the Southeastern United States.

Currently, this free data base contains about 12,000 records with almost 3,500 abstracts. Sources include journal articles, books and monographs, government documents, conference proceedings, and magazine and newspaper articles. The data base can be searched by author, title, year, keywords, or words that appear in titles or abstracts. A strength of the data base is the detail that keywords—such as fire, ecological, and forestry terms; habitat types; management styles; and geographic designations—are assigned to describe the contents of data base items. A comprehensive online fire ecology thesaurus provides a guide to searching and indexing the literature in the data base. Notes in the thesaurus define how a particular term is used in the data base. Broader, narrower, and related terms are suggested for many of the keywords to help users target their subject; alternate keywords are suggested when a common term is not used in the data base.

Found at **<http://www.talltimbers.org/feco.html/>**

** Occasionally,* Fire Management Today *briefly describes Websites brought to our attention by the wildland fire community. Readers should not construe the description of these sites as in any way exhaustive or as an official endorsement by the USDA Forest Service. To have a Website described, contact the managing editor, Hutch Brown, at USDA Forest Service, 2CEN Yates, P.O. Box 96090, Washington, DC 20090-6090, tel. 202-205-1021, fax 202-205-0885, e-mail: hutchbrown@fs.fed.us.*

Wildland Fire Use in Roadless Areas: Restoring Ecosystems and Rewilding Landscapes

Timothy Ingalsbee

In May 2000, the Forest Service released a proposal to protect roadless areas on the national forests and grasslands from degradation through future roadbuilding. The Roadless Area Conservation Draft Environmental Impact Statement, coupled with an unusually severe fire season in 2000, precipitated an unprecedented level of discussion and debate on wildland fire management in roadless wildlands.

The Forest Service's roadless area initiative reflects broad popular support for a new wildland management paradigm: protecting and restoring our public wildlands. In the next few years, several developments are possible:

- The final Roadless Area Conservation Rule will prohibit both logging and roadbuilding in roadless wildlands;
- Federal appropriations for the next decade will include increased funds for fire preparedness and fuels management programs; and
- A strong popular mandate will develop for restoring roadless wildlands degraded by past timber extraction and fire exclusion. However, conservationists will oppose mechanical fuels treatments, and rural communities will oppose large-scale prescribed fire treatments.

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> In the future, how will roadless areas be protected and restored? Through wildland fire use.

For argument's sake, let's suppose all this comes to pass. The traditional tools of intensive forest management—mechanical timber removal and prescribed fire—will then be highly constrained. How will roadless areas be protected and restored? The answer: through wildland fire use.

New Definition, New Vision

Fire management to protect and restore roadless wildlands will require a new definition of suppression as part of ecosystem fire restoration. The old view of suppression as the "moral equivalent of war," complete with military-style terminology such as "fighting" fire and initial "attack," will have to change into something more reflective of a restoration ethos. Indeed, in a new system that promotes wildland fire use for *restoration* benefits, suppression will no longer be defined as limiting the temporal or spatial extent of fires, but rather as lowering the intensity of fire behavior and the severity of fire effects. Consequently, the category "acres burned" will become less relevant except in connection with the qualitative analysis of fire behavior and effects; acres burned will be associated with high, moderate, or low intensity and severity.

Ironically, fire managers might be rewarded for increasing the number of acres burned by wildland fires. If and when suppression actions become necessary, they will serve long-term, planned ecosystem restoration goals, not short-term fire containment objectives. Indeed, fire managers might be more interested in promoting fires in roadless wildlands than in preventing or suppressing them. If there is a place for aggressive suppression, it will be near human communities where lives and property are at stake—not in roadless wildlands that depend on the restoration of wildland fire.

Converting Firefighters into Fire Lighters

In practice, firefighting in roadless wildlands will become something more akin to fire lighting. Burning out has already become the tool of choice for suppressing wildland fires in roadless areas. Backfiring poses less danger to firefighters in the steep, rugged terrain of most roadless areas than fireline containment. Incident commanders are increasingly ordering more backfires and large-scale burnout operations, usually with the intention of containing fires along major ridges or perimeter roads.

Some backfires have been excessively severe, ignited with the intention of complete consumption "from ground to crown." Moreover, creating contiguous blocks of burned soil and vegetation through large-scale burnout operations can reduce fire's benefits in maintaining biological, structural, and stand age diversity. Eliminating those "green islands" of unburned fuel adversely affects refugia for wildlife and soil micoorganisms—vital agents in natural postfire recovery processes. The scale of backburning will likely be vastly increased in order to manage wildland fire use for resource benefits in roadless areas. But backburns should be "sloppy"—ignited in a mindset of sensitive restoration, not aggressive suppression.

In the new paradigm of ecosystem fire restoration, the vanguard of roadless area fire management will be smokejumpers, helitacks, and hotshots. These are the best trained, best equipped, most physically fit firefighters. Comfortable with igniting fires, they are the most capable of managing wildland fires for resource benefits in roadless areas.

Given a new mandate to promote wildland fires, professional firefighters such as smokejumpers will no longer have to apologize for "milking" fires; on the contrary, they will be able to assert with pride their competency in maintaining low-severity fires. Minimum-impact suppression tactics will become the norm rather than the exception. Light burning—the predecessor of prescribed burning, all but suppressed when the Forest Service began systematic fire control—will revive, evolving into a kind of landscape art form. In the new fire restoration regime, firefighters will more accurately be called pyrotechnicians for their skill in using the best available science and technology to manage wildland fires in roadless areas.

Fire Management Planning

The Federal Wildland Fire Management Policy (USDA/USDI 1995) mandates the development of fire management plans (FMP's) for all areas subject to wildland fires. Unfortunately, according to a high-level Forest Service report (F&AM 2000), "Fire management planning has not been a priority, with less than 5 percent (5%) of the National Forests having current, approved fire plans. The agency is not in compliance with the National Fire Management Policy." Without FMP's, fire managers have no choice but to aggressively suppress all wildland fires, regardless of location, size, intensity, and predicted behavior or effects. This can result in unnecessary economic costs and environmental impacts associated with aggressive suppression—not to mention hazards to firefighters.

With an approved FMP, managers will be able to implement an appropriate management response (AMR) to wildland fires. The AMR, a term introduced in the Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide (NIFC 1998), reflects the new paradigm of managing wildland fire for the desired future condition of the land. The AMR allows a full range of fire management strategies and tactics to be employed on a single fire. For example, where a portion of a wildland fire threatens to burn into a populated area, aggressive suppression can be used; whereas another portion of the same fire burning in roadless wildlands might simply be monitored as long as the fire conforms to prescribed behavior and effects. Although most management activities will likely be severely constrained in roadless areas, fire management planning will offer many opportunities for ecosystem restoration.

Indeed, fire management planning will likely become a primary focus of roadless area managers, especially if Congress approves significant funding increases for fuels management programs. FMP's will not only include current fuels surveys and data on historical fires, weather, and terrain, but also outputs from fire simulation models that are run under various

Bunchgrass Ridge, burned by the 1991 Warner Creek Fire in the Cornpatch Inventoried Roadless Area, Willamette National Forest, OR. The fire helped reduce fir encroachment—a product of fire exclusion policies—and restore ridgetop meadows. Photo: Timothy Ingalsbee, Eugene, OR.

scenarios. A key component will be information on special resources and sensitive sites (such as riparian areas, fragile soils, and habitat for endangered species) where aggressive suppression will be prohibited. A complete "go/no-go" checklist will allow Federal personnel to utilize the FMP, develop a wildland fire situation analysis, and (as appropriate) select an AMR favoring wildland fire use on some or all portions of a roadless area fire. Winter could become the busiest time of the year for fire staff as they collate data bases, play fire simulation games, and develop FMP's in hopeful anticipation of the next summer's fires.

From Roads to Trails

Conventional wisdom has it that roads are great assets for wildland fire suppression. However, the scientific analysis behind the Forest Service's roadless area initiative reveals that the net effect of forest roads is to increase the rate of human-caused ignitions, thereby undermining fire prevention efforts (USDA Forest Service 2000). Roads are also vectors for the spread of flammable invasive weeds. Any benefits from roads in facilitating wildland fire suppression are offset by the tendency of roads to undermine fire prevention efforts.

Fire and fuels management are important but subordinate parts of protecting wildlands and restoring ecosystems. The scientific assessments for the Interior Columbia Basin Ecosystem Management Project concluded that unroaded and unlogged subbasins have a higher ecological integrity and greater fire resiliency than roaded and logged subbasins (Quigley and Arbelbide 1997). Accordingly, roads are liabilities for roadless area protection, not assets. The future of forest conservation lies not only in keeping out new roads, but also in taking out old roads to rewild roadless landscapes.

Kelsey Ridge, burned by the 1991 Warner Creek Fire in the Cornpatch Inventoried Roadless Area, Willamette National Forest, OR. Roadcuts and clearcuts intruding into roadless areas can cause more adverse impacts than do fires, including the degradation of scenic values. Photo: Timothy Ingalsbee, Eugene, OR.

Moreover, roads are unnecessary for wildland fire management. Aviation resources are fully capable of ferrying fire crews to remote areas. Using longlines and cargo nets, helicopters can deliver all the supplies needed for suppression at remote sites. Helicopters can even deliver complete water systems, including foldatanks, pumps, hoselays, and the water itself. Large base fire camps, with their associated costs, will become increasingly unnecessary, especially on wildland fires in roadless areas. Smaller spike camps and coyote tactics will become the norm, saving time and money and avoiding the hazards of vehicular traffic—a high cause of firefighter fatalities and injuries (Mangan 1999). Most firefighters prefer the peace and quiet of an isolated spike camp to the cacophony of a large fire camp.

Opponents of the Forest Service's roadless area initiative raise the specter of a huge "land lockup." To the contrary, the future will see an active program of constructing hiking trails and locating helispots in roadless areas to promote ecosystem fire restoration. Hiking trails will provide critical infrastructure for fire use operations, giving hand crews access to strategic areas and serving as minimal-impact firing and holding lines for large-scale wildland fire use.

Helispots, however, must be carefully located to avoid significant environmental or aesthetic impacts. Helispots should not be small clearcuts in dense stands. Instead, they should be located in natural clearings, such as ridgetop meadows or rock outcrops suitable for safe landing and loading zones, where maintenance costs and impacts remain minimal.

Well-situated hiking trails and helispots, planned long in advance, will prevent the adverse environmental impacts that now occur when helispots are hastily built for aggressive suppression. Moreover, hiking trails and helispots in roadless areas will have multiple uses, including recreation, research, and restoration work. Unlike proposals for new road construction, a program to construct hiking trails and locate helispots in roadless areas might therefore enjoy broad public support.

Wildland Fire Use: A Viable Alternative

In the future, if both mechanical fuels reduction and large-scale prescribed fire treatments in roadless areas face insurmountable public opposition, the only viable alternative for managing fuels will be through wildland fire use. This idea is not as farfetched as might seem. In 2000, when dozens of large fires were burning at once across the interior West, fires in roadless areas were often the lowest priority for dispatching personnel and equipment. Thinly stretched firefighting forces concentrated on fighting fires that threatened lives, homes, and communities. Backcountry fires in some roadless areas were carefully monitored and steered away from sensitive areas, but not actively suppressed. The National Fire Plan announced by the President in September 2000 reinforces the trend toward focusing on fires in the wildland–urban interface while managing remote fires through wildland fire use teams.

However, some fires in roadless and even wilderness areas have been actively suppressed. For example, the 1999 Big Bar Complex Fire on the Shasta–Trinity National Forest in northern California and the Kirk Complex Fire on the Los Padres National Forest in southern California were both lightning-caused wildland fires in wilderness or roadless areas. Suppressing the two fires cost a total of $178 million—fully 30 percent of the Forest Service's national suppression budget in 1999—and caused considerable environmental damage (F&AM 2000).

As information about the economic costs and environmental impacts of these and other suppression efforts in roadless areas are revealed, a public outcry might ensue against future similar practices. Conservationists will likely demand a "let-burn" policy in roadless and wilderness areas. Given the widespread public prejudice against the "let-burn" concept, it behooves fire managers to explain the merits of wildland fire use for ecosystem restoration benefits to the public, politicians, and fellow government employees.

Ecosystem Fire Restoration

As lands with the highest ecological integrity and best fire resiliency, roadless areas offer great opportunities to demonstrate progressive fire and fuels management programs serving wildland protection and ecosystem restoration. A first step will be to abandon our military metaphors and aggressive contain-and-control models of suppression. Compliance with the Federal Wildland Fire Management Policy, new fire management planning, and improved firefighter training in burning techniques will also be strategic necessities.

Land management agencies will need to move beyond "balancing" prevention, suppression, and prescription programs. They will need to create a fully integrated fire shop that incorporates each leg of the triad—prevention, suppression, and prescription—on perhaps every wildland fire. Above all, fire managers will need to approach their work with sensitivity and humility, working with—not against—natural processes and human communities. In time, society and its public land stewards will come to realize that ecosystem fire restoration is a labor of love, not an act of war.

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Sustainable Forestry Practices: Science Can Suggest Them but the Culture Must Choose the Path*

Gary Snyder

Editor's note: Gary Snyder, a prominent American poet, lives in California's north-central Sierra foothills, where he is involved in local and regional ecosystem stewardship. Winner of the Pulitzer Prize for Poetry in 1975, he has published 18 books, which have been translated into more than 20 languages. Some of his poems were inspired by his early experiences as a trail crew laborer in California's Yosemite National Park and as a lookout in the mountains of Washington.

I'm a longtime forest and mountain person living on the West Coast of the United States. I grew up on a farm outside Seattle, WA. My father and uncles all worked at various times in the logging and fishing industries; and I started on one end of a two-man saw when I was 11. I've worked in the woods from the Canadian border down to Yosemite National Park. I've fought fire, built trails, been on lookouts, scaled timber, set chokers, and been active in forestry issues since I was 17—when I first wrote my congressional representative about management on the Olympic National Forest.

As a self-righteous youth in my twenties, I thought that my jobs as fire lookout and firefighter gave me a real moral advantage—I told my city friends, "Look—when I do this kind of work I can really say I'm doing no harm in the world. I'm doing good."

Such ironies. Now, I join the chorus that says it was all wrongheaded, even if well intentioned.

Gary Snyder is a poet and writer who lives in the north-central Sierra Nevada, CA.

> If we don't reduce the fuel load, the really big fires that will inevitably come will make good forestry a moot point.

Environmental Concern

Our north-central Sierra Mountains share their geological and biological history with the rest of the Great Sierran ecosystem. There are registered Paleo-Indian sites in this county that indicate human presence from 8,000 years ago. Before European contact, this forest was apparently a mosaic of various different forest stages, including many broad and open ancient-forest stands. During the spring and fall, salmon ran up all the rivers. Deer, salmon, waterfowl, and black oak acorns were the basis of a large and economically comfortable native population.

The Yankee newcomers initially came looking for gold. They needed lumber and thought that the forest was limitless. Early photographs taken around the foothill towns show denuded hills. It's a tribute to the resilience of the local forest type that, where allowed to, it has come back quite well.

So, early on in these parts, there was vigorous mining and extensive logging. Later, much of the mountain land was declared public domain, and it became the responsibility of the USDA Forest Service and the USDI Bureau of Land Management.

From the 1920's up until the 1970's, the Forest Service was a confident, paternalistic organization that thought it always knew best, and for a while, maybe it did. During those years, the Forest Service was generally trusted by both the conservation movement and the timber industry. In any case, from the 1950's on there was a lot of heavy industrial logging in the public and private lands of the Sierra.

With the 1970's came a renewed rise of environmental concern. Part of that consciousness was connected maybe to better biology education in the schools and a general rise of interest in nature. Curious people got out in the

* This article was excerpted from remarks made by Gary Snyder on June 6, 1996, to the California Biodiversity Council in Grass Valley, CA. They are reprinted here, lightly edited, by permission of the author.

Greenup 5 weeks following the 1994 Fish Day Fire, which burned 24,600 acres (9,950 ha) on the Croatan National Forest, NC. For thousands of years, fire has been part of the landscape throughout most of North America, shaping highly diverse fire-adapted ecosystems, including this open longleaf pine forest on the southeastern Coastal Plain. Photo: Bill Lea, USDA Forest Service, 1994.

mountains by pickup, on foot, or by bike and sometimes studied the areas that had been logged. People could see that old-growth habitat was shrinking.

We all knew that some species were being lost or endangered (the wolf and grizzly were already gone from the area and probably the wolverine as well); and there were rumors that the remaining public forest was being logged in the same old way, sometimes at an actual financial loss to the taxpayers. The public became aware, as never before, of its stake in the Sierra Nevada.

Wildland Fire Historically Necessary

The fairly recent realization that the Sierra Nevada is a fire-adapted ecosystem, and that a certain amount of wildland fire has historically been necessary for its health, has given everyone at least one territory within which they can agree. Another such area of potential agreement is the growing awareness that we will eventually have to do long-range sustainable forestry.

In fact, the two absolutely go together. If we don't reduce the fuel load, the really big fires that will inevitably come will make good forestry a moot point. However, it will take a little more than new fire policies to achieve good forestry.

I was on a panel in San Francisco several years ago with Jerry Franklin, the eminent forest scientist now based at the University of Washington. So last month I took it on myself to write him the following question, "When I talk to the Biodiversity Council, I would like to be able to say something like this: 'Long-range sustainable forestry practices—that will support full biodiversity—and be relatively fire resistant—and also be on some scale economically viable—over centuries—is fully possible. And what we must now do is search out and implement the management program that will do that.' Do you think I can say this and the science will support it?"

Jerry Franklin immediately wrote back. "What you propose is totally and absolutely feasible for the Sierra Nevada—i.e., long-term sustainability, full biological diversity, relative fire resistance (low probability of catastrophic crown fire), and economic viability. A system which provides for restoration and maintenance of a large-diameter tree component (with its derived large snags and down logs) and which provides for moderate to high levels of harvest in the small- and medium-diameter classes (allowing escapement of enough trees into the large-diameter class to provide replacements for mortality in the large-diameter group) and prescribed burning in some locations can do this. Other considerations include riparian protection and, perhaps, shaded fuel breaks. Economic and sustainable in perpetuity!"

So it's theoretically possible. But science can only suggest—such a marvelous sustainable forestry cannot actually happen unless the culture itself chooses that path. "The culture" means not only the national public, but also the working people of the very region where the resource policy decisions are made. It will take local people working together with local land managers, I am convinced, to begin making serious changes in public lands management, place by place.

Just a quarter of a century ago, the idea of serious local input into public land decisionmaking would have been a pretty novel thought.

The forestry and biology experts of the Tahoe National Forest, the Bureau of Land Management, and the schools have been generous in sharing their time and expertise with ordinary citizens. In addition, timber operators have visited at least one school I know of, Grizzly Hill, and allowed children to come and observe a logging show.

Getting Involved

There are a number of significant citizens' organizations in the north-central Sierra. Many are focused on ecological issues and some are concerned about access to resources. They all have a stake in the health of the Greater Sierran ecosystem. For new fire and forestry practices to really become national public policy, they must be local public choices, first.

We locals can help bring this to reality by getting involved with the Forest Service and Bureau of Land Management in further community forestry projects; in working toward innovative value-added local wood products industries; and also, of course, in supporting cooperative fire management projects.

If we can clarify our own choices, our congressional representatives might just represent us, and there'd be a good chance the Federal policies on our regional public lands would reflect that. The agencies could facilitate this process by being a lot more willing to take risks with the public than they've been so far, putting more of their people out in the field where they meet folks, looking for opportunities to try to break out and try things with locals.

A prescribed burn on the Lewis and Clark National Forest, MT. Local support is needed for sustainable forestry practices such as prescribed fire. Photo: Jill Bauermeister, USDA Forest Service, Washington Office, Washington, DC, 1991.

Fire as Friend

There has always been fire. The cat-faces on the oaks, the multiple stems sprouting from certain old oak centers, and the black cedar stumps that seem to never go away, made it clear to me that there had been a sizable fire through my land at some point in time. Whenever it was, our little forest is recovering well.

The Sierra ecosystem has been fire adapted for millions of years, and fire can be our friend. The growing recognition of this fact—both by the public and by the fire agencies—has been a remarkable change to watch during the past 10 years. In my own neighborhood, a small prescribed burn was done this spring with considerable success. Moreover, we've also been trying out the mechanical crunching of brushfields—expensive, but it works.

One word of caution, however; as our enthusiasm for prescribed burns and more sophisticated fire management grows, we need to remember for a moment the fire ideologies and bureaucracies of the past. Steve Pyne, in his book *World Fire*, traces the history of the American wildland firefighting establishment, and the way it demonized fire as an enemy.

Firefighting requires organization, courage, and tremendous energy and dedication, to be sure. But we are called to a more complex moral attitude now, where we see fire as a partner in the forest, even while recognizing its power to do damage. I would hope that the statewide enthusiasm for the new fire management is received with a certain humility on the part of the firefighting establishment, even as it gears up to take the lead in the new policies.

Understanding fire—its hazards, its use as a tool, and the way it shapes a fire-adapted forest—should help keep our different factions working together. We may disagree about how important the survival of some species might be, how many acres of land should reasonably be converted to suburbs, or what the annual allowed timber cut ought to be, but surely we can agree that we're all opposed to tall flames burning timber and houses, and that we should work together for a fire management that sees fire as a partner—not an enemy—in the ecosystem.

This may be a wonderful step toward new and more amicable relations between conservationists, who want to go slow and be careful, and resource users, who have their businesses to run.

Wildland–Urban Interface

There's another hard fact here that I haven't mentioned. It may be the most important factor of all. Our whole area is experiencing an amazing rate of growth, which brings suburban homes right up against wildlife habitat, public forests, or mineralized zones. These new uses will be in conflict with both loggers and environmentalists. The public lands will become even more precious to us as ranches and farms give way to development.

The public lands are lands held in trust for all of us. A certain responsibility goes with that, for the government, the public at large, and for the people of the region. As for stewardship or trust, the whole world is in the trust of humans now, whether we want this responsibility or not. The air and waters, the rivers, the deer and owls, the genetic health of all life, is in our trust. ■

Control Burn*

What the Indians
here
used to do, was,
to burn out the brush every year.
in the woods, up the gorges,
keeping the oak and the pine stands
tall and clear
with grasses
and kitkitdizze under them,†
never enough fuel there
that a fire could crown.

Now, manzanita,
(a fine bush in its right)
crowds up under the new trees
mixed up with logging slash
and a fire can wipe out all.

Fire is an old story.
I would like,
with a sense of helpful order,
with respect for laws
of nature,
to help my land
with a burn. a hot clean
burn.
(manzanita seeds will only open
after a fire passes over
or once passed through a bear)

And then
it would be more
like,
when it belonged to the Indians

Before.

Gary Snyder

† Kitkitdizze, also known as Sierra mountain misery, is a shrub that grows in open ponderosa pine and mixed-conifer forests on the western slopes of the Cascade Range and Sierra Nevada in California. The name derives from an American Indian word for the shrub.

Trial by Bulldozer: Roadbuilding in Roadless Areas*

Bud Moore

Editor's note: A veteran of the USDA Forest Service from 1934 to 1974, Bud Moore led early efforts to restore wildland fire to wilderness areas in the Forest Service's Northern Region. In winter 1949, while Moore was serving as the district ranger on the Powell Ranger District, Clearwater National Forest, ID, a huge regional blowdown occurred. Traditionally, blowdowns were managed through salvage sales, partly to stop beetle infestations in the down timber from killing standing trees and compounding the fuels problem. The 1949 blowdown affected pristine areas without roads; new roads were needed for timber removal. Moore played a role in putting them in. In this abridged account of his experiences, Moore gives land managers pause to reflect on the wisdom of logging and roadbuilding for fuels management in areas without roads.

It took us nearly two years [after the 1949 blowdown] to learn that disease stalked our land. We learned that spruce bark beetles (*Dendroctonus engelmannii*) were crawling out of the trees devastated by the '49 Blow and taking to the air in search of more trees to attack. A fourfold or even twofold annual multiplication of infested trees would, if left unchecked, in a very few years reduce the region's spruce forests from expanses of green to sick shades of brown, followed by thousands of acres of rotting snags.

Since most beetles clustered in patches near the blowdowns, we would use logging to cut out the infestations. At stake was the future of an estimated six hundred million board feet [3.4 million m^3] of commercial-sized spruce timber growing in the upper Lochsa [River] country [on the Powell Ranger District, Clearwater National Forest, ID].

Bud Moore is a retired Director of Fire and Aviation Management for the USDA Forest Service, Northern Region. He currently manages private forestland in Montana's Swan Valley.

* Abridged and reprinted, by permission of the author, from *The Lochsa Story: Land Ethics in the Bitterroot Mountains,* chapter 9, pages 305–324. Copyright © 1996 by Bud Moore. To facilitate reading, the excerpt does not indicate omitted words and passages, and intertitles are added.

> None of us had the wisdom to foresee the consequences of the program we had devised.

Immature Land Ethic

Except for our plans for the flats alongside the Lochsa River, our approach lacked the detail needed to guide the land use revolution that was sure to be generated by our decision to log the beetle-killed timber as fast as possible. The fate of the land of the Lochsa, outside the wilderness [now the Selway–Bitterroot Wilderness], would for the most part be determined by the wisdom of the people of the Forest Service, the Northern Pacific Railway Company, the loggers, and the road builders. Such immense responsibility for so humble a band.

The pace of the race was outstripping our knowledge of the land. What would logging and road

Blowdown timber on the Gifford Pinchot National Forest, WA. Vigorous forest regeneration is fed by nutrients from the decaying down timber. Photo: USDA Forest Service, 1992.

building do to the soils, water, wildlife, trout, and salmon so vital to the spirit of place in the land of the Lochsa? Our land ethic was growing but not yet mature. None of us had the wisdom to foresee the consequences of the program we had devised. We had no [Aldo] Leopolds to give us advice. That we were moving too fast and with too little knowledge seemed obvious, but the bugs wouldn't wait and we couldn't either.

The location of the roads was especially important because roads, more than any other factor, would ordain patterns for the use of the land. Main roads would be permanent. Where the roads went, most people in the future would go also, and those wild things not adaptable to man and machines would perish or leave. For instance, road building held the potential to degrade the Lochsa's pure water and the fisheries, both sea-run and local, dependent thereon. Depending on where and how they were built, roads could turn out to be either long-term blessings or the means of destroying important land and resource values. I spent many long days in the woods with engineers and road-building loggers, locating control points ahead of construction, trying to avoid needless damage to the land and its variety of life.

Scars on the Land

While the bears hibernated in the winter of 1953–54, the snows hid the scars on the land inflicted by the [roadbuilding] activities of the preceding summer. As they had always done, the steelhead waited far downstream for a burst of fresh water to signal that spring had arrived in the uplands. Clear water and stable streams—those were the hallmarks of springtime in the Lochsa, where the power, the rumble, and the beauty of water transcended, and surrounded, all else.

Spring had always been that way. Nevertheless, the confluence of Squaw Creek and the Lochsa River was a different place in May 1954. A new gravel bar, six feet [2 m] deep and thirty feet [9 m] wide, stretched from the creek's mouth seventy-five feet [23 m] out into the river. That the stones in the bar were new could be told from their light color; their lichen coatings had been ground away by road-building dozers clanking up and down the stream in Squaw Creek's canyon the fall before. Indeed, the gravel bar contained much of upper Squaw Creek's streambed and part of the newly built road as well.

Under natural conditions, stream damage was unheard of in the land of the Lochsa. After all, there was nothing man-made there to damage and human values had to be introduced before even powerful, natural events could be seen as destructive. But with new roads crowding streams in narrow canyons, and with other kinds of human impacts to stream channels and banks, we began seeing—and talking about—damage in 1954. On the evening of May 17 supervisor Hy Lyman and I stood on the banks of Squaw Creek above the new gravel bar; the stream ran bank-full of powerful water. We could hear boulders rolling in its channel as the water tore loose the gravel, further enlarging the bar.

Hy said: "Bud, we can't do this to the land."

Roadbuilding Consequences

The cedars, their shade, and the ferns were gone. The rumbling of boulders and the roar of water filled the canyon. Their protest drained our hearts and souls. The Lochsa belonged to the people, and we were their government agents: ordinary men, a ranger and his boss, with the life of a land in our hands. Only an hour before, Hy had told me that the Powell district ranger position had been upgraded to GS–11, confirming that we had at last attained long-awaited management status. But that achievement paled in the din of the ravaged stream. That night on the banks of Squaw Creek, it seemed that the consequences of bulldozing the earth might be more than the land could bear. ■

Managing down timber on the Hoover Wilderness, Toiyabe National Forest, NV. Management is by hand, without motorized vehicles or equipment such as chainsaws. Photo: USDA Forest Service, 1993.

NIFC FIRE RAWS Unit Survives Burnover

Kelly Andersson

On Monday, July 24, on the Bircher Fire near Durango, CO, a NIFC FIRE RAWS unit was burned over by a fire that blew up and made a canyon-gobbling run in the middle of the night. The FIRE RAWS is an enhanced Remote Automated Weather Station (RAWS) unit that collects weather information and can alert firefighters on the line by transmitting that information via radio. The first blaze to burn over a FIRE RAWS unit, the Bircher Fire in Mesa Verde National Park was for a couple days a fire of the nightmare class.

Incident commander Joe Hartman and his type 2 team, who were managing the fire, ordered the FIRE RAWS unit from the National Interagency Fire Center (NIFC) in Boise, ID. "We were dispatched Saturday from Boise," said Denise Buske, one of the two specialists who came with the unit. "We arrived Sunday about noon and deployed the unit about 3 p.m. at the Park Point Lookout."

The NIFC FIRE RAWS, which was last year (fire season 2000) in its second year of testing, detects any unusual measurements—such as high winds or a change in temperature or humidity—and then can automatically warn firefighters over the radio. The system includes a complete weather station. This station broadcasts weather observations via satellite and can be "called" over the radio by firefighters. Parameters critical to fireline safety can be programmed to alert firefighters about wind shifts, humidity change, or a sudden temperature rise or decline. Calibrated sensors monitor windspeed and wind direction, peak winds, air temperature, fuel temperature and moisture, relative humidity (RH), solar radiation, and programmed warning thresholds including low RH or high winds.

The NIFC FIRE RAWS detects any unusual measurements—such as high winds or a change in temperature or humidity—and can automatically warn firefighters over the radio.

The FIRE RAWS units are individually calibrated and fine-tuned for accuracy. "Each of these is specially calibrated so we know they are right on," explained Mark Barbo, logistical FIRE RAWS coordinator at NIFC. "The units are calibrated for accuracy beyond the manufacturers' specifications, and the specialists here take this accuracy thing really personally."

Park Point Lookout, where the unit was deployed, is the highest point in the park. "There was low to moderate coverage of fuels where we set it up," said Mario Marquez, one of the technical specialists with the FIRE RAWS

The July 2000 Bircher Fire in Mesa Verde National Park near Durango, CO. Visible for miles, the convection column reached a height of more than 40,000 feet (12,000 m). Photo: Charles S. Maxwell, National Weather Service, Albuquerque, NM, 2000.

Kelly Andersson is a contract Web editor in northern Arizona who works for the USDA Forest Service, Fire and Aviation Management.

Acronyms, Technical Terms, and Links

RAWS – Remote Automated Weather Station <http://www.fs.fed.us/raws>

NIFC – National Interagency Fire Center <http://www.nifc.gov>

IMET – Incident meteorologist

Type 2 team – An interagency incident management team assigned to a fire or other incident. Fires of larger size or greater complexity are handled by type 1 teams, which are national interagency teams.

RH – Relative humidity

Haines Index – A lower atmosphere stability index developed by Forest Service research meteorologist Donald Haines, the index is computed from morning soundings across North America and is made up of a stability term (derived from the temperature difference at two atmosphere levels) and a moisture term (derived from the dewpoint depression at a single atmosphere level). The index is correlated with large-fire growth. <http://www.wrh.noaa.gov/Portland/haines.htm> *and* <http://www.fs.fed.us/land/wfas/haines.gif>

BLM – Bureau of Land Management <http://www.blm.gov>

ASCADS – Automated Sorting Conversion and Distribution System

WIMS – Weather Information Management System

FBA – Fire behavior analyst

WRCC – Western Regional Climate Center <http://wrcc.sage.dri.edu/>

unit. "It was mostly pinyon–juniper and Gambel oak fuels before the fire burned over the point. There's no fuels at all there now."

Fire Cuts Off Exit

After the RAWS technicians had the unit set up and were ready to head back down from the point, the fire made a run over the road and blocked their way out. "The road was closed," said Buske. "We concluded that the fire was laying down for the evening and it probably wouldn't get up here on the point till about 10 in the morning. So we figured we'd go into town, be back in time for the morning briefing, and then come up here and pull it out before the fire got here."

Best predictions were that the fire would reach the unit, but not until the next morning. The winds picked up, though, turned around 180 degrees, and pushed the fire up through the drainages. "Like they said at the briefing," Marquez said, "you should expect the unexpected. You can try to predict and foresee, and you can use your training and experience. But if I could predict stuff I wouldn't be doing this."

At Monday morning's briefing, they were told that the FIRE RAWS had been burned over at 1:30 a.m.

Chuck Maxwell, fire weather program leader for the Albuquerque, NM, office of the National Weather Service, was the incident meteorologist (IMET) ordered by Hartman's team and dispatched to the Bircher Fire. During the briefing on Saturday night, the weather forecast and fire behavior forecast for Sunday were outlined for fire personnel. "We discussed what would happen with fire behavior if the fire was driving the weather," said Maxwell. "You can't predict a plume-dominated event, but we explained what could happen if we got into that situation. Then we went back outside, and that's when everything basically went nuclear."

Fire Behavior: From Extreme to Bizarre

"It was hot and dry," he said, "with single-digit relative humidity and Haines* of about 12—the indices were three or four degrees over." He explained that the indices and conditions at the time indicated an extremely unstable situation. "The indices went way beyond just exceeding the differences," he said. "It crushed them."

"The plume had set up over this north–south canyon and then burned into the middle," explained Maxwell. "We had upcanyon winds, and that got the wind going up the canyon, with a hot fire, and pulled it right up into the column and just blasted. It consumed all fuels

* For a detailed discussion of the Haines Index, see John Werth and Paul Werth, "Haines Index Climatology for the Western United States," *Fire Management Notes* 58(3): 8–17.

Technical specialists replace a burned-over NIFC FIRE Remote Automated Weather Station (RAWS) on the Bircher Fire. To the right of the RAWS, local fire managers talk to a fire behavior analyst. Photo: Charles S. Maxwell, National Weather Service, Albuquerque, NM, 2000.

in all directions, and after that, the plume took off. The fire had started to calm down some, to the point where it was just extreme. But then a dry thunderstorm formed and moved south, and we had a push of wind from the east. That blew the column over, making it a wind-driven fire. The fire blazed over the next two canyons."

Maxwell said the convection column went up about 6 p.m. and grew to at least 40,000 feet (12,000 m). "We were all watching it grow, a group of about 100 people standing there with their heads up, and traffic was pulling over on the road and gawking at it. We figured as the sun went down it would cool down the top of it, and the column would collapse. The thing just pushed back out like a plunger. As it started to collapse, you could see the top come down, and the smoke just poured out in all directions. It cranked outflow wind from it like a thunderstorm, and we all had ash and smoke blown in our faces. It was getting dark by now, and people out on the road said it was unreal, with an orange glow dominating the top of the mesa."

The Morning After

Marquez said on Monday morning they knew the unit had been burned over. After the briefing at the incident command post, he and Buske drove up to the point where the burned-over unit was. "We found the windspeed and direction were both working," he said, "and there was a little soot on the RAWS station. The cables were melted and fused together. But the unit itself was in pretty good shape."

"There wasn't a piece of vegetation anywhere around it," said Buske, "but the unit looked almost normal. The box wasn't charred, but the fuel moisture stick was browned. The cables were melted and bubbly, but all the sensors were working. The power had dropped, but other than that we found the unit was able to sustain some pretty good heat. Now we know that it does really well—it continued to put data out the whole time."

She said they packed up the unit and sent it back to Boise. The team had a spare unit in the NIFC trailer, so they set that up on the ridge. The burned-over unit arrived back in Boise at 7:30 that

The roiling base of the Bircher Fire's convection column, photographed from 3 miles (5 km) away. The convection column at this time reached 30,000 feet (9,000 m). Photo: Charles S. Maxwell, National Weather Service, Albuquerque, NM, 2000.

evening. "We had to replace the cables and the fuel stick," said Barbo, "but the box and sensors survived well. The unit kept putting out data the whole time." He said the sensor that showed the most damage was the fuel stick. "It was dark brown, and the cables were connected, but the rubber bushings were rendered unusable. We're more concerned with the cable setup because without them the sensors don't work. It looks like we sustained only minimal damage to the sensors."

NIFC FIRE RAWS Applications

One of the units was moved to another division to support operations on the fire, and Barbo said the units on the Bircher Fire even assisted with aviation resources. "It's a safety issue," he said. "Air ops used the data to help with retardant spread and mixtures, elevation, wind direction and approaches."

According to Kolleen Shelley, USDA Forest Service national RAWS coordinator, the USDI Bureau of Land Management (BLM) and Forest Service are working together on field implementation for the program. "Though the technology was available for some time," she said, "people at the remote sensing weather unit at NIFC started getting requests from field personnel for weather data that was representative of what was happening on the fireline. They combined the hardware they had with enhanced software and made the firefighters' need a reality."

Shelley said the FIRE RAWS units not only collect a wide array of fire weather data, they can also record all the data for the duration of an incident. The data automatically go out every hour via satellite to the Automated Sorting Conversion and Distribution System, which forwards the data to the Weather Information Management System, the BLM's Web server, the National Weather Service, and the Western Regional Climate Center.

Barbo said they're working with the incident management teams on how multiple units are deployed. Fire behavior analysts (FBA's) and IMET's want the full round of all the data available from the units, but operations people say they don't need it all. "They need the basic operational-period fire weather," said Barbo. "They want to be able to key their radio and interrogate the unit and get immediate and accurate weather data. They want just the basic four things—relative humidity, windspeed and direction, and air temperature—in that order. The FBA and the IMET, though, get the full complement of data from the station. That information is just for them in fire behavior—so the first unit we put out on a fire is centrally located for an overall look at the conditions for the FBA and the IMET." He said a second or third unit can be set up for operations; the team members consult with operations staff, who designate one or more personnel to receive warnings issued over the radio by the unit.

Each NIFC FIRE RAWS unit is sent out with one red-carded electronics technician and one red-carded fire person with RAWS experience.

It's All About Safety

Barbo explained that each unit is sent out with one red-carded electronics technician and one red-carded fire person with RAWS experience. "Both our techs and our fire guys are fully carded," he said. He added that the unit and its use are being incorporated into the Incident Command System as a tool to advise command staff to issue a warning when necessary. "If you get into a situation where there is a dangerous canyon, and they're going to put crews in there, we can deploy a unit right where they are. The crew boss has the code and can access the unit at any time."

Barbo said crews on the fires appreciate not only the new technology, but also the efforts of the team to make it functional in the field. "We have people come up to us in the chow line," said Barbo. "'Are you guys the FIRE RAWS guys? Yeah. Well, thanks for covering us out there, and for teaching us how to use this.'"

"That's what it's all about," he said. "That's what we care about—safety for those crews out on the line."

For more information on the national interagency RAWS program, e-mail Forest Service RAWS Coordinator Kolleen Shelley at kshelley@fs.fed.us or BLM Remote Sensing Support Unit Supervisor Phil Sielaff at Phil_Sielaff@blm.gov. ■

British Columbia Forest Service Adds New Software for Wildland Firefighting

Moira Finn

"Find it fast, hit it hard, and attack where the need is greatest." That has been the British Columbia Forest Service's (BCFS's) motto for fighting wildland fires since the agency was founded in 1912.

The BCFS's fire protection program—the division tasked with wildland fire prevention and suppression—still adheres to this approach in fighting British Columbia's 3,000 wildland fires each year. But, thanks to advances in technology and fire sciences, battling blazes today is a much safer job for the Province's 885 wildland firefighters than it was nearly a century ago.

Computer tools, including a network of weather stations and new software programs operated by a team of fire protection officers and weather specialists, ensure that fire attack crews on the ground have the most timely and accurate fire and weather data, forecasts, topographical information, and fire behavior predictions available. "The safety of our firefighters is paramount," said Judi Beck, fire sciences leader for BCFS's fire protection program, "and the best tool we can give them for fire suppression and prevention is accurate information, conveyed clearly and on time."

Moira Finn is a communications and publications manager for Remsoft Inc., Fredericton, New Brunswick, Canada.

> "The safety of our firefighters is paramount, and the best tool we can give them is accurate information, conveyed clearly and on time."
>
> *Judi Beck, BCFS Fire Sciences Leader*

New Software System

The ability to calculate and convey vital fire and weather data to firefighters has recently improved through an upgraded fire behavior advisory and warning system. Key to the system are two software products, WeatherPro3 and FBP97. Customized to fit British Columbia's specific requirements, both were created by the software developer Remsoft Inc.* of Fredericton, NB.

BCFS's six fire centers utilize WeatherPro3 to capture data from weather stations and use it to calculate fire and weather codes and indexes. WeatherPro3 helps determine the likelihood of a fire igniting, as well as the timing and location of flareups.

When fire does break out, fire analysts use FBP97, a Microsoft Windows-based software, to evaluate how hot it will be, how quickly it will spread, which way it will move, and what measures will be needed to contain or extinguish the blaze. This information appears in a graph or report that is packaged into fire behavior advisories or warnings distributed by fax and radio to fire managers. Based on the information, fire managers determine the safest and most effective way to attack the fire or, in extreme cases, to move out of the way. "The new system," said Beck, "puts more intelligence behind the way we practice fire suppression, so fire managers on the ground can decide where to position firefighters and equipment, and how to use them. With more information available faster, it is inevitable then that our crews will be safer and used more effectively."

System Advantages

Better information is particularly crucial on the 8 percent of British Columbia's wildland fires that escape initial attack. Project fires require officers at BCFS's fire control centers to issue more frequent advisories and warnings and to revise them based on feedback from fire crews. "What we can do now that we couldn't do previously," explained Beck, "is to

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take advantage of two-way communications with incident commanders onsite who can call in and say, 'The wind here is way stronger than forecast,' or, 'The fuel type is primarily boreal spruce, not jack pine,' and the protection officer can then recalculate fire behavior predictions and issue a new advisory in a matter of minutes."

Prior to the introduction of WeatherPro3 in May 2000, the BCFS fire protection branch officer would take weather data from about 40 weather stations within a given zone, manually enter the data, and calculate fire behavior predictions for different fuel types. Graphs projecting fire intensity throughout the day were then drawn by hand and faxed to fire crews.

For the fire behavior specialist Ed Lussier, the new system for developing advisories and warnings will mean greater confidence in the accuracy of information sent to fire crews. Lussier is one of 16 BCFS fire protection specialists to participate in a May 2000 software training session. "I can stop hand-drawing graphs," he observed, "and spend more time looking at 'what-if' scenarios. For example, what if the windspeed increases? How will this affect the fire? The fire is burning on the south slope, but what if it is on the north slope? We can be so much better prepared this way. And because the system is Windows based, the interface is familiar to everyone."

WeatherPro3's more sophisticated reporting and graphing capabilities are the features Bruce MacLean says will be most useful to him in his role as a fire weather specialist. "I anticipate using the reporting capabilities extensively," he noted.

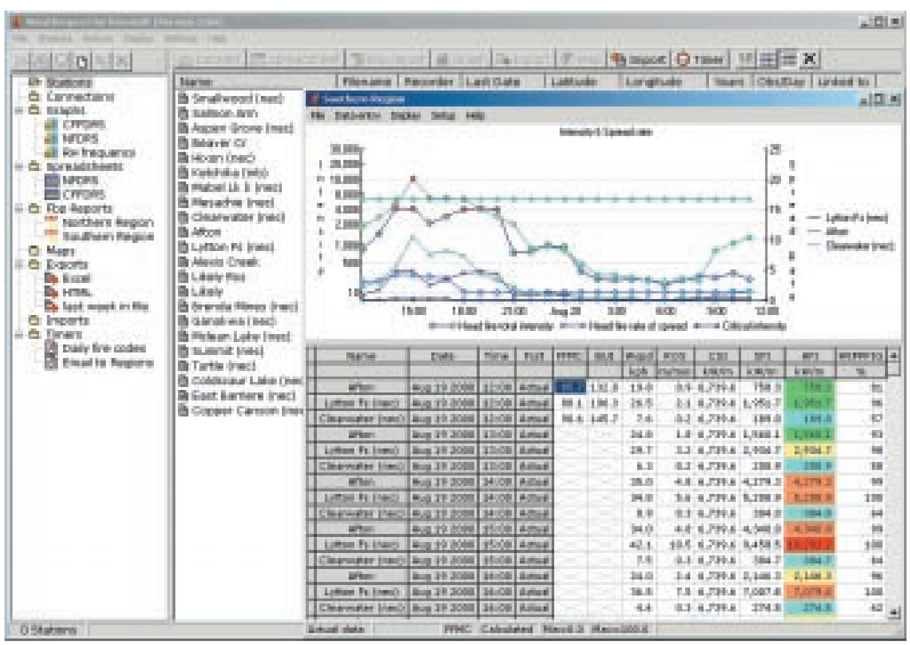
With more fire behavior information available faster, BCFS's crews will be safer and used more effectively.

"Not only can it help me show graphically how dry a particular area might be, but with WeatherPro3's ability to graph historical weather data, I can also put that piece of information in context. This gives our reports more meaning and credibility with the fire crews and with the public."

Enhanced Safety

BCFS's new, updated advisory and warning system incorporates customized modules as well as off-the-shelf products from Remsoft. Both will improve safety for wildland firefighters. "British Columbia has always had access to a rich source of weather and fire data, both current and historic," said Ugo Feunekes, vice president of research and development at Remsoft. "But now we have an improved ability to make sense of that data and to give it meaning."

For now, BCFS's fire protection program is using WeatherPro3's reporting capabilities to send information to staff by fax and radio. In the future, however, BCFS could post advisories on the Internet or send them by e-mail if a broader audience needed to be kept informed. For more information, visit the BCFS Website at <http://www.for.gov.bc.ca/protect/Program/> or the Remsoft Website at <http://www.remsoft.com>, or contact Moira Finn, Communications and Publications Manager, Remsoft Inc., 332 Brunswick Street, Fredericton, New Brunswick, Canada E3B 1H1, 800-792-9468 (voice), moira@remsoft.com (e-mail). ■



The British Columbia Forest Service has added new software for wildland firefighting, including graphic representations of fire danger and behavior. Illustration: Remsoft Inc., Fredericton, New Brunswick, Canada, 2000.

Fireline Safety Training Course Available on CD-ROM

Martin E. Alexander and Robert W. Thorburn

Information technology has been put to work to improve fireline safety. Wildland firefighters and fire managers can now take a fireline safety training course at home on their PC's, using a CD-ROM with the latest in interactive multimedia technology. The course, "Wildland Fire—Safety on the Fireline," was completed in July 2000 by a Canadian consortium consisting of the Environmental Training Centre, Hinton, Alberta; the National Training Working Group, Canadian Interagency Forest Fire Centre, Winnipeg, Manitoba; and Christie Communications and Vicom Multimedia,* both of Edmonton, Alberta (Thorburn and others 2000).

Advantages

A national team of specialists in wildland fire behavior and safety developed and reviewed the course. Its purpose is to reduce injuries and fatalities associated with suppression activities on wildland fires. The course's use of interactive multimedia technology offers several advantages:

- Consistent, high-quality training for large numbers;
- Cost savings through reduced travel and learning time and minimal use of instructors; and
- Enhanced knowledge retention, perhaps the greatest advantage.

The course focuses on due diligence, situational awareness, entrapment survival, firefighter health, firefighting equipment, and fireline hazards. Four sections (Introduction, Entrapment, On-the-Job, and On the Line) are each followed by a board game test in preparation for a final, computer-tracked test.

"Wildland Fire—Safety on the Fireline" contains 72 video clips, more than 250 audio clips, about 500 graphics and photos, online help, a glossary, and a conversion calculator for the International System of Units.

System Requirements

The course can be run on a stand-alone computer or over a network. System requirements are:

- A Pentium 166 or better, with Windows 95, 98, or NT;
- A minimum of 32 megabytes RAM and 100 megabytes of free hard drive space (4 megabytes are actually required for the software);
- A color SVGA monitor set for 800 by 600, 16-bit color and 4 megabytes of video memory;
- A 16-bit sound card (SoundBlaster);
- A 16X or better CD-ROM and its driver(s) (on every workstation); and
- A mouse.

The CD-ROM "Wildland Fire—Safety on the Fireline" costs $CAN 98.95 plus shipping charges. To order, contact Raincoast Distributors, 8680 Cambie Street, Vancouver, British Columbia, Canada V6P 6M9, 1-800-663-5714 (voice), 1-800-565-3770 (fax), custserv@raincoast.com (e-mail).

Reference

Thorburn, R.W.; MacMillan, A.; Alexander, M.E. 2000. The application of interactive multimedia CD-ROM technology to wildland fire safety training. Forestry Chronicle. 76: 953–959.

Marty Alexander is a senior fire behavior research officer for the Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta, Canada; and Rob Thorburn is the team leader for the wildland fire management training program with Alberta Environment at the Environmental Training Centre, Hinton, Alberta, Canada.

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The CD-ROM "Wildland Fire—Safety on the Fireline" lets you take a fireline safety training course at home using the latest in interactive multimedia technology.

Guidelines for Contributors

Editorial Policy
Fire Management Today (*FMT*) is an international quarterly magazine for the wildland fire community. *FMT* welcomes unsolicited manuscripts from readers on any subject related to fire management. Because space is a consideration, long manuscripts might be abridged by the editor, subject to approval by the author; *FMT* does print short pieces of interest to readers.

Submission Guidelines
Submit manuscripts to either the general manager or the managing editor at:

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Attn: April J. Baily, F&AM Staff
P.O. Box 96090
Washington, DC 20090-6090
tel. 202-205-0891, fax 202-205-1272
Internet e-mail: abaily@fs.fed.us

USDA Forest Service
Attn: Hutch Brown, 2CEN Yates
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Washington, DC 20090-6090
tel. 202-205-1028, fax 202-205-0885
e-mail: hutchbrown@fs.fed.us

If you have questions about a submission, please contact the managing editor, Hutch Brown.

Paper Copy. Type or word-process the manuscript on white paper (double-spaced) on one side. Include the complete name(s), title(s), affiliation(s), and address(es) of the author(s), as well as telephone and fax numbers and e-mail information. If the same or a similar manuscript is being submitted elsewhere, include that information also. Authors who are affiliated should submit a camera-ready logo for their agency, institution, or organization.

Style. Authors are responsible for using wildland fire terminology that conforms to the latest standards set by the National Wildfire Coordinating Group under the National Interagency Incident Management System. *FMT* uses the spelling, capitalization, hyphenation, and other styles recommended in the *United States Government Printing Office Style Manual*, as required by the U.S. Department of Agriculture. Authors should use the U.S. system of weight and measure, with equivalent values in the metric system. Try to keep titles concise and descriptive; subheadings and bulleted material are useful and help readability. As a general rule of clear writing, use the active voice (e.g., write, “Fire managers know…” and not, “It is known…”). Provide spellouts for all abbreviations. Consult recent issues (on the World Wide Web at <http://www.fs.fed.us/fire/planning/firenote.htm>) for placement of the author’s name, title, agency affiliation, and location, as well as for style of paragraph headings and references.

Tables. Tables should be logical and understandable without reading the text. Include tables at the end of the manuscript.

Photos and Illustrations. Figures, illustrations, overhead transparencies (originals are preferable), and clear photographs (color slides or glossy color prints are preferable) are often essential to the understanding of articles. Clearly label all photos and illustrations (figure 1, 2, 3, etc.; photograph A, B, C, etc.). At the end of the manuscript, include clear, thorough figure and photo captions labeled in the same way as the corresponding material (figure 1, 2, 3; photograph A, B, C; etc.). Captions should make photos and illustrations understandable without reading the text. For photos, indicate the name and affiliation of the photographer and the year the photo was taken.

Electronic Files. Please label all disks carefully with name(s) of file(s) and system(s) used. If the manuscript is word-processed, please submit a 3-1/2 inch, IBM-compatible disk together with the paper copy (see above) as an electronic file in one of these formats: WordPerfect 5.1 for DOS; WordPerfect 7.0 or earlier for Windows 95; Microsoft Word 6.0 or earlier for Windows 95; Rich Text format; or ASCII. Digital photos may be submitted but must be at least 300 dpi and accompanied by a high-resolution (preferably laser) printout for editorial review and quality control during the printing process. Do not embed illustrations (such as maps, charts, and graphs) in the electronic file for the manuscript. Instead, submit each illustration at 1,200 dpi in a separate file using a standard interchange format such as EPS, TIFF, or JPEG (EPS format is preferable, 256K colors), accompanied by a high-resolution (preferably laser) printout. For charts and graphs, include the data needed to reconstruct them.

Release Authorization. Non-Federal Government authors must sign a release to allow their work to be in the public domain and on the World Wide Web. In addition, all photos and illustrations require a written release by the photographer or illustrator. The author, photo, and illustration release forms are available from General Manager April Baily.

Contributors Wanted

We need your fire-related articles and photographs for *Fire Management Today*! Feature articles should be up to about 2,000 words in length. We also need short items of up to 200 words. Subjects of articles published in *Fire Management Today* include:

Aviation	Firefighting experiences
Communication	Incident management
Cooperation	Information management (including systems)
Ecosystem management	Personnel
Education	Planning (including budgeting)
Equipment and technology	Preparedness
Fire behavior	Prevention
Fire ecology	Safety
Fire effects	Suppression
Fire history	Training
Fire use (including prescribed fire)	Weather
Fuels management	Wildland–urban interface

To help prepare your submission, see “Guidelines for Contributors” in this issue.

Photo Contest for 2002

Fire Management Today invites you to submit your best fire-related photos to be judged in our annual competition. Winners in each category will receive awards (first place—camera equipment worth $300 and a 16- by 20-inch framed copy of your photo; second place—an 11- by 14-inch framed copy of your photo; third place—an 8- by 10-inch framed copy of your photo). Winning photos will appear in a future issue of *Fire Management Today*. All contestants will receive a CD–ROM with all of the photos not eliminated from competition.

Categories

- Wildland fire
- Prescribed fire
- Wildland-urban interface fire
- Aerial resources
- Ground resources
- Miscellaneous (fire effects; fire weather; fire-dependent communities or species; etc.)

Rules

- The contest is open to everyone. You may submit an unlimited number of entries from any place or time; but for each photo, you must indicate only one competition category.
- Each photo must be an ***original color slide***. We are not responsible for photos lost or damaged, and photos submitted will not be returned (so make a duplicate before submission).
- You must own the rights to the photo, and the photo must not have been published prior to submission.
- For every photo you submit, you must give a detailed caption (including, for example, name, location, and date of the fire; names of any people and/or their job descriptions; and descriptions of any vegetation and/or wildlife).
- You must complete and sign a statement granting rights to use your photo(s) to the USDA Forest Service (see sample statement below). Include your full name, agency or institutional affiliation (if any), address, and telephone number.
- Photos are eliminated from competition if they lack detailed captions; have date stamps; show unsafe firefighting practices (unless that is their express purpose); or are of low technical quality (for example, have soft focus or show camera movement). (Duplicates—including most overlays and other composites—have soft focus and will be eliminated.)
- Photos are judged by a photography professional whose decision is final.

Postmark Deadline

March 1, 2002

Send submissions to:

USDA Forest Service
Fire Management Today Photo Contest
Attn: Hutch Brown, 2CEN Yates
P.O. Box 96090
Washington, DC 20090-6090

Sample Photo Release Statement

(You may copy and use this statement. It ***must be signed.***)

Enclosed is/are __________ (*number*) slide(s) for publication by the USDA Forest Service. For each slide submitted, the contest category is indicated and a detailed caption is enclosed. I have the authority to give permission to the Forest Service to publish the enclosed photograph(s) and am aware that, if used, it or they will be in the public domain and appear on the World Wide Web.

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