Fire Management *today*

Volume 61 • No. 3 • Summer 2001

Reducing Costs on Large Fires

United States Department of Agriculture
Forest Service

Guidelines for Contributors

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

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

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

USDA Forest Service
Attn: Hutch Brown, 2CEN Yates
P.O. Box 96090
Washington, DC 20090-6090
tel. 202-205-1028, fax 202-205-0885
e-mail: hutchbrown@fs.fed.us

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

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

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

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

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

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

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

Fire Management Today is published by the Forest Service of the U.S. Department of Agriculture, Washington, DC. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department.

Fire Management Today is for sale by the Superintendent of Documents, U.S. Government Printing Office, at:
Internet: bookstore.gpo.gov Phone: 202-512-1800 Fax: 202-512-2250
Mail: Stop SSOP, Washington, DC 20402-0001

Fire Management Today is available on the World Wide Web at <http://www.fs.fed.us/fire/planning/firenote.htm>.

Ann Veneman, Secretary
U.S. Department of Agriculture

Mike Dombeck, Chief
Forest Service

Harry Croft, Acting Director
Fire and Aviation Management

April J. Baily
General Manager

Robert H. "Hutch" Brown, Ph.D.
Managing Editor

Madelyn Dillon
Editor

Fire Management today

Volume 61 • No. 3 • Summer 2001

On the Cover:

A member of the Payson Hotshots on the 1994 Bear Creek Fire, Boise National Forest, ID. Controlling the blaze was relatively inexpensive; the fire scorched 4,600 acres (1,860 ha) at a cost of $357,800, or about $78 per acre ($193/ha). By comparison, the average large-fire suppression cost per acre burned in the National Forest System in 1994 was $576 ($1,423/ha); by 1999, it had reached $976 ($2,411/ha). Reducing costs on large fires has become a growing national concern (see the articles by Dick Mangan in this issue). Photo: Karen Wattenmaker, USDA Forest Service, Boise National Forest, Boise, ID, 1994.

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.

Firefighter and public safety is our first priority.

Contents

Reducing Fire Suppression Costs: A National Priority 4
Hutch Brown

Issues in Reducing Costs on Large Wildland Fires 6
Richard J. Mangan

Equipment Standardization Reduces Costs on Wildland Fires 11
Richard J. Mangan

Forecasting Fire Season Severity 15
Everett M. "Sonny" Stiger

Can the Fire-Dependent Whitebark Pine Be Saved? 17
Robert E. Keane

Fire Ignition From Horseback 21
Carlton Britton, Rob Mitchell, Brent Racher, and Ernest Fish

Fighting Fire Without Fire: Biomass Removal as a Prelude to Prescribed Fire 23
Stephen M. Jolley

Workforce Diversity Program: A Progress Report From the Payette National Forest 26
Francisco Romero

Tractor Plow Safety: Know Your Terrain and Wear Your Seatbelt! 29
Timothy G. Wyant

Short Features

Guidelines for Contributors 2

Websites on Fire 31

Annual Photo Contest 31

Reducing Fire Suppression Costs: A National Priority

Hutch Brown

Reducing fire suppression costs has long been a priority for agencies charged with wildland fire management in the United States. In 1993, Congress passed the Government Results and Performance Act, holding Federal agencies to high standards of accountability and cost-effective performance. As the USDA Forest Service's Strategic Plan (2000 Revision) put it, "the agency is … required to conduct its business in the most effective and efficient manner possible, providing the best possible value for the American people."

Rising Costs

For years, Federal land managers have grappled with a rising number of large fires (1,000 acres [405 ha] or more in size). Since the mid-1980's, the number of acres burned has been growing on the national forestlands (table 1), especially in the interior West. In 1987, for only the first time since 1919, more than a million acres burned on our national forests and grasslands. More than a million acres burned again in 1988, 1994, and 1996. In 2000, more than 2 million acres burned.

One result has been a disturbing rise in both total suppression costs and the cost per acre burned (fig. 1). Large fires in particular can be associated with stunning suppression costs. For example, the 1999 Big Bar and Kirk Complex Fires in California together consumed more than 227,000 acres (92,000 ha) at a cost of about $178 million, or about 30 percent of the total Forest Service fire suppression budget for 1999 (F&AM 2000).

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

> Since the 1980's, there has been a disturbing rise in both total suppression costs and the cost per acre burned.

In 2000, Congress appropriated funds to support the National Fire Plan, a blueprint for improving fire protection, restoring fire-ravaged communities and landscapes, and reducing the fire risk to communities and ecosystems nationwide.* New funds under the plan for fiscal year 2001 included $1.1 billion for the Forest Service alone.

However, given the scope of the Nation's fire-related forest health problem, the National Fire Plan will require a sustained commitment. Fire managers can build support for the plan by showing Congress and the American people positive results achieved in the least controversial and most cost-effective manner—with the most "bang for the buck." Finding ways to reduce suppression costs therefore remains a high national priority.

* See Mike Dombeck, "A National Fire Plan for Future Land Health," *Fire Management Today* 61(2): 4–8; and "Managing the Impact of Wildfires on Communities and the Environment: A Report to the President in Response to the Wildfires of 2000," *Fire Management Today* 61(2): 9–11.

Seeking Solutions

Since the early 1990's, a series of studies has explored the reasons for rising large-fire costs, culminating in a report in 2000 by the Forest Service's Strategic Overview of Large Costs Team under the title "Policy Implications of Large Fire Management: A Strategic Assessment of Factors Influencing Costs" (F&AM 2000). The report contains a detailed literature discussion.

This issue of *Fire Management Today* contributes to the discussion with two thoughtful articles by Dick Mangan on reducing large-fire costs (see pages 6 and 11). A future issue will further explore the problem. Contributions of up to about 2,000 words are welcome; see "Guidelines for Contributors" on page 2.

References

F&AM (Fire and Aviation Management). 2000. Policy implications of large fire management: A strategic assessment of factors influencing costs. Report by the Strategic Overview of Large Costs Team. Website <http://www.fs.fed.us/fire/planning/Large_Fire_Mgt.pdf>. Washington, DC: USDA Forest Service, F&AM.

NIFC (National Interagency Fire Center). 2000. National Interagency Coordination Center: Incident management situation reports. Website <http://www.nifc.gov/news/nicc.html>. Boise, ID: NIFC.

Table 1—*Forest Service expenditures[a] for emergency fire suppression on lands in the National Forest System, 1980–99 (F&AM 2000).*

Year	Cost	Acres burned	Cost per acre burned
1980	136,767,256	379,000	360.86
1981	191,011,998	325,000	587.73
1982	50,128,049	83,000	603.95
1983	56,711,069	81,000	700.14
1984	102,490,769	187,000	548.08
1985	249,250,324	741,000	336.37
1986	167,696,327	406,000	413.05
1987	368,538,256	1,281,000	287.70
1988	604,357,759	1,556,000	388.40
1989	442,166,330	597,000	740.65
1990	319,088,563	585,000	545.45
1991	163,741,389	200,000	818.71
1992	340,802,589	699,000	487.56
1993	205,616,119	330,000	623.08
1994	849,987,396	1,476,000	575.87
1995	350,635,608	376,000	932.54
1996	514,153,200	1,367,000	376.12
1997	154,246,960	241,000	640.03
1998	219,300,000	306,000	716.67
1999	$591,000,000	605,000	$976.86
Total	$6,077,689,961	11,821,000	—
Average	$303,884,498	591,050	$582.99

a. All expenditures are expressed in terms of 1999 dollars.

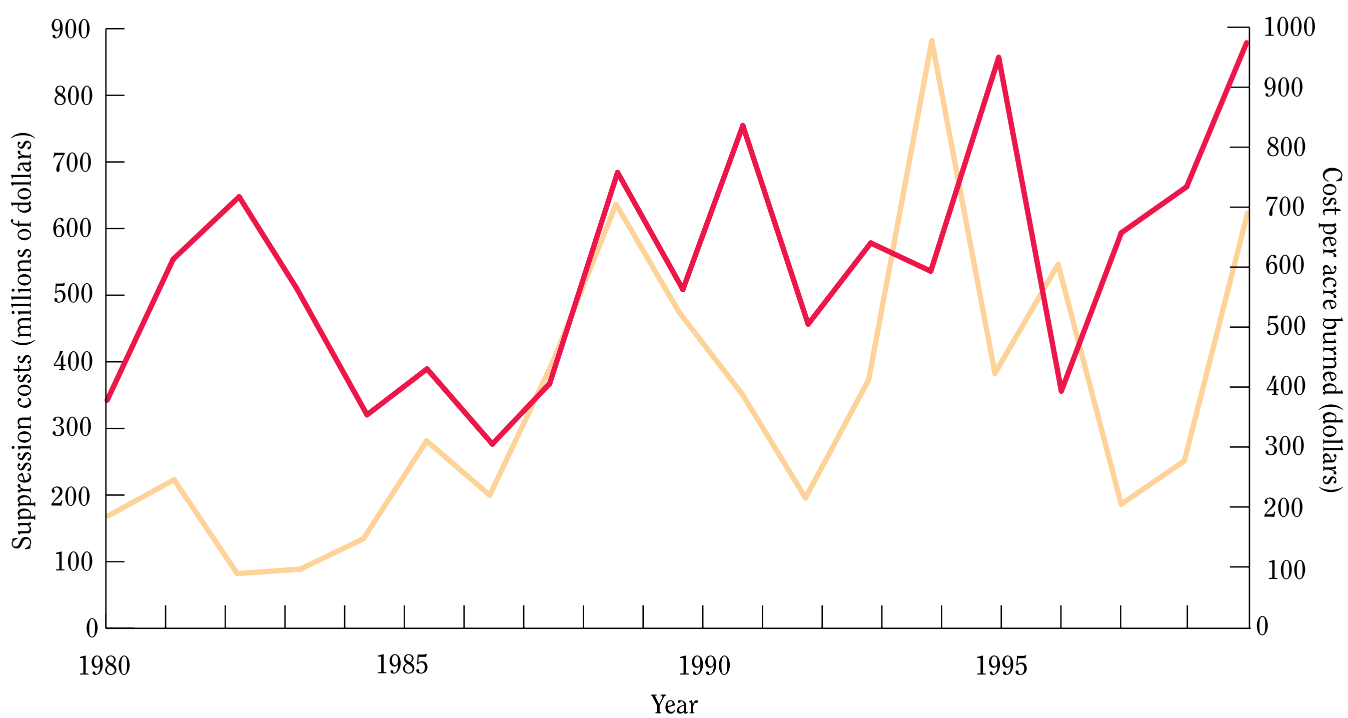

Figure 1—*Forest Service expenditures for emergency fire suppression on lands in the National Forest System, 1980–99 (F&AM 2000); all costs are in 1999 dollars. There is no correspondence between total costs and cost per acre burned. Both figures fluctuate greatly from year to year, but both show an overall rising trend. Illustration: Gene Hansen Creative Services, Inc., Annapolis, MD, 2000.*

Issues in Reducing Costs on Large Wildland Fires

Richard J. Mangan

Editor's note: This article is based on a paper presented by the author at the symposium "Fire Economics, Planning, and Policy: Bottom Lines" on April 5–9, 1999, in San Diego, CA. The article still has broad applicability. However, readers should also refer to more recent studies, particularly the 2000 report by the Forest Service's Strategic Overview of Large Costs Team under the title, "Policy Implications of Large Fire Management: A Strategic Assessment of Factors Influencing Costs" (on the World Wide Web at <http://www.fs.fed.us/fire/planning/Large_Fire_Mgt.pdf>).

Wildland fires are big business. Every year, fires burn millions of acres in the United States. Numerous contractors, hundreds of aircraft, and tens of thousands of firefighters suppress the fires at a cost of hundreds of millions of dollars.

From June 1 to July 22, 1998, Florida experienced 2,282 wildland fires that burned 499,477 acres (202,138 ha), mostly on State-protected land. More than 10,000 firefighters from 47 States constructed more than 1,000 miles (1,600 km) of fireline to suppress these fires. One hundred and fifty-six aircraft supported them. Suppression costs were estimated at $160 million.

Across the United States in 1998, 81,043 wildland fires burned 2,329,704 acres (942,831 ha). Those figures are based only on what agencies reported to the National Interagency Fire Center in Boise, ID; actual figures are certainly higher. Suppressing the 1998 fires might have cost more than $1 billion.

Dick Mangan is the program leader (retired) for Fire and Aviation Management, Missoula Technology and Development Center, USDA Forest Service, Missoula, MT.

Every year, hundreds of aircraft and tens of thousands of firefighters are needed to suppress wildland fires in the United States, at a cost of hundreds of millions of dollars.

The Large-Fire Problem

Large fires are not a new phenomenon in the United States. In 1910, vast areas of the country were burned over. Statistics published by the National Interagency Fire Center in Boise, ID, show that large fires have again been on the rise since the mid-1980's.

In recent years, several factors have changed fire suppression methods (especially on the largest wildland fires):

- The reduced Federal workforce in natural resources agencies;
- Changing forest health conditions, often the result of previous fire exclusion practices;
- Changes in the fire camp environment to meet the needs and expectations of the 1990's workforce;
- Public and media expectations;
- Large-scale climatic events, such as El Niño and global warming;
- Escaped prescribed fires and escaped natural fires designated for wildland fire use in wilderness and parks;

The 1994 North Fork Fire, part of the Idaho City Complex on the Boise National Forest, ID. The Idaho City Complex took weeks to suppress at a cost of tens of millions of dollars; fuel loadings were a contributing factor. Photo: Karen Wattenmaker, USDA Forest Service, Boise National Forest, Boise, ID, 1994.

- The public's intolerance of lingering smoke; and
- The politics of wildland fire at the local, State, and national levels. An excellent example was the 1995 Long Island Fire in New York. Although the fire burned only about 5,000 acres (2,000 ha), it drew the attention of New York's governor, the State's senior U.S. Senator, the Director of the Federal Emergency Management Agency, the Deputy Under Secretary of Agriculture for Natural Resources and the Environment, and the personal adviser to the President.

All of these factors, often in combination, require fire managers to take actions (and spend money) that might not have been needed in previous years.

Cost Factors on Large Fires

Fire-related expenditures, especially for large fires, came under increased scrutiny in the 1990's, partly as a result of the long and costly fires in the greater Yellowstone area in 1988. Comptrollers were introduced on incident management teams to advise line officers on cost issues specific to a given fire. Oversight reviews and studies were done to examine individual fires, season-long expenditures, and long-term trends in suppression costs.

These studies offer important insights into large-fire expenditures. For example:

- Many large fires are managed by national incident management teams that spend more than $1 million per day.
- From 1970 to 1995, USDA Forest Service fire expenditures were nearly $7.9 billion.
- From 1991 to 1995, Forest Service fire costs increased 15.5 percent per year.

Schuster and others (1997) examined costs on 171 medium and large fires, paying particular attention to 20 of the largest, most expensive fires in 1994. Costs broke down as follows:

- 56.6 percent—aviation resources, equipment, food, showers, and toilets;
- 31.7 percent—personnel (mostly overtime pay for regular employees and pay for casual employees); and
- 11.7 percent—all other expenses.

The authors also surveyed incident commanders on large wildland fires in 1994 to identify factors that drive up costs. Of the 34 factors listed in the survey, the incident commanders rated only two ("weather during fire" and "access") as very important. According to the survey, other factors that increased costs included terrain; fuel loadings; protecting lives and structures; and firefighter availability, quantity, and quality.

Operations Section Costs

Under the Incident Command System (see sidebar on page 8), the operations section of an incident management team on a large wildland fire includes some of the highest cost items in recent years, particularly personnel, equipment, and aviation.

Personnel. Personnel costs are a big part of total fire suppression costs. Base pay, hazardous-duty pay, and premium overtime all figure in. Personnel costs have recently mushroomed on large wildland fires, because natural resource agencies have lost locally available personnel. It is not uncommon to send crews and overhead personnel across the country to large fires, allowing for up to 2 days' travel time each way. This travel time incurs substantial personnel costs, with no corresponding fireline action during transit.

Flagstaff Hotshots constructing fireline on the 1994 Rabbit Creek Fire, Boise National Forest, ID. According to one study, personnel accounted for almost a third of large-fire costs in 1994. Photo: Karen Wattenmaker, USDA Forest Service, Boise National Forest, Boise, ID, 1994.

Incident Command System

Since the mid-1980's, large wildland fires in the United States have been managed under the Incident Command System (ICS), an organizational structure similar to the military organization for combat. Under the ICS, the basic structure of an incident management team includes sections for command, plans, operations, logistics, finance, safety, and information.

The operations section is responsible for on-the-ground implementation of strategic decisions made by the incident commander. The other sections provide supporting information, equipment, supplies, transportation, and personnel for suppression. The operations section includes:

- Personnel (crews, supervisors, aircraft managers, etc.);
- Equipment (engines, dozers, water tenders, lowboys, etc.); and
- Aircraft (airtankers, helicopters, lead planes, and air attack).

Equipment. Equipment such as engines, dozers, and water tenders is also expensive. Costs can easily exceed $1,000 per day for each piece of contract equipment mobilized to a distant wildland fire and placed in around-the-clock operational status. Other costs might include salaries of operators or crews hired under casual labor authority.

Aircraft. Aircraft are the most visible symbol of our fire suppression efforts and our single most expensive resource on a large wildland fire. Agencies pay for availability guarantees and per-hour flight costs when employing aircraft. Aircraft costs alone can account for more than one-third of the total suppression costs on large wildland fires.

Both equipment and aircraft require personnel to manage and supervise them. Those personnel and the crews assigned to the fire need three meals per day, often in a remote setting a long way from food service facilities. Daily meal costs under the 1998 fire food service contracts averaged $35 to $40 per day per firefighter.

Future Conditions

Before considering options for reducing costs on future fires, we must first forecast conditions that will affect our expenditures. Recent trends on large wildland fires give us a fairly accurate picture of future conditions:

- Continued staff reductions in the natural resource agencies will increase the use of contractors for crews, equipment, and possibly incident management teams.* The seasonality and uncertainty of contract work generally make contract resources higher priced than regular agency personnel and equipment.
- The availability and efficiency of large type 1 helicopters will increase their use on large

* Under the National Fire Plan signed by the President in 2000, Congress appropriated fiscal year 2001 funding for hiring new Federal employees for wildland fire management, including 3,500 new Forest Service employees (permanent and temporary), helping to reverse the shortage of Federal personnel.

Dozers for wildland firefighting. Engines, dozers, and other contract equipment can drive up costs on wildland fires. Costs can easily exceed $1,000 per day for each piece of contract equipment. Photo: USDA Forest Service, Missoula Technology and Development Center, Missoula, MT.

wildland fires. These helicopters are very expensive, costing in excess of $100 per minute of flight time.

- Modernization of the airtanker fleet by private contractors will increase the costs of using airtankers on large wildland fires.
- As more people move into the wildland–urban interface and as news is broadcast with ever-increasing speed, interest in wildland fires will increase for the general public, media, and politicians.
- The 1995 Federal Wildland Fire Policy will increasingly affect State and county agencies and local fire departments involved in large interagency wildland fires.

Cost Reduction Opportunities

Significant savings on large fires will not come from shaving costs at the edges (see sidebar below). To really save money, we must address spending by the operations sections of our incident management teams. Opportunities for cost reductions in the operations section fall into several categories: strategies and tactics, fireline operations, contract equipment, shift times, flight time, and postfire operations.

Strategies and Tactics. During periods when extreme fire behavior conditions are forecast, cost reduction opportunities include:

- Thoroughly analyzing the implementation of fire suppression efforts. If crews, equipment, and aircraft cannot take safe, effective actions during periods of extreme fire behavior, take them off line and off shift.
- Returning crews to base camp after 8-hour shifts. Keeping a 20-person crew at the GS–4 level on a fireline costs $1,900 more for 14 hours than for 8 hours. If extreme fire behavior is likely to force crews to retreat to safety zones, it is better to return them to the incident base camp for additional rest, safety, and cost savings.
- Keeping airtankers and water-dropping helicopters on the ground. It is inefficient and dangerous to fly airtankers and helicopters under extreme fire conditions.
- Placing dozers, engines, and water tenders off shift. Such equipment might not function very effectively under conditions of extreme fire behavior.

Fireline Operations. Constructing and holding fireline is a major function of the operations section. Opportunities to reduce fireline costs include:

- Using natural barriers instead of constructed fireline.
- Choosing the proper fireline construction method (handline, dozer line, or fireline explosives).
- Considering the required mopup standards in light of the current and forecasted weather and fire behavior conditions. "Let it burn out" is often safer and more cost-effective than "put it out."*
- Constructing spike camps closer to the fire work area when travel time will result in long shift times. Transporting crews becomes a large cost factor when travel times approach 2 to 3 hours per operational period.

Contract Equipment. Contract equipment is another large cost center in the operations section on a large wildland fire. The need for 24-hour double shifting and around-the-clock availability of prime movers and lowboys (trucks used to move dozers) must be carefully weighed against

* For a description of a burnout strategy, see Tom Leuschen and Ken Frederick, "The Consumption Strategy: Increasing Safety During Mopup," *Fire Management Today* 59(4): 29–33.

These Are Not the Solutions

Recent attempts to reduce costs on large wildland fires have produced a long list of simplistic suggestions for saving money. Recommendations include:

- Supplying fewer newspapers to incident base camps;
- Using canteens with water from large potable-water trucks instead of bottled water;
- Using National Guard trucks instead of school buses for crew transportation;
- Avoiding the use of national incident management teams because they spend too much money; and
- Keeping trainees, human resources specialists, and union representatives off large fires.

These "easy answers" reduce the total fire suppression bill by a small percentage but do not address the bigger cost centers and therefore fail to produce significant savings.

production efficiency and cost per hour. Accountability for actual hours worked should be emphasized, with single-resource unit leaders assigned to monitor time performance, as appropriate.

Shift Times. Managing shift times on the fireline can be an effective tool for reducing personnel costs. When a 12-hour operational period extends to 15 hours, costs increase by 24 percent. When this happens, for example, a 20-person crew at the GS–4 level costs an additional $940.

Flight Time. Managing flight time for aircraft, both fixed and rotary wing, offers these cost-saving opportunities:

- Using airtankers earlier in the burning period, thereby dramatically increasing their efficiency and reducing their costs.
- Reducing airtanker flights ordered for public and media visibility rather than for fire suppression effectiveness.
- Ordering the right resource for the job. Large airtankers, single-engine airtankers, and type 1 and type 2 helicopters all have their own unique advantages. Depending on conditions, each can be the most effective and efficient tool to use.
- Using type 1 and type 2 helicopters as needed rather than merely to retain them. During periods when incident management teams are competing for scarce resources, they might have helicopters log flight time just to prove they are needed. At costs that can exceed $7,000 per hour of flight time, such use is highly wasteful. Incident commanders, operations section chiefs, and air operations directors must work closely with the regional and national fire coordinators to ensure that actual and projected needs—rather than flight hours logged—determine helicopter resource assignments.

Many large fires are managed by national incident management teams that spend more than $1 million per day.

Declaring Control. Deciding to declare a fire "controlled" results in a major cost reduction, because personnel no longer receive hazard pay. For a 20-person crew at the GS–4 level working 14-hour operational periods, savings can exceed $600 per period. For 30 such crews, savings can reach nearly $19,000 per operational period. Similarly, deciding to demobilize resources, both personnel and equipment, can result in large savings in salaries and in support costs such as contracted food services.

Cost Savings

Wildland fires will always be damaging and costly, even when well managed. But opportunities do exist for significant cost savings by making the operations sections of our incident management teams more efficient. To realize savings, the agency administrator and incident commander on a fire must work together to make cost reduction a clearly stated priority and to strongly support all necessary actions.

Reference

Schuster, E.G.; Cleaves, D.A.; Bell, E.F. 1997. Analysis of USDA Forest Service fire-related expenditures 1970–1995. Res. Pap. PSW–RP–230. Albany, CA: USDA Forest Service, Pacific Southwest Research Station. ■

Firefighters mopping up on a wildland fire. Choosing the right strategies and tactics, including feasible alternatives to mopup, can help reduce large fire costs. Photo: USDA Forest Service, Missoula Technology and Development Center, Missoula, MT.

Equipment Standardization Reduces Costs on Wildland Fires*

Richard J. Mangan

At the beginning of the 20th century, equipment development for wildland firefighting was an informal, backyard affair. Farmers, ranchers, and loggers developed equipment for their specific needs, often sharing their best ideas with neighbors. After 1905, when the fledgling USDA Forest Service took the lead in wildland firefighting nationwide, equipment development gradually became more focused and systematic (see sidebar).

Standardization Benefits

In 1960, the Forest Service chartered two equipment development centers, now known as the Missoula Technology and Development Center in Missoula, MT, and the San Dimas Technology and Development Center in San Dimas, CA. For the first time, Federal wildland fire management agencies started seeing the benefits of equipment standardization on a large scale.

The equipment development centers designed more and more equipment, tested it in the field, and completed it with design specifications and drawings. Today,

Dick Mangan is the program leader (retired) for Fire and Aviation Management, Missoula Technology and Development Center, USDA Forest Service, Missoula, MT.

* The author presented a version of this article at the symposium "Fire Economics, Planning, and Policy: Bottom Lines," 5–9 April 1999, San Diego, CA.

Today, the two Forest Service equipment development centers are responsible for more than 200 design specifications.

Historical Highlights in Equipment Development for Wildland Firefighting

- The Transfer Act of 1905 brought focus to equipment development for the USDA Forest Service by making wildland fire suppression and associated equipment development Forest Service priorities. Ranger Malcolm McLeod headed the initial efforts by developing several handtools on the job.
- In 1910, when Ranger Edward Pulaski's heroic actions saved the lives of 35 firefighters during the Big Blowup in the northern Rocky Mountains, the need for better firefighting equipment became clear. In the next few years, Pulaski refined a firefighting tool that became widely popular and still bears his name.
- In 1912, a fire shield was developed that allowed firefighters to get closer to a fire.
- In 1920, the Forest Service awarded the first commercial contract for production of pulaski tools.
- In 1921, at the Mather Field Conference near Sacramento, CA, Chief Forester William B. Greeley emphasized the importance of inspecting, inventorying, and distributing firefighting equipment.
- In 1936, an equipment standardization conference at Spokane, WA, brought additional focus to wildland fire equipment development.
- In 1960, the Forest Service established equipment development centers in Montana and California.
- In 1976, the Michigan Department of Natural Resources established the Forest Fire Equipment Center in Roscommon, MI.

Early supply cache for wildland firefighting. From its inception in 1905, the Forest Service has made equipment development for fire suppression a high priority. Photo: USDA Forest Service, Missoula Technology and Development Center, Missoula, MT.

the two Forest Service centers are responsible for more than 200 design specifications. The General Services Administration (GSA) procures items that meet these specifications for Federal wildland fire management agencies, their State partners, and other cooperators. The equipment is distributed nationally and to other countries during emergencies (see sidebar on page 13).

How big has the GSA program grown? From 1994 to 1998, total GSA sales based on specifications and drawings produced by the two Forest Service centers averaged nearly $26 million per year. In 1994, when large fires burned throughout the Western United States, sales topped $34 million.

In 1993, standardization of wildland fire equipment in the United States reached a new milestone with the adoption of the first National Fire Protection Association (NFPA) standard on personal protective equipment (PPE). The standard, known as NFPA 1977, established minimum performance requirements for helmets, shirts, trousers, gloves, boots, and fire shelters. The standard enabled commercial vendors to supply PPE outside the GSA program. Updated in 1998, NFPA 1977 helps provide all firefighters with minimum levels of protection from the dangers of wildland fire.

In the mid-1990's, the Canadian General Standards Board completed the first Canadian standard for wildland fire PPE. In addition, the International Standards Organization is working on a standard for PPE that will have international standing under the General Agreement on Tariffs and Trade.

Through the Forest Service's equipment development centers, Federal wildland fire management agencies started seeing the benefits of equipment standardization on a large scale.

Cost Savings Though Standardization

The Government works with the private sector to procure equipment of a consistent quality at the best price to the taxpayer. Design specifications prepared by the two Forest Service centers are forwarded to the GSA wildland fire equipment program in Fort Worth, TX. There, procurement contract specialists solicit proposals and award contracts to commercial vendors for the production of clothing, tools, and equipment needed by wildland firefighters. Because the GSA bidding process provides vast economies of scale, manufacturers are able to offer low, "most-favored-customer" prices, resulting in huge cost savings for the taxpayer.

In addition to contracting, the GSA performs quality assurance at vendor plants to ensure that design specifications are rigidly followed. The GSA also maintains large fire equipment warehouses in Stockton, CA, and Fort Worth, TX, to meet short-term emergency equipment needs by firefighting agencies nationwide and to supply international support missions, such as to Mexico and Mongolia in 1998.

Each year, the GSA publishes and distributes a catalog of wildland fire PPE and supplies. Because each item in the catalog is standardized, firefighting units know that they will receive exactly what they expect and that it will be fully interchangeable or compatible

Equipment specialist designing new equipment for wildland firefighting at the USDA Forest Service's Missoula Technology and Development Center, Missoula, MT. Today, the two Forest Service equipment development centers are responsible for more than 200 design specifications. Photo: USDA Forest Service, Missoula Technology and Development Center, Missoula, MT.

with equipment already in the field.

Do standardization and large-scale purchasing really result in cost savings? In 1997, a study by the Missoula Technology and Development Center compared prices in the GSA fire equipment catalog to those in catalogs for major commercial suppliers. Prices charged by the commercial suppliers were averaged and compared to the GSA prices to show the potential savings. Table 1 shows the results for fire shelters and Nomex shirts, indicating that lower GSA prices resulted in significant savings.

Across the board, firefighting agencies save about 25 percent by procuring clothing and equipment through the GSA. Applying the 25-percent savings rate to the average annual GSA sales of $26 million in firefighting equipment suggests that average savings for the taxpayer amount to $6.5 million each year.

Standardization Drawbacks

Despite its advantages, standardization does have drawbacks. Cost efficiencies through standardization are greatest for large production runs, especially for clothing. Standardized production runs often fail to meet the clothing needs of those who are very tall, short, heavy, or thin—perhaps 10 to 20 percent of all firefighters. Fortunately, the wildland fire community has found suppliers who cater to large and tall sizes.

Another consideration is that standardized equipment used by wildland firefighters, such as handtools and backpacks, leaves little room for individual expression. The proliferation of specialized handtools—the Super P, the Reinhartski, and similar tools—and of firefighter field packs shows

How Do Wildland Firefighters Obtain Equipment?

Unlike structural firefighters, who get their equipment almost exclusively from commercial sources, agencies that fight wildland fires have multiple types of sources:

- Commercial suppliers (available to all agencies, regardless of size);
- The General Services Administration (GSA) (available to Federal agencies and their cooperators); and
- Organizations such as prison industries (available to larger State agencies, such as the California Department of Forestry and Fire Protection, for the manufacture of clothing for firefighters).

Federal agencies equip firefighters with standard equipment that can be used by all agencies. On project fires, 11 national fire caches (9 managed by the Forest Service and 2 by the USDI Bureau of Land Management) and 2 GSA warehouses are available for equipment supply. In addition, a fleet of fire cache trailers, each able to equip 250 firefighters, is distributed nationwide.

For the increasingly used contract crews, which cannot buy from Federal sources, commercial suppliers have begun to supplement stocks during fire seasons. Firefighters on multistate wildland fires carry only two sets of clothing, exchanging them as needed at the supply unit—a method similar to the direct exchange widely used by the military services.

Table 1—*Cost savings to the taxpayer through procurement of two items from the General Services Administration (GSA) in fiscal year 1998.*

Item	*GSA price*	*Average commercial price*	*Savings per item*	*Items procured*	*Total savings*
Fire shelter[a]	$39.34	$89.98	$50.64	28,370	$1,436,657
Nomex shirt	$43.43[b]	$74.12[b]	$30.69	27,888	$855,883

a. The only commercially manufactured fire shelter, built to Forest Service specifications.
b. The GSA shirt weighed 5.5 ounces (155.9 g), whereas the commercial shirt weighed 4.5 ounces (127.6 g).

that many firefighters insist on expressing their individuality. Cost efficiency is unimportant to those trying to establish independent identities in the world of wildland firefighting. Fortunately, those who refuse to use standardized equipment are still a small percentage of the total workforce.

The Future of Equipment Supply

What changes will the 21st century bring to the supply system for wildland fire equipment? Predictions can be made about the future of wildland firefighting worldwide:

- The problem of wildland fires will increase in scope and complexity.
- Wildland firefighters will no longer be able to count on unlimited Federal funding.
- Fire suppression will become ever more interagency.
- International standardization through the General Agreement on Trade and Tariffs and the International Standards Organization will affect equipment procurement for wildland fire management agencies worldwide.

Growing interagency cooperation at the national and international levels, especially at a time of stagnating or declining Federal budgets, will require more equipment standardization to maximize cost-effectiveness and safety for wildland firefighters. ■

The NFPA standard for personal protective equipment helps provide all firefighters with minimum levels of protection from the dangers of wildland fire.

Wildland firefighter on a fireline, equipped with a McLeod tool and standard personal protective equipment such as Nomex clothing. Using standardized clothing and equipment helps reduce costs on large fires. Photo: Ravi Miro Fry, USDA Forest Service, Boise National Forest, Boise, ID.

Supply depot at Warm Springs Base Camp on the 1994 Rabbit Creek Fire, Boise National Forest, Boise, ID. The General Services Administration works with the private sector to procure equipment of a consistent quality at the best price to the taxpayer, saving about 25 percent of costs for firefighter clothing and equipment. Photo: Bob Nichols, USDA Forest Service, Boise National Forest, Boise, ID, 1994.

Forecasting Fire Season Severity*

Everett M. "Sonny" Stiger

Each year, wildland fire managers prepare for the coming fire season based on factors such as long-range weather forecasts by the National Interagency Fire Center in Boise, ID (through the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service). Adequate preparedness is vital to successful wildland fire management, as the severity of the 2000 fire season showed only all too well.

Prior to the 2000 fire season, I was able to make a fairly good prediction of fire season severity in the area around Helena, MT. My forecasting method is based on a procedure I developed to help wildland fire managers decide whether to let a lightning fire burn as a wildland fire use in a designated wilderness area.

Prior to the 2000 fire season, I was able to make a fairly good prediction of fire season severity in the area around Helena, MT.

Beginnings

I began my career with the USDA Forest Service in Colorado in 1959 and quickly found my niche in wildland fire management. In 1977, I transferred from the Rocky Mountain Region to the Northern Region as a fuel and fire management specialist for the Beaverhead, Deerlodge, Helena, and Lewis and Clark National Forests. One of my first tasks was to develop and implement fire management plans for the Anaconda–Pintler and Bob Marshal Wildernesses. The first plans went into effect in the early 1980's.

It quickly became obvious that conventional, long-range weather forecasts were insufficient for predicting the severity of the upcoming fire season. Something else was needed to help managers feel confident that a June decision to designate a lightning fire as a wildland fire use would not result in an escaped fire if unusually severe fire conditions developed by August.

I had been toying with a procedure that was put to the test during the 1988 fire season, the year of the Yellowstone Fires. In 1988, Yellowstone National Park had one of its wettest Mays on record. The wet spring weather gave no hint of the severe fire season to come. I believed that a wet spring was only part of the picture; if winter precipitation was only 50 percent of normal, a wet May might not be of much help by August. Ensuing events proved me right.

The 2000 Fire Season

After retiring from the Forest Service, I continued to test my procedure in the area around Helena, MT, by monitoring local indicators (see sidebar). In the winter of 1999–2000, I became increasingly alarmed by indications that the coming fire season

Fire Season Severity Indicators

Fire season severity can be predicted with reasonable accuracy based on:

- Snowpack size (i.e., the percentage of the average snow water equivalent);
- Cumulative winter precipitation (i.e., the percentage of the normal level);
- The thousand-hour fuel moisture level (in relation to the average level);
- The energy release component (in relation to the average and to the 80th and 90th percentiles); and
- Climatology (in a very simplified sense; for example, the area near Helena, MT, tends to dry out from late June through late August or early September).

This information combined gives one a good idea by early May of what the fire season will be like in July and August.

Sonny Stiger is an associate with Montana Prescribed Fire Services, Inc., Wolf Creek, MT.

* The procedure outlined in this article was published by the author in the proceedings of the 11th Conference on Fire and Meteorology, 16–19 April 1991, Missoula, MT.

would be the most severe since 1988. By February 2000, I felt compelled to warn our county fire council and the Tri-County Fire Working Group that a severe fire season might be in the making. I continued to monitor conditions and report on a monthly basis to groups that included the Helena National Forest staff. By June 1, I was convinced that a severe fire season was imminent:

- The snow water equivalent was "extremely below average" (less than 50 percent) for two-thirds of the mountains in Montana and "much below average" (50 to 70 percent) for the remaining one-third.
- Cumulative precipitation for the winter of 1999–2000 was seriously below normal for many valley stations in central and southwestern Montana—about the same or less than for the same period in 1988 (i.e., since October 1 of the preceding year, the beginning of the water year).
- At our Helena Fire Weather Station, the thousand-hour fuel moisture was at an all-time low and the energy release component was at an all-time high.
- The weather forecast for June was for normal precipitation and above-normal temperatures. However, we would have needed several times the normal precipitation in June to get us out of the hole, and climatology told us we would dry out in July and August. A look at the ground confirmed the dry conditions: Springs and ponds that had never gone dry were drying up or already dry.

In early June 2000, I began waving a red warning flag based on fire season severity indicators, data comparisons to 1988, and a good historical feel for the weather in our area. I believed that the Helena area and particularly the Belt Mountains would be in for a tough fire season. By midnight on July 23, there was no doubt. Before the 2000 fire season was over, more than 150,000 acres (60,000 ha) had burned in the Helena area, along with many homes and outbuildings.

A Valuable Prediction Tool

The past 15 years have shown the severe consequences of long-term fuel buildups in the interior West. We all know what the future holds until our fuels are recycled, whether through management actions or through fires ignited by careless people or natural events. Wildland fire managers will need all the help they can get to stay on top of a serious situation.

Awareness by managers early in the year of the potential for a severe fire season can improve preparedness and reduce losses. Too many of us in the wildland fire business are unwilling to stick out our necks and make predictions for fear of being ridiculed. However, we do have enough information available to make reasonably good predictions. It's time to use it!

For more information on forecasting fire season severity, contact Sonny Stiger, 1555 Beartooth Road, Wolf Creek, MT 59648, 406-235-4337 (voice), 406-235-4374 (fax), stigerem@in-tch.com (e-mail). ■

Snowpack on the Gunnison National Forest in Colorado. Snowpack size and cumulative winter precipitation are some of the indicators that can be used to predict a severe fire season. Photo: R.E. Grossman, USDA Forest Service, Grand Mesa, CO, 1992.

Can the Fire-Dependent Whitebark Pine Be Saved?

Robert E. Keane

High atop the western ranges traversed by some of America's most intrepid explorers, the whitebark pine (*Pinus albicaulis*) is making a last desperate stand. Captains Meriwether Lewis and William Clark, passing through the Bitterroot Mountains in 1805–06 on their historic expedition to the mouth of the Columbia River, saw the whitebark pine in its prime. Gifford Pinchot, who later became the first Chief of the USDA Forest Service, noted the tree while surveying the forest reserves in 1897.

In recent decades, whitebark pine has been declining due to epidemics and fire exclusion (Keane and Arno 1993; Kendall and Arno 1990). In the northern Rocky Mountains, a project is underway to explore the feasibility of using fire and silviculture to restore the tree's high-elevation habitat.

Fire exclusion has allowed fir and spruce to displace whitebark pine as the dominant species in many subalpine forests.

Fire Ecology

Whitebark pine historically comprised about 10 to 15 percent of the forests in the Western United States (Arno and Hoff 1989) (fig. 1). Although long-lived (the oldest identified living individual is more than 1,300 years of age), whitebark pine is eventually replaced, in the absence of fire, by more shade-tolerant species, such as subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), and mountain hemlock (*Tsuga mertensiana*) (Arno and Hoff 1990).

Three types of fire regimes govern whitebark pine forests (Morgan and others 1994; Arno and Hoff 1990). The most common is the mixed-severity fire regime, where fire intensity and frequency vary widely, creating complex patterns of tree survival and mortality. Most fires in the mixed-severity regime include both nonlethal underburns and stand-replacing blazes (Morgan and others 1994). In sparse surface fuels, fires burn at low severities, killing the smallest trees and the most fire-susceptible overstory species, often subalpine fir; severities increase in areas with high fuel loads or where winds drive the fire into tree crowns. Mixed-severity fires can occur at intervals of 60 to 300 years (Arno and Hoff 1990; Morgan and others 1994). Burned patches are often 2.5 to 120 acres (1–50 ha) in size, depending on topography and fuels (Norment 1991; Tomback and others 1990).

Whitebark Pine: An Invaluable High-Mountain Resource

Whitebark pine (*Pinus albicaulis*) is an important tree in upper subalpine forests of the northern Rocky Mountains, Sierra Nevada, and Cascades (Arno and Hoff 1990). Of limited commercial value, whitebark pine produces large seeds that feed at least 110 different species, including the threatened grizzly bear (*Ursus arctos horribilis*), the red squirrel (*Tamiasciurus hudsonicus*), and the Clark's nutcracker (*Nucifraga columbiana*) (Tomback 1989). Nutcrackers cache the seeds in loose mountain soils, particularly on burn sites, where unclaimed seeds germinate and grow to form the next generation of whitebark pine. Squirrels cache whitebark pine cones in places called middens; in summer, bears travel to the high country in search of the middens. Whitebark pine also protects snowpack in high-elevation watersheds and delays snowmelt, providing high-quality water to valleys below (Arno and Hoff 1990; Hann 1990).

Bob Keane is a research ecologist for the USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT.

Figure 1—*Historical range of the whitebark pine. More than 60 years of fire exclusion have allowed fir and spruce to displace whitebark pine as the dominant species in much of its historical range. Illustration: Arno and Hoff (1990).*

Some whitebark pine stands experience recurrent nonlethal underburns due to sparse fuel loads, mostly in the southern parts of the pine's range in the Rocky Mountains. By contrast, most whitebark pine forests in northwestern Montana, northern Idaho, and the Cascades originated after large, stand-replacing fires that occur at intervals of 250 years or more (Morgan and others 1994). Stand-replacing fires are usually wind driven and often start in lower elevation stands.

Whitebark pine is more capable of surviving low-severity fires than its competitors due to its thicker bark, thinner crowns, and deeper roots (Arno and Hoff 1990). Whitebark pine readily recolonizes large, stand-replacing burns because its seeds are transported from great distances by Clark's nutcracker (*Nucifraga columbiana*)—up to 100 times farther than wind can disperse the seeds of fir and spruce (Tomback and others 1990). Nutcrackers cache whitebark pine seeds on the ground for future consumption when other foodstuffs become rare. Essentially all regeneration comes from unclaimed nutcracker caches, where seeds eventually germinate and grow into seedlings. Nutcrackers prefer open sites with many visual cues for seed caching. Burn sites are ideal.

> Whitebark pine is more capable of surviving fires than its competitors due to its thicker bark, thinner crowns, and deeper roots.

Whitebark Pine Decline

More than 60 years of fire exclusion have allowed fir and spruce to replace whitebark pine as the dominant species in many subalpine forests (Arno 1986; Keane and others 1994). The successional process in these slow-growing, high-elevation forests was accelerated by two types of epidemics:

- In the 1930's, white pine blister rust (*Cronartium ribicola*), an exotic disease from Europe, started killing whitebark pines in northwestern Montana, northern and central Idaho, and the Cascades.
- In the 1930's and 1940's, the native mountain pine beetle (*Dendroctonus ponderosae*) killed many whitebark pines in western Montana and central Idaho.

The epidemics had a cumulative impact: The rust weakened many trees, preventing them from defending themselves against beetle attack. Both the rust and the beetle kill mature, cone-bearing trees, thereby accelerating succession to the more shade-tolerant fir and spruce.

Adapted to cyclical beetle epidemics, the whitebark pine ecosystem could easily have recovered if fires had been allowed to burn the beetle-killed forests. But, coupled

Whitebark pine (Pinus albicaulis) *ecosystem. An important upper subalpine forest tree in much of the West, whitebark pine has declined in recent decades due to epidemics and fire exclusion. Photo: Steve Arno, USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT, 1996.*

with the lack of fire as a recycling agent and the introduction of the exotic rust, the epidemics have caused a major shift in landscape composition and structure from early-seral whitebark pine to late-seral fir and spruce. In Montana's Glacier Nat-ional Park, for example, whitebark pine is down to 5 percent of its historical range; in places near Missoula, MT, 60 to 80 percent of the trees have died (Kendall and Arno 1990).

Clark's nutcracker (Nucifraga columbiana). *Nutcrackers cache whitebark pine seeds in loose mountain soils, particularly on burn sites, thereby planting the next generation of whitebark pines. Photo: Steve Arno, USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT, 1996.*

Restoring Whitebark Pine Ecosystems

On five research sites in or near the Bitterroot Mountains of Montana and Idaho, the Forest Service's Fire Sciences Laboratory, Rocky Mountain Research Station, is investigating methods of restoring whitebark pine (Keane and Arno 1996) (fig. 2). Researchers are using prescribed fire and silvicultural harvest to counter the effects of blister rust and advancing succession. The sites represent different biophysical environments, degrees of rust infection, and stand structures.

Prescribed Fire. Four study areas (Smith Creek, Beaver Ridge, Coyote Meadows, and Bear Overlook) are in the mixed-severity fire regime, where fires before 1900 occurred at intervals of 100 to 200 years. Keane and Arno (1996) designed treatments to mimic historical fire effects. A low- to moderate-severity prescribed burn was conducted on a treatment unit in each of the four study areas. The primary objective was to kill all fir and spruce, sparing as many whitebark pines as possible.

Parts of the Musgrove, Beaver Ridge, Coyote Meadows, and Bear Overlook study areas did not have sufficient fuels to carry the fire to all parts of the stand. Therefore, an adjacent treatment unit was created in each area where standing firs were cut and left on the ground to augment fuel beds. Then fire was applied at the intensity appropriate for each site.

Silvicultural Cuttings. In three study areas (Smith Creek, Beaver Ridge, and Bear Overlook), Keane and Arno (1996) designed silvicultural cuttings to mimic patchy mixed-severity burns. On parts of the Smith Creek site, all trees were commercially cut except for healthy, cone-bearing whitebark pine, creating quarter-acre (0.1-ha) circular openings where nutcrackers could cache whitebark pine seeds (Norment 1991; Tomback

Whitebark pine ecosystem in decline. White pine blister rust often weakens individual trees, preventing them from exuding enough sap to defend themselves against attack by the mountain pine beetle. In beetle-killed forests, fire exclusion has eliminated fire as a recycling agent, accelerating the succession from early-seral whitebark pine to late-seral fir and spruce. Photo: Bob Keane, USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT, 1996.

Figure 2—*Sites in Montana and Idaho where Forest Service researchers are investigating methods of using prescribed fire and silvicultural treatments to restore whitebark pine. Illustration: Bob Keane, USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT, 1996.*

1998). In the forested areas between the openings, all fir and spruce were removed, leaving some healthy lodgepole pine and all living whitebark pine. The purpose was to limit wind-dispersed seed from competitor species.

On the Beaver Ridge site, similar "nutcracker openings" were created by cutting all fir, spruce, lodgepole pine, and dying whitebark pine in patches of 2.5 to 5 acres (1–2 ha). The felled trees were left onsite, with their branches piled to clear the ground for nutcracker seed caching. Half of the 75-acre (30-ha) harvest area was then burned, and half of all nutcracker openings (burned and unburned) were planted with rust-resistant whitebark pine seedlings.

On the Bear Overlook site, a treatment unit was thinned to remove all lodgepole pine, fir, and spruce, leaving healthy whitebark pine uncut. The purpose was to enhance whitebark pine cone production.

Natural Fire Needed

Labor-intensive restoration efforts, such as those described here, are possible only in small, easily accessible areas. In most of the whitebark pine's range, inaccessible stands will likely continue to decline unless natural fire is allowed to return. Nutcrackers like to cache white-bark pine seeds in openings, especially those created by wildland fires (Tomback and others 1990). The chances for whitebark pine seedlings are best in large burned areas where competition is minimal (McCaughey and Schmidt 1990). Fire exclusion prevents large natural openings from forming. Without fire, there are fewer places where seeds from rust-resistant trees (up to 5 percent of the whitebark pine population) can grow into viable, seed-producing, rust-resistant individuals. The most important management action for conserving and maintaining vital whitebark pine forests is to avoid extinguishing all fires in wilderness areas and other remote settings.

For more information on the whitebark pine restoration project, contact Bob Keane, USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, P.O. Box 8089, Missoula, MT 59807, 406-329-4846 (voice), 406-329-4877 (fax), rkeane@fs.fed.us (e-mail).

References

Arno, S. 1986. Whitebark pine cone crops—A diminishing source of wildlife food? Western Journal of Applied Forestry. 1: 92–94.

Arno, S.; Hoff, R. 1990. *Pinus albicaulis* Engelm. Whitebark pine. In: Burns, R.M.; Honkala, B.H., tech. coords. Silvics of North America. Vol. 1: Conifers. Ag. Handbk. 654. Washington, DC: USDA Forest Service: 268–279.

Hann, W.J. 1990. Landscape and ecosystem-level management in whitebark pine ecosystems. In: Schmidt, W.C.; McDonald, K.J., comps. Proceedings—Symposium on Whitebark Pine Ecosystems: Ecology and Management of a High Mountain Resource; 29–31 March 1989; Bozeman, MT. Gen. Tech. Rep. INT–270. Ogden, UT: USDA Forest Service, Intermountain Research Station: 335–340.

Keane, R.; Arno, S. 1993. Rapid decline of whitebark pine in western Montana: Evidence from 20-year remeasurements. Western Journal of Applied Forestry. 8(2): 44–47.

Keane, R.E.; Morgan, P.; Menakis, J.P. 1994. Landscape assessment of the decline of whitebark pine (*Pinus albicaulis*) in the Bob Marshall Wilderness Complex, Montana, USA. Northwest Science. 68(3): 213–229.

Keane, R.E.; Arno, S.F. 1996. Whitebark Pine (*Pinus albicaulis*) ecosystem restoration in western Montana. In: Arno, S.F.; Hardy, C.C., eds. The Use of Fire in Forest Restoration: A General Session at the Annual Meeting of the Society of Ecosystem Restoration, "Taking a Broader View"; 14–16 September 1996; Seattle, WA. Gen. Tech. Rep. INT–GTR–341. Ogden, UT: Intermountain Research Station: 51–54.

Kendall, K.C.; Arno, S.F. 1990. Whitebark pine—an important but endangered wildlife resource. In: Schmidt, W.C.; McDonald, K.J., comps. Proceedings—Symposium on Whitebark Pine Ecosystems: Ecology and Management of a High Mountain Resource; 29–31 March 1989; Bozeman, MT. Gen. Tech. Rep. INT–270. Ogden, UT: USDA Forest Service, Intermountain Research Station: 264–274.

McCaughey, W.W.; Schmidt, W.C. 1990. Autecology of whitebark pine. In: Schmidt, W.C.; McDonald, K.J., comps. Proceedings—Symposium on Whitebark Pine Ecosystems: Ecology and Management of a High Mountain Resource; 29–31 March 1989; Bozeman, MT. Gen. Tech. Rep. INT–270. Ogden, UT: USDA Forest Service, Intermountain Research Station: 85–95.

Morgan, P.; Bunting, S.C.; Keane, R.E.; Arno, S.F. 1994. Fire ecology of whitebark pine (*Pinus albicaulis*) forests in the Rocky Mountains, USA. In: Schmidt, W.C.; Holtzmeier, F.-K., comps. Proceedings of the International Symposium Subalpine Stone Pines and Their Environment: The Status of Our Knowledge; 5–11 September 1992; St. Moritz, Switzerland. Gen. Tech. Rep. INT–GTR–309. Ogden, UT: USDA Forest Service, Intermountain Research Station: 136–142.

Norment, C.J. 1991. Bird use of forest patches in the subalpine forest–alpine tundra ecotone of the Beartooth Mountains, Wyoming. Northwest Science. 65(1): 1–10.

Tomback, D.F. 1989. The broken circle: Fire, birds and whitebark pine. In: Walsh, T., ed. Wilderness and wildfire. Misc. Pub. 50. Missoula, MT: University of Montana, School of Forestry, Montana Forest and Range Experiment Station: 14–17.

Tomback, D.F. 1998. Clark's nutcracker (*Nucifraga columbiana*). In: Poole, A.; Gill, F., eds. The birds of North America. No. 331. Philadelphia, PA: The Birds of North America, Inc.

Tomback, D.F.; Hoffman, L.A.; Sund, S.K. 1990. Coevolution of whitebark pine and nutcrackers: Implications for forest regeneration. In: Schmidt, W.C.; McDonald, K.J., comps. Proceedings—Symposium on Whitebark Pine Ecosystems: Ecology and Management of a High Mountain Resource; 29–31 March 1989; Bozeman, MT. Gen. Tech. Rep. INT–270. Ogden, UT: USDA Forest Service, Intermountain Research Station: 118–130. ■

Fire Ignition From Horseback

Carlton Britton, Rob Mitchell, Brent Racher, and Ernest Fish

Successful use of prescribed fire on western rangeland depends on an abundance of fine fuel and a rapid, safe, and effective head fire (see sidebar). Preserving safety, maintaining control, minimizing costs, and meeting ecological objectives are key to a successful prescribed burn.

On rough western rangeland, land managers have few options for rapid, efficient head fire ignition. Head fire ignition by hand crews is effective, inexpensive, and usually safe; moreover, it affords access to most areas. However, it is also time consuming and sometimes fails to ignite a continuous fire front. Helitorch ignition is efficient even where poor grazing management has minimized fine fuel loads; but it is expensive, especially when used on small burns of 1,000 to 3,000 acres (400–1,200 ha). Four-wheel all-terrain vehicles (ATV's) are successfully used for head fire ignition on rough rangeland, but safety concerns, steep slopes, and restricted use on some public lands often make their use inappropriate. Consequently, some rugged, inaccessible areas require an alternative to head fire ignition by hand crews, helitorches, or ATV's.

Horses Handle Head Firing

On the Pitchfork Ranch, Dickens County, TX, we tested horses for rapid ignition of head fires on rough rangeland. The ranch was an ideal location because the quality of its horses and cowboys is unsurpassed in the Western United States, and the land is dominated by rough rangeland infested with redberry juniper. This working ranch has 165,000 acres (67,000 ha), with about 5,000 cows, 250 bulls, and 120 horses. Our evaluation occurred in February, March, and April 1998 on a 2,844-acre (1,150-ha) pasture, with an average elevation of about 2,900 feet (880 m); 24 percent of the pasture is at a slope greater than 10 percent (fig. 1).

Carlton Britton and Rob Mitchell are directors and Brent Racher is the fire boss of the Texas Tech University Fire Ecology Center, Lubbock, TX; and Ernest Fish is the director of the Geospatial Technologies Laboratory and the chair of the Department of Range, Wildlife, and Fisheries Management, Texas Tech University, Lubbock, TX.

> Unlike ATV's, horses do not get flats, do not consume gasoline, and do not tip over in rocky, steep areas.

Even in dense juniper, two cowboys mounted on horseback skillfully followed fine fuels along plowed firelines at a lope, igniting the range (fig. 2). By contrast, ignition by hand crews and ATV's failed to light a continuous fire front. The horses were sure-footed in the rough terrain, and we did not have to stop to change any flat tires or fill up a gas tank! Drip torches, modified with 28-inch (71-cm) spout extensions to get the wick close to the fine fuel (fig. 3), were easy to handle on horseback and did not excite the horses. We used three horses in 2 days of head firing, and the burning torches did not make any of them nervous or uncomfortable.

Horseback ignition was safer and at least three times faster than using ATV's. It was also three times faster than hand crew ignition and nearly as accurate. Although slower than helitorch ignition, horseback ignition proved significantly more cost-effective.

Careful Burn Planning Is Key

Successful prescribed fire use on western rangelands requires abundant fine fuels. Land managers, recognizing the need, wisely defer grazing for all or part of the year. Then, even in semiarid grasslands, fine fuels will accumulate with careful advance planning, including a burning delay until the conditions are suitable. Containing fire within the boundaries of a prescribed burn means installing blacklines on the leeward edges of the unit that are wide enough to stop the head fire. Safety is paramount—the time invested in planning and executing prescribed burns is well spent.

Capable Cowboys and Calm Horses Are Key

Our experience using horses for head fire ignition was successful and added no expense to the

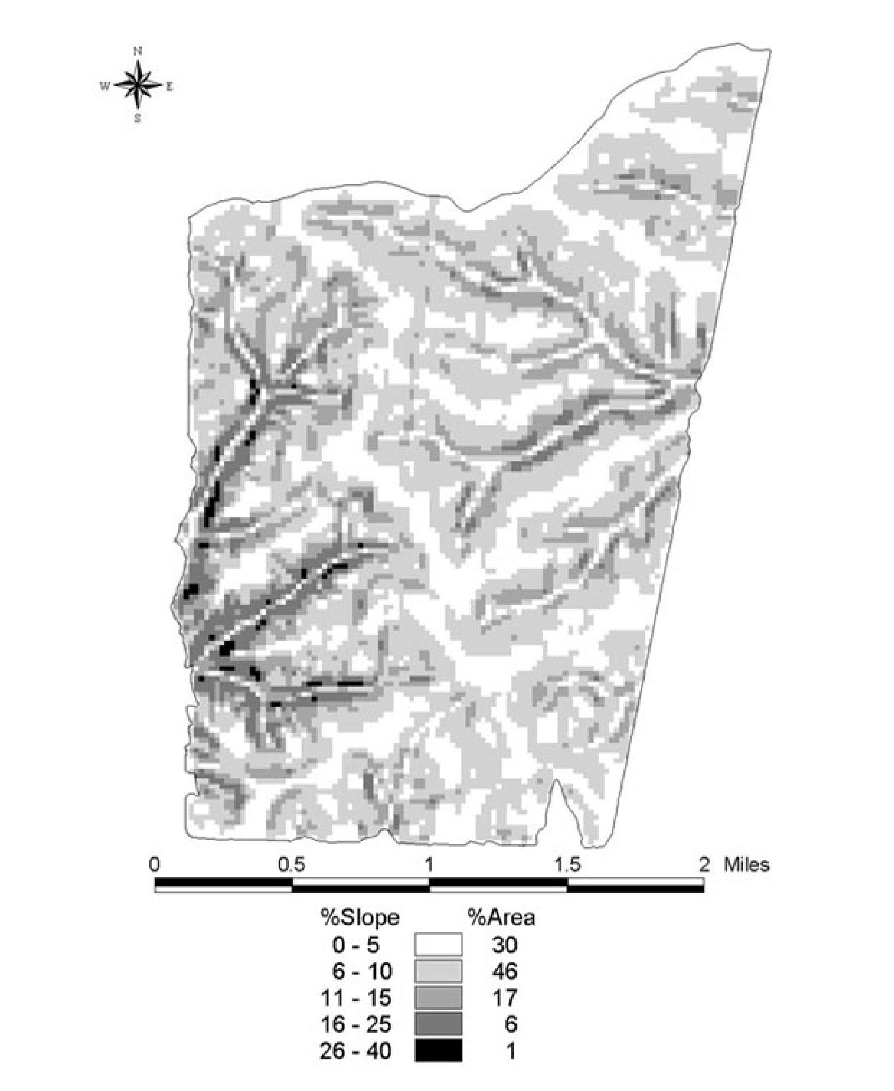

Figure 1—*Slope map derived from a digital elevation model of the 2,844-acre (1,150-ha) pasture burned from horseback in 1998 on the Pitchfork Ranch in Dickens County, TX.*

Figure 2—*Lighting juniper-infested rangeland from horseback on the Pitchfork Ranch in Dickens County, TX. Photo: Wyman Meinzer, Benjamin, TX, 1998.*

prescribed fire ignition. Total cost for labor, torch fuel, mileage, and food on this prescribed fire was $3.07 per acre. Using a helitorch for head fire ignition on this pasture would cost at least $5.07 per acre, increasing prescribed fire application costs by 65 percent.

Taking the time to train proficient horseback riders to use drip torches is better than trying to teach ignition crews to become skilled riders. We encourage using well-trained horses and skilled riders to ignite head fires in rough rangeland.

Acknowledgments

The authors wish to thank the Dr. Leon Bromberg Charitable Trust Fund and the Pitchfork Ranch for their support of this project. ■

Figure 3—*Drip torches modified with a 28-inch (71-cm) extension to get the wick close to the fine fuel from horseback. Photo: Wyman Meinzer, Benjamin, TX, 1998.*

Fighting Fire Without Fire: Biomass Removal as a Prelude to Prescribed Fire

Wheelabrator Environmental Systems Inc.

Stephen M. Jolley

Federal forestland managers recognize that the level of fuel loading is unnaturally high on tens of millions of wildland acres throughout the Western United States (Dombeck 2000). Many individuals and organizations are striving to find effective, economical solutions to the western forest fuels problem. Proposed solutions vary greatly in their methods, costs, and timelines. To do the greatest good at the least cost, land managers should consider, for each solution, the economics involved and the number of years necessary to achieve the desired conditions on the ground.

Comparing Methods

Let's assume that the goal is to manage fuel loads to minimize the possibility of losing a forest to a stand-replacing wildfire. Let's further assume that after the desired condition is achieved, prescribed fire will be used to maintain the stand structure. Figure 1 shows three scenarios for converting 500 acres (200 ha) of overstocked forest on gentle terrain (with a slope of less than 30 percent) to a fire-tolerant stand. Each scenario is based on a different method of initial fuel load reduction before prescribed fire is introduced.

> Reducing heavy fuel buildups in the Western United States will require the use of every available tool, including biomass removal.

Two scenarios entail removing excess biomass using mechanized thinning. In scenario I, trees are removed and marketed, generating revenues to offset operational costs. No diameter limit is set for the size of trees to be removed; the guiding principle is to modify the types and distribution of vegetation to meet prescribed criteria for stand density and crown closure.

In scenario II, merchantable trees are not removed, but revenues generated from removed small-diameter materials offset some expenses. Depending on the location of the activity, markets

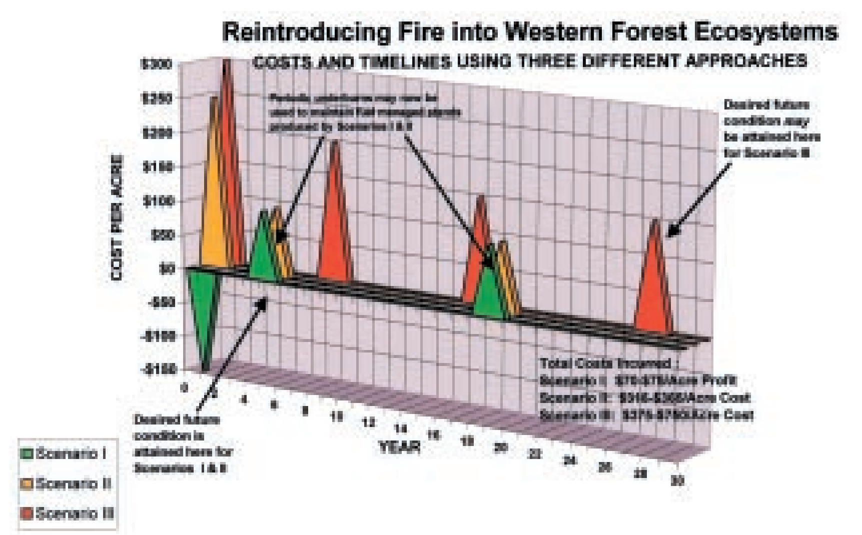

Figure 1—*Costs and timelines using three different approaches to initial fuels reduction on 500 acres (200 ha) in western forest ecosystems. Under scenario I, biomass removal would include harvesting merchantable trees; the desired stand condition would be reached in 3 to 6 years at a profit of $70 to $75 per acre. Periodic underburns would then begin. Under scenario II, biomass removal would not include harvesting merchantable trees; the desired condition would be reached in 3 to 6 years at a cost of $315 to $365 per acre. Under scenario III, only prescribed fire would be used; the desired condition would be reached in 25 to 30 years at a cost of $375 to $750 per acre. Illustration: Stephen M. Jolley, Wheelabrator Shasta Energy Company, Anderson, CA, 2000.*

Stephen Jolley is a fuel manager for the Wheelabrator Shasta Energy Company, Inc., in Anderson, CA.

might already exist for small-diameter materials used to manufacture particle-board furnish, pulp chips, biomass fuel, mulch, compost, or landscaping material. The sheer volume of treatments needed is likely to generate new markets even where none currently exist.

Scenario III relies exclusively on prescribed fire, the method often preferred by Federal land managers in the West. Because prescribed burning generates no revenues, the number of treatable acres is limited by the amount of appropriated funding.

Prescribed Fire: Costs and Delay

Scenario I yields a profit that could be used to fund other resource management operations, whereas scenarios II and III both require appropriated funding. Scenario III has higher costs than scenario II (ranging from $10 to $435 more per acre).

Prescribed fire cost estimates are based on information from a contractor who plans and executes prescribed burns for private landowners and public agencies. The estimates take into account the hidden costs of prescribed fire—costs associated with uncounted personnel, planning and preparation, having more engines at a burn than originally planned, final cleanup, and damages from escapes. For example, the 1999 Lowden Fire near Lewiston, CA, and the 2000 Cerro Grande Fire in Los Alamos, NM, were both escaped prescribed burns associated with enormous unanticipated costs. Given the size of the fuels problem in the West, it is reasonable to assume that continued prescribed fire use will engender substantial costs from escaped fires.

Biomass removal as a prelude to prescribed fire has often been overlooked and underrated.

Scenario III is not only more expensive than scenarios I and II, but also costlier in terms of the time required to achieve the desired stand condition. The timeline in scenarios I and II is 3 to 6 years, whereas in scenario III, it is 25 to 30 years. It could be more; the number of years required to achieve the desired condition is uncertain in scenario III, because multiple burns are required. From the standpoints of both cost and timeline, scenario III is the least attractive alternative.

Prescribed fire has other drawbacks as well:

- Air quality. Smoke is a growing concern in the West, for health, economic, and other reasons. The surest form of smoke management is to seek alternatives to burning.
- Community stability. Prescribed fire does not generate the level of economic activity associated with biomass removal, which can produce much-needed jobs in rural communities. Indeed, prescribed fire can harm the local recreation industry by filling the air with smoke and keeping away recreational users.
- Resource risk. Exposing a forest stand to multiple prescribed fires risks each time losing the stand to an escaped fire. The more years required to achieve the desired future condition, the higher the resource risk.

Biomass Removal: Pros and Cons

Opponents of biomass removal make several arguments:

- **Biomass removal requires an adequate road system.**

True, but so do most forms of active land management, including most prescribed fire use. Anyway, vast road systems already exist on public lands that are usable to reduce fuels without building new roads.

- **Biomass removal is impractical on steep slopes.**

True; for the time being, fire use without mechanized pretreatment is probably the only viable solution on steep slopes. Therefore, mechanized pretreatments should focus first on relatively gentle terrain. Eventually, however, new technology development might enable the safe treatment of steeper slopes by mechanical means.

- **Markets are insufficient for the removed biomass material.**

Many areas have established markets for sawlogs and less valuable biomass, marketable as particleboard furnish, pulp chips, and boiler fuel. However, history teaches that markets respond to opportunities. A sustained flow of biomass materials will stimulate new investment and markets.

> Using prescribed fire alone is not only more expensive than biomass removal, but also costlier in terms of the time required to achieve the desired stand condition.

Benefits From Mechanized Pretreatments

Figure 2 shows the result of using prescribed fire in a stand without first thinning (scenario III). More fires will be required in the future. Figure 3 shows how biomass harvest, including sawlog production (scenario I), changed a forest within 8 years following a single treatment. The resulting fuel load can be safely maintained using prescribed fire.

The severe problem of excess fuels in the Western United States demands the use of every available tool. Biomass removal as a prefire treatment has often been overlooked and underrated. A thorough analysis will reveal that initial fuel reduction goals can be achieved most quickly and cost-effectively, with the least risk to the environment, through mechanized pretreatment as a prelude to prescribed fire. Only then can a prescribed fire maintenance program be safely and effectively adopted.

Reference

Dombeck, M. 2000. How can we reduce the fire danger in the interior West? Fire Management Today. 61(1): 5–10. ■

Figure 2—*Young, unthinned forest where prescribed fire has been used with unacceptable results. Photo: Stephen M. Jolley, Wheelabrator Shasta Energy Company, Anderson, CA, 1999.*

Figure 3—*Forest stand near Viola, CA, 8 years after thinning. This fuel load can be managed with prescribed fire at little risk. Photo: Stephen M. Jolley, Wheelabrator Shasta Energy Company, Anderson, CA, 1995.*

Workforce Diversity Program: A Progress Report From the Payette National Forest

Francisco Romero

Recognizing the need to integrate underrepresented groups and minorities into its fire management organization, in 1994 the Payette National Forest (NF), McCall, ID, began its Developmental Assistant Fire Management Officer Workforce Diversity Program. This program helps the USDA Forest Service accomplish workforce diversity by providing qualified candidates with the training and experience they need to become fire management officers (FMO's) or assistant FMO's (AFMO's) at the district level—an organizational level that has underrepresentation by minority groups.

> The custom-tailored training program provides students with a blend of formal instruction and on-the-job skills to reach target qualifications.

The Program

Forest Service district FMO's and AFMO's receive on-the-ground experience and in-the-classroom education in fire suppression and prescribed fire techniques. The Payette NF uses the suppression and prescribed fire qualifications of division supervisor and intermediate burn boss as targets in designing each apprentice's training and development plan. This means that program graduates are qualified to manage complex assignments—such as emergency response activities—and to plan and implement prescribed fire. The custom-tailored program provides students with a blend of formal training and on-the-job skills to reach target qualifications and to learn about fiscal accountability, hiring, purchasing, crew management, and project planning.

In addition to the training in fire suppression and prescribed fire required by the Forest Service, the Developmental AFMO program encourages students to use a variety of other teaching sources. Depending on the qualifications and education of each apprentice, instructional opportunities include enrollment in agency-sponsored continuing education programs such as Technical Fire Management or Continuing Education in Ecosystem Management. The program also provides funding to pursue advanced degrees in fire science and fire ecology from accredited universities.

Education and training in fire suppression and prescribed burning provide a solid foundation for a career in this discipline. But the heart and soul of the Developmental AFMO program is the experiential learning that occurs when an apprentice is integrated into a fire management staff on a selected Forest Service district. Spending approximately 1 year per district, each apprentice is immersed in the facets of fire management—fuels, prescribed fire, project planning, wilderness fire management, and initial attack coordination. After a year, the trainee graduates to another district and the focus is shifted to provide the most holistic experience possible. To broaden their knowledge and experience, trainees are also encouraged to seek short-term suppression assignments and prescribed burning opportunities throughout the United States.

On the Payette NF, a diverse fire program and an average of 170 fires each season provide many opportunities for program apprentices to experience on-the-ground suppression operations and district management and logistic techniques. A variety of prescribed fire needs—fuel reduction, reforestation, ecological maintenance, and support of endangered species habitat—completes the apprentice's fire management experience.

Candidates and Funding

In 1997, Kelly Martin, the first program apprentice, graduated from her 3-year individualized Developmental AFMO program. Since then, Martin has successfully competed for her job as a district FMO on the Manti–La Sal National Forest, Price, UT. Suzanne Acton and I followed, beginning our

---

Frankie Romero is a zone fire management officer for the Upper Colorado River Interagency Fire Management Unit, Rifle, CO.

The heart and soul of the program is the experiential learning that occurs when an apprentice is integrated into a fire management staff on a Forest Service district.

apprenticeships in 1998. After completing my program in March 2000, I accepted my current position, while keeping my career sights focused on a fire ecologist or district FMO or AFMO position. Acton, in the final year of her program, is looking forward to a fire ecologist, FMO, or AFMO position. The Payette NF has received funding for and will soon select two candidates who will begin their Developmental AFMO programs in 2001.

A competitive grant process administered by the Forest Service, Washington Office, Fire and Aviation Management, funds the Developmental AFMO program. Grants supporting workforce diversity projects are awarded to forests based on the objectives of their program and their ability to meet those objectives. The Payette NF successfully competed for and was awarded a diversity program grant in 1994 and 1998. Based on the success of the program, the Intermountain Region of the Forest Service and the Payette NF will contribute matching funds to augment future allocations from Fire and Aviation Management.

My Experience

When I started the program in 1998, I was a lead firefighter with 13 seasons of type 1 firefighting experience, a master's degree in forest fire science, and a desire to advance my career by moving into fire management. Fire suppression was the focus of my career experience, so the Developmental AFMO program was an opportunity to diversify my knowledge base into the prescribed fire arena. I worked with the Payette NF's fire management staff, and together we identified four areas to emphasize in my program:

1. Wilderness fire management;
2. Initial attack coordination;
3. Fuel management and prescribed fire; and
4. District-level fire management, including budget, crew supervision, and planning—specifically, National Environmental Policy Act analysis.

On the Payette NF, my experiences ranged from managing wildland-fire-use fires in the Frank Church Wilderness, to performing initial attack coordination under multiple fire starts, to planning and implementing fuel work related to timber harvest and natural fuel complexes. Because the Payette NF's suppression organization is robust, the full spectrum of suppression resources—hand crews, engines, helitack, helirappellers, helicopters, smokejumpers, and retardant aircraft—

Suzanne Acton, an apprentice in the Developmental Assistant Fire Management Officer Workforce Diversity Program, igniting a March 2000 prescribed fire to maintain migratory waterfowl habitat on the Quivira National Wildlife Refuge in Kansas. Acton was onsite to gain experience burning in a less familiar fuel type. Photo: Bill Qualm, U.S. Fish and Wildlife Service, Quivira National Wildlife Refuge, Stafford, KS, 2000.

were readily available. This type of fire organization, combined with relatively frequent fire occurrence, gave me the opportunity to "sit in the driver's seat" during several fire outbreaks, to learn how to best use all the available resources to achieve suppression objectives, and to ecologically manage naturally ignited fires. I planned and executed more than 30 prescribed fires, including landscape-scale natural fuel treatments, hazard fuel reduction, and site preparation burning. The quality of the experience and training that I received in this program prepared me for a career in fire management through a concentrated program of work on a fire-active forest.

Site of a September 1997 hazardous-fuels burn conducted by program apprentice Frankie Romero to prepare the site for reforestation on the Council Ranger District, Payette National Forest, ID. At a time of shrinking workforces, the Developmental Assistant Fire Management Officer Workforce Diversity Program is training underrepresented groups and minorities for integration into fire management organizations. Photo: Frankie Romero, USDA Forest Service, Payette National Forest, McCall, ID, 1997.

Although the Developmental AFMO program was established to build diversity in the fire management workforce, the program is a model for training all prospective FMO's or AFMO's as they take their first steps into wildland fire management. For more information on the Developmental AFMO program, contact Merrill Saleen, aviation/training officer, Payette National Forest, P.O. Box 1026, McCall, ID 83638, 208-634-0746 (voice), msaleen/r4,payette@fs.fed.us (e-mail).

Acknowledgments

The author wishes to thank Merrill Saleen (aviation/training officer), Nikki Dyke (forest fuels specialist), Gene Benedict (forest FMO [retired]), Sam Hescock (Krassel district FMO), Dennis Winkler (Weiser district FMO), Monte Hurd (Weiser district AFMO), Randy Swick (Krassel/McCall district ranger), and John Baglien (Weiser district ranger) for the opportunities they provided and for sharing their wealth of experience. ■

Tractor Plow Safety: Know Your Terrain and Wear Your Seatbelt!

Timothy G. Wyant

The 2000 fire season was the worst in memory in LaSalle Parish, located in north-central Louisiana. On February 17, the Louisiana Department of Agriculture and Forestry office in Olla dispatched several tractor plow units to help fight the Nebo–Goodpine Fire, which burned 25 acres (10 ha) of private forestland and took 2 hours and 20 minutes to contain. The area is densely wooded, mostly under pine; the terrain is generally flat, but creek beds form occasional ravines. We soon discovered just how dangerous such conditions can be, especially at night.

Suddenly the dozer's lights dropped out of sight, and then I heard a crash.

Nighttime Dozer Incident

The call for dozers came at 10 p.m., well after nightfall. We found the fire actively burning; our units were quickly assigned to different parts of the fire. Together with my boss, the assistant parish supervisor for the Louisiana Department of Agriculture and Forestry, I took my John Deere 450 tractor plow unit to the north flank of the fire. The other units were some distance away, on another flank of the fire.

In the pitch dark, I started plowing fireline while my boss set backfires. On our two-person tractor plow crews, we periodically relieve each other on backfire duty to prevent fatigue for the person setting backfires. After 30 minutes, I started backfiring and turned the unit over to my boss, a veteran firefighter with more than 10 years of experience. As my boss continued cutting line, I could see the dozer's lights dancing in the pines ahead of us.

Suddenly the dozer's lights dropped out of sight, and then I heard a crash. I thought my boss was gone! I rushed forward to find a yawning dropoff that appeared out of nowhere. In the darkness, I could barely make out the dozer at the bottom of the ravine.

It was a dry creek bed. With pines growing straight up the sides, the ravine had been impossible to see in the dozer's headlights until it was too late. After plunging off the edge, the dozer turned over twice before coming to rest 40 feet (12 m) below.

Luckily, my boss was wearing his seatbelt, which kept him from being thrown from the dozer. He escaped with a bruised head and a 2-inch (5-cm) gash in his arm. The seatbelt saved his life.

Lessons Learned

What lessons can dozer operators learn from our harrowing experience?

- Always were your seatbelt.
- Always keep the 18 Watchout Situations in mind. Two of them applied on the night of the incident:
  - #2—You are in country not seen in the daylight.
  - #5—You are not informed of strategy, tactics, and hazards.
- Know your terrain in advance. The Fireline Handbook (NWCG

Tim Wyant is a tractor fireplow operator for the Louisiana Department of Agriculture and Forestry, Olla, LA.

The Saint Maurice Fire on November 15, 1999, near the town of Saint Maurice, LA. The fire burned 617 acres (250 ha) of private and national forestland in Louisiana's Winnfield Parish, where the Kisatchie National Forest is partly located. Photo: Tim Wyant, Louisiana Department of Agriculture and Forestry, Olla, LA, 2000.

1998) instructs dozer and tractor plow operators to "Watch out for wetlands, steep slopes, rocks, ditches, and other obstacles that might stop the equipment." Because the ravine our dozer fell into was practically invisible at night in the pines, watching out was not enough. Before working a fire, operators should study a current contour map for any breaks in the terrain or other signs of safety hazards.

John Deere 450 tractor plow after falling into a ravine during nighttime fireline operations. The unit plunged about 40 feet (12 m) down the slope at right, flipping over twice. The operator escaped with light injuries thanks to wearing his seatbelt. Photo: Tim Wyant, Louisiana Department of Agriculture and Forestry, Olla, LA, 2000.

One of the most important functions of fire managers on the fireline is to recognize when Watch Out Situations and Standard Fire Orders are excessively compromised, and to take immediate corrective action to ensure firefighter safety. Tractor plow unit operators and managers should bear in mind that unknown terrain can pose unexpected, potentially life-threatening hazards.

Reference

NWCG (National Wildfire Coordinating Group). 1998. Fireline handbook. PMS 410-1, NFES 0065. Boise, ID: National Interagency Fire Center. ■

Louisiana Fire Crew

Louisiana is proud of its wildland firefighting heritage. The fire crew from the Louisiana Department of Agriculture and Forestry, District 3, in Olla, LA, is a fine example. These firefighters work together as a team in the battle against wildland fire. The older folks on the crew pass on the benefits of their years of experience to the younger folks. Each one is proud to be a firefighter, proud to know they are protecting lives, homes, and forests from fire.

The first priority for the District 3 crew, as for all wildland firefighters, is to make sure everyone on the team goes home safely. Safety courses are a routine part of the district's training curriculum. The firefighters are trained to care for their equipment to ensure reliability. They are trained to coordinate with pilots overhead, who track the tractor plow operators by numbers painted on their roofs and contact them to warn them of danger. They are trained in how to deal with pipeline hazards to tractor plow operators, such as gas, ammonia, and oil lines. And they learn proper backfiring techniques. The crew's motto is: "Never let your guard down on a fire!"

Members of the fire crew from the Louisiana Department of Agriculture and Forestry's District 3 in Olla, LA, pose in front of a tractor plow used for wildland firefighting. Photo: Tim Wyant, Louisiana Department of Agriculture and Forestry, Olla, LA, 2000.

Websites on Fire*

Wilderness Manager's Toolbox

As with every toolbox, the more complete the array of tools, the better and easier it is to get the job done. The Wilderness Information Network has recently added a new tool to its already impressive Website—Fire Management in Wilderness. The site is a compilation of references and resources to help managers make decisions about fire management and restoration. Recently created in response to the 2000 fire season, this site offers visitors links to Federal agency fire staff sites, Federal wildland fire policy documents, case studies, and current research findings.

Found at **<http://www.wilderness.net/toolbox/fire/default.cfm>**

* *Occasionally,* Fire Management Today *briefly describes Websites brought to our attention by the wildland fire community. Readers should not construe the description of these sites as in any way exhaustive or as an official endorsement by the USDA Forest Service. To have a Website described, contact the managing editor, Hutch Brown, at USDA Forest Service, 2CEN Yates, P.O. Box 96090, Washington, DC 20090-6090, 202-205-1028 (tel.), 202-205-0885 (fax), hutchbrown@fs.fed.us (e-mail).*

Living With Fire

Sponsored by the Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT, this Website lets visitors play a game—based on research and tools used by fire managers—in managing wildland fire in a ponderosa pine ecosystem. Players choose different fuel treatment options, learning about the effects of their choices. Fire behavior, suppression, and ecology are just a few of the topics that visitors can explore, based on materials prepared by such notables as Steve Arno, Jean Hoadley, and Rich Lasko. Educators will enjoy the online teaching tour and lesson plans provided for presentations and classroom use. Recommended for ages 10 and above, this Website provides plenty of high-end graphics, video streaming, and links to related sites ranging from the Discovery Channel's Line of Fire to the National Smokejumper Association.

Found at **<http://www.fs.fed.us/rm/fire_game>**

Annual Photo Contest

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

Postmark Deadline

First Friday in March

Send submissions to:

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

Sample Photo Release Statement

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

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

Signature ______________________________ Date ______________

Superintendent of Documents **Subscription** Order Form

Order Processing Code:

***5614**

S3

☐ **YES,** enter my subscription(s) as follows:

Charge your order. It's easy!

To fax your orders (202) 512–2250
To phone your orders (202) 512–1800

_____ subscription(s) to **Fire Management Today** for $13.00 each per year ($16.25 foreign).

The total cost of my order is $_________. Price includes regular shipping and handling and is subject to change. International customers please add 25%.

Company or personal name (Please type or print)

Additional address/attention line

Street address

City, State, Zip code

Daytime phone including area code

Purchase order number (optional)

For privacy protection, check the box below:

❑ Do not make my name available to other mailers

Check method of payment:

❑ Check payable to Superintendent of Documents

❑ GPO Deposit Account ☐☐☐☐☐☐☐ – ☐

❑ VISA ❑ MasterCard

(expiration date)

Thank you for your order!

Authorizing signature

4/95

Mail To: Superintendent of Documents
P.O. Box 371954, Pittsburgh, PA 15250–7954