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Why Are Fire Seasons Growing?

United States Department of Agriculture
Forest Service

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Fire Management *today*

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On the Cover:

A fast-moving firestorm sweeps upslope through pine on the 2000 Hash Rock Fire, Ochoco National Forest, OR. Rolling 10-year averages for acres burned on the National Forest System suggest a dramatic rise in fire season severity since the 1980s. For a discussion of growing fire season severity and management response, see the articles by Dale Bosworth beginning on page 4 and by Stephen F. Arno and Steven Allison-Bunnel beginning on page 12. Photo: Thomas Iraci, USDA Forest Service, Pacific Northwest Region, Portland, OR, 2000.

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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Short Features

Fires and Forest Health: Our Future Is at Stake*

Dale Bosworth

In the last 40 years, we have seen tremendous changes—changes in the marketplace for forest and rangeland products; changes in demographics and development patterns, particularly in our Western States; changes in public values and expectations from public lands; and changes in the landscape itself and in our scientific understanding. In terms of wildland fire science alone, we have made tremendous progress in our understanding of the critical role fire plays in shaping ecosystems.

Our problem is not really change; change is inevitable. Our problem is that too many people seem to be stuck in the past. When you read the newspapers, you often find the same old folks being quoted in the same old way on both sides of the same old issues. You might think nothing about our forest management has changed in the last 40 years.

We need to move beyond the conflicts of the past if we are to strike the right balance for the future. The point is this: We have a serious forest health problem, and we aren't doing enough about it. We need to get on with the job of restoring forest health. For that, we first need to move beyond the conflicts of the past.

Dale Bosworth is the Chief of the USDA Forest Service, Washington, DC.

* This article is based on Chief Bosworth's McClure Lecture at the University of Idaho in Moscow, ID, on September 18, 2002.

We need to move beyond
the conflicts of the past
if we are to strike
the right balance for the future.

Stuck in the Past

In 2002, our firefighters were more effective than ever, controlling about 99 percent of the fires during initial attack. Yet we still had one of the biggest fire seasons in memory. Four States in the West—Arizona, Colorado, New Mexico, and Oregon—had their largest fires in history, and California had its fourth largest. Almost as many acres burned as in 2000, when we had our biggest fire season since 1954.*

People looked hard for someone to blame. Some blamed environmental groups for not letting us cut enough trees, thereby making forests too dense. Environmentalists responded that this was just an excuse for more logging; big fires, they said, are normal under drought conditions. There was a kernel of truth in what both sides said, but the reality is far more complex.

The point is this: The blame game gets us nowhere. It does nothing to address our forest health problem, and therefore it misses the point. It focuses instead on battles fought long ago, and that is not where our focus should be. To understand this, you need to step back in time.

When I first started working for the USDA Forest Service in the 1960s, we had a very different situation. The focus was on efficient, cost-effective timber production. State and private timber supplies were exhausted after World War II, and there were fears of a timber famine. The Nation needed national forest

* According to statistics collected by the National Interagency Fire Center in Boise, ID, as of October 11, 2002.

Extreme fire behavior on the 2000 Valley Complex Fire, Bitterroot Valley, MT. Since the 1980s, a growing number of fires have burned outside the historical range of variability in forests that evolved with frequent low-intensity fire. Photo: USDA Forest Service, 2000.

> Today, long-term ecosystem health drives everything we do. It determines whether or not—and where and how—we decide to cut trees.

timber to help realize the American dream of owning a single-family home.

From 1960 to 1985, the national forests met about 25 percent of America's softwood timber needs. That gave State and private stocks time to recover. Today, fears of a timber famine are over. Fifty years from now, we expect that timber growing in the United States will be nearly double the levels in 1960.

In 1970, the first Earth Day signaled a change in public values. The environmental movement was born, and I think it did a lot of good. Congress passed a number of environmental laws aimed at sustainable management for the long-term health of the land. Science contributed by laying the basis for new multidisciplinary, ecosystem-based approaches.

With the help of science, we began basing much of our management on watershed health. Today, the Forest Service no longer focuses on the most efficient, cost-effective way to remove timber. Instead, we focus on long-term ecosystem health, measured in terms of healthy watersheds.

Zero-Sum Game

So the battle is over—or, at least, it should be. But some still seem to want to snatch defeat from the jaws of victory.

There is a common misconception that all logging is one thing—that the primary goal is economic, and that the focus is on providing timber to mills for a profit from Federal lands. We need to help people understand that there are different types of tree removal. It all depends on what you are trying to achieve.

On the national forests, our purpose for tree removal is not what it was 40 years ago. Today, long-term ecosystem health drives everything we do. It determines whether or not—and where and how—we decide to cut trees. Our vegetation management projects are guided by the principle that what we leave on the land is more important than what we take away. It's the exact opposite of the old "pick-and-pluck" philosophy of taking the best and leaving the rest.

So the debate today—focusing on limits to diameter size—misses the mark. It continues to focus on what we take, not on what we leave. On a landscape scale, diameter size doesn't matter. The number and size of the trees we remove doesn't matter. What matters is the number, size, and type of trees we leave on the land to achieve healthy landscape conditions. The goal is to meet the desired future condition of the land.

Too often, we focus on the wrong thing because we are playing a zero-sum game. In the zero-sum game, people measure their own success in terms of the misfortune of their adversaries. So if you're in a timber group and you see something the environmentalists like, you jump to the conclusion that it must be a bad idea, even if it really isn't. Or if you're an environmentalist and you see some people getting jobs in one of our vegetation management programs, you automatically think we must be in bed with the timber industry. Your focus is not on the land and what it needs. Instead, your focus is on how well your adversaries are doing, because if they seem to be winning, you must be losing. That's the zero-sum game.

Of course, not all timber and environmental groups are so shortsighted. A lot of people on both sides understand just how divisive and destructive that can be. Too often, though, the debate is driven by conflict. Caught between the extremes, people often lose sight of long-term ecosystem health, which is where our focus should be.

Forest Health Problem

The fact is, we can no longer afford to play the zero-sum game. Our problems are simply too pressing. They have been building for a long time. Fires started getting bigger in the 1980s, while we were still removing record volumes of timber. In 1987, for the first time in almost 70 years, we saw more than a million acres burn on the national forests. Since then, the problem has just kept on growing. Today, we have some 73 million acres (30 million ha) of national forest land at risk from wildland fires that could compromise human safety and ecosystem integrity.

The problem took generations to develop. For most of the last century, we focused on removing big trees and suppressing all fires. In the process, we altered the land. Many of our lands at highest risk are in the ponderosa pine forests of the Interior West, from the Sierras and eastside Cascades to the Colorado Plateau, the Rockies, and the Black Hills. Some of our worst fires

The most important thing we can do in a good part of the West is some thinning and burning in a controlled manner.

Aftermath of the 2000 Valley Complex Fire, Bitterroot Valley, MT. Many areas historically covered by open ponderosa pine forest burned far more intensively than they had for centuries. Photo: USDA Forest Service, 2000.

occur in forests historically governed by frequent low-intensity fire.

Climate fluctuations in the arid West have helped to alter these forests. In New Mexico, for example, the last 200 years have been the wettest in more than a millennium (RMRS 2002a). Within that 200-year period, the last 30 to 40 years have been the wettest. Fire exclusion, a wetter climate, and deferred management in recent years have combined to make many forests more dense than they were historically, because trees have grown faster than fire, harvest, and mortality have combined to remove them. For example (USDA Forest Service 2002a):

- From 1952 to 1997, net annual softwood growth more than doubled in the West.
- On the national forests, net annual softwood growth also more than doubled.
- In the next 10 to 20 years, we expect the upward trend to continue.

Just to give you some idea of what that means, in the Southwest—in Arizona and New Mexico—net annual growth is enough to cover a football field 1 mile (1.6 km) high with solid wood (Johnson 2002). Recent removals have only been about 10 percent of this.

Historically, these forests were relatively open; today, they are overcrowded with trees. Beset by drought and under stress from competition, the trees are more susceptible to insect attack and catastrophic fire than ever before. In summer 2002, for example, bark beetles multiplied exponentially in an outbreak of unprecedented proportions in Arizona. The beetles killed millions of ponderosa pines on more than 500,000 acres (200,000 ha) on the national forests and American Indian reservations alone (RMRS 2002b). At the same time, we got record-breaking fires—the Rodeo-Chediski Fire in Arizona, the Hayman Fire in Colorado, the Ponil Fire in New Mexico, and the Biscuit Fire in Oregon.

The situation is simply not sustainable—not socially, not economically, not ecologically. Socially, our communities are increasingly disrupted by catastrophic fires and the associated evacuations. Economically, these fires cost jobs and income from recreational activities on Federal lands. Besides, they can sweep from Federal lands onto State and private lands, threatening jobs and futures there, too. Ecologically, sensitive species cannot find suitable habitat in overcrowded forests, and catastrophic fires can destroy the few remaining refuges they have.

Some good examples come from Colorado, where the Hayman Fire affected habitat for five threatened species (USDA Forest Service 2002b): the Canada lynx, bald eagle, Mexican spotted owl, Preble's minnow jumping mouse, and Pawnee montane skipper. The skipper, a butterfly, lost 40 percent of its known habitat. It might not even survive.

Active Management

Some people say we ought to leave the land alone to heal itself. But it is an illusion to think that just leaving nature alone will restore the open old-growth pine forests that once dominated lower elevations across the Interior West. Competition for limited resources will keep the dense trees that are there now small forever—or until they are destroyed by insects or fire. In fact, the original open forests were probably never entirely natural; studies suggest that they evolved together with American Indians and their land management practices, particularly burning (Bonnicksen 2000; Boyd 1999; Pyne 1982; Whitney 1994).

Historically, the fires that burned in these open forests were relatively cool and low to the ground. Today, the fires are like nothing the American Indians ever saw. They burn extremely hot and destroy entire stands, with catastrophic results for soils, waters, and wildlife habitat.

Our American Indian heritage teaches the need for active management. We have got to remove some of the small materials that are threatening the health of our forests and fueling our worst fires. We have two choices: The excess trees can either go up in smoke or out on the back of a truck. The most important thing we can do in a good part of the West is some thinning and burning in a controlled manner.

We have been saying and doing that for years, but it has not been enough. Through the National Fire Plan, we are now picking up the pace. In 2002, the Forest Service and U.S. Department of the Interior together plan to treat about 2.5 million acres (1 million ha). By September, we had already treated more than 1.5 million acres (0.6 million ha), a 30-percent increase from 2001. But it is still not enough. We must do much more.

Treated areas must be large enough for a fire crew to have enough time to get in and contain it while it is still on the ground and not too dangerous.

Green spots mark houses that survived the 2000 Valley Complex Fire in Montana's Bitterroot Mountains. Homeowners might have saved their houses, but they lost their homes in the surrounding blackened landscape. Photo: USDA Forest Service, 2000.

Fire is part of the solution. Today, we no longer practice fire exclusion. Our policy is to restore fire's ecological role on the land. We do that by allowing natural fires to burn in remote areas and by conducting carefully controlled burns in other areas. In both cases, we can only do so where conditions permit and where we have an approved fire management plan in place.

Where we cannot burn, the only alternative is to remove the excess trees. In such places, we need to carefully thin the forest before restoring fire to the land. Some areas will require a combination of thinning and controlled burning. We now have the tools, techniques, and technologies for low-impact tree removal. We are not talking about clearcutting majestic old-growth stands. We are talking about thinning and burning where needed to restore the healthy, fire-adapted forests that historically dominated the Interior West.

Priority Areas

Our first priority should be treating the areas most at risk, areas where people live and work—the wildland/urban interface. Homeowners need to take responsibility for making their properties firesafe, and we are doing what we can to help by working with our local communities.

But it is not enough just to thin right around homes and communities. You might save your house from a catastrophic fire, but you have lost your home if it is surrounded by a blackened landscape. You probably can't even sell and move, because who would buy?

Besides, values most at risk include municipal watersheds in the backcountry. This year's Hayman Fire, for example, burned much of the area that supplies Denver's water. The wildland/urban interface is really much bigger than most people think.

We know that our treatments work where the areas we treat are big enough. When a large fire enters a treated area, it will often drop to the forest floor and leave most trees unburned. But a large fire can throw firebrands a half mile or more, so it can easily ignite dense forest beyond a small treated area.

Treated areas must be large enough for a fire crew to have enough time to get in and contain a fire while it is still on the ground and not too dangerous. The Hayman Fire burned right through some small treated areas; it just dropped to the ground and came out the other side. Some of the treated areas were so small that the fire just blew right through without even dropping down.

But when the Hayman Fire reached the Polhemus Burn, it changed dramatically (Egan 2002; RMRS 2002c). On the Polhemus Burn, we had treated about 8,000 acres (3,200 ha) in October 2001, less than a year before the Hayman Fire, so surface fuels were few. The fire hit the area and dropped down, giving us a chance to get in and construct fireline. In some places, the fire even went out on its own. Hundreds of homes were saved. It's a great example of the kind of treatment that works.

Adaptive Management

Admittedly, we still have much to learn about the effects of our forest health treatments. Forest science did not traditionally focus on the long-term effects of thinning and burning. In the past, we mostly asked questions related to timber harvest—for example, what is the level of growth where returns are greatest if you harvest?

> We have got to strategically focus our projects where they will do the most good—where they will help us achieve the desired future condition of the land.

In the last 10 to 15 years, we have begun asking more questions about forest restoration. Forests are long-lived, so it takes a very long time—decades or even centuries—before some of the answers are known. Ecosystems are also tremendously complex. Former Forest Service Chief Jack Ward Thomas used to say, quoting the ecologist Frank Egler (1977), "Ecosystems are not only more complex than we think, they are more complex than we can think." So I would never say that we have all the answers.

But does that mean we should do nothing? I would say no. At least we are asking the right questions now, and we are learning a great deal from the answers. For example, our Rocky Mountain Research Station in Flagstaff, AZ, has been working with the Ecological Restoration Institute at Northern Arizona University to improve our understanding of burning and thinning treatments. There is much that we have already learned.

Wally Covington, who is in charge of the program, has pointed out that we used to think we had enough time for all the answers to come in, but now we see that we don't (Robbins 2002). We no longer have that luxury. We must act now. Then we must carefully monitor the results, see what works, and change our management accordingly. It's called adaptive management, and it makes sense.

Collaborative Solutions

We cannot act alone. The days are gone when we could narrowly focus on national forest land. Today, we need to think strategically on a landscape scale. That means connecting our fuels and forest health treatments to our efforts to help homeowners make their properties firesafe. It means engaging our State and local partners, including our local communities, in deciding what our priorities should be.

We are not talking about treating every acre at risk of catastrophic fire—all 73 million acres (30 million ha) of national forest land. Even if we had the means, it might make more sense in some areas to leave the land alone. We have got to strategically focus our projects where they will do the most good—where they will help us achieve the desired future condition of the land.

The highest priority areas are where the risk to people, property, and wildland resources is greatest. Those are often the areas next to or near to the wildland/urban interface. For example, the burn that stopped the Hayman Fire backed up to a settlement and protected it. Other high-priority areas are in or near our municipal watersheds. Some projects might be designed to restore a healthy landscape mosaic or the original open pine forest. For

> When it comes to delivering on our partnership commitments, the Forest Service often finds itself mired in process and unable to move forward with actual projects on the ground.

all of our projects, we must carefully monitor the results and adapt our management accordingly.

I think we can find common ground for deciding at the local level what our priorities and treatments should be. Today, we have amazing new opportunities for collaboration. New technologies such as the Internet allow us to work together with partners all across the landscape.

We've got some good examples in place, such as the Blue Mountain Demonstration Area in Oregon or the Greater Flagstaff Forests Partnership in Arizona. Our partnerships are based on broad areas of agreement, such as focusing on reduced risk, using multidisciplinary science, managing at the landscape level, measuring success in terms of watershed health, and monitoring results for adaptive management.

If we work together based on shared goals for the land, everyone benefits. Ecologically, we can benefit the land by restoring ecosystems to something more resembling their condition at the time of European settlement. Socially, we can benefit our local communities by helping people make themselves safer from wildland fire. Economically, we can benefit our citizens by providing jobs and by helping them take advantage of local business opportunities to utilize excess trees and brush.

Fire effects in treated versus untreated areas. Long before the 2002 Rodeo–Chediski Fire charged through, the area in the foreground was thinned and prescribe-burned; the ponderosa pines, though scorched at the base, will survive. In the untreated area behind the people, the stand was much more dense, and the trees totally burned. Photo: Tom Iraci, USDA Forest Service, 2002.

I for one would much rather see Americans use products from our forests and in turn get jobs out of it than import the wood from countries with fewer environmental protections. I would also much rather see wood used than most substitutes; wood takes far less energy and water to produce, and it is a better insulator than steel or aluminum. Best of all, it is renewable. I think we can use forest products in a way that meets our shared goals for long-term ecosystem health.

Process Predicament

So what's stopping us? Well, we have a big problem. The Forest Service is caught in a bind. On the one hand, we strongly encourage collaboration through partnerships on a landscape scale. On the other hand, when it comes to delivering on our partnership commitments, the Forest Service often finds itself mired in process and unable to move forward with actual projects on the ground. When we fail to fulfill our promises, all the trust and goodwill we spend so much time building evaporates.

The many reasons for the problem are outlined in a report we delivered to Congress (USDA Forest Service 2002c). Part of the problem is our process for appeals. I believe that people ought to have the right and the ability to question our decisions. But I also believe that the right to appeal carries with it a responsibility. Those who question our decisions have a responsibility to all the other people who are involved in the decision or have a stake in the outcome. They have a responsibility to engage upfront in the discussion instead of waiting in the wings while others hammer out an agreement, then using procedural or legal maneuvers to torpedo it.

Understandably, our partners are deeply discouraged by our process predicament. Governor Kitzhaber of Oregon, for example, has written that "the current procedure-bound, litigious, cumbersome, and glacial process that has engulfed federal land management agencies does not produce sustainable land management" (Kitzhaber 2001). I would have to agree.

It is time to reevaluate our tools and processes if we are truly committed to sustainable land management. That does not mean overhauling our environmental laws; we need the national sideboards they give us for managing healthy lands. But I think we can do much better in terms of how we apply the laws. We need to fix the processes that are so clearly broken.

In August 2002, President Bush announced the Healthy Forests Initiative (see the sidebar). The purpose of the initiative is to improve some of our processes for more timely decisions and greater efficiency, specifically with respect to fuels treatments and forest health restoration projects. I am pleased that the President's announcement has raised the level of consciousness about our forest health crisis and the need for the tools to address it. With the right tools, we can spend less time tucked away in windowless planning rooms and more time working with people to reach agreements that everyone can live with—and that we can act on to deliver results.

A Great Experiment

When you think about it, the national forests and grasslands are a great unfinished experiment. We as a Nation are testing a hypothesis—the hypothesis that a great system of public lands can provide benefits to many different people, for generation after generation, forever and ever.

It is time to reevaluate our tools and processes if we are truly committed to sustainable land management.

The experiment hinges on the answers to these questions: Do our communities get enough economic benefit from the national forests and grasslands? Do the American people derive enough social and personal benefits? Are ecosystems still as healthy as they were a century ago? Will we leave a legacy for our children that we can all be proud of?

We need affirmative answers to every one of these questions if our experiment is to succeed. The jury is still out. People all over the world are watching and waiting to see if what we are doing is the right thing. A lot is at stake.

In a great experiment like this, the outcome is never certain. There will always be ups and downs. Despite the best of intentions, we have made some really big mistakes. We have also found that people's values and expectations change. We do not have all the answers, and we never

Healthy Forests Initiative

On August 22, 2002, President George W. Bush announced the Healthy Forests Initiative. The initiative is designed to help implement the Ten-Year Comprehensive Strategy and Implementation Plan under the National Fire Plan. The Ten-Year Plan was adopted in spring 2002 by Secretary of Agriculture Ann M. Veneman, Secretary of the Interior Gale Norton, and 17 Western Governors, in cooperation with county commissioners, State Foresters, and tribal officials. The plan establishes a framework for local collaboration on forest restoration projects to protect communities and the environment.

The Healthy Forests Initiative has several parts. Under the initiative, the Forest Service is working, among other things, to:

- Improve procedures for developing and implementing projects, in collaboration with local governments;
- Reduce the number of overlapping environmental reviews;
- Develop guidance for weighing short-term risks against long-term benefits;
- Ensure that procedures under the National Environmental Policy Act are consistent, partly by developing a model environmental assessment; and
- Simplify the Forest Service's appeals process.

We as a Nation are testing a hypothesis—the hypothesis that a great system of public lands can provide benefits to many different people, for generation after generation, forever and ever.

will. All we can do is learn from our mistakes, adjust to change, and work to make the experiment a success.

One thing is clear: We cannot succeed unless society works together. If there is anything that will cause this experiment to fail, it will be people's desire to have it all their own way. If people cannot work together enough to give everyone a stake in the outcome, that will be the end of the national forests and grasslands as we know them. And the biggest losers will be the next generation.

It's a new day and a new time. It's time for people to stop refighting the battles of the past. It's time to start finding broad areas of agreement, then working together to strike the right balance for the future. Ultimately, conservation is about our obligation to the next generation. We owe the next generation at least that much.

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Websites on Fire*

Community Preparedness for Wildfire

The first of 15 case study summaries that evaluate what each community is doing to increase wildfire preparedness is posted on this Website. Researchers at the USDA Forest Service's North Central Research Station studied the northeastern Minnesota community of Gunflint Trail to determine its level of wildfire preparedness, what could be done to improve wildfire preparedness, and how other communities can learn from the Gunflint experience. The researchers developed a model that demonstrates how individual and community decisions affect actions to increase wildfire preparedness, suggesting actions that the community might take within the confines of its social and landscape characteristics.

Found at **<http:www.ncrs.fs.fed.us/4803/highlights.htm>**

*Occasionally, *Fire Management Today* 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 considered for inclusion, contact the managing editor, Hutch Brown, at USDA Forest Service, Mail Stop 1111, 1400 Independence Avenue, SW, Washington, DC 20250-1111, tel. 202-205-1028, e-mail:hbrown@fs.fed.us.

MANAGING FIRE-PRONE FORESTS: ROOTS OF OUR DILEMMA*

Stephen F. Arno and Steven Allison-Bunnell

The year 2002 again produced large, destructive wildfires in the Western United States. Not counting Alaska, more than 3 million acres (1.2 million ha) burned in the West, including more than 600 homes. Arizona, Colorado, and Oregon experienced their largest fires since records began.

Our dilemma is that in trying to protect forests from fire we have increased the hazard of severe wildfires as well as insect and disease epidemics and loss of historical biodiversity. The 90-year-old policy of trying to exclude fire from fire-prone forests without controlling the buildup of thickets of small trees, shrubs, dead wood, and leaf litter is at the root of this conundrum.

Strident voices dominated media coverage of the issue. Many foresters and loggers argued that the solution to saving western forests from destructive wildfires lies in thinning, selective logging, and slash disposal to open up the forest and reduce fuel accumulations. Environmental activists countered that past mismanagement is a source of our wildfire problems, and that now we must leave the forest alone and let it heal. In order to build broader understanding for achieving better management of fire, fuels, and the western forests themselves, it might be useful to review some key features in the century-old history behind our present predicament.

> The initial concepts of forestry brought to this country were developed in humid regions of Europe, where foresters viewed fire in the forest as entirely unnecessary and destructive.

Fire Regimes

For thousands of years, western forests have been shaped by repeated patterns of burning (Arno 2000). The patterns include:

- An *understory fire regime* (fig. 1), in which frequent low-intensity fires kept forests of ponderosa pine and other species, along with oak woodlands, relatively open;
- A *mixed fire regime* (fig. 2), where fires of varying intensity killed a large proportion of fire-sensitive trees and allowed long-lived resistant trees to thrive, such as thick-barked pines, western larch, coastal Douglas-fir, and redwood; and

Figure 1—*Ponderosa pine forest near Seeley Lake in western Montana in 1899, before logging and fire suppression. Frequent understory fires kept most ponderosa pine stands relatively open, with few understory trees and only small quanitities of surface fuel. Photo: H. Ayres, USDI U.S. Geological Survey, 1899.*

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* The article draws on the authors' book *Flames in Our Forest: Disaster or Renewal?* (Washington, DC: Island Press, 2002).

Figure 2—*Western larch–lodgepole pine forest north of Seeley Lake in western Montana in 1899, before logging and fire suppression. A mixed-severity fire about two decades earlier evidently killed some of the overstory trees and allowed vigorous regeneration of lodgepole pine (dark saplings) and some larch. Photo: H. Ayres, USDI U.S. Geological Survey, 1899.*

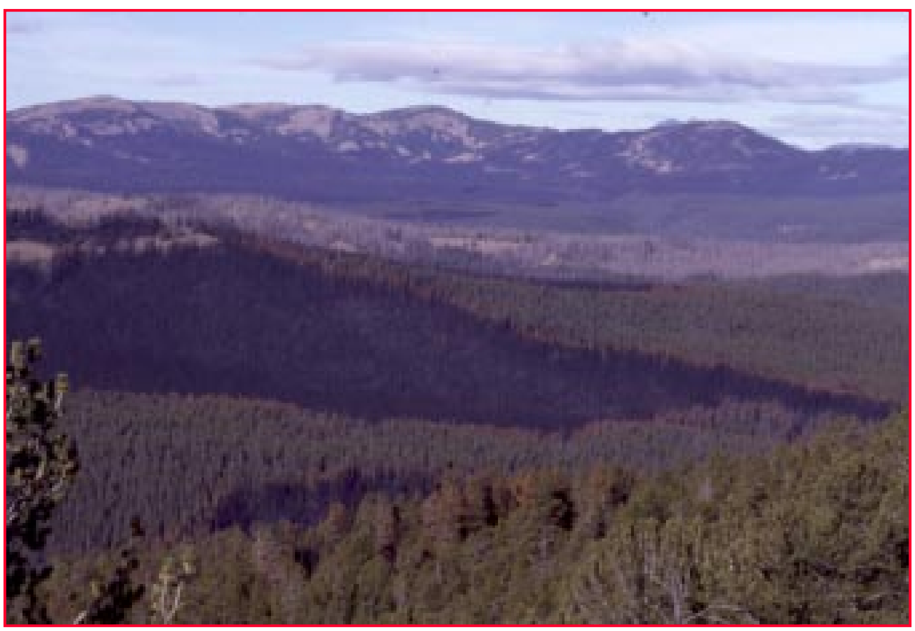

Figure 3—*Burn mosaic in a stand replacement fire regime. Fire-killed stands will regenerate, forming a much younger forest than in adjacent stands. Forests in the stand-replacement fire regime are often diverse patchworks of different age classes. Photo: USDA Forest Service, 1988.*

- A *stand replacement fire regime* (fig. 3) in some moist and high-elevation forests, where severe fires at intervals of one to four centuries left a mosaic of new and older stands.

Trying to eliminate fire from these ecosystems without effective surrogate treatments was a radical departure from natural conditions. It led to fuel accumulations and increasingly severe wildfires in the historical understory and mixed fire regimes that govern the largest portion of western forests, including most areas around homes and developments.

Origins of Fire Exclusion

At the turn of the 20th century, Gifford Pinchot traveled widely while trying to establish a Federal forestry program to conserve American forests. In his travels, he observed that fire had played an important role in producing some of the most magnificent natural forests, such as the venerable Douglas-fir forests of western Washington. In an essay titled "The Relation of Forests and Forest Fires," Pinchot (1899) urged that the role of fire in creating forests be studied to help in designing forest management. Pinchot wanted to prevent destructive fires, but he also wanted to understand fire's role as an ecological force.

However, the initial concepts of forestry brought to this country were developed in humid regions of Europe, where foresters viewed fire in the forest as entirely unnecessary and destructive. Fires caused largely by human carelessness were indeed a serious threat to both watersheds and timber in the newly established forest reserves (later called national forests). Pinchot's tiny new agency, the USDA Forest Service, needed to define and fund its mission to protect the reserves.

In 1908, the Forest Service found its mission when it was charged with preventing and controlling fires. A parsimonious Congress set up a unique system, like an open checkbook, to ensure payment for fire suppression efforts as needed (Pyne 1982). The political need to establish complete suppression of fire now overshadowed any scientific need to study fire's natural role in the forest (Pyne 2001). Although the Forest Service published a detailed report by pioneer ecologist Frederic Clements (1910) calling for the use of fire as a management tool in lodgepole pine forests, it ignored Clements's recommendations.

Light Burning Controversy

Not everyone saw fire as the enemy. Several influential timberland owners in California advocated "light burning" to reduce the threat of wildfires (Hoxie 1910; Pyne 2001). Light burning involved informally setting fire to the forest floor litter across large areas during a "safe" season. Secretary of the Interior Richard Ballinger, whom Pinchot thoroughly disliked, supported the idea, stating that "we may find it necessary to revert to the old Indian method of burning over the forests annually at a seasonable period" (Pyne 1982).

In the summer of 1910, one of the California light burns got out of control (Pyne 1982). It burned 33,000 acres (13,000 ha) before finally being stopped at the boundary of a national forest. Then the disastrous 1910 wildfires in Idaho and Montana burned 3 million acres (1.2 million ha), mostly in a

The political need to establish complete suppression of fire came to overshadow any scientific need to study fire's natural role in the forest.

stand replacement fire regime, making a mockery of the Forest Service's assertion that it could control fires. Heated controversy in the aftermath of these events gave birth to the Forest Service's resolve to anchor its mission of forest protection to the exclusion of fire from the forest.

During the 1920s, the debate about the merits of light burning intensified. The Forest Service regarded the controversy as a serious threat to its mission (Biswell 1989; Pyne 1982). Light burning was unacceptable to the Forest Service because it was too difficult for its advocates to apply with any consistency. There was no formal knowledge of the interrelationships among fuels, weather, and fire behavior, and foresters trained on the European model saw no value in such studies. Also, the Forest Service argued that light burning had to be detrimental to new timber because it killed seedlings and small trees.

Timber Management: Fire Surrogate?

Government foresters did not realize that, without fire as a thinning agent, *too many* small trees would spring up and create problems. Selective harvesting removed large, fire-resistant trees and allowed small trees to prolifer-

Logs being loaded for power and telephone poles, Routt National Forest, CO. After World War II, large clearcuts were seen as the answer to fuel management problems. However, extensive clearcutting fed public dissatisfaction with harvesting practices and did little to prevent severe fires. Photo: Courtesy of National Agricultural Library, Special Collections, Forest Service Photograph Collection, Beltsville, MD (Crozer, 1966; 515477).

> Government foresters did not realize that, without fire as a thinning agent, too many small trees would spring up and create problems.

ate, especially shade-tolerant species such as firs. Foresters counted on timber management as a benign replacement for historical fires. However, selective harvesting could not control the increase in small trees, which eventually developed into understory layers and thickets of ladder fuels susceptible to crown fire.

After World War II, large clearcuts were seen as the answer to fuel management problems. After a few decades, however, clearcuts gave rise to dense stands of small trees with branches reaching to the ground, accompanied by aging tall shrubs that included many dead branches. These even-aged stands were more vulnerable to severe wildfires than many of the historical stands in the understory and mixed fire regimes, which formed mixtures of trees of many sizes kept relatively open by periodic fires.

Also, extensive clearcutting fueled public dissatisfaction with harvesting practices. By the year 2000, public opposition put the entire timber management program on national forest land in danger of being abandoned.

Alternative Approaches

An alternative approach to fuels management was beginning to develop. By the 1960s, foresters Harold Weaver of the USDI Bureau of Indian Affairs and Harold Biswell of the University of California at Berkeley were attracting support for their techniques of controlled burning in conjunction with selective harvesting to maintain open, multiaged stands in ponderosa pine forests (Biswell and others 1973).

At about the same time, several scientists in the emerging field of ecology concluded that attempts to eliminate fire on national forests, national parks, and other western wildlands were a grave mistake. A committee of prominent wildlife biologists recommended to the Secretary of the Interior that fire be reintroduced in the national parks (Leopold and others 1963). By the 1970s, "natural fire programs" were allowing some lightning fires to burn in western national parks and national forest wilderness areas (Kilgore and Briggs 1972; Pyne 1982).

Still, not until the 1990s did the Forest Service adopt ecosystem-based management on western forest lands (Salwasser and Pfister 1994). Ecosystem-based approaches, like those advanced by Weaver and Biswell, are designed to restore and maintain natural forest structure and biodiversity. Where appropriate, they incorporate the use of fire.

Fire and Fuels Management

In the late 1970s, Federal land management agencies changed their mission from fire control to a broader program called "fire management." Fire management includes reducing forest fuels, using prescribed fire, allowing some lightning fires to burn, and conducting limited suppression on some wildfires while fully suppressing others (Kilgore 1976; Nelson 1979).

However, Federal agencies have had difficulty replacing the "war on wildfire" with fire management. Public sentiment and modern environmental regulations are more aligned with forestry's traditional credo that fire is bad, unnecessary, and subject to elimination. Although agencies have made great strides in developing and implementing prescribed burning techniques, the scale of burning and fuel treatments is only a tiny fraction of what is needed in most forest types to maintain historical ecological conditions or to reduce excessive fuels.

Prescribed fire and fuels management are funded at much lower levels than suppression. Over the decades, professional and institutional rewards and incentives have been linked to fire suppression. Policy revisions to integrate preventive fuels management and prescribed fire into fire management did not include changes in rewards and incentives (Czech 1996; GAO 1999; Mutch 2001). Those who suppress fires are regarded as heros, whereas those who conduct prescribed burns might be perceived as doing harm by creating smoke, scorching green trees, and risking an escaped burn.

Challenges Ahead

The next few years offer us a chance to finally adapt to living with fire-dependent forests and to shape fire to suit our needs. The Federal Government has supported a great expansion of fuels management and fire use in western forests, while at the same time markedly increasing suppression efforts. It will be

Prescribed fire, Lewis and Clark National Forest, MT. In recent years, the Federal Government has supported a great expansion of fuels management and fire use in western forests. However, much more will be needed. Photo: Jill Bauermeister, USDA Forest Service, 1990.

challenging, and require considerable public support, to achieve fire management goals. In contrast, it will be easy to escalate suppression efforts, even though the corresponding increases in spending might be largely ineffective.

Forest managers have lost credibility with many members of the public. Often, the public is concerned about preserving the forest but does not understand the forest's dependence on historical fires that cannot be recreated or even simulated without proactive management. Some people object to any commercial use of trees on public lands without recognizing the compelling reasons for making use of the enormous quantity of small and medium-sized trees that need to be removed. Many people believe that it is unnecessary to remove any of the trees killed in wildfires, despite the eventual danger of severe double burns (Arno 2000; Brown and others 2001).

One way to win support has been by conducting well-managed fuel reduction projects in forests near residential areas. Another has been to lead field trips to areas recently burned by wildfires, including those previously treated for fuels. The forestry profession is taking its lumps for having charged ahead with management that was not well suited to the needs of naturally fire-prone forests. Now we need to earnestly and patiently develop and demonstrate more suitable management practices.

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Firestop II

Stephen J. Pyne

The hot wars had ended, the Cold War had calmed, and the United States had a decade's worth of accumulated experience in large-scale organization and applied science, and—not least—a mountainous surplus of military hardware. The time seemed right for a grand exercise to transfer those varied stockpiles from the military to fire protection. The outcome was a 1-year crash program in 1954 called Operation Firestop.

A decade of big fire years, the morphing complexity of fire management, and quantum advances in electronics, materials science, and communications all argue for another study.

Grand Exercise

Staged in California, Firestop assembled the major fire agencies operating in that state, among them the Forest Service, California Department of Forestry, Los Angeles County Fire Department, Office of Civil Defense, and Department of Defense, which also made Camp Pendleton available as a site for field trials. The program tried everything, from chemical retardants, to helicopters and airtankers, to conversions of jeeps, to experiments in fire behavior. The immediate consequences were few, but the fallout, over the next decade, was considerable. The project sparked what is widely regarded as a golden age of equipment development. Nothing like it has happened since.

Which is why the time has arrived to restage it. In some respects, the technology of fire management and the tactics of fighting and lighting fires have not significantly evolved since the afterglow of Firestop. A firefight today looks much like one 50 years ago. Crews function in much the same way, though outfitted with niftier clothing and smaller radios. Aircraft fly similar missions—sometimes it's the same aircraft. Engines lay hose in the same ways to the same ends. Of course, some aspects have changed: the need for housing protection, for example. But in general, newer technology simply adds to the mix, like giving firefighters fire shelters. It doesn't replace staffing or fundamentally alter tactics.

Time for Another Study?

It may be that this is just how fire management must work. Or maybe not. But it would be worthwhile to sponsor a wholesale, across-the-board experiment in modernizing fire equipment and tactics, and in particular trying new ways to integrate high-technology with on-the-ground operations. Put it all up for examination—not policy, of which we have gobs, but practice. What is the best kind of crew for different jobs? How can information technology simplify tasks, improve crew performance and safety, reduce costs? What mix of aircraft best suits contemporary fire management? What sorts of prescribed burning belong with what lands, and how might modern technology make it both more specific and more broadly applicable? What kind of military equipment and tactics might transfer? Some of this goes on, of course, but in a hand-to-mouth sort of way. A decade of big fire years, the morphing complexity of fire management, and quantum advances in electronics, materials science, and communications all argue for a more resolute and systematic study.

I propose a 2-year program. Stage it from 2004 to 2005, which would coincide with the 50th anniversary of Firestop and the 100th anniversary of the Forest Service. The immediate results would, in all likelihood, be marginally impressive. The benevolent fallout could linger for decades. ■

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Fire and Invasive Plants in California Ecosystems*

Jon E. Keeley

In parts of California and adjacent regions with a Mediterranean climate, nonnative invasive plants are largely concentrated in valleys and foothills. Fire has historically been important in many of these ecosystems. However, human-caused disruptions of natural fire regimes have contributed to widespread invasion by nonnative species.

Throughout the Coast Ranges and the foothills of the Sierra Nevada and Cascades, high-frequency fire has helped to convert shrublands and closed woodlands into annual grasslands dominated by grasses and forbs that originated in the Mediterranean Basin. Returning these landscapes to their former closed-canopy condition is the only way likely to reduce the presence of nonnatives.

In many parts of California, human-caused disruptions of natural fire regimes have contributed to widespread invasion by nonnative species.

Chaparral Conversion

California's chaparral communities are highly fire adapted. For good regeneration, they require stand-replacing fires at intervals of two decades or more. It might seem counterintuitive that fire would make fire-prone chaparral more susceptible to invasion by nonnative species. However, plants evolve in association not with fire per se, but with a particular fire regime. When the natural fire regime is altered, even highly fire-adapted plant communities can become vulnerable to competition from nonnatives.

Herbaceous growth forms, annuals in particular, are more resilient to higher fire frequencies than woody growth forms. Invasives make few inroads where chaparral communities remain intact, because they cannot establish under the closed canopies. However, as fire frequency increases, the canopy thins and more sites become available for colonization by nonnatives. Nonnative plants in turn increase the flammability of surface fuels, thereby promoting more frequent, lower intensity fires. The altered fire regime ultimately decimates native shrubs, converting chaparral to grassland dominated by nonnative annuals. Conversion is accelerated if fire is combined with grazing.

Urban and suburban development in California has promoted the spread of invasives by introducing many more ignitions and thereby altering local fire regimes. Prescribed burning on sites with higher-than-natural fire frequencies can also favor the spread of nonnative invasives.

Grassland Invasion

Valleys and other sites with relatively deep clay soils, formerly dominated by native perennial grasses, have been converted to nonnative annual grasslands through intensive grazing and plowing. Today, grasslands cover about 8.4 million acres (3.4 million ha) in California, about 99 percent of which are dominated by nonnative annual grasses and forbs.

In California, fires normally occur in summer and fall, when both annuals and perennials are dormant. Annual seeds and perennial basal buds typically survive the fires to regenerate the following spring. However, fires in spring destroy seed crops, favoring the perennials, which can resprout from basal buds. Spring burning can therefore shift the balance from annual exotic grasses to native cover, but only on sites where perennial bunchgrasses are present.

Remaining sites with native bunchgrasses are rare in California. On the vast majority of grasslands, burning prescriptions might alter species composition but will not

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* Based on Jon E. Keeley, "Fire and Invasive Plants in Mediterranean-Climate Ecosystems of California," in Galley, K.E.M.; Wilson, T.P., eds., *Proceedings of the Invasive Species Workshop: The Role of Fire in the Control and Spread of Invasive Species* (Fire Conference 2000: The First National Congress on Fire Ecology, Prevention, and Management; 2000 November 27–December 1; San Diego, CA), Misc. Pub. No. 11, Tallahassee, FL: Tall Timbers Research Station: 81–94.

suffice to eliminate exotics. Moreover, spring burning might not be appropriate for community restoration because it also inhibits native annual plants.

Pre- and Postfire Treatments

Fuel manipulation can contribute to invasion by exotic plants. For example, fuel breaks can act as invasive highways, carrying exotic species into uninfested wildlands. Normally destroyed by stand-replacing fires, exotic seed banks can survive the lower fire severities in fuel breaks, resulting in source populations poised to invade adjacent burned sites.

Postfire rehabilitation programs often include seeding of exotic species for erosion control. In the past, seeding has contributed to the spread of noxious weeds such as black mustard and short-pod mustard. Postfire seeding continues to spread exotics such as Italian ryegrass and Zorro fescue, which readily colonize some native habitats. In shrubland, postfire seeding of exotic grasses can contribute to the acceleration of the fire return interval, decimating native shrubs.

Management Implications

Prescribed fire and other treatments to protect and restore ecosystems can have unforeseen adverse consequences. Land managers should keep the following in mind:

- Many grasslands are dominated by annuals due to historical changes in fire regime that have degraded native shrublands. On such sites, the only way to reduce exotic species is to restore closed-canopy shrublands. The first step is to reduce the incidence of human-caused fire.
- Prescribed burning can be effective in controlling noxious weeds. However, it is unlikely to diminish dominance by exotic species unless accompanied by revegetation with native species.
- Management activities can promote the invasion of exotic species. For example:
  – if the frequency of prescribed burning exceeds the natural fire frequency, natives are readily displaced by nonnative weeds;
  – postfire seeding can promote the spread of exotic species and alter historical fire regimes; and
  – fuel manipulations such as fuel breaks can create favorable conditions for nonnative weeds, increasing their movement into wildlands and building seed sources capable of invading after fire. Associating fuel breaks with roadways would reduce the risk.

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When the natural fire regime is altered, even highly fire-adapted plant communities can become vulnerable to competition from nonnatives.

Burned knobcone pine plantation invaded by grasses in southern California. Frequent fires in the region's Mediterranean climate can promote the spread of exotic plants, which dominate 99 percent of California's grasslands. Photo: USDA Forest Service.

A Burning Issue: American Indian Fire Use on the Mt. Rainier Forest Reserve

Cheryl A. Mack

Whether and how American Indians burned the land has long been a topic of discussion. On the Mt. Rainier Forest Reserve, precursor to the Gifford Pinchot National Forest in southwestern Washington, several sources describe how American Indians used fire as a tool to manage huckleberry patches (French 1957; Mowry 1854; Plummer 1900). Huckleberries are an early-seral species that grows best in areas that have been recently burned.

American Indians today claim that their ancestors purposefully set fires under very specific conditions in order to manage huckleberries.

Early Records

Some of the earliest descriptions come from the 1853 journals and reports of a Pacific Railroad Survey party under the leadership of Capt. George B. McClellan.* An officer in the U.S. Army Corps of Engineers, McClellan was under orders to explore the Northern Cascades for a suitable railroad route. His expedition's records attest to the extent of fire in the area, the role local Indians played in these fires, and the relationship between fire and huckleberries.

Expedition members frequently referred to fire, with statements such as, "Most of the way led through a burnt forest" (Cooper 1853) or, "These mountains have been burned over, so their appearance is bald and barren" (Duncan 1854). The expedition followed a well-established American Indian trail across the Cascades. The party's meteorologist, Lt. Sylvester Mowry (1854), wrote, "On leaving the low prairie lands back of Vancouver [an outpost across the Columbia River from present-day Portland, OR], and gradually penetrating the range of mountains, the atmosphere, clear below, became smoky. This appearance continued throughout the country in the vicinity of the mountains. It is believed to be caused chiefly by the immense fires which, from time to time, are kindled in the forests by the Indians, and which lay waste large sections of the country."

Mowry's use of the term "lay waste" is amusing, because most references to fire in the expedition's journals are immediately followed by descriptions of abundant berries. The party's naturalist, Dr. J.G. Cooper (1853), wrote, "The hill was covered with a species of

Sawtooth huckleberry fields on the Gifford Pinchot National Forest, showing tree encroachment. Photo: Jim Bull, USDA Forest Service, Gifford Pinchot National Forest, 1992.

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* McClellan went on to high command during the Civil War, leading the Army of the Potomac against Confederate forces during the Peninsula Campaign and Battle of Antietam in 1862.

Of the 32 fires reported in 1904 and 1905, 16 were said to have been caused by American Indians.

Vaccinium, the fruit nearly so finely flavored as a grape, and the ground in many places carpeted by strawberry vines with ripe fruit of delicious flavor." Lt. Johnson Duncan (1854), the party's draftsman, wrote, "These mountains … are remarkable for the quantity of berries growing on them. Strawberries and four varieties of whortleberries were noted. Berries are generally found on any tract of country visited by fire, but they are mostly found in the mountains, and seem to flourish best near the summit."

Oral Tradition

American Indians today claim that their ancestors purposefully set fires under very specific conditions in order to manage the huckleberry resource over time and space. However, Indian land-burning practices were generally curtailed by the Forest Service in the early 1900s. Most of the related information dates back several generations, passed down by word of mouth. In most cases, the oral tradition is quite general; the specific conditions under which American Indians burned the land are usually no longer known.

For example, Mary Kiona (1953), a Taidnapam woman born in 1868 in the northern part of what is now the Gifford Pinchot National Forest, provided this description: "[T]hey used to burn, and then after a while the Indians would grow berries, blackberries, and in higher places, huckleberries … every now and then they would burn such a small area in there so that the huckleberries would grow."

Yakama woman picking huckleberries in the Sawtooth huckleberry fields, on what is now the Gifford Pinchot National Forest. Photo: K.D. Swan, USDA Forest Service, 1933.

Finding supporting evidence for intentional burning is difficult. In many instances, particularly in Forest Service fire reports from the 1910s, fires were often attributed to carelessness by American Indians. Forest Supervisor H.O. Stabler (1910) wrote, "A great many Indians camp in and around Twin Buttes during July and August, and these camps need constant looking after because fires frequently owe their origin to logs used … in drying huckleberries." Forest Assistant Arthur Wilcox (1911) wrote, "In the high, open country around the summit of the Cascades the most prolific cause of fire is the method the Indians use in drying huckleberries by means of a burning log." Fire is and always has been a strategic part of forest ecosystems, and Indians would undoubtedly have taken advantage of the resources made available through natural forest fires.

In the early 1970s, a study on huckleberry productivity was conducted on the Gifford Pinchot National Forest (Minore 1972; Minore and others 1979). The researchers concluded that maintaining huckleberry patches through burning was exceedingly difficult at high elevations, because there is usually not enough fuel to carry a fire. The study has influenced both managers' and researchers' perceptions regarding the utility of fire for maintaining huckleberry patches.

Report of Fires

The National Archives and Records Administration in Washington, DC, has monthly and annual reports submitted by forest reserves, including a set of reports under the title “Report of Fires in the Mt. Rainier Forest Reserve” (Allen 1904a, 1905). Two of these reports describe fires on the Mt. Rainier Forest Reserve in 1904 and 1905. Though established in 1897, the 2-million-acre (800,000-ha) reserve did not employ a single ranger on its southern half until 1902. The year 1904 was the first year that a ranger was assigned to the White Salmon River drainage, which occupies the southeastern portion of the reserve. The years 1904 and 1905 probably represent the very beginnings of custodial management on this portion of the reserve.

The fire reports contain a number of categories, including fire location, size, and date, and the name of the person who reported the fire. There is also a category for fire cause. Figure 1 shows part of the monthly report for September 1904.

Of the 32 fires in 1904 and 1905, 16 were reported to have been caused by American Indians. All 16 of these fires were in the southeastern portion of the reserve, an area known from ethnohistorical sources to have been used for huckleberry collection. The 16 fires occurred between August 4 and September 22 (mostly in mid-September).

Nine of the 16 fires were less than 1 acre (0.4 ha) in size, and four were from 1 to 10 acres (0.4–4 ha). The remaining three were, respectively, 80 acres (32 ha), 600 acres (240 ha), and 5,760 acres (2,310 ha) in size. Six of the fires were extinguished by rain, and 10 were extinguished by forest rangers, often on the same day they started.*

** For one of the nine small fires and for one of the six fires extinguished by rain, the information is missing in the original report but seems clear in context.*

What we see here is a pattern of repeated fires set in areas where the tree cover is very light, either within or adjacent to existing larger burns.

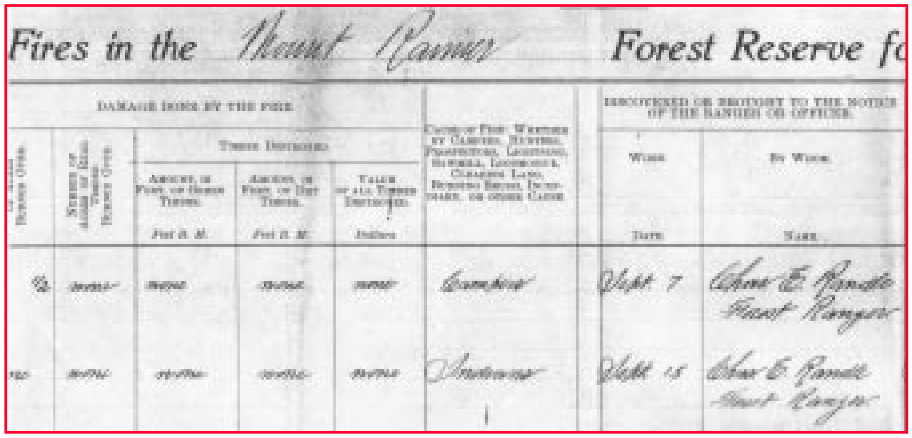

Figure 1—*Excerpt from “Report of Fires in the Mt. Rainier Forest Reserve” for September 1904, showing categories of information such as amount of “green timber” and “dry timber” burned and cause of fire.*

In the cover letter accompanying the 1904 fire report, Forest Supervisor G.F. Allen (1904b) discussed the two largest fires. “This [600-acre] fire and the large [5,760-acre] fire, south and west of the Mummy and Steamboat Mountain were set out by Indians from the Columbia river. They were probably actuated by a variety of motives. It is their practice to drive the game to the meadows and lakes by fire. The burning of the brush makes the country more open and accessible to horses. … It is the custom of the Indians to go into the mountains every summer, in great numbers. The women pick berries and the men hunt, gamble, run horses …”

Allen does not specifically attribute the fires to maintenance of huckleberry patches. But that is probably due to his lack of familiarity with or even consideration of huckleberry ecology. Huckleberries were simply not a major concern of forest rangers at that time.

Burn Patterns

Do the 16 fires tell us anything about traditional Indian land management practices? For the small fires, their location is intriguing, particularly when placed on an 1899 map, which classifies the reserve by categories of timber volume (fig. 2). Most of these fires occurred in areas that were either very lightly timbered or already classified as “burns.” They cluster in the same general area and occur in the same area in consecutive years.

For the larger fires, the report provides additional information on the type and amount of timber burned. The categories “real timber,” “dry timber,” and “green timber” probably equate to mature, dead, and immature timber. An 8-acre (3.2-ha) fire in 1905 burned 48,000 board feet (260 m^3) of “dry timber” in an area classified as a burn. The 80-acre (32-ha) fire in 1905 burned 900,000 board feet (4,900 m^3) of “green timber” on 60 acres (24 ha), with the unstated

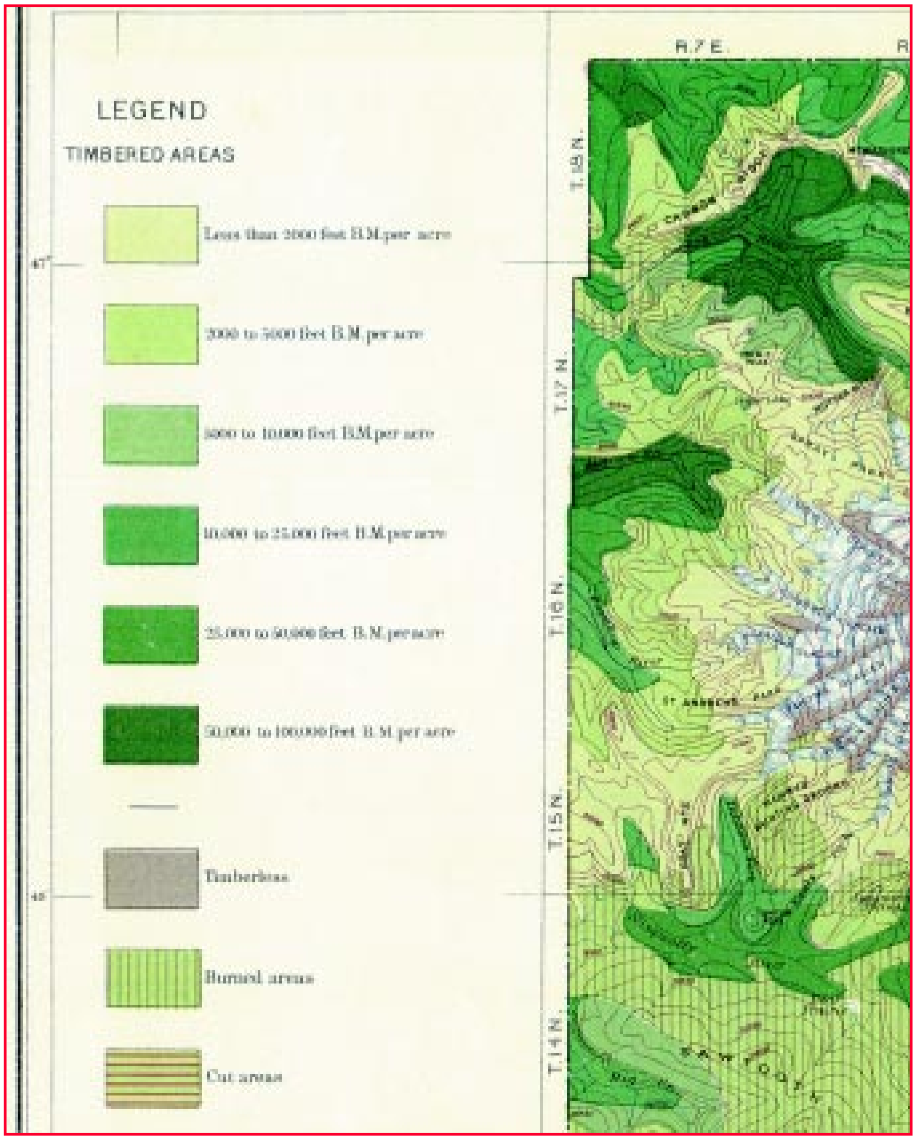

Figure 2—*Part of Fred Plummer's 1899 map classifying the Mt. Rainier Forest Reserve by relative timber volume and burned areas.*

assumption that 20 acres (8 ha) had no trees. That amounts to 15,000 board feet burned per acre (33 m^3/ha), a very light volume, indicating that the trees were immature. Average timber volume in mature forests in this area ranges from 35,000 to 50,000 board feet per acre (77 m^3/ha–110 m^3/ha).

The 600-acre (240-ha) fire in 1904, which burned north of Mt. Adams, reportedly destroyed 350,000 board feet (1,910 m^3) of "green timber." As stated in the report, "the amount of timber burned is comparatively light"—less than 600 board feet per acre (1.3 m^3/ha). The entire area is shown as a burn on the 1899 map; it is known ethnohistorically to have been used for huckleberry collection. Allen (1904b) also reported that the ranger who was trying to estimate the extent of the fire had to turn back, because deep snows in October prevented access.

The largest fire, which burned 5,760 acres (2,310 ha) in 1904 in the Indian Heaven area, reportedly damaged no "real timber" but did burn 100,000 board feet (540 m^3) of "green timber," or less than 20 board feet per acre (0.04 m^3/ha). The area burned was located entirely within what were considered berry fields at that time (fig. 3).

A 1909 silvicultural report describes the area (Wilcox 1909): "Fires set by Indians have been frequent on the western edge of this tract in years past. There is a large area west of Dead Horse Meadows and north of Lemei Rock, that has been burned over repeatedly until there are no seed trees left. … No other burns are known, at present, in this type."

Fred Plummer, the geographer who prepared the 1899 map of the reserve, commented specifically on the same area in his accompanying report (Plummer 1900): "The recent burns near Steamboat Mountain and over scattered patches to the southward have occurred periodically during the past twenty years, the last and most extensive fire being in 1897." This suggests a well-established pattern of repeated burning. From the American Indian point of view, the large fire of 1904 most likely represented a successful reburn within the older, larger burn of 1897, removing mostly conifer seedlings.

Maintenance Fires

What we see here is a pattern of repeated fires set in areas where the tree cover is very light, either within or adjacent to existing larger burns. They were set at a time of year when either rain or snow could be counted on to extinguish them within a month's time. They could certainly be described as maintenance fires.

Their time was ending. By 1907, only 1 of the 22 fires reported by Allen (1907) was described as incendiary. By that time, the ranger presence on the forest was much

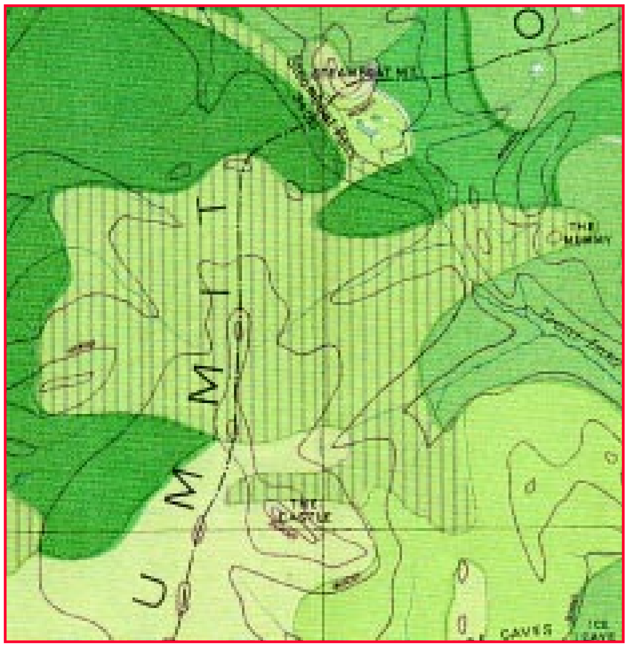

Figure 3—*Large burn (hatched area) shown on the 1899 map of Mt. Rainier Forest Reserve, "south and west of the Mummy and Steamboat Mountain," where a 5,760-acre (2,310-ha) fire occurred in 1904. In the early 1900s, this was one of the most productive huckleberry fields in the Pacific Northwest. Today's Sawtooth huckleberry fields are the last remnant.*

stronger. A few years later, H.O. Stabler (1911) could report, "During the last two summers and particularly … last summer, the Indians have been rather overawed by the number of Forest Officers and other Service employees that have appeared among them at any and all times."

Mary Kiona (1953) succinctly summarized the decline of traditional land-burning practices in her testimony before the Indian Claims Commission: "And until some time ago when the white man came, why, they couldn't make any more of them berry patches by starting fires on account of … forest fire hazard and stuff like that. So since then the huckleberry patches have disappeared almost completely from the Cowlitz land today."

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Safety Alert for Wildland Firefighters: Fuel Conditions in Spruce-Beetle-Killed Forests of Alaska[*]

Martin E. Alexander and Joseph C. Stam

The fire environment on Kenai Peninsula and in south-central Alaska has experienced significant changes due to the recent spruce beetle epidemic (Fastabend 2002). Firefighters and fire researchers do not have enough experience with wildland fires that occur in the dead-spruce/cured-grass fuel complexes to appraise potential fire behavior in these fuel types accurately. All firefighters, despite their general experience level, should use caution when approaching fire incidents in beetle-killed areas.

Look Up, Look Down, Look Around—and Look Out!

The Fireline Safety Reference (NWCG 1993) lists "bug kill" as a fuel component indicator of potentially erratic fire behavior. When evaluating and suppressing a wildland fire in spruce-beetle-killed forests in Alaska, the LCES (lookouts, communications, escape routes, safety zones) checklist (Gleason 1991) must address the factors shown below. The factors are based on fuel and stand sampling in spruce-beetle-killed stands, observations of recent wildland fires in similar fuel situations, experimental fires in other, similar insect-affected fuel types (Stocks 1987), and accepted fire behavior principles.

- Spruce beetle-killed forests are usually more flammable than live spruce forests. Therefore, they exhibit characteristics associated with extreme, difficult-to-predict fire behavior.
- The increase in grass fuels following a spruce beetle outbreak will predispose the dead and dying forests to fires that rapidly spread in the spring before greenup. Spread rates and fire intensities are usually greater in beetle-killed areas than in healthy spruce stands.
- Candling, torching, and crown fires are common in spruce-beetle-killed areas, even under seemingly mild burning conditions.
- Prolific fire spotting and the potential for "mass fire" or area ignition are usual in spruce-beetle-killed areas.
- Dead trees that have blown or fallen down in beetle-killed areas will impede fireline construction and hinder escape to safety zones. The combination of dead grass and large quantities of dead and down timber will severely limit fire shelter deployment opportunities.
- Falling snags can be expected in spruce-beetle-killed areas during strong winds and along the fire perimeter after passage of an active flame front.

Spruce-beetle-killed forest, Kenai Peninsula, AK, illustrating the dead-tree and cured-grass components of these fuel complexes. Photo: W. Wahrenbrock, Alaska Department of Natural Resources, Division of Forestry, Soldotna, AK, 1998.

Heavy accumulations of dead and down woody surface fuels associated with a Sitka spruce stand killed by the spruce beetle, Kenai Peninsula, AK. Note the individual (W. Wahrenbrock) in the background. Photo: W. Oja, USDA Forest Service, Chugach National Forest, Steward Ranger District, Steward, AK, 2002.

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* This article is based on a wildland fire safety message originally posted on the Alaska Fire Service Website at <http://fire.ak.blm.gov> in May 2001.

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Injuries and Fatalities During Nighttime Firefighting Operations*

Dan Thorpe

Should agencies be aggressively fighting fire at night, or is this practice too risky? Are we missing important nighttime hours to control fire, or are we compromising safety every time a team of firefighters packs into a fire scene after sunset? These questions have fueled a decade-long debate in the wildland firefighting community.

Some people think that any nighttime firefighting operation presents an unacceptable safety risk, whereas others believe that each situation is to be individually evaluated.

Data were needed to analyze and answer these questions, and I was just the person to search and, hopefully, resolve the conflicting viewpoints. I understood that a direct comparison between nighttime and daytime accidents would be statistically insignificant because the exposure hours would likely be substantially different. However, I believed that the data trends would be significant, and I hoped that they would provide the needed evidence to determine the safest course for future wildland nighttime firefighting operations (Wagner 1997).

What I Did

Surprisingly little information exists about the time of day that firefighting accidents and fatalities occur. Some agencies record the time of the injury on the accident report but do not include it in the database; other data sets record the time reported rather than the time of the incident. After conducting a thorough literature search, I found only one publication that reported fatality times (Karter 1998). Unfortunately, the study also analyzed all types of fireground deaths, not just fatalities directly related to wildland fire.

I examined fatality investigation reports, accident and injury listings, and entrapment reports about wildland firefighting in the United States to determine the type of fire-related fatalities and injuries that have historically occurred during nighttime firefighting operations. By reading the reports, I was able to determine the shift on which many incidents occurred. I also researched information about nighttime atmospheric conditions to determine the likelihood of nighttime blowup conditions, which relate to entrapment.

Specifically, I examined:

- *Historical Wildland Firefighter Fatalities 1910–1996* (NWCG 1997);
- Unpublished data from 1997 and 1998 collected by the National Wildfire Coordinating Group (NWCG 1998);
- Data from 1975 through 1999 about incidents involving both Government and nongovernment employees, collected by the USDI Bureau of Land Management (BLM) through its Safety Management Information System (BLM 1999);

Firefighters taking a break after containing the 500-acre (200-ha) East Nevada Lightning Fire near Ashland, OR. Photo: Oregon Department of Forestry, Southwest Oregon District, Medford Unit, Medford, OR, 1994.

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* Based on a November 1999 report by the author under the title, "Injury Analysis during Nighttime Operations in Wildland Firefighting." For the full report, see the Website of the Oregon Department of Forestry at <http://159.121.125.11/swo/>.

- Unpublished data from 1996 through 1998 collected by the California Department of Forestry and Fire Protection (CDF), the largest State fire protection organization (CDF 1998); and
- Data for the years 1975 through 1999 collected by the Oregon Department of Forestry (ODF), the third largest State forestry organization (SAIF Corporation 1999).

I also reviewed historical entrapment situations (MTDC 1999), which generally involved incidents since 1980, although five incident reports concerned events between 1956 and 1979. I analyzed a data set on entrapments from the Missoula Technology and Development Center (MTDC) by reviewing the MTDC library of reported entrapments. Additionally, I interviewed two fire weather forecasters (Saltenberger 1999; Werth 1999) to determine the likelihood of a high Haines Index at night. The Haines Index indicates the potential for fire growth by measuring the stability and dryness of the air over a fire.

I did not consider several types of accidents and fatalities because they were beyond the scope of my study. I did not examine aircraft incidents, training incidents, vehicle accidents, and heart attacks because they are generally connected to specific problems unrelated to fireground operations at night, or else they are associated with specific prevention measures. For example, heart attacks can occur at any time of day, and aircraft incidents, vehicle accidents, and training accidents might not be related to the shift worked. Moreover, specific training and prevention measures target each corresponding area. Additionally, the organization of data sets recording these types of incidents often prevented a viable comparison.

What I Learned

Data from the NWCG (1997, 1998) show 383 different incidents totaling 723 fatalities. After removing aircraft accidents and training fatalities, and eliminating the incidents without information on time of occurrence, I found that 43 incidents resulting in 101 deaths occurred during daytime firefighting operations, whereas 8 incidents involving 13 fatalities occurred during nighttime operations (table 1).

Nighttime firefighting fatalities frequently occur in southern California, in association with unexpected topographic winds or with Santa Ana winds (dry, northeasterly winds that usually occur in late fall and winter when a high-pressure system forms in the Great Basin between the Sierra Nevada and Rocky Mountain ranges). However, no wind-related nighttime firefighting fatalities occurred in California after 1979, which suggests that fire managers and forecasters in southern California improved their understanding of and ability to predict wind occurrence.

Falling snags caused the same number of fatalities at night as during the day. Because there are fewer firefighters during nighttime activities, it is reasonable to assume

Table 1—*Incidents and fatalities by time of day and general cause, 1910–98, based on NWCG (1997, 1998).*

Cause	*Day*		*Night*	
	Incidents	***Fatalities***	***Incidents***	***Fatalities***
Burnovers	34	91	5	10
Snags	2	2	2	2
Vehicles	3	4	1	1
Miscellaneous[a]	4	4	0	0
Total	**43**	**101**	**8**	**13**

[a]Includes powerline, parachute, heat stress, etc.

that nighttime firefighting operations produce a higher incidence rate of fatalities caused by fallen snags.

I reviewed each of the 336 nighttime injuries recorded by the BLM (1999) individually. However, data organization prohibited comparison to similar daytime injuries. For instance, sometimes an incident was reported by the part of the body injured, whereas other times it was listed by the task that caused the injury.

Nighttime injures represented 19 percent of the total injuries during the period examined (1975–99). Many injuries, such as gastritis, ear infections, boils, and broken teeth, did not occur during classic fireline activities. Also, several categories of injuries, such as poison oak, tick bites, bronchitis, and fatigue, could not be attributed directly to any nighttime firefighting activity since the injuries were either chronic or the event might not have occurred at night but rather was discovered at night. Injuries that could be attributed to nighttime firefighting activity are categorized in table 2.

Data from the CDF (1998) show that approximately 1,500 claims were filed annually during a 3-year period (1996–98), including some for injuries that were not related to firefighting. Of that number, an annual average of 74 (5 percent) occurred during nighttime firefighting operations. After removing the injuries unrelated to nighttime firefighting, the remaining injuries are categorized in table 3.

Data from the ODF (SAIF Corporation 1999) showed that approximately 3,500 injuries occurred during a 25-year period (1975–99), including some that were not related to firefighting. Of that number, about 215 (6 percent) occurred during nighttime firefighting operations (table 4).

In all three data sets (tables 2–4), approximately one-fourth of the injuries were related to footing problems. Falling-snag and rolling-rock injuries were important in all three data sets because they can be life threatening. Smoke problems resulting in respiratory distress, carbon monoxide exposure, bronchitis, and pneumonia were likely

Table 2—*Nighttime injuries on incidents, 1975–99, based on BLM (1999).*

Injury	*Number*
Slips/falls resulting in bruises, fractures, back problems, etc.	80
Respiratory problems from smoke	39
Insect stings (bees, etc.)	23
Eye injuries from ash, sticks, dust, wood chips	20
Lacerations	13
Hit by rolling rocks and snags	6
Burns	6
Heat exhaustion/dehydration	3

Table 3—*Nighttime injuries, 1996–98, based on CDF (1998).*

Injury	*Number*
Slips/falls resulting in bruises, fractures, back problems, etc.	37
Respiratory problems from smoke	32
Insect stings (bees, etc.)	15
Eye injuries from ash, sticks, dust, wood chips	20
Lacerations	21
Burns	17
Struck by falling/flying object	4
Pushing/pulling/lifting	10

due to environmental conditions, such as air inversions and light winds.

I reviewed more than 100 MTDC entrapment reports (MTDC 1999). Of these, 63 burnover entrapments indicated the approximate time of occurrence. The 63 burnover entrapments affected 611 entrapped persons (table 5). Four burnover entrapments (6 percent) occurred at night, affecting 84 people (14 percent).

Atmospheric conditions, which frequently cause a firestorm or a plume-dominated fire, contributed to the number and severity of burnover entrapments. A Haines Index of 5 or 6, associated with the potential for large fire growth or extreme fire behavior, can occur at night if conditions close to the ground do not outweigh conditions influenced by the upper atmosphere (Saltenberger undated; Werth and Werth 1997). Although nighttime entrapments accounted for only four incidents, an average of 12 persons per incident were involved. None of the entrapments were in California, even though California has a relatively high number of fire-related fatalities.

Table 4—*Nighttime juries, 1975–99, based on ODF data (SAIF Corporation 1999).*

Injury	*Number*
Slips/trips/falls resulting in strains/sprains, etc..	57
Lacerations/abrasions/punctures	19
Poison oak/dermatitis	33
Respiratory problems from smoke, etc.	10
Struck by falling/rolling objects	12
Bee stings/animal bites	10
Vehicle accidents	9
Fatigue/heat problems	5
Burns	4
Undetermined or nonfireline	47

Table 5—*Entrapments, 1956–99, based on MTDC (1999).*

Factor	*Day*	*Night*	*Total*
Burnovers	59 (94%)	4 (6%)	63
Persons involved	527 (86%)	84 (14%)	611

Future Opportunities

Although this study might be the most comprehensive analysis of nighttime injuries to date, further research is necessary to determine whether firefighting is more hazardous at night than during the day. However, my research established the following trends, which provide opportunities to improve the safety level for firefighters during nighttime wildland firefighting operations:

- Good scouting during the day, proper timing, and established escape routes can mitigate the potential for injury at night when indirect attack is followed by a nighttime burnout operation. When crews will be working at night in burned areas where standing timber remains, aggressive snag felling should first be done during the day.
- Fire behavior in brush and grass fuels is quickly influenced by a change in environmental conditions. Nevertheless, a change in fire behavior is readily apparent during direct attack, and alert crews can adjust rapidly. Because entrapments can occur at night, safety zones continue to be critical for firefighter survival, which should be stressed to night crews.
- We can assume that footing injuries on uneven ground increase as daylight wanes. Fire managers should strive to use experienced crews, locate them during the daylight, and emphasize footing hazards during safety briefings. Because reliable mitiga-

tion measures might be impossible, each objective must be evaluated based on the hazards of the particular topography. CDF's use of the 24-hour shift might have merit in addressing this safety challenge (Terwilliger and Waggoner 1999).

- Sharkey (1997) makes recommendations concerning smoke inhalation that are valid at night. Fire managers should adjust operational periods, move personnel, find adequate fire camp locations, give notice in safety briefings, and monitor equipment.
- Agencies should make it mandatory to wear eye protection, at least at night.
- The Haines Index should be an important component of fire behavior forecasts at night as well as during the day.
- Accident investigations and statistical data, including the NWCG's Wildland Fire Fatality and Entrapment Initial Report (NFES 0869, available at <http://www.nwcg.gov/pms/forms_otr/forms_otr.htm>) should include the time of the incident for all accidents and injuries. Supervisors should carefully review the report to verify that the time of the incident, not the time that the incident was reported, is being recorded.
- Accident investigations should look beyond the circumstances and examine why particular decisions were made, objectives conceived, and timeframes established.

Despite the lack of data about nighttime firefighting injuries and fatalities, decisionmakers must establish policy and make operational judgments concerning nighttime firefighting.

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How Would a 24-hour Pay System Affect Suppression Costs?*

Krista M. Gebert, Ervin G. Schuster, and Hayley Hesseln

The severe 2000 and 2002 fire seasons highlighted the long-term disruption in historic fire cycles and the increased risk of severe wildland fires. Beyond rising concerns about the magnitude of the fire suppression costs, firefighter safety remains the priority during any fire event.

The current pay system is complex, costly to administer, and might provide monetary incentives, such as working excessively long shifts, for firefighters to engage in unsafe practices. The problem is extensive, given that the total number of people employed by the Forest Service for firefighting activities in, for example, fiscal year 2000 (FY00) was about 51,000 (USDA Forest Service 2001) in an organization with a permanent workforce of only about 28,000 (USDA Forest Service 2002).

Our study tested the hypothesis that a 24-hour pay system would help control the rising cost of fire suppression and improve firefighter safety. Under this system, emergency firefighting employees would receive their regular base pay 24 hours a day, regardless of the length of the shift worked. Sometimes called "portal-to-portal," this system is much simpler to administer and might improve safety by removing the incentive to work excessively long hours.

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Salaries and other compensation paid to employees on fire duty consume more than one-third of the staggering cost of fire suppression.

Compared to Current System

We examined Forest Service pay records for FY96, using a stratified, random sample of 527 fire-related personnel to determine the effect of a 24-hour pay system on (1) total personnel costs during fire suppression; and (2) different groups of employees in terms of pay grade (lower than GS-9 or GS-9 and higher), job type (administrative or operations), and fire type (type 1 or type 2). We considered the type of incident management team assigned to the fire as an indication of the fire's size and complexity. A type 1 incident management team has a larger staff and more types of positions than a type 2 team. We also examined how hazard pay and restricting the shift length would affect compensation.

We calculated pay as follows:

- ***24-hour Pay System.*** We calculated pay at an employee's regular pay rate from the time that they left their home unit until the time they returned to their home unit. Although a 24-hour pay system does not usually include hazard pay, we used hazard pay rates of 0, 5, 15, and 25 percent. Employees were not eligible for 24-hour pay if they:
  - Worked less than 12 hours on a fire;
  - Consistently worked less than 12-hour shifts;
  - Charged time to an unrelated funding code on the same day that time was charged to the fire; or
  - Continued to work at their home unit (for example, a dispatcher).
- ***Current Pay System.*** We calculated pay by multiplying the hours worked at the appropriate pay rate, which is regular pay, overtime (1.5 times regular pay), hazard pay (0.25 times regular pay), night differential (1.1 times regular pay), Sunday differential (1.25 times regular pay), Sunday night differential (1.1 times regular pay), and holiday (2 times regular pay). When more than one pay rate applied, the rates were totaled. Shift-length restrictions, using the same assumptions as mentioned below, were also imposed for the current pay system.
- ***Shift Length.*** Because the number of hours worked relates to safety, we restricted the shift lengths to 12, 14, or 16 hours. We assumed that:

– The amount of firefighting time needed to suppress a fire was constant, despite the shift length. By holding constant the amount of firefighting time needed but restricting the shift length, firefighters would not work as many hours per day, and more firefighters would be needed to achieve the same effort.
– Employees would work only the amount of the restricted shift length.
– No travel time was required for any of the additional personnel; calculations were made for only the middle days of the fire, excluding travel days and the associated pay uncertainties.

Higher Costs

A 24-hour pay system would increase personnel costs substantially (table 1). Even without shift length restrictions or hazard pay, total employee compensation would cost 13 percent more under the 24-hour pay system than under the current pay system. (It should be noted that compensation differences account for removal of the overtime cap in 2000—see the sidebar.) When hazard pay is included, compensation increases another 3 percent for every 5-percent increase in the hazard rate. When the shift lengths are shortened, compensation increases dramatically, by up to 44 percent.

Effects of Overtime Cap Removal

Compensation under the 24-hour pay system was compared to compensation under the current pay system, after accounting for removal of the overtime cap. In December 2000, Congress passed legislation removing the overtime cap that had existed up to that time (a maximum hourly overtime rate of GS-10, step 1). However, the increased pay rates have not been fully incorporated into the pay system, and fire suppression expenditures do not yet reflect the increase.

In an earlier phase of the study (Gebert and Schuster 2000), we estimated that removing the overtime cap would add approximately 7 percent to personnel compensation expenditures for fire suppression efforts. If, in addition to the overtime cap removal, a 24-hour pay system were adopted, total employee compensation expenditures would increase by 20 percent (13 percent due to the 24-hour pay system and 7 percent due to overtime cap removal), compared to the old system before overtime cap removal. The increase does not include hazard pay; if it did, the increase in total personnel compensation would be even higher.

Table 1—*Percentage change in total compensation, 24-hour pay system compared to current pay system, for employees working on large fires in FY96 by hazard pay rate and shift length restriction.*

Pay system	*Hazard pay*	*Shift length restriction*[a]			
		12-hour	*14-hour*	*16-hour*	*None*[b]
Current	25%	–3	–1	0	—
24-hour	0%	28	17	13	13
	5%	31	20	16	16
	15%	38	26	21	21
	25%	44	32	27	27

[a] Restricting the maximum allowable shift length to 12, 14, or 16 hours increased the number of person hours by 18.6%, 5.8%, and 0.7%, respectively.
[b] The differences between compensation using unrestricted shift length and the 16-hour shift length restriction were statistically insignificant ($\alpha = 0.05$).

> The current pay system is complex, costly, and might inadvertently provide monetary incentives for firefighters to engage in unsafe practices.

Although the average shift length for the sampled employees was 12 hours, many employees worked shifts in excess of 16 hours, which can adversely affect safety. Assuming that the time required to suppress the fire remains constant across workforces, with 16-hour shifts the size of the workforce increases by only 1 percent. This increase results in additional costs, relative to 24-hour pay with no shift length restriction, of only 0.5 percent. If we restrict shifts to 14 hours, 6 percent more firefighters are needed to do the same job, which increases the suppression costs an additional 4.5 percent. When shifts are restricted to 12 hours, the total workforce needed to do the same job is 19 percent higher, and costs increase an additional 16 percent.

Although compensation increases substantially when the shift lengths are restricted under the 24-hour pay system, this is not the case under the current pay system. Under a 24-hour pay system, employees are paid for 24 hours, whether they work 12 or 16 hours; therefore, adding additional employees increases costs. Conversely, if the shift length is restricted under the current pay system, existing employees lose overtime hours and earn less money. The hours worked by the additional employees would be at base wages or at a combination of base and overtime wages; either rate is less expensive than straight overtime. Safety is the priority, and it is accomplished less expensively under the current pay system than under a 24-hour pay system.

Differences in Pay

To determine how a 24-hour pay system would affect the compensation of different types of firefighting employees, we used the actual shift lengths worked for each sampled employee. Depending on the type of fire, job type, pay grade, and hazard pay rate, we found substantial differences in compensation under a 24-hour pay system (table 2). Compensation changes under a 24-hour pay system range from no change for high-grade administrative employees working on type 2 fires to increases of 36 percent for high-grade operations employees working on type 1 fires using a 25-percent hazard pay rate.

Hazard pay under a 24-hour pay system significantly affects compensation differences among groups. Without hazard pay, which is typical under a 24-hour pay system, operations personnel below a GS-9 level receive a smaller increase in compensation than any other group. In fact, more than half the employees receive less compensation under the 24-hour pay system.

Table 2—*Percentage change in employee compensation, 24-hour pay system compared to current pay system, for large fires in FY96 and unrestricted shift length, by hazard pay rate, fire type, job type, and grade level.*

Hazard pay rate	Type 1 fire[a]				Type 2 fire[a]			
	Administration		Operations		Administration		Operations	
	<GS-9	≥GS-9	<GS-9	≥GS-9	<GS-9	≥GS-9	<GS-9	≥GS-9
0%	11	13	1	9	12	0	4	6
5%	11	13	6	14	12	0	9	11
15%	11	13	16	25	12	0	18	21
25%	11	13	25	36	12	0	28	31

[a] Type 1 and type 2 fires are assigned a type 1 and a type 2 incident management team, respectively.

Conversely, only 5 percent of the administrative employees receive less compensation under the 24-hour pay system. However, operations personnel earn more than administrative personnel when a hazard pay rate of at least 15 percent is included. On average, these employees then receive an 8-percent larger increase under the 24-hour pay system than do administrative personnel. Overall, for each 10-percent increase in hazard pay, operations employees receive about a 5-percent pay increase.

Fire type is the next most influential factor. Despite job type, high-grade employees receive a larger percentage pay increase when working on type 1 fires than on type 2 fires. Conversely, employees below the GS-9 level receive a larger percentage pay increase when working on type 2 fires than when working on type 1 fires. Administrative employees, whatever their pay grade, receive a larger percentage pay increase when working on type 1 fires than when working on type 2 fires. Operations employees receive approximately the same percentage pay increase, whatever the fire type.

If firefighter safety is a primary consideration, restricting shift length under the current pay system would be less expensive than under a 24-hour pay system.

24-Hour Pay: Is It Worth It?

Adopting a 24-hour pay system would increase personnel costs during fire suppression efforts. Depending on whether hazard pay is included and the hazard pay rate, the cost increase ranges from 13 to 27 percent. Even if the 24-hour pay system eliminated all of the problems and costs associated with the current pay system, a cost increase averaging 20 percent negates any efficiency otherwise realized. Additionally, because firefighter safety is the primary consideration, restricting shift length under the current pay system would be less expensive than under a 24-hour pay system.

Restricting shift length under the 24-hour pay system would involve a higher cost to Government but no change in employee compensation.

Whether personnel receive 24 hours of pay for working 20 or 12 hours a day, their compensation is the same. However, if the shift length were restricted under the current pay system, employees would receive less compensation because they would work fewer overtime hours. Under the current pay system, changing the shift length would reduce the cost to Government as well as individual employee compensation.

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Improving Fire Hazard Assessment in South Lake Tahoe, CA*

Lisa de Jong

Because homeowners must be actively involved in fire hazard mitigation in the wildland/ urban interface (WUI), private landscaping practices are closely regulated in high-fire-hazard areas in California (California Public Resources Code [PRC] 4291). PRC 4291 limits plant choice, density, and placement; regulates property maintenance practices; and requires at least 30 feet (9 m) of defensible space around homes (Cohen 1995; Foote and others 1991; Tran and others 1992).

Although compliance with PRC 4291 might increase fire safety, the policy does not recognize individual landscaping preferences or the impact of neighboring parcels on a homeowner's fire hazard potential. Property owners may resist firesafe regulations if compliance means a decrease in what they value in their landscapes (Abt and others 1991; Bailey 1991; Cortner 1991; Foote and others 1991; Hodgson 1993; Manfredo and others 1990; Smith and Rebori 2001; Winter and Fried 2000).

This article describes a fire hazard analysis conducted on private, developed lots in South Lake Tahoe, CA. In this WUI community, many developed lots are noncompliant with PRC 4291, although active agency outreach and public support of fuels reduction on undeveloped lots exists (Garrett 2002; Harcourt 2002). Fire hazard was assessed by using the National Fire Protection Association's Standard for Protection of Life and Property from Wildfire (NFPA 299); determining compliance with PRC 4291; and observing construction materials, irrigation practices, and the condition of neighboring properties.

> People living in the wildland / urban interface have unique, individual values and preferences reflected in the landscapes they create and maintain around their homes.

Study Site

About 24,000 people live in South Lake Tahoe, which ranges in elevation from approximately 6,200 feet (1,900 m) to more than 7,000 feet (2,130 m). Historically, the Lake Tahoe Basin experienced low- and medium-intensity surface fires that occurred every 15 to 25 years. Rarely becoming stand-replacing events, these fires consumed mostly light surface fuels (Skinner and Chang 1996). Eighty-five years of fire suppression (Murphy and Knopp 2001), combined with prolonged drought and extensive tree mortality from insect infestations, have increased the area's highly flammable understory fuels. The average January temperature for the basin is slightly below 32 °F (0 °C) and the average July temperature is approximately 60 °F (16 °C). The average annual precipitation is 29 inches (74 cm). Average annual snowfall ranges from 8 feet (2.5 m) to almost 350 inches (9 m). At lake level, there are an average of 70 to 100 frost-free days annually.

Methods

Sample sites were chosen from approximately 6,500 single-family residential parcels. The 102 parcels sampled were classified by low, medium, and high canopy cover and by low, medium, and high residential density. The vegetation and structural characteristics of each parcel were documented, measured, and mapped to the nearest 0.3 foot (0.1 m).

We divided the city into six neighborhoods based on observed differences in vegetation, lot size, and building characteristics. We refined the initial classification through statistical analysis for homogeneity in the defined neighborhoods. Neighborhood boundaries include areas with homes within city limits and exclude areas without homes, such as parks and golf courses. Major roads define the boundaries

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between adjacent neighborhoods.

Neighborhood 1 is the Tahoe Keys, characterized by wide streets; canals; large, new homes; exotic vegetation; and turf grass. None of the parcels in this neighborhood have any significant slope. Neighborhoods 2 through 5 all have small homes on small parcels. Native conifer species and an assortment of exotic shrubs and other plants dominate the vegetation, although species composition and structure differ among neighborhoods. Some parcels are slightly sloped. Neighborhood 2 is called the "Y" because it includes a large area surrounding the Y-shaped junction of Highways 50 and 89. Neighborhood 3, North Central, is located in that part of the city. Neighborhood 4 is the Sierra tract, and neighborhood 5 contains the Bijou and Tahoe tracts. Native conifer species dominate neighborhood 6, the Heavenly Ski Resort tract, which contains large, new homes on large lots. Slopes in this neighborhood are significant.

We conducted a fire hazard analysis on each parcel and then qualitatively compared the results to the fire hazard of neighboring parcels. We based the assessment predominantly on NFPA 299, which assigns a score for risk factors; and compliance with PRC 4291, which requires homeowners to prune dead branches, clear needles and other litter from roofs and gutters, cover vents with wire mesh, and clear tree branches for 10 feet (3 m) around chimney outlets. We also rated characteristics that contribute to the structural ignition potential, such as a wood roof, decks, and single-paned windows (Foote and others 1991; Quarles 2001; Quarles 2002; White 2000). High scores reflect a high fire hazard.

The combination of small lot size and landscape preferences can impede individual and community fire hazard mitigation.

We analyzed defensible space alone, maintenance alone, and a combination of the two for PRC 4291 compliance. We designated parcels as "noncompliant" if they had little or no defensible space and did not comply with one or more of PRC 4291's maintenance requirements. We considered wood decks hazardous if they were more than 1.5 feet (0.5 m) high and were either open or had flammable material stored underneath.

We classified parcels as small and under the direct influence of fire hazard from immediate neighbors if the distance between the house and the side boundaries of the parcel was less than 23 feet (7 m), if the difference between the total width of the parcel and the total width of the house was less than 45 feet (14 m), or if the difference between the total length of the parcel and the total length of the house was less than 45 feet (14 m). We considered large parcels independently of neighboring parcels.

We adjusted the fire hazard ratings for individual small parcels to include the fire hazard from the neighboring parcels. We rated small parcels with good defensible space and "better" maintenance the same

Controlling the Ecological Impact of Development

Management agencies and consortiums were developed in the Lake Tahoe Basin to mitigate the negative ecological impacts of the basin's growing population. Among the most visible are:

- ***The Tahoe Regional Planning Agency*** (TRPA), a powerful regulatory organization whose primary objective is to develop land use and management standards that maximize environmental health and mitigate negative environmental impacts from development (Murphy and Knopp 2000). Since the early 1970s, TRPA has prohibited development on environmentally sensitive parcels and has regulated private landowners' parcel management.
- ***The Forest Service's Lake Tahoe Basin Management Unit*** (LTBMU), which—alongside the California State Tahoe Conservancy—has compensated landowners for TRPA's restrictions on development by purchasing many private lots. The LTBMU also plays an active role in fuel management on the undeveloped urban lots owned by the Forest Service.
- ***Tahoe Re-Green***, an interagency consortium whose objective is to educate residents and help them reduce fire hazards by removing fuels on privately owned land.

for defensible space as medium or large parcels with moderate defensible space. Additionally, we rated small parcels with good defensible space and the "same" maintenance the same for defensible space as a medium or large parcel with good defensible space.

We assigned neighborhoods a mean fire hazard rating based on the fire hazards of the parcels sampled within the neighborhoods. Table 1 describes the point scoring system. The range of possible scores was 9 to 80 or greater, depending on the number of decks. Remember, high scores reflect a high fire hazard.

Results

Overall Fire Hazard Rating. The mean fire hazard rating was a relatively low 30, largely due to the city's wide, paved roads, the availability of water, and the presence of firefighting resources (table 2). Neighborhood 1 (Tahoe Keys) had the lowest fire hazard (24), whereas neighborhood 6 (Heavenly Ski Resort) had the highest (38). Neighborhoods 2 through 5 had mean ratings ranging from 28 to 30.

Lot Size. Mean lot size varies from 0.14 acres (0.06 ha) in the Sierra tract to 0.30 acres (0.12 ha) in Heavenly. The mean lot width is 72 feet (22 m). Lot sizes in the Sierra tract are smaller than those in any other neighborhood.

Compliance With PRC 4291. Most of the parcels have increased fire hazard ratings because they are partially or wholly noncompliant with PRC 4291. About 66 percent of the parcels are noncompliant with PRC 4291's requirements for maintenance and 75 percent have little or no defensible space. In total, 53 percent of the parcels are

Table 1—*Point scoring system for risk factors. Each parcel received a score depending on the degree of risk associated with each risk factor. The sum of the scores is a parcel's fire hazard rating. The higher the score, the higher the fire hazard.*

Risk factor	***Score***
Ingress/egress	1: two or more primary roads 3: one road, primary route 5: one way in/out
Primary road width	1: > 20 feet (6.1 m) 3: < 20 feet (6.1 m)
Accessibility	1: smooth road, < 5% grade 3: rough road, > 5% grade 5: other
Culdesacs	I: outside radius > 50 feet (15 m) 3: outside radius < 50 feet (15 m)
Turnarounds	3: dead end road is < 200 feet (60 m) 5: dead end road is > 200 feet (60 m)
Street signs	1: present (= 4 inches [10 cm] and reflect) 5: not present
Water	1: source < 20 minutes round trip 5: source 20–45 minutes round trip 10: source > 45 minutes round trip
Utilities	1: all underground 3: one above-, one underground 5: all aboveground
Maintenance	1: high 3: moderate 5: none
Defensible space	1: high (33+ feet [10+ m] treatment) 5: medium (10–23 feet [3–7 m] treatment) 10: no treatment
Roof materials	3: wood roof
Branches in chimney	2: branches within 6.6 feet [2 m] of chimney outlet
Irrigation	1: little or no irrigation
Vegetation	1: medium canopy cover 2: high canopy cover
Slope	1: 25–40% 2: > 40%
Wall materials	1: wood siding
Wall, eave, roof vents	2: some present without quarter-inch (6.35-mm) mesh cover
Predominant number of window panes	1: predominantly single-paned
Deck height	1: each deck with height > 1.6 feet (0.5 m)
Open space below deck	1: each deck with open space beneath
Storage of flammable materials under deck	1: each deck with storage of flammables beneath
Deck materials	1: each wooden deck
Parcel size	Adjustments made for small parcels
Relative maintenance	1: parcel is worse than neighbors 3: about the same 5: neighbors are worse than parcel

Table 2—*Fire hazard rating, noncompliance rates, and risk factors in South Lake Tahoe, CA, neighborhoods. Numbers (n) in parentheses below each neighborhood are the number of parcels sampled in that neighborhood. Mean fire hazard rating for each neighborhood is expressed as a number; all other values are percentages of the properties measured. "Total noncompliance" is noncompliance with both maintenance and defensible space codes.*

Risk factor	City total (n = 102)	Neighborhood					
		Tahoe Keys (n = 15)	Y (n = 22)	North Central (n = 13)	Sierra (n = 22)	Bijou/Tahoe (n = 21)	Heavenly (n = 9)
Mean fire hazard rating (standard deviation)	30 (6)	24 (5)	30 (4)	30 (6)	30 (6)	28 (5)	38 (7)
Maintenance noncompliance rate (%)	66	20	68	69	73	76	89
Indiv. defensible space noncompliance rate (%)	75	47	86	85	77	62	100
Indiv. total noncompliance rate (%)	53	7	59	62	64	48	89
Indiv. defensible space noncompliance rate, adj. for small parcels (%)	86	80	91	92	82	81	100
Indiv. total noncompliance rate, adj. for small parcels (%)	57	20	59	62	64	58	89
Irrigation (% of parcels with less than half irrigated)	52	13	45	69	59	58	78
Mean slope % (standard deviation)	2 (6)	0 (0)	0 (0)	0 (0)	1 (3)	0 (0)	15 (16)
Wood exterior (% of homes)	96	87	95	100	100	95	100
Wood roof (% of homes)	31	27	18	54	27	29	56
Single-paned windows (% of homes with more than half single-paned)	29	27	41	23	32	24	22
Deck hazard (% of homes)	67	60	68	77	73	48	89

noncompliant for both maintenance and defensible space. When considering the vegetation of neighboring parcels, 86 percent of the parcels are noncompliant for defensible space, whereas 57 percent are noncompliant for both maintenance and defensible space. Adjusting the defensible space rating to account for neighboring lots had the greatest effect on the defensible space compliance rates for the Tahoe Keys and Bijou/Tahoe tracts. Smaller changes were observed for the Y, North Central, and Sierra tracts, whereas there was no effect for the Heavenly tract.

Irrigation. More than half the parcels have irrigation on less than half the vegetation on the parcel. The vegetation in Tahoe Keys is well irrigated, whereas more than 75 percent of the parcels in Heavenly have little evidence of irrigation. Less than a third of the parcels in North Central are irrigated. Vegetation without irrigation in the other neighborhoods ranged from 45 percent to 59 percent.

Slope. Most of the parcels have little or no slope, except parcels in Heavenly, where the mean slope is 15 percent and the range is from 0 to 53 percent.

Wall Material. Ninety-six percent of the exterior walls in the homes sampled have shake, log, or wood siding. In Tahoe Keys, 13 percent of the homes are brick, stucco, or stone, but 95 to 100 percent of the homes in the remaining neighborhoods have wood exteriors.

Roof Material. Thirty-one percent of the homes sampled have wood roofs. Neighborhoods where more than half the homes have wood roofs are North Central (54 percent) and Heavenly (56 percent). The fewest number of wood roofs is in the Y, where only 18 percent of the sampled homes have wood roofs.

Window Panes. More than half the windows are single-paned in 29 percent of the homes sampled. The highest percentage of homes that have predominantly single-paned windows is in the Y (41 percent), while the lowest percentage is in Heavenly (22 percent).

Decks. Sixty-seven percent of the homes sampled have decks. Deck construction and placement is particularly problematic in Heavenly, where slopes are the greatest. In that neighborhood, the fire hazard of only one of the nine homes sampled was unaffected by a deck. In Bijou/Tahoe, only 48 percent of the homes have a deck, whereas 60 to 77 percent of the homes in the remaining neighborhoods have a deck.

Discussion

The results of this study show that standard fire hazard rating in South Lake Tahoe will not provide managers and planners with enough information to implement an effective fire hazard mitigation program. Although the city's firefighting infrastructure is well developed, individual homeowners in the community rarely consider fire safety when choosing construction materials, type of property maintenance and landscaping, and defensible space. Many compliant small lots are affected by the fire hazard on neighboring noncompliant lots. Therefore, fire hazard ratings should consider the fire hazard created by neighboring vegetation and houses in areas dominated by small lots.

When developing a fire hazard rating system, each component should support fire management decisions, including identifying high-priority areas for treatment, noncompliant areas, and reasons for noncompliance. Each of the six neighborhoods in South Lake Tahoe has a unique profile that contributes to fire hazard at the neighborhood scale. Neighborhood profiles can be used to direct and focus management and homeowner education efforts. The obvious differences between the Tahoe Keys and Heavenly tracts, for example, provide managers with a clear set of objectives; however, there are also important, less obvious differences between the other neighborhoods. Data should be used to guide management decisions, including fuels reduction programs and outreach and education efforts that focus on the particular needs of each neighborhood.

In addition to education efforts regarding defensible space and maintenance, residents should learn about other fire hazards. Homeowners should understand the benefits of irrigation in raising the moisture content of vegetation and the relationship among drought stress, insect infestation, and fire hazard. Most homes in the South Lake Tahoe area have double-paned windows for better insulation against winter weather, but many residents are unaware of the fire protection that double-paned windows offer. Hazardous decks are a chronic problem for homes in the Heavenly tract, where most decks hang over steep slopes covered with surface fuels. In Heavenly, with its small lots and many seasonal residents, education on the importance of neighborhood-scale cooperation is critical.

In South Lake Tahoe and similar communities, fire hazard assessment that does not take homeowner practices and lot size into consideration is likely to underestimate an individual parcel's fire hazard. Defensible space and compliance with PRC 4291 are the most important factors in structure survivability, but the city's low fire hazard rating obscures the fact that three-quarters of the parcels are noncompliant with defensible space codes and two-thirds are noncompliant with maintenance codes. Also, the fire hazard on small lots may be underestimated due to the influence of neighboring parcels.

A more appropriate approach to fire hazard assessment in South Lake Tahoe is to assess parcels for compliance, lot size, construction materials, and irrigation. Analysis of compliance rates and homeowner choices will help to prioritize areas, provide a more accurate estimate of individual fire hazard, and support decisions to conduct outreach and education efforts.

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South Lake Tahoe is at high fire risk due to the reluctance of homeowners to provide defensible space, maintain and irrigate their property, and use firesafe construction materials.

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Technology Transfer and Wildland Fire Management/Research

Martin E. Alexander

I would like to see fire scientists and fire managers work much closer together … I see too many examples of researchers and managers pulling against each other, rather than working together. I regard the scientists as our motivators for change while the managers are implementers of change. Successful change will not be achieved unless it is managed properly, this is, presented in a positive and cooperative climate so that it is rapidly incorporated into the daily business of ecosystem management and community protection.

–Underwood (1995)

In 2001, I participated in a survey commissioned by the Canadian Interagency Forest Fire Centre's Forest Fire Science and Technology Working Group (MacKendrick 2001). The survey dealt with how fire managers and fire researchers could more effectively work together in the future.

Wealth of Information

There is a wealth of general information on the interaction between management (operations) and research. I recall attending an excellent session on "Management vs. Research" during the Seventh Conference on Fire and Forest Meteorology, which was jointly sponsored by the American Meteorological Society and the Society of American Foresters on April 25–28, 1983, in Fort Collins, CO. Unfortunately, the 10 papers presented at that conference session were not published as part of the conference proceedings.

There are a couple of excellent older documents that specifically relate to wildland fire (e.g., Underwood 1985; USDA Forest Service 1984). More recently, the subject was discussed during the Wildland Fire Research Future Search Conference on October 6–8, 1997, in Park City, UT (Saveland and Thomas 1998). I also had the opportunity to attend this conference.

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Useful Reference

One of the more general but highly useful references I have found on the subject, discovered during the course of preparing a paper by Kiil and others (1986), includes recommendations resulting from the conference on "Technology Transfer in Forestry" held by the International Union of Forestry Research Organizations on 25 July–1 August, 1983, at Edinburgh University, Scotland (Moeller and Seal 1984). The recommendations are reprinted in their entirety on page 42 for the benefit of readers.

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Technology Transfer in Forestry: Recommendations*

The final session of the conference on "Technology Transfer in Forestry" was used to assemble and record recommendations. Recommendations for forest managers, the users of research results, were distinguished from those intended for the researchers themselves. Both kinds of recommendations are set forth below.

There was some difference of opinion among conference participants as to the relative importance of the recommendations, and it was acknowledged that different or changing circumstances must change the order of value. Nevertheless, the degree of agreement was remarkable, considering the range of countries and experience represented by the conference participants. All points below deserve the most careful attention.

What can users of research and their organizations do to improve technology transfer?

Users must be actively involved in the early stages of research planning. They should:

- Identify and prioritize their research needs; and
- Make sure researchers understand these needs.

Users must create an organizational environment that encourages innovation. They should:

- Establish a person responsible for user liaison to research;
- Involve researchers in management teams;
- Encourage interaction and cooperation between researchers and managers;
- Provide managers with technology transfer training;
- Allocate staff time to attend meetings, demonstrations, workshops, etc.;
- Set up an administrative structure to ensure technology transfer;
- Monitor technology in primary and related fields;
- Be open to new ideas;
- Reward people who innovate;
- Establish a technology transfer advisor in a senior staff position;
- Interchange staff with research whenever possible; and
- Form user cooperatives to encourage innovation.

Users must be involved in research application and evaluation activities. They should:

- Help fund application efforts;
- Test and demonstrate innovations and inform research about results;
- Make a solid commitment to trying new technology; and
- Conduct benefit/cost and cost-effectiveness studies.

What can researchers and their organizations do to improve technology transfer?

Research must involve users in early stages of research planning:

- To help identify problems and set priorities;
- To establish reasonable expectations and commitments; and
- To understand the user market.

Researchers must create an organizational environment that encourages innovation. They should:

- Encourage direct contacts between researchers and users;
- Keep users informed and involved throughout the research process;
- Attend management meetings;
- Encourage staff exchanges between research and management;
- Train researchers in technology transfer and communication techniques;
- Commit adequate resources to technology transfer;
- Recognize and reward scientists for application work;
- Establish an organizational focal point for technology transfer;
- Take initiative to motivate managers; and
- Recognize technology transfer as a continuing commitment.

Researchers must be involved in application and evaluation activities. They should:

- Whenever possible, quantify the benefits of research;
- Concentrate on the most beneficial results;
- Involve users in application efforts;
- Understand the capability of users to implement research results;
- Provide state-of-the-art summaries;
- Use the most appropriate means of transferring results through demonstration and personal contacts, whenever possible; and
- Ask for and utilize evaluation feedback from users.

* From Moeller and Seal (1984) (see page 41).

"Principles of Fire Behavior": A CD-ROM-Based Interactive Multimedia Training Course*

W.R. Thorburn, A. MacMillan, M.E. Alexander, N. Nimchuk, K.W. Frederick, and T.A. Van Nest

The development of formalized wildland fire behavior and related training courses for fire suppression personnel began in the mid- to late 1950s (e.g., Cochran 1957). The fundamentals that were taught are essentially the same as those relayed today, but technological advancements have completely altered the delivery method. Although conventional classroom-style lectures and outdoor field demonstrations (e.g., Pearce and Alexander 1995) remain valuable, the application of computer technology to wildland fire behavior training has steadily increased in the past two decades (e.g., Jenkins and Matsumoto 1986).

"Principles of Fire Behavior" received the 2001 VIDEOFUEGO Special Mention (For Quality) Award for Best Multimedia CD-ROM Program of Formation (<http: / / www.videofuego.com / >).

New Technology, Fundamental Information

"Principles of Fire Behavior" (ETC 1998), developed and reviewed by a Canadian team of experts in fire operations, fire behavior, and fire weather, is an intermediate fire behavior training course developed specifically for a Canadian audience. The course is the Canadian version of the CD-ROM-based training course "Intermediate Fire Behavior" (S–290) (ETC and NWCG 1997). Both courses are based on text material provided by the National Wildfire Coordinating Group (NWCG 1994a, 1994b). The interaction of video, audio, text, graphics, photos, and animation increases student interest and retention and decreases learning time. Students typically complete the course in 8 to 10 hours, and a bookmarking feature gives students flexibility in course completion.

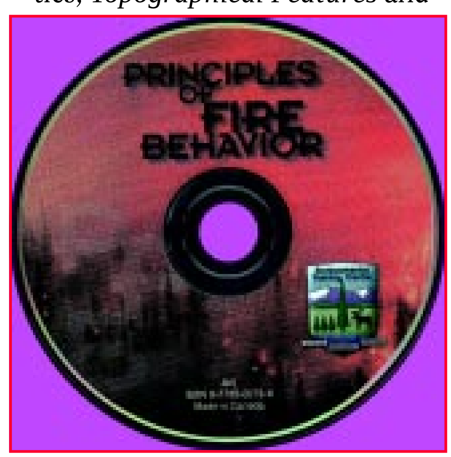
"Principles of Fire Behavior" runs on a personal computer or a network. Minimum system requirements include:

- Windows 95,
- Pentium 100,
- 16 MB RAM,
- 100 MB of free hard drive space,
- Color SVGA monitor set for 640 x 480,
- 16-bit color,
- "Video for Windows" software (included on the CD-ROM),
- 16-bit sound card,
- 8X CD-ROM and driver(s), and
- mouse.

Six Sections

"Principles of Fire Behavior" begins with an Overview Activity, followed by a pretest of introductory-level wildland fire behavior. After the pretest, students navigate through the following six sections:

- ***Fire Environment*** introduces students to basic fire behavior and appropriate terminology and reviews the factors that affect fire behavior and the components of the wildland fire environment (Countryman 1972).
- ***Topography*** includes two activities, *Topographical Features* and



The CD-ROM "Principles of Fire Behavior" provides students with an at-home intermediate fire-behavior-training course that uses the latest in interactive multimedia technology. Photo: M.E. Alexander, Canadian Forest Service, Northern Forestry Centre, Edmonton, AB, 2001.

Rob Thorburn is the team leader for the wildland fire management training program and Terry Van Nest is the operations manager, Environmental Training Centre, Hinton, Alberta, Canada; Alexis MacMillan is the president, Christie Communications, Edmonton, Alberta; Marty Alexander is a senior fire behavior research officer, Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta, Canada; and Nick Nimchuk is the fire weather supervisor and Kurt Frederick is the provincial fire behavior officer, Alberta Sustainable Resource Development, Provincial Forest Fire Centre, Edmonton, Alberta, Canada.

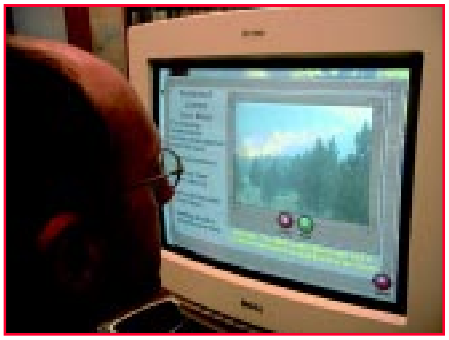
* This article is based on a poster paper presented at the 2001 International Wildland Fire Safety Summit sponsored by the International Association of Wildland Fire, 6–8 November 2001, Missoula, MT (http://www.edu/ecesp/wfs/>).

Topography and Fire, which focus on the characteristics of topography that influence fire behavior.

- ***Fuel*** also includes two activities. *Fuel Characteristics* teaches students the main characteristics of wildland fuels, and *Fuel and Fire* describes the relationship between fire behavior and fuels.
- ***Weather*** is the largest section of the course. Its multiple activities—*Atmosphere, Wind, Clouds, Weather Observation, Weather Forecasting*, and *Weather and Fire*—all focus on the important link between fire behavior and the atmosphere and weather (Schroeder and Buck 1970).
- ***Extreme Fire Behavior*** shows students how to recognize fire behavior in the third dimension and to understand some causes of this phenomenon.
- ***Assessing Fire Behavior*** allows students to practice their new knowledge of the fire environment, topography, fuel, weather, and extreme fire behavior to recognize indicators of problematic fire behavior and identify situations that might be hazardous to fireline personnel.

Testing

At the end of each section is at least one test to help students review the material and to ensure their competency before proceeding. After students have completed all six sections, they take a final test. A performance-tracking system records all test scores, which course administrators can use for certification purposes.



A "Principles of Fire Behavior" CD-ROM training session. Students generally complete the course in 8 to 10 hours. Photo: R.W. Thorburn, Alberta Sustainable Resource Development, Environmental Training Centre, Hinton, AB, 2001.

For a copy of "Principles of Fire Behavior," contact the University of British Columbia Press, Georgetown Terminals Warehouses, 34 Armstrong Avenue, Georgetown, Ontario L7G 4R9, 1-877-864-8477 (voice), 1-877-864-4272 (fax), info@ubcpress.ca (e-mail); or visit the University of British Columbia Press Website at <http://www.ubcpress.ca>. The U.S. version (ETC and NWCG 1997) is available through the National Fire Equipment System (NWCG 2002).

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Computer-Based Training in Canada

In the late 1980s, the Environmental Training Centre in Canada initiated a computer-based wildland fire behavior training course. This venture involved a Canadian version of the "Fire Behavior Interactive Computer-Videodisc Program" course developed by the National Wildfire Coordinating Group in the United States (Jenkins 1990; NWCG 1989).

The course was developed by D. Quintilio (Environmental Training Centre), M.E. Alexander, and T.A. Van Nest, with some minor revisions by W.R. Thorburn and K.G. Hirsch (Canadian Forest Service) in 1991. The result was the "Principles of Fire Behavior Laserdisc" (later replaced by a CD-ROM), which most Canadian fire management agencies have used to train personnel since 1989.

Franklin Awards for Achievements in Cooperative Fire Protection

April J. Baily

Ensuring that all citizens benefit is a critical part of the USDA Forest Service's Cooperative Fire Protection programs. Therefore, encouraging increased interaction by our State forestry fire service cooperators with underserved communities is vital.

> The Franklin Awards recognize outstanding efforts by State employees, units, or groups in fire protection outreach to underserved communities.

Franklin Awards Established

With this goal in mind, Jerry T. Williams, Director of the Forest Service's Fire and Aviation Management (F&AM), has conferred four annual awards to recognize outstanding efforts by State forestry service employees, units, or groups in outreach to underserved communities. Named for Benjamin Franklin, the founder of the volunteer firefighting force, the awards are for:

- Volunteer fire assistance (VFA),
- State fire assistance (SFA),
- Management of Federal excess personal property (FEPP), and
- Overall excellence in reaching underserved communities (through a special Director's Award).

Not all awards are given every year.

2000

The 2000 awards were presented on October 4, 2000, at the annual awards banquet for the National Association of State Foresters in Kansas City, KS. Bill Terry, national training officer for F&AM, presented the awards.

VFA Award. VFA is designed to help small communities improve (or begin) fire protection. The VFA award is for the State that demonstrates the best outreach to help underserved communities improve fire protection.

The late Tom Roberts was the forest fire supervisor for Wisconsin's Department of Natural Resources (DNR). Tom's leadership in developing, implementing, and supporting the State's Forest Fire Protection Grant Program immensely improved the DNR's and communities' wildland firefighting capabilities.

The publicity received by the grant program has improved DNR's relationships and communications with local communities and raised local awareness of the volunteer fire departments. The grants have provided local departments with training and personal protective equipment, enhancing firefighting

Don Johnson (right) accepting the 2000 Franklin Award for volunteer fire assistance on behalf of the late Tom Roberts and the Wisconsin Department of Natural Resources. Presenting the award is Bill Terry, national training officer for the USDA Forest Service's Fire and Aviation Management. Photo: USDA Forest Service, 2000.

April Baily is the Federal Excess Personal Property Program officer for the USDA Forest Service, Fire and Aviation Management, Washington, DC; and the general manager of Fire Management Today.

capabilities and firefighter safety. Because Tom was so instrumental in getting the program off the ground, F&AM was pleased to present him and the Wisconsin DNR with the 2000 Franklin Award for VFA.

FEPP Award. FEPP is made available to help State and local fire services obtain equipment that might otherwise be unaffordable. The FEPP award is for the State that demonstrates the best outreach to help underserved communities equip themselves to improve fire protection.

George Cooper manages the Florida Division of Forestry FEPP Program and the Rural Community Fire Protection Cooperative Equipment Lease Program. Under his leadership, the State of Florida has provided millions of dollars in FEPP to underfunded communities across the State, including vehicles, pumps, tanks, and self-contained breathing apparatus. George has implemented an Internet program that allows local departments to get information and print needed forms easily and quickly. Additional duties include managing the VFA grant program, planning and administering the training for incident management teams, and maintaining the statistical database for fire response time. Because of his leadership and skills in managing the FEPP program, F&AM was proud to present George and the Florida Division of Forestry with the 2000 Franklin Award for FEPP.

Earl Peterson (left) accepting the 2000 Franklin Award for Federal excess personal property on behalf of George Cooper and the Florida Division of Forestry. Presenting the award is Bill Terry, national training officer for the USDA Forest Service's Fire and Aviation Management. Photo: USDA Forest Service, 2000.

2001

The 2001 awards were presented on October 3, 2001, at the luncheon for the National Association of State Foresters in Hot Springs, AR. Janet Anderson-Tyler, Assistant Director of F&AM, made the presentations.

VFA Award. In the past, surplus firefighting equipment was often destroyed in Texas because the owners feared liability suits. Today, that is no longer the case. The Texas Forest Service (TFS) was able to obtain legislation protecting donors from liability if they give surplus equipment to volunteer fire departments.*

The TFS hosted a Volunteer Firefighter Appreciation Day in Llano, TX, attended by more than 570 volunteer firefighters from 168 departments representing 85 counties. More than $500,000 in equipment was placed with volunteer fire departments. A similar event placed more than $200,000 in equipment with departments in serious need along the Texas–Mexico border. In total, the program has placed nearly $7 million worth of equipment. In recognition of these accomplishments, F&AM is pleased to annouce that the winner of the 2001 Franklin Award for VFA is the TFS.

SFA Award. The Franklin Award for SFA also went to the TFS. Beginning in 1998, the TFS implemented wildfire mitigation outreach initiatives, with cooperative wildland fire prevention/education teams being deployed at the State and national level in Texas.** The teams carried the prevention and Firewise messages to communities of every size, from major metropolitan areas such as San Antonio to unincorporated villages.

The initiative was expanded in 1999 to include the “Living on the Edge“ traveling display, seen by an estimated 50,000 residents in communities of all sizes. In 2000, the operation was expanded from 3 to

* For more information, see Traci Bowen, “Texas Volunteer Firefighters Benefit From New Legislation,” *Fire Management Today* 62(4) [Fall 2002], pp. 51–52.

** For more information, see Judith K. Kissinger, “Interagency Teams Prevent Fires From Alaska to Florida,” *Fire Management Notes* 59(4) [Fall 1999]: 13–18.

20 specialists and technicians. It currently uses a community empowerment model to bring Firewise practices to communities statewide. In 2000 and 2001, 11 SFA Urban Wildland Interface Grants of more than $550,000 were awarded to help deliver wildfire mitigation and Firewise assistance statewide.

As a result, 55 communities at risk from wildland fires have established survivable space; posted fire prevention messages; and promoted activities to reduce fire hazards, such as cleanup, slash removal, and fuelbreaks. The communities have employed the entire range of Firewise concepts, including survivable space training for residents, fire service training in wildland/urban interface tactics, evacuation planning, and disaster incident management teams. Community groups are strengthening fire mitigation programs by promoting local ownership and stakeholder involvement. Progress is measured in terms of public participation in fire safety days and slash disposal events.

Additionally, Texas hosted a national Firewise conference in Austin in April 2001. The conference inaugurated a serious of regional 1-day seminars serving major wildland/urban interface areas. SFA grants have been awarded to support the initiatives in raising awareness, promoting stakeholder involvement, and installing community survivable space demonstrations.

In recognition of an outstanding SFA program to benefit communities throughout Texas, F&AM is pleased to announce that the winner of the 2001 Franklin Award for SFA is the TFS.

We congratulate our 2000, 2001, and 2002 Franklin Award winners and gratefully acknowledge the outstanding efforts of all our State partners to ensure fire protection for all Americans.

FEPP Award. The Arkansas Forestry Commission's (AFC's) Rural Fire Protection program has targeted 51 communities without fire insurance reductions, along with communities without fire protection within 5 miles (8 km). The AFC has also identified small communities with specific fire protection needs and insufficient funds to meet those needs.

So far, 31 of the 51 targeted communities have been assisted by more than one means, including FEPP on loan. The AFC's aggressive FEPP program does an outstanding job of equipping needful fire departments. In recognition of this accomplishment, F&AM takes pleasure in awarding the 2001 Franklin Award for FEPP to AFC's Rural Fire Protection program.

Director's Award. The AFC also received the coveted Director's Award for 2001. Under the able direction of John Shannon, State Forester, and Robert Summerville, Rural Fire Protection administrator, the AFC has extended an already excellent program to better serve Arkansas communities. Examples include:

- Participation in the Rural Fire Protection Work Group, organized by the Governor, to submit a unified plan and report. One positive effect of the report was a $50,000 bond issue for the purchase of fire equipment and buildings by rural fire departments.
- The identification of 51 communities in rural areas with the highest insurance rates and the least amount of fire protection. As of May 2001, 31 of those communities have received assistance.
- The location, purchase, and transportation of type 1 fire trucks (for structural fire protection) for rural communities. The cost of these trucks to the communities is $10,000 to $15,000, and most are financed through the State's interest-free loan program.
- The creation of an improved Wildland Urban Interface Training course, with assistance from the Forest Service and other States.
- The establishment of a Website that volunteer and rural fire departments can use to access laws, grants, information, and contacts for assistance in organizing, training, and developing local departments.

Texas State Forester Jim Hull receiving the Franklin Award on behalf of the Texas Forest Service from Janet Anderson-Tyler, Assistant Director of the USDA Forest Service's Fire and Aviation Management. Photo: USDA Forest Service, 2001.

- Media outreach for publicity on the programs. Much positive information is shared with the public by Arkansas newspapers.

Through outreach and constant communication between Rural Fire Protection Staff and State firefighters, the AFC continues to improve fire protection for rural Arkansas. In recognition of its fine service, F&AM Director Jerry Williams was pleased to present the 2001 Director's Award to the AFC.

2002

The 2002 Franklin Awards brought in some new participants, along with nominations from some past winners. Forest Service Chief Dale Bosworth presented the winners with their trophies at the annual awards luncheon of the National Association of State Foresters on September 30, 2002.

VFA Award. Thanks to the National Fire Plan, grant monies from the Forest Service for the Montana Department of Natural Resources and Conservation (DNRC) reached an all-time high. DNRC took the monies, supplemented them with funds from the U.S. Department of the Interior (USDI) for similar programs, and passed more than $1 million in grants to Montana's rural fire departments.

The administration of the grants was a collaborative effort of the DNRC with the Forest Service and the USDI Bureau of Indian Affairs, Bureau of Land Management, and U.S. Fish and Wildlife Service. By combining grants, DNRC was able to serve diverse applicants, including tribal fire organizations and very small underserved rural fire departments. For its outstanding use of VFA funding and its exemplary interagency cooperation, F&AM has awarded the 2002 Franklin Award for VFA to the Montana DNRC.

SFA Award. The Florida Division of Forestry (DOF) created an outstanding program to teach students about the importance of fire in managing ecosystems. The Florida Wildfire Prevention CD-ROM is designed to:

- Show that fire is vital to the health of Florida's ecosystems;
- Teach how prescribed fire benefits Florida's wildlife and prevents disastrous wildfires;
- Promote the importance of wildfire prevention; and
- Provide an educational tool that can be used in the classroom to enhance critical-thinking skills concerning the environment.

Based on interactive games, exercises, and messages, the program helps students understand how fire shapes Florida's natural environment. The CD-ROM is accompanied

Franklin Award Judges

Nominations for the Franklin Awards came for many deserving parties. The Forest Service assembled excellent panels of judges, people who are committed to fairly applying Government assistance and to providing fire protection to underserved communities. Panel members were:

- Noreen Blair, communication consultant, Forest Service, Office of Communication, Washington, DC (2002);
- Malcolm Gramley, cooperative fire operations officer, Forest Service, Northeastern Area, Radnor, PA (2000–2001);
- Judy Kissinger, public affairs officer, Forest Service, Office of Communication, Washington, DC (2000–2001);
- Joan O'Hara Wehner (nonvoting), business manager, National Association of State Foresters, Washington, DC (2000–2001);
- Mary Owens, civil rights specialist, Forest Service, Civil Rights Staff, Washington, DC (2000);
- Robert Ragos, EEO manager, Forest Service, Civil Rights Staff, Washington, DC (2001);
- Jerry Ross, congressional liaison, Congressional Fire Services Institute, Washington, DC (2001);
- Craig Sharman, government affairs representative, National Volunteer Fire Council, Washington, DC;
- Tom Valluzzi, EEO manager, Forest Service, Civil Rights Staff, Washington, DC (2002);
- Bill Webb, Executive Director, Congressional Fire Services Institute, Washington, DC (2000, 2002); and
- Steve Yaddof, community assistance specialist, Forest Service, Cooperative Forestry, Washington DC (2002).

These judges each gave us a day of their time to examine the nominations and evaluate their merits. Each deserves sincere thanks.

by an instructor's guide. Aimed at students in grades 4 through 6, it was created through a partnership between the DOF and Interactive Training Media, Inc., of Tallahassee, FL. In recognition of an outstanding use of SFA grant funds in an educational effort, F&AM was pleased to present the 2002 Franklin Award for SFA to the Florida DOF.

FEPP Award. The Florida DOF also received the 2002 Franklin Award for FEPP. In 2001, the agency placed 37 trucks with local fire departments, supplemented by 13 State trucks. The focus was on rural communities with populations of less than 10,000 and no tax base. In all, the State has placed about 550 trucks with local departments, along with hundreds of other inventory items. The State's FEPP program serves more than 700 communities, many of which would otherwise have no firefighting equipment.

Director's Award. The Directors Award for 2002 also went to the Florida DOF for its innovative and effective use overall of cooperative fire programs. The DOF not only produced the training CD-ROM that won the Franklin Award for SFA, but also produced a brochure designed to help Florida motorists cope with smoke on the highway. The DOF also spearheaded efforts to pass State legislation providing liability protection for entities that donate equipment, vehicles, or supplies for use in fire and rescue missions.

Additionally, DOF has made a focused effort to complete a wildland fire risk assessment analysis. The analysis will help communities work with State and Federal agencies to better define priorities and improve emergency response, better analyze complex landscapes using geographic information systems, plan for resource needs, and identify resource allocations based on potentially severe fire problems. For a cooperative fire protection program that serves the needs of Florida residents very well, F&AM was pleased to award the Directors Award for overall excellence to the Florida DOF.

Nominations for Future Awards

F&AM congratulates the Franklin Award winners and gratefully acknowledges the outstanding efforts of our State partners to ensure fire protection for all Americans. Nominations for the Franklin Awards are due each year on May 31. For nomination forms and information on how to nominate units, groups, or individuals, contact your regional director for F&AM or Director, Fire and Aviation Management, Mail Stop 1107, 1400 Independence Avenue S.W., Washington, DC 20250-1107. The information is also available on the F&AM Website at <http://www.fs.fed.us/fire/partners/vfa/>. ■

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

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

"Keeper of the Flame": A Journey to the Heart of Fire

Stephen Vittoria

The vast majority of Americans view fire as a hostile, destructive, and dangerous force—an entity that at times is even viewed as evil. In fact, Americans have at times attempted to remove fire from nature altogether. The practice of fire exclusion has been the accepted rule in much of America's history, fortified throughout the 20th century by policy, procedure, and public relations campaigns.

> There is nothing even remotely equivalent in the media that argues that fire might have a legitimate role in global ecosystems … until now.

Fire Is the Central Character

"Keeper of the Flame"—a full-length feature documentary film produced by Deep Image (a Los Angeles-based film production company) in conjunction with the National Wildfire Coordinating Group's Wildland Urban Interface Working Team—attempts to reposition fire as an intregral part of ecosystems, leaving little doubt in the viewer's mind that fire is not only needed but also instrumental in maintaining the planet's delicate balance of biodiversity. The film contends that the future of global ecology greatly depends on the role fire plays in preserving its equilibrium. Most documentary films on wildland fire have focused on firefighting and the heroic men and women who battle the blazes. By contrast, "Keeper of the Flame" features fire as the central character.

The film opens with a question posed by the writer Jack Kerouac, who served in 1965 as a fire lookout on Desolation Peak in the State of Washington: "As for lightning and fires, who loses when a forest burns … and what did nature do about [it] for a million years up to now?" It is an intriguing question, one that resonates throughout "Keeper of the Flame."

Stephen Vittoria is the creative director of Deep Image, Los Angeles, CA.

The film fosters a reeducation process now underway across America by exploring forest and land management practices that will allow humanity to use fire, live with fire, and ultimately regard fire as an essential and fundamental part of nature. Ultimately, "Keeper of the Flame" points the audience toward the ongoing and simmering conflict between humanity and nature, a scuffle played out each fire season in wildland/urban interfaces across the Nation.

Fire History

The study of anything depends on a study of history, and history takes center stage in "Keeper of the Flame." The story unfolds with the history of fire—from the emergence of flame on the planet, through humanity's conflicting and dual relationship with it, to a glimpse of the human involvement with fire on the North American continent, including misconceptions and mismanagement in the 20th century.

Historical recreations by noted film actor Wilford Brimley drive the story along in dramatic fashion as the filmmakers take a look at three "infamous" fires in America's history, fires that illustrate human heartbreak while examining Government policy: the 1871 Peshtigo Fire, in which an estimated 1,500 people died in a single hellish night; the 1910 Big Blowup in Idaho and Montana, which spewed ash as far away as the snow-covered landscape of Greenland; and the 1949 Mann Gulch Fire, where 13 smokejumpers died, prompting a widespread reexamination of Federal firefighting policy. In addition, the history of Federal fire management, from the U.S. cavalry in Yellowstone to the USDA Forest Service today, is examined and documented.

Asking Tough Questions

Writer/Director Stephen Vittoria and Producer Frank Fischer offer interviews with fire experts and ecologists with various backgrounds and areas of study and experience. The settings stretch from Yellowstone National Park, to the Black Hills of South Dakota, to a land reserve overlooking Manhattan Island. As one might expect with an issue so complex, the film is chock-full of varying opinions, thoughts, solutions, and historical perspectives. The filmmakers don't shy away from asking tough questions like, “What’s been the economic and ecological cost associated with a century of fire suppression?”

The most intriguing of all the interviews is with fire guru, author, and Arizona State University Professor Stephen J. Pyne (see the sidebar). Noted for his study of fire and seminal written works over the past 25 years, Pyne peppers the film’s journey through the flames with a unique passion and perspective—candid observations on the loss of burning by American Indians, the Federal Government’s “Cold War mentality” with regard to eliminating fire from various ecosystems during the 19th and 20th centuries, why fire must be reintroduced into the landscape as a vital and necessary force, and the tremendous impact that development and urban sprawl are having nationally and globally.

The film is hosted by Emmy-Award-winning journalist Linda Ellerbee. Many other interviews also capture the drama:

- Roy Renkin, a vegetation specialist for Yellowstone National Park, relives his experiences during the historic fires that engulfed the park in 1988;
- The filmmakers follow Doc Smith, a forest restoration expert, and his college class through heavily wooded areas and burned-out forests just south of the Grand Canyon; and
- Edward Albert, an American Indian heritage expert, recalls the historic and symbiotic relationship between the American Indian and nature, especially with fire.

Pyne on Fire

“Keeper of the Flame” features insights by the prominent fire historian Stephen J. Pyne. For example:

Everything in Yellowstone [during the 1988 fires] was exaggerated: Trees exploded into flame like toothpicks in front of a blowtorch; towering convective clouds rained down a hailstorm of ash; crown fires propagated at rates of up to 2 miles per hour [0.9 m/s], velocities unheard of for forest fuels. ... But the idea that fire is war, that we see firefight as battlefield and fire crew as paramilitary unit ... [t]here is a great failure in using this metaphor because we demonize fire and go to great lengths to suppress it at all costs.

Entertainment Value

Visually, the film is a patchwork of new and pristine nature photography; historic footage and still photography from the Forest Service’s library; and action footage that paints a giant canvas of fire, flame, ash, and stunning regrowth in the blackness of destruction.

“Keeper of the Flame” also offers a good deal of entertainment. Historic Smokey Bear ad campaigns are highlighted; and fire prevention television commercials starring Rod Serling, Rock Hudson, and Jonathan Winters are woven into the film, as are various scenes from the hit NBC series “The West Wing.” The environmental paintings of Monte Dolack are an integral part of the film’s imagery.

Music in the film is scarce; but when it shows up, it’s obvious that the filmmakers are giving the flames a voice (for example, through Neil Young’s powerful guitar thumps) and the fire history some texture (for example, through Bob Dylan’s “All Along the Watchtower”). Johnny Cash’s “Ring of Fire” and Woody Guthrie’s “This Land Is Your Land” are also highlights.

Fire Education Campaign

In the final act, “Keeper of the Flame” delves into current fire education campaigns such as Firewise (spearheaded by the National Fire Protection Association and the Forest Service). Their stated mission is to define the personal responsibility associated with living with nature, often smack-dab in the middle of the wildland/urban interface. The filmmakers interview spokespeople for fire education programs, who encourage action to prevent catastrophic fires and who explain what Americans can do right now (in a real and practical way) to protect their lives and property. Their words dramatically illustrate the need for national awareness of fire’s role in the American wilderness.

For more information on “Keeper of the Flame,” see the Website at <http://www.keeperoftheflame.org>. ■

Book Review: *Ghosts of the Fireground*

Hutch Brown

Some say that firefighters are just in it for the money (Brown 2001). That is certainly not true of Peter M. Leschak, whose 20-odd years of firefighting experience have inspired a successful career as an outdoor writer. Leschak's new book, *Ghosts of the Fireground: Echoes of the Great Peshtigo Fire and the Calling of a Wildland Firefighter* (HarperSanFrancisco; San Francisco, CA; 2002), bears testimony to what many firefighters know: Firefighting can be a calling.

Firefighter Calling

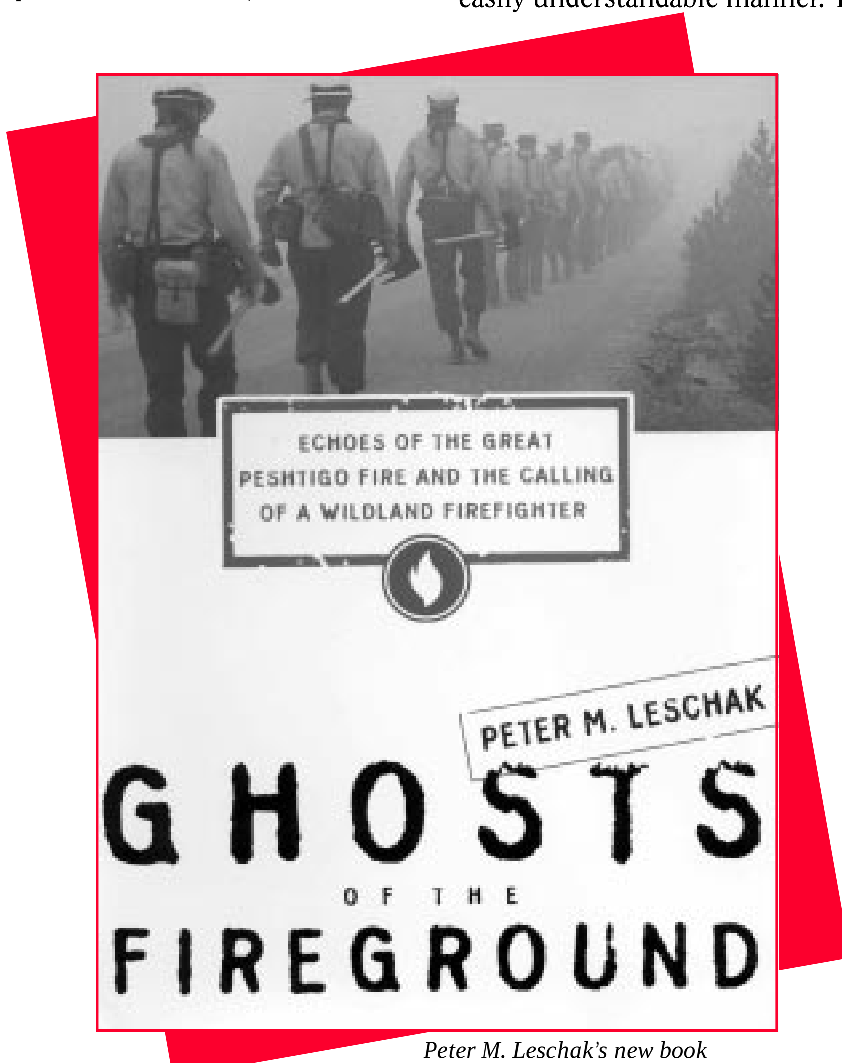
Leschak recounts his experiences as a helitack manager during the 2000 fire season, weaving in the story of Father Peter Pernin, a Catholic priest who survived the 1871 Peshtigo Fire, one of the greatest tragedy fires in U.S. history. In many ways, Leschak's book is confessional. A one-time theology student, Leschak chronicles his progression toward and through the fireground, which for him came to replace the role of religion. "I've tapped into the spiritual aspects of fighting fire," he declares in the first chapter. The spiritual side of firefighting is what much of his book is about.

Leschak is a skillful writer, and some passages show all the lyricism of good nature writing. At times, however, the style is uneven. It seems odd, for example, to read that a fire burning "beneath a canopy of large firs" should be "in full sunlight"; or that human lives are "dramas reenacted from scripts created ten thousand years ago," long before the first tablet bore the first script. At times, it seems unclear who the intended audience is; the reader learns what a snag is, but not what an "Incident [Management] Situation Report out of Boise" is. Firefighters need no explanation for either, but the general public certainly does, at least for a Situation Report.

> The book is chock-full of interesting insights presented in a very readable, easily understandable manner.

Valuable Book

But these quibbles do not detract from the tremendous value of Leschak's book. It is chock-full of interesting insights and information presented in a very readable, easily understandable manner. The



Peter M. Leschak's new book Ghosts of the Fireground.

Hutch Brown is the managing editor of Fire Management Today for the USDA Forest Service, Washington Office, Washington, DC.

story of Father Pernin and the Peshtigo Fire is an obvious instance. Another is the plight of emergency firefighters, who “possess few of the rights and privileges that most American workers take for granted. There is no guaranteed term of employment, no health benefits, no sick leave, no vacation time, no seniority consideration, no grievance procedure, no career path.” Leschak’s passion for fire kept him coming back, but he “watched dozens of good firefighters regretfully quit the profession because they couldn’t afford homes, families, or even a reliable vehicle.” So much for being in it just for the money.

Leschak gives wonderful explanations on complex subjects, such as fire behavior in steep terrain or the significance of thousand-hour fuels. His rendition of an “old trick used by firefighting instructors” (see the sidebar) marvelously illustrates the interaction of heat and fuel in the fire triangle. Even neophytes will easily get the point.

Leschak’s most important points relate to firefighter safety. The safety theme pervades the book, beginning with a description of risk homeostasis. People tend to accept certain levels of risk; paradoxically, if they think they are somehow safer, they will behave more dangerously just to reestablish the accustomed level of risk. Leschak cites a study showing “that after acquiring antilock brakes, a sample of cab drivers eventually drove more aggressively.”

A related problem is normalizing risk. “It’s a paradoxical aspect of firefighting,” notes Leschak, “that often it’s the veterans rather than the rookies who sink themselves into trouble.” Whereas a rooky might think twice about entering into danger, the veterans have survived so many risky situations that they begin to accept them as normal. Leschak frankly admits to normalizing risk and to becoming “a victim of a common fire service mind-set: can do!”

The book’s most important points relate to firefighter safety.

Leschak’s self-critical accounts of his fireground experiences carry strong safety messages, culminating in his refusal to follow an order that would have compromised the safety of his crew. The book concludes on that note: “But in surveying the season and our own trials, one moment focused in front of all others: on the hot, lost road at Boulder Creek, bracketed by flames, the soot-stained flock gathered round; and the word I offered to my commander was *no*.”

Spirituality

The “soot-stained flock” is Leschak’s crew, his “congregation.” Ultimately, the book is about Leschak’s search for salvation on the fireground, partly by protecting his crew. Leschak accepted his calling as a firefighter “for the same reason I once matriculated at a Bible school—to be a minister in a church. To scratch a line to salvation.”

Leschak makes an interesting and credible connection between firefighting and finding spiritual salvation. “The fireground can be sacramental,” he concludes, “in the sense of providing an outward sign of inner ‘grace,’ that is, the favor and blessings of moral strength. We are often better for having worked there.” Firefighters will know exactly what he means.

Reference

Brown, E. 2001. What burns me about the way we fight wildfires. Washington Post (Washington, DC). April 29. ■

Which Ones Will Burn?*

There’s an old trick used by firefighting instructors. Write a list under Column A on the blackboard: water, rock, concrete, steel, asbestos, brick. Then under Column B: gasoline, wood, paper, charcoal, kerosene, cow chips.

“Now,” you say, suppressing a benign smirk, “which of these lists is composed of materials that will burn?”

Many students sense a trap, but few know the correct answer: neither. None of the listed substances actually burns. No solids or liquids, just gases. It’s possible to douse a small fire with diesel fuel.

Only when the materials in Column B are heated to the point of outgassing will they ignite. Since gasoline, for example, vaporizes easily under normal atmospheric conditions, it readily and violently burns; … wood is tougher to light.

* From Peter M. Leschak, *Ghosts of the Fireground: Echoes of the Great Peshtigo Fire and the Calling of a Wildland Firefighter* (San Francisco, CA: HarperSanFrancisco, 2002), p. 48.

The Bison and the Wildfire*

Paul Keller

I watch the smoke and tiny stars of flame,
The night opening behind us in wind-drunk fire
Inside the huge red moons of your eyes.

How could I have known as I flagged this route out
That you were waiting here for the sound of my bones?
One thousand years of blood and dust and dung.

Now, inside your ears, my crew's first voices. A horrible chant
Of power saws and hand tools. Their slow attack echoes
Toward us. So I promise to stay with you all night,

To whisper into this radio cinched against my heart,
To warn them if you should turn and spin your great weight
Past sumac and chokecherry into the sound of their lives.

Above us, inside the black sky on those old Sioux ridges
Shapes of white pine begin to remember themselves
Back into flame. Your giant skull heaves up

Into such a terrible silence. The dry peppery taste
Of skunkbush heating your breath, this night, the fire
Your ancient passion to kill me. I move even closer.

You are the biggest animal I ever dreamed.
Will either of us ever understand this fragile hate
Rising between us? I hear myself speak to you.

Tomorrow I will tell them everything. How you
Warned me like thunder with sudden low grunts.
How, even so, I followed you back into your dark,

Into this crazy bison and wildfire true story.
I was so young and fell in love with this danger.
With your eyes. With your sweet skunkbush breath.

Bison grazing on rangeland framed by the Rocky Mountains. Photo: USDA Forest Service.

Paul Keller, a former hotshot and journalist, is a contract writer/editor for the USDA Forest Service's Fire and Aviation Management Staff, Washington Office, Washington, DC.

* This poem is based on the author's experience as a member of the Zigzag Hotshot Crew on a wildland fire in the Black Hills of South Dakota. The poem first appeared in *Appalachia*, December 2000: 75–76.

Photo Contest Announcement

Fire Management Today invites you to submit your best fire-related photos to be judged in our annual competition. Judging begins after the first Friday in March of each year.

Awards

All contestants will receive a CD–ROM with all photos not eliminated from competition. Winning photos will appear in a future issue of *Fire Management Today*. In addition, winners in each category will receive:

- 1st place—Camera equipment worth $300 and a 16- by 20-inch framed copy of your photo.
- 2nd place—An 11- by 14-inch framed copy of your photo.
- 3rd place—An 8- by 10-inch framed copy of your photo.

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. To ensure fair evaluation, we reserve the right to change the competition category for your photo.
- Each photo must be an ***original color slide*** or ***print***. We are not responsible for photos lost or damaged, and photos submitted will not be returned (so make a duplicate before submission). ***Digital photos will not be accepted*** because of difficulty reproducing them in print.
- 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 be eliminated from competition if they 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

First Friday in March

Send submissions to:

Madelyn Dillon
CAT Publishing Arts
2150 Centre Avenue
Building A, Suite 361
Fort Collins, CO 80526

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.

Signature____ Date ________________________

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