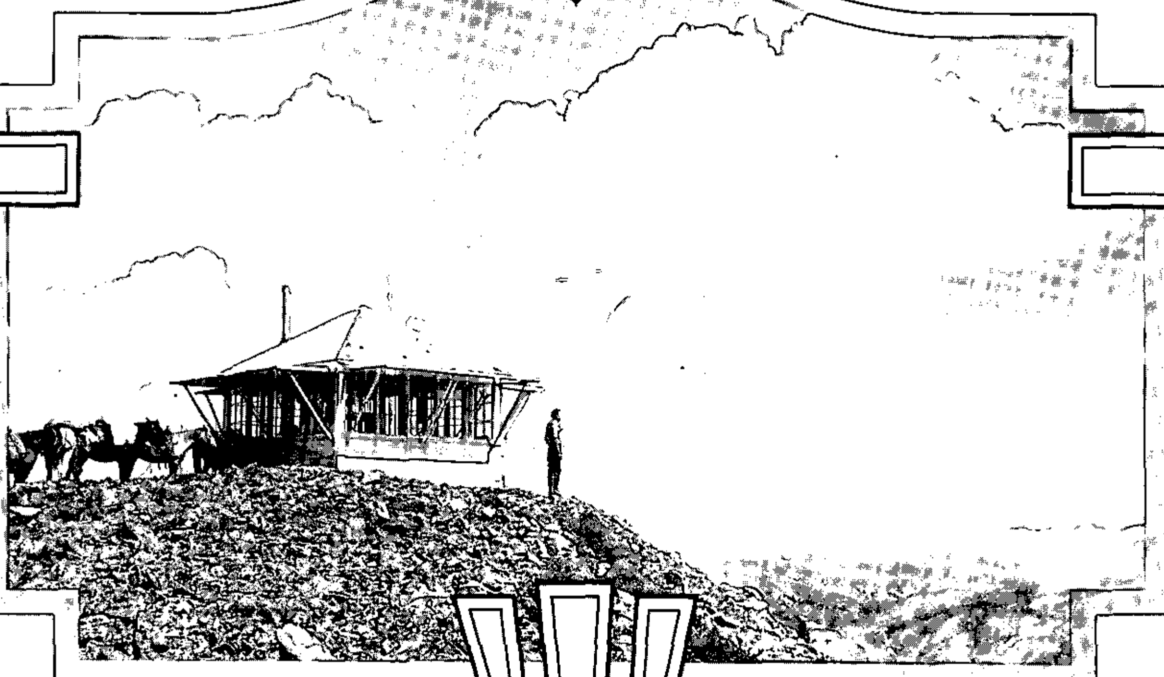
FIRE MANAGEMENT NOTES



50TH ANNIVERSARY

Volume 50 No.2 • 1989

Fire Management Notes

An international quarterly periodical devoted to forest fire management

United States Department of Agriculture

Forest Service

Volume 50, No. 2
1989

Contents

3 The Environmental Effects of Wildfire
William McCleese

9 Forest Fire Prevention and Management in Indonesia
Wynne Cougill

14 Air Tanker Vortex Turbulence—Revisited
Donald A. Haines

16 Hands-On Management—the Challenge of ICS at Work
T.C. Harbour, Jr.

18 Twenty-Eight Years of Aviation in the Forest Service
Fred A. Fuchs

22 The Wildland-Urban Interface: What It Is, Where It Is, and Its Fire Management Problems
James B. Davis

34 After the Terra Torch, What's Next?
Ted Tveidt

37 A Lightweight, Inexpensive, Portable Pump Foam Induction System
Tom French

39 The USDA Forest Service's Water-Bombing Beavers
Robert S. Grant

41 Use of Posters for Interpreting Fire Behavior and Danger Research
Martin E. Alexander, William J. De Groot, Kelvin G. Hirsch, and Rick A. Lanoville

45 Natural Fires in Parks—What Does the Record Show?
Jason Greenlee and Julia Gaudinski

Short Features

8 Unrequested Federal Excess Personal Property
Francis R. Russ

13 Reducing Firefighter Fatigue and Injury
Jerry Monesmith

17 Firefighter Retirement Information
Jerry Baughman

28 Former Military Aircraft in Fire Protection
Francis R. Russ

36 Toss That Old Fire Shelter and Protect Your New One!
William Shenk

40 National Advanced Resource Technology Center Course Schedule for Fiscal Year 1990

Special Feature

29 A Room (Sometimes) with a View (Always)

Fire Management Notes is published by the Forest Service of the United States 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.

Subscriptions may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Send suggestions and articles to Chief, Forest Service (Attn: Fire Management Notes), P.O. Box 96090, U.S. Department of Agriculture, Washington, DC 20090–6090.

Front cover: Lightning Peak Lookout. Lookout observes Idaho Primitive Area. (M.S. Benedict, 1937).

Back cover: *Fire Control Notes* first reproduced this Smokey Bear poster on the back cover of its January 1956 issue.

The Environmental Effects of Wildfire

William McCleese

Assistant director for planning, USDA Forest Service, Fire and Aviation Management, Washington, DC

This speech was given by William McCleese at the National Fire Protection Association meeting held November 14–16, 1988, in Nashville, TN.

Everyone knows wildfires are bad! Why else would we spend over one-half billion dollars in 1988 fighting them?

But, you say you heard and saw in the media this past summer that the fires in Yellowstone National Park were good? Then you heard and read later that those same fires were not good after all, but were the result of failed or flawed "let-burn" policies of Federal agencies and were going to produce catastrophic environmental effects.

Which is it? How can it be both ways? Are wildland fires good or bad? How could the fires in and around Yellowstone National Park this past summer be good and welcomed for a time, then later judged to be a disaster?

The answers to these questions are not simple. The truth is that fire in wildland areas is both good and bad, depending on its location and situation. Sometimes a fire can have both a positive and negative environmental effect at the same time. An analogy can be made to rainfall: In the right places and at the right times, rain is beneficial; if it comes down too hard or in too great a quantity, it can have a detrimental effect.

It is important at this point to spend a few minutes defining the scope of the wildland fire problem in America and then go on to talk about the environmental effects of fire in wildland areas and the conditions that determine when they are positive and when they are negative.

Scope of Problem

Wildfires continue to be a significant problem in the United States. As I mentioned, over one-half billion dollars have been spent in 1988 fighting wildland fires. The Greater Yellowstone Area fires that you heard so much about burned 1.6 million acres (647,520 ha) and cost over $112 million to suppress. The total wildland fire statistics the first week in September were a staggering 71,957 fires that burned about 4.3 million acres (1.7 million ha) nationwide.

Obviously when wildfires burn in areas where they are a threat to life and property, the potential effects from them are unacceptable.... But what about fires that burn in the backcountry and are not a threat to homes and people?

Unfortunately, I have to say "to date" because some of the worst fires in southern California have historically been in the late fall. In 1980, the arson-caused Panorama Fire swept down from the San Bernardino National Forest the week before Thanksgiving into the town of San Bernardino, destroying 286 homes and damaging another 32.

We have been in a cycle of warm dry years and have had a serious fire season in each of the last 4 years. In 1987, 4.5 million acres (1.8 million ha) were burned; in 1986, 3.2 million acres (1.3 million ha); and in 1985, 5.3 million acres (2.1 million ha).

The year 1985 was especially memorable because of the devastating losses from wildfires in addition to the cost of fighting them. At year's end the toll was 44 lives lost due to wildfires and 1,400 homes destroyed. The losses were in places like Florida, Minnesota, and Washington, not just in California where homes burned by wildfire in the wildland-urban interface is old news.

It was after the 1985 fire season that the National Fire Protection Association (NFPA) and the USDA Forest Service, joined forces to launch the National Wildland/Urban Interface Fire Initiative to work toward solutions to the problem. Later joined by land management agencies of the Department of the Interior, the U.S. Fire Administration, and the National Association of State Foresters, the national initiative is now moving into its third full year. The newly created Fire Management Section of NFPA is an outgrowth of this initiative.

Fire in the Environment

Obviously when wildfires burn in areas where they are a threat to life and property, the potential effects from them are unacceptable and everything must be done to minimize the threat before a fire burns in that kind of area. Once a fire starts in the interface, the protection of life and property becomes the number one priority of suppression forces.

But what about fires that burn in the backcountry and are not a threat to homes and people?

Let's look at some of the effects of wildland fire in the natural environment and use the fires in and around Yellowstone National Park to examine whether they produced good or bad environmental effects.

Fire Dependent Species. Fire plays a natural role in the life cycle of certain species of plants and animals. Vegetation species of this type are identified as fire dependent; that is, without fire occurrence this type of vegetation cannot exist. The role fire plays varies with the vegetative species. Some need fire to open cones and release seeds. Others need fire to break the dormancy of seeds that have lain on the forest floor for years. Also, to thrive, the young plants of most fire dependent species require the ash seedbed, open sunlight, and lack of competition found in a burned area. Birds and animals that are dependent on fire dependent plants will disappear if their habitat is not perpetuated. For fire dependent species then, fire is good because it is necessary.

The predominant vegetative type that burned in the Greater Yellowstone Area fires was lodgepole pine—a fire dependent species. *Therefore the Yellowstone fires must have been good—right?*

Vegetative Recycling and Renewal. Wildland fire can also play a role in the successional evolution and renewal of vegetative species within an ecosystem. As vegetation matures and ultimately dies, it is replaced by other types of vegetation until the climax species for the particular ecosystem takes control of the area. Once the climax species mature, some event occurs that removes the climax species, and early successional vegetation takes control of the site and the sequence starts over again.

The event that triggers the change from one species to another in the natural succession and the eventual removal of the climax is quite often fire. In unmanaged forest areas, it is almost always fire. Insect and disease epidemics sometimes are the primary causal agent of mortality, but fire usually follows, feeding on the dead and dry vegetation left behind. Of course, volcanic eruptions such as that of Mount St. Helens do a pretty fair job of renewal and recycling, but volcanic eruptions don't happen too frequently.

In managed forest areas such as the 83 percent of the National Forest land in the United States that is managed under multiple use management, harvesting of mature timber is another way of recycling and renewal. This enables the timber to be utilized and the commercial value captured as well as providing for recycling and renewal of the vegetation.

All but approximately 2,000 of the 1.6 million acres (809 of the 647,520 ha) that burned in the Greater Yellowstone Area fires were in the National Park or within designated wilderness areas—where timber harvesting is precluded—on the five National Forests that surround the National Park. The lodgepole pine was overmature, and in fact 50 percent or more of it was dead in some areas due to a mountain pine beetle epidemic in recent years.

Therefore the fires in Yellowstone must have been good—right?

Insects and Disease. As was the case on much of the land of the Greater Yellowstone Area fires, insect-killed and -damaged timber often provides the fuel that can feed wildland fire conflagrations.

Forest insects or diseases move from endemic infestations to epidemic proportions in overmature and dying stands of timber and accelerate the demise of the timber stand. Allowed to play its natural role, fire enters the picture and—as it did in Yellowstone National Park—becomes the agent of change, removing the dead and dying vegetation and providing a suitable environment for regeneration of new and healthy vegetation. In that role, we have already concluded that this was a good effect. However, the relationship between forest insects and diseases and fire is a two-way street. Fires burning in otherwise healthy vigorous stands of timber can kill or damage enough trees to create favorable conditions for insect and disease infestations to become epidemics and if unchecked can move out of the areas affected by fires and cause mortality in healthy trees.

The relationship between fire and forest insects and diseases—the effect of one on the other—then is one of those that can be good or bad depending on the particular situation. How about Yellowstone? As I previously mentioned, insect-killed lodgepole pine covered much of the area burned by Greater Yellowstone Area fires. In these areas, fire played its natural role of removing the dead and dying timber. *Therefore the effects of the fires were good—right?*

There is another side to the effect of the fires in Yellowstone on vegetation, however. The fires also burned in areas that had not been attacked by the mountain pine beetle and may create the opportunity for additional insect infestations that could move out of the burned areas, creating other areas of extreme fire hazard in the park and wilderness areas as well as affecting commercial forest areas on the surrounding National Forests. *Therefore the effects of the fires were bad—right?*

This is a case in which some of the effects of fire are good but at the same time potentially bad. The extent of the potential negative effects in regard to future insect and disease outbreak will be evaluated over the next couple of years.

Wildlife and Fish. Wildland fires have been commonly thought to have a negative effect on wildlife. One of the first national forest fire prevention posters used Walt Disney's "Bambi" as the symbol of the destructive force of fire. We all know what happened to Bambi's mother as a result of a forest fire started by humans. For over 40 years, Smokey Bear has been reminding us that "Only You Can Prevent Forest Fires." The real-life bear who became this important fire prevention symbol was an orphaned, injured bear cub found in a burned-over forest in New Mexico.

The effects of fire on wildlife are in actuality more complicated than these symbols immediately suggest. In fact many species of wildlife are dependent on fire to periodically rejuvenate habitat that is critical for their survival. The role that fire plays in recycling vegetation is vital to maintain a viable habitat for many species of wildlife. This is true for both the browsers who depend on the young vegetation that comes in after a fire and species that are associated with them.

Cover for wildlife is another key wildlife factor affected by fire. Vegetation cover near feeding and watering areas is important to wildlife. Healthier, more numerous, and more diverse wildlife populations are found where there is the most "edge effect," those boundary areas between different amounts or types of vegetation. When fires burn unevenly, they leave a mosaic pattern in the vegetation, which creates the "edge effect" that is so critical to many species of wildlife.

This isn't to say that there isn't mortality to wildlife during wildland fires. Our own Smokey Bear is testimony to that, and there have been real-life examples of Bambi's story. In general though, the majority of wildlife in an area of a wildfire either flies, migrates, or burrows under and survives the movement of the fire through an area. What mortality there is must be weighed against the overall benefit the fire may be offering in terms of wildlife habitat improvement. A few individual animals may suffer but the overall population is benefited.

We have already established that the fires in the Greater Yellowstone Area—burned in an overmature, dead-and-dying forest—will undoubtedly improve wildlife habitat in the long run, even though there were some documented cases of wildlife mortality. *Knowing this, the Yellowstone fires must have been good fires for wildlife—right?* Well, we're not sure—the question here relates not to whether the vegetation and wildlife habitat needed renewal and recycling in the area that burned, but rather to the extent of critical habitat area that burned.

Within the overall habitat range of certain wildlife species, there are areas defined as "critical" or "key" habitat. This is usually a limited area within the entire range that the particular wildlife population is dependent upon for a certain time of the year, usually summer or winter.

There are concerns in the Yellowstone that an excessive amount of key winter elk and moose range may have been burned over and supplemental feeding may be necessary for a couple of years to carry the existing populations through until there is sufficient sprouting and regrowth in these areas. If this isn't done, there will be a decline in the health and number of the existing populations as well as overbrowsing, further delaying recovery.

The effect on fish is more clear cut—bad! The immediate threat to fisheries during wildfires is direct heating of and ash in waterways. Both can cause mortality under certain conditions.

The other effects are more long-term in nature and related to the effects on soil and water that I will mention later. Sedimentation from accelerated erosion may have a negative effect on spawning areas. Removal of shading vegetation may cause significant increases in water temperatures, which can also affect spawning and survival rates.

Because of the cumulative effects from the large acreage involved in the Greater Yellowstone Area fires, the short- and long-term negative effects on the fisheries in the area are a major concern. (These are fisheries, if you aren't familiar with them, that have been recognized as the best in the nation.)

Soil and Water. The effects of wildland fire on soil and water are generally negative. I am sure you have heard the term "watershed damage" applied to wildland fires. Watershed damage refers to the effects of vegetation being removed during a fire, resulting in exposed soil. This damage is a result of accelerated water runoff during rainstorms and spring runoff producing increased rates of erosion, loss of topsoil, diminished water quality, negative effects on fisheries, mudflows, road and trail slip-outs, and downstream flooding.

Besides the loss of soil protecting vegetation and the live root structures that serve to bind the soil, helping to keep it in place, research has found that extremely hot fires actually seal some soils, preventing any moisture from soaking in. This in turn produces more runoff during peak periods. A bare watershed will magnify the intensity and magnitude of a particular storm by delivering more water over a shorter period of time into a stream or river, thus greatly increasing the chances of downstream flooding and damages. The quantity of water running off a watershed may be greater, but the quality due to high sediment levels and the timing of delivery to storage facilities often make it unusable.

The resulting loss of topsoil from the accelerated erosion can seriously influence how long it takes for the vegetation to recover as well as affect long-term productivity of the land. The potential negative effects on soil and water from wildland fires are significant enough to prompt erosion control measures to be initiated while the fire is still burning and emergency rehabilitation actions implemented before the first rains. Emergency measures most often include grass seeding (in the hope of establishing vegetative cover before the first rains), channel clearance, and drainage cleanout along roads. Reforestation comes later as part of the long-term recovery effort.

What are the fire effects on soil and water as a result of the Greater Yellowstone Area fires? By far, the cumulative watershed impact from burning 1.6 million acres (647,520 ha) of the Greater Yellowstone Area ecosystem is potentially the greatest negative environmental impact.

The effect on fisheries, water quality, sedimentation of water storage facilities, and potential downstream flooding is a major concern. While the fires may have been good in terms of renewal, recycling, and wildlife habitat, no responsible land manager would advocate curing 100 years of fuel buildup by burning 1.6 million acres (647,520 ha) of an ecosystem in a single year.

Even though most of the National Forest acreage that burned in the Greater Yellowstone Area fires was classified as wilderness, emergency rehabilitation, including seeding, was carried out in an attempt to mitigate, to the extent possible, potential damage to soil and water. An estimated $1.4 million was spent for emergency rehabilitation work on the affected National Forest lands in the Greater Yellowstone Area. In Yellowstone National Park, emergency rehabilitation was limited to firelines and critical areas along roads.

Air Quality. Probably the most visible environmental effect from wildfires is the effect on air quality. The immediate effect is smoke that can obscure visibility and affect those with respiratory ailments who live in the immediate area.

The effects are normally short-term and limited to areas downwind of the fire. There are exceptions, however. Numerous fires such as those in the Northern Rocky Mountains this summer when the smoke from several fires was dispersed into the atmosphere day after day can cloud over an entire area of the country and some cities hundreds of miles from the fires. Of more concern from a human health standpoint is the development of inversion layers trapping great volumes of smoke in a particular airshed for days at a time.

This happened several times last year on the northern California fires where firefighters were forced to use flashlights to read maps during daylight hours and oxygen tents were set up in fire camp to permit firefighters returning from the line to breathe fresh air.

Inversions, although not as severe as those in California, occurred several times in Yellowstone this year, affecting firefighters and local residents alike. Concerned about firefighters' prolonged exposure to these types of conditions, the Forest Service is participating in a study with Johns Hopkins University to research the health effects.

Also, because of the importance to the smoke management aspects of our prescribed burning program, the Forest Service has active research underway relating to the entire issue of smoke from woody vegetation in the atmosphere. Investigations concerning the amount, type, and conditions for release of particulate matter may be crucial to the future of our planned burning program.

How was air quality affected by the fires in and around Yellowstone? All the above conditions existed at one time or another. Inversion layers kept the smoke at ground level and the fires quiet for several days at a time. Wind-driven weather fronts periodically caused fires to burn under extreme conditions, with major runs putting smoke 25,000 to 30,000 feet (8,022 to 9,144 m) into the atmosphere, affecting locations hundreds of miles from the fires. Long-term health effects of such exposure are thought to be minimum. Short-term health affects are under investigation.

Economic Effects

There can be a number of direct and indirect economic effects from wildland fire. Besides the obvious economic impact from the loss of homes and other structures and subsequent flooding and sedimentation of reservoirs, there can be damage and loss to commercial timber and loss of tourism.

When wildland fires burn commercial forest land, plans are made to salvage the burned timber. Some of the commercial value is captured through salvage logging, but it is normally only a fraction of the original value of the timber. A secondary impact relating to salvage of timber on National Forest lands is a reduction in the funds returned to local government. Local counties receive 25 percent of the value of timber sales and other fees collected by the Forest Service to support roads and schools. A reduced value of the fire-damaged timber would result in lower returns to the counties. Specific to the Greater Yellowstone Area, with most of the burned acreage in the National Park or wilderness areas on the National Forests, very little commercial forest land was affected, and economic impact was negligible. Elsewhere in the West, preliminary loss was estimated to be $64 million.

There was an economic impact on local business in and around Yellowstone National Park as a result of the fires. The National Park Service made every attempt to keep the park open, but there was a major dropoff in visitation during August and September. Many of the communities in the area are dependent economically on tourism at the park, and businesses in those communities suffered significant losses. This was offset somewhat by local purchasing for the fires and lodging of some fire personnel, but there is no question some of those local businesses were hit hard.

The U.S. Department of Agriculture formed a task force to develop a program to assist people who lost livestock, feed stock, and capital improvements to the fires. Legislation was introduced to provide economic assistance to people who had physical loss of property. There is concern about the national and international misperception that the park was "destroyed" and the possible negative effect of that viewpoint on future tourism. The National Park Service is working closely with the local communities to encourage visitation and plans to develop fire recovery interpretive programs to help park visitors better understand the fires and the recovery process.

Fire Policy

There was a lot of attention focused on the so-called "let-burn" policies of the National Park Service and the Forest Service as well as "light-hand-on-the-land" suppression tactics and strategies.

Both the National Park Service and the Forest Service modified their fire policies in the early 1970's to permit fire to play its natural role in certain areas and under specified conditions. The National Park policy and the Forest Service wilderness fire management policy are fairly similar. The Forest Service policy permits lightning-caused fires in wilderness areas, where there is a preapproved fire plan, to be managed as prescribed fires so long as they meet prescribed-fire conditions. If conditions change and the fires go beyond the prescribed conditions, suppression action is taken. The Forest Service fire policy calls for appropriate suppression action to be taken on all other fires.

Light-hand-on-the-land suppression tactics mean only that fire managers don't create more impact and disturbance on the land than necessary to suppress the fire. It does not specifically preclude the use of mechanized equipment or any other tactic that is deemed necessary by the fire and land manager.

Both the National Park Service and the Forest Service have had some natural prescribed fires escape and become large wildfires. The Chief of the Forest Service has stated, "We wish we could have a couple of those decisions back." He referred to the decisions made to manage those fires as prescribed fires rather than put them out when they started.

We are conducting internal fire reviews as we always do after a major fire season to look at what went well and what could have been done better. One of the things we will be looking at is our ability to judge the effects of drought conditions and factor that into our decisionmaking.

Because of the high degree of political interest in the fires this summer, particularly the Yellowstone fires, the Secretaries of Agriculture and of the Interior have appointed an Inter-Departmental Secretarial Fire Policy Review Team that is currently making their review. The findings of this group along with any recommended changes are due to the Secretaries by December 15.[1]

Thank you for the opportunity to talk about the effects of wildland fire on the environment. I hope I have been able to convey that the effects can be both beneficial and detrimental—sometimes at the same time. The next time you read in the newspaper or see on television that a wildfire has "destroyed" an area, I hope you will remember what I have told you about the good and bad effects of wildfires and appreciate the complexity of the situation. ■

[1]Editor's Note: The joint report of the Department of Agriculture and the Department of the Interior, "Report on Fire Management Policy," was published May 5, 1989.

Unrequested Federal Excess Personal Property

The USDA Forest Service is authorized to lend Federal Excess Personal Property (FEPP) to the State forestry agencies for rural and wildland fire protection. These loans of Federal property are authorized under the Federal Property and Administrative Services Act of 1949, as amended, and the Cooperative Forestry Assistance Act of 1978. Occasionally, property officers at Federal installations will release quantities of FEPP that exceed the approved quantity on the transfer order.

All property accepted in an FEPP transaction remains Federal property whether originally listed on the transfer document or not. This property should be added to the signed receipt copy when sent to the Forest Service. The rationale behind this is: In the FEPP program, a State forestry official is acting as an agent for the USDA Forest Service, accepting Federal property that is on loan to the State. Any Federal property accepted under that authority remains Federal property to be used and accounted for in accordance with the Property Acquisition Assistance Handbook (FSH 3109.12). ■

Francis R. Russ, *property management specialist, USDA Forest Service Fire and Aviation Management, Washington, DC*

Forest Fire Prevention and Management in Indonesia

Wynne Cougill

Freelance editor and writer, U.S. Agency for International Development, Mission in Jakarta, Indonesia

In 1982 and 1983, Indonesia's province of East Kalimantan, on the island of Borneo, suffered the largest forest fire in recorded history. The combination of 2 years of extraordinarily severe drought, large areas of degraded logged forest, and rapid population expansion were responsible for this fire, which affected nearly 8.9 million acres (3.6 million ha) of land. Although few human lives were lost, the economic losses (over $2 billion) and adverse environmental effects were enormous.

When the fire first began, local people simply let it burn. When the fire quickly raged out of control, people burned the area around their villages to protect themselves, but unsuccessfully. Provincial officials then called on the central government for help, which purchased two "water bomber" aircraft in the mid-1980's at a cost of $6 million. However, this sophisticated equipment requires highly organized group support, which Indonesia lacked, and the fire grew. Even today, the remnants of the fire are still burning in East Kalimantan's coal seams, requiring a large amount of maintenance and resulting in the loss of valuable fossil fuel. During the dry season of 1987–88, the same factors—drought, degraded forest, and population pressures—in combination with the continuing coal seam fires, resulted in another major fire in the province. In that same year, lightning started fires in Sumatra, causing extensive damage.

During the last 10 years, particularly, Indonesia has begun to appreciate the full value of its forests and the need to protect them. According to Indonesian Government estimates, the country's forest lands cover 355.8 million acres (144 million ha) (almost 75 percent of the country's total land mass), encompass over half of the rain forests in tropical Asia, and form perhaps the most biologically rich ecosystem in the world. Furthermore, they are the country's most important nonoil export, constituting roughly 12 percent of export earnings.

Along with this heightened appreciation has come a recognition of the formidable problems the country faces in controlling fires. Indonesia has a massive land area (stretching a distance approximately that of the contiguous United States, spread over 13,677 islands), a climate that ranges from tropical to semiarid, a population of over 171 million people with more than 250 ethnic groups—each with its own language—and a severely reduced government budget as a result of the recent declines in oil prices. For these reasons, the government has begun to seek solutions to forest fire management that do not encompass high-tech, expensive equipment, but instead rely on the country's greatest resource: its people. It thus sought the assistance of the United States in finding methods for preventing and managing forest fires that are simple, inexpensive, adaptable, appropriate, and easily replicable.

The U.S. Agency for International Development's Office of Foreign Disaster Assistance together with the USDA Forest Service support programs in developing countries aimed at teaching technically and culturally appropriate methods of forest fire prevention, detection, and mitigation to qualified local foresters who can in turn teach what they have learned to others.

Institutional Cooperation

During September-November 1987 period, abnormally dry weather conditions exacerbated the spread of the Sumatra and East Kalimantan forest fires. The fires in Sumatra were eventually extinguished, and the Kalimantan fires retreated to the coal seams with the arrival of the rainy season. Nevertheless, impressed with the magnitude of destruction caused by these and earlier fires, officials in BAPPENAS (Indonesia's Central Planning Body) asked David Merrill, Director of U.S. Agency for International Development (USAID) Mission in Indonesia, if the Mission could provide assistance in detecting and mitigating the effects of forest fires. In turn, the Mission consulted with USAID's Office of Foreign Disaster Assistance (OFDA) in Washington. It learned that OFDA, in conjunction with the USDA Forest Service, was supporting programs in a number of developing countries, aimed at teaching technically and culturally appropriate methods of forest fire prevention, detection, and mitigation to qualified local foresters, who in turn teach what they have learned to others.

OFDA's coordinator for this program, Charles Mills, visited Indonesia from November 18–25,

Hands-on training in the field (Forest Education Center) Gunung Walat, Sukabumi, West Java.

1987. Assisted by the Mission's Disaster Relief Officer, Dave Nelson, and his Indonesian assistant, Abas Rozali, Mills met with officials of the Indonesian Ministry of Forestry and the Ministry of Social Affair's Indonesia Disaster Management Center. Together, they formulated plans for a 2-week course to train master trainers. The course was to be jointly conducted by the USDA Forest Service and the Indonesian Forestry Ministry personnel section. Both the United States and Indonesian representatives agreed that the Indonesia Disaster Management Center would be an ideal location for the training course. This facility, located in Jakarta, was established with funding from USAID and the United Nations Disaster Relief Organization (UNDRO) through the United Nations Development Program (UNDP) to support the "Strengthening Disaster Preparedness and Management Project."

A memorandum of understanding describing the course outline, sources of funding, and each party's responsibilities was signed by the Ministries of Forestry and Social Affairs, and the U.S. Government on the occasion of OFDA Director Julia V. Taft's visit to Indonesia on February 25, 1988. OFDA was to cover approximately $90,000 of the costs, including transportation for USDA Forest Service personnel and the procurement and air shipment of instructional materials. The costs borne by the Indonesian Government, which do not include boarding participants and the use of its training and research station in West Java, amounted to approximately $47,500. USAID's Mission in Indonesia contributed $15,000 to cover the in-country air travel of the candidate master trainers.

Addressing Local Needs

Five U.S. fire instructors were chosen to conduct the training:

- Whitney K. Lerer, USDA Forest Service fire staff officer, Columbia, SC.
- Steve Pedigo, USDA Forest Service fire management specialist, Atlanta, GA.
- John G. Shepherd, North Carolina Division of Forest Resources, fire chief, Raleigh, NC.
- Sheryl K. Maddux, USDA Forest Service, fire management specialist, Atlanta, GA.
- Ken Hulick, USDI National Park Service, fire coordinator, Flat Rock, NC.

In the early stages of planning for the course, it was decided to use fire

Whitney Lerer (Francis Marion-Sumter National Forest) demonstrates the use of a backpack pump to trainees.

instructors from the southeast United States, where tropical climate and forest conditions are similar to those in Indonesia. (Conditions in the two areas differ somewhat, however, because Indonesia has more severe droughts and is thus more prone to forest fires.)

To prepare for the course, Steve Pedigo, John Shepherd, and Mills spent 2 days during May 1988 in the Balikpapan and Samarinda areas of East Kalimantan. While they observed the fire there "from the back of a cab," in their short visit, they estimate they saw 200 to 300 small fires still burning in coal seams. But more important than assessing the Kalimantan fire first-hand, they met with officials from the Ministries of Forestry and Social Affairs, local people, and university staff. All the people with whom Mills, Pedigo, and Shepherd met stressed that they needed basic help in planning, training, and firefighting techniques, not sophisticated technical assistance. With the tremendous amount of maintenance and manpower required to detect fires and keep them isolated, the U.S. foresters readily perceived that basic education in fire control was a critical need for Indonesia's forest management effort. The Indonesians saw that the trained core group of officers would pass their knowledge on to their co-workers, who would in turn instruct villagers.

Like many other developing countries, Indonesia experiences special fire control problems at the local level. For example, cultivators using traditional slash-and-burn methods of land clearing have deep respect for

John Shepherd (North Carolina Division of Forest Resources) demonstrates how to use drip torch.

the forest and seldom in the past have their fires raged out of control. However, while this method of cultivation is a rational one for the farmer, the conditions under which it is practiced have altered dramatically. Since 1950, approximately 34 percent of Indonesia's forest land has been converted for agriculture or cut for commercial purposes (estimates of current deforestation rates are approximately 2.5 million acres (1 million ha) per year). Further, it is estimated that in 30 years, all of the country's timber concessions will have been selectively logged. This practice damages the forest canopy and promotes rapid drying of the forest. The large volume of dead trees and slash act as a ready source for fires. Although slash-and-burn farmers are responsible for a very small portion of the country's deforestation, officials realize they must be educated on the proper season in which to burn, how to prevent fires by burning accumulated fuel after logging, and leaving vegetation around planting to reduce the risk of fires spreading to forests.

Also, in many areas of Indonesia, people and companies enter the forest and cut down trees illegally. Although the Ministry of Forestry has mounted educational programs and shown films to stop this practice, it continues, often because of the limited economic alternatives for poor farmers and landless people. Here lies a basic dilemma for the government: Some of the illegal cutters are among the very poorest of

Indonesia's people. They take forest products for such basic needs as fuel and to earn a meager income, but they are also contributing to severe forest degradation in some areas of the country. In this vein, the government is seeking innovative means to involve local people in forest management and foster a sense of commitment to preserving this important resource. Ministry of Forestry officials thus envisioned that Indonesian forest officers who were trained by U.S. experts could teach local people the rudiments of forest management.

The Forest Fire Prevention and Mitigation Course

The Forest Fire Prevention and Mitigation Course was opened at the Ministry of Forestry on August 2, 1988, by Hasjul Harahap, Minister of Forestry, and Michael V. Connors, Deputy Chief of Mission at the U.S. Embassy. Attended by 40 experienced foresters from 8 Indonesian provinces on the islands of Sumatra, South Sulawesi, Kalimantan, and Java, the course participants represented a wide range of professional responsibilities within the Ministry of Forestry: from managers of national forests and parks to fire control officers from national, regional, and provincial offices. Although some of the participants had previous training in forest fire prevention and maintenance from Finland and South Korea, this course represented the first opportunity for many of them to receive such training.

According to their instructors, though, one thing that all of the participants had in common was their enthusiasm. Steve Pedigo noted that he had never seen a group of students so eager to learn, and their energy never seemed to flag, even though they averaged 14 hours a day in the classroom over the 2-week course.

Classroom instruction, which was held at the Indonesia Disaster Management Center in Jakarta, stressed basic firefighting methods and prevention, with a special emphasis on safety. Training topics included how to prepare for fires, basic equipment, fire supervision, training ground forces, environmental values (including instruction on the greenhouse effect), community fire prevention, education and awareness, and methods to protect homes and villages.

The participants universally responded eagerly to this instruction, asking questions, interacting with each other and with their instructors, and generally soaking up enormous amounts of information quickly. Even the limited English abilities of some participants did not dampen their enthusiasm. Using several visual aids, the U.S. team spoke slowly, clearly, and with a great deal of body language, which was quickly understood by their Indonesian counterparts. With good cheer and a spirit of cooperation, participants would sometimes consult translators but also observe intently, checking with each other and clarifying points to make sure that everyone understood the instruction.

In addition, the participants rapidly devised solutions to problems, making sure that the solutions were tailored to their local area's needs. For example, one forester, after seeing a U.S. firemat made from rubber, constructed his own firemat from metal screening. This adaptation was devised for use in alang-alang fires (alang-alang is a particularly course and hardy grass that invades converted forest land).

On the last 2 days of the course, the class stayed at the Gunung Walad Training and Research Station in Sukabumi, West Java. Here, the U.S. instructional team demonstrated how to create a fire line, mop-up, and use basic fire tools. Participants learned how to use devices for firing (including backfire and drip torches), cutting tools (brush hood, double-bit axe, single-bit axe, pulaski, backpack pump, and weedeater), scraping tools (combination tool, shovel, council rake, and McCleod), and personal protective gear (plastic hardhat, head lantern, fire shelter, goggles, gloves, first-aid kit, canteen, web gear bag, and a belt weather kit with a compass, anemometer, sling cycrometer, and tables and slide rule). Throughout the demonstrations, safety was stressed.

Participants not only learned how to use these tools but also had ideas for adapting them to Indonesian conditions. After being shown how to use a phosphorous fusee torch, for example, one participant lengthened it by attaching it to a bamboo pole, which is easily available in tropical forests.

Altogether, the U.S. team shipped approximately $10,000 worth of equipment to Indonesia for this course. Each participant was given his or her own set of personal protective gear, a backpack pump, and a fusee torch. The remaining equipment will be kept at the Indonesian Disaster Management Center and used in future training sessions.

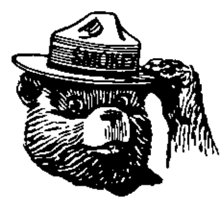
Future Directions

According to Achmad Rachmadi, Director of Forest Protection at the Ministry of Forestry, this course was primarily intended to stimulate ideas for forest management. Using an active approach, each of the 40 foresters trained in this course will use their new ideas when they return to their provinces. There, they will motivate and train 40 others, who will in turn educate and motivate their staffs and local villagers. Ultimately, the Ministry of Forestry foresees that Indonesia will have 140 master trainers who will take the Forest Fire Prevention and Mitigation Course at the Indonesia Disaster Management Center (this equals about one master trainer for every 2.5 million acres (1 million ha) of Indonesia's forest land). These master trainers will work from course materials that have been translated into the Indonesian language.

Now that the process of thinking about forest fire management has begun, Director Rachmadi is hopeful that Indonesia will be able to send four foresters from this year's class to the United States for internships. In addition, he and the class participants see the need for providing such educational vehicles as extension films and mobile units to both forest professionals and villagers. Beyond these needs, only one other request was made: Participants stressed that they want further training, especially field work, and the opportunity to come together in another forum and exchange their ideas and experiences, both with U.S. officials and among themselves.

The course also stressed the cooperation and coordination of a number of agencies that have an interest in forest protection. The United States has long had interagency cooperation for fighting and preventing fires, and Indonesia also recognizes its need for such cooperation among its agencies. Although this course was attended solely by officials from the Ministry of Forestry, plans for the future also include training and involving staff from other Government of Indonesia ministries, such as Transportation and Transmigration.

Participants have left this training session with a renewed sense of hope: They are receiving critically needed instruction from experts in fire management, their problems are shared by other provinces as well as the United States, and there are solutions to these problems. They now know that with a little creative thinking and a great deal of dedication and work, they can now make great strides in fire prevention and maintenance and in preserving a valuable resource for Indonesia and the world. ■



Reducing Firefighter Fatigue and Injury

Wildland firefighting is hard, dangerous work. Wildland fire agencies counter these hazards by equipping firefighters with quality personal protective equipment and up-to-date scientific information developed or obtained by the Forest Service's Missoula Technology and Development Center in Missoula, MT.

The latest research finds physical fitness reduces fatigue and injury and improves productivity. The Technology and Development Staff has worked with an orthopedic surgeon to develop a series of stretching exercises to make firefighters less susceptible to ankle, knee, and back injuries. The staff has also produced a video program about firefighter fatigue. The video, entitled "Fatigue and the Firefighter's Environment," shows how to better manage the fatigue-related stresses produced by the firefighting environment in order to maintain productivity and reduce injuries.

The video is available through the Boise Interagency Fire Cache (Order No. NFES 2071) at a cost of $4.07 each and the accompanying pamphlet (Order No. NFES 2072) at $0.09 each. The ordering address and telephone number are as follows: Boise Interagency Fire Center Warehouse, Attention: Supply, 3905 Vista Avenue, Boise, ID 83705; FTS 554-2542 and commercial (208) 389-2542. ■

Jerry Monesmith, *safety and training group leader, USDA Forest Service, Fire and Aviation Management, Washington, DC*

Air Tanker Vortex Turbulence—Revisited

Donald A. Haines

Research meterologist, USDA Forest Service, North Central Forest Experiment Station, East Lansing, MI

The Stockyard Fire

Extreme drought had a devastating impact on wildland fire activity over much of the Central and Western United States during the summer and autumn of 1988. State and Federal suppression forces in Michigan's Upper Peninsula confronted fire behavior rarely experienced in early summer, typically a period of low fire occurrence.

The Stockyard Fire, near Escanaba, MI, proved especially troublesome because of unexpected fire behavior. Among other features, 100-foot-long (30-m) sheets of flame moved horizontally, undulating like waves on a water surface. Fire brands moving with the sheets caused spot fires that quickly turned into 15- to 30-foot-high (4.5- to 9-m) fire whirlwinds. Even though the Burning Index (National Fire Danger Rating System) was 27 with fuel model E, burning was so intense along some sectors of the fire that escaping gases did not ignite until well above the fire. In those cases, the gases exploded as large bubbles high in the air.

But the most interesting behavior occurred along a 300-foot (91-m) length of the right flank. Here three tractor-plow operators built line within a jack pine plantation. The trees were 3 to 6 inches (8 to 15 cm) in diameter and 25 to 30 feet (7.5 to 9 m) high. Compared with other sectors, this was a quiet area. The operators plowed 50 feet (15 m) from a backing fire with 2-foot (0.6-m) flame lengths. Aided by a firing-out crew well behind the tractor operators, the fire burned to the line, leaving a wide black area.

Winds were light and then became calm. The low flames suddenly began to "climb" up a few trees into the crowns. Within a minute or two the flames became a high wall. The wall changed into a crown fire, moving directly toward the tractor crew. Flame tilt had shifted from slightly eastward to vertical and then to westward.

The resultant crown fire was described as a "waterfall," a "breaking wave," a "curl," and a "wave curl." In other words, it was a horizontal roll vortex of some type. Witnesses also stated that this wave (vortex) moved along the fire line at about 15 miles per hour (24 km/h). The vortex rotation threw foot-long (0.3-m) fire brands westward, 100 feet (30 m) away from the flank, into unburned fuels. Flame heights increased to 150 to 250 feet (45 to 76 m). Luckily no one was killed, although one of the tractor operators was badly injured and spent weeks in a medical burn center.

What happened? Of equal interest, why did it happen only along this section of the line?

Possibilities Rejected

None of the more typical causes can explain the unexpected changes in fire behavior. There were no heavy fuel concentrations. Fuels were relatively uniform in a typical jack pine plantation. Also, the area was relatively flat with no unusual topographic features.

There were no apparent immediate weather concerns. The weather charts showed that the region was covered by a large, flat, high-pressure cell. Although the fire occurred near one of the Great Lakes, the land/sea breeze circulation did not change at that time. Also there was no apparent change in the vertical structure of the atmosphere over the fire.

Burnout operations upstream of the site had no effect on downstream activity nor did anyone see the formation of a large vertical fire whirl or other suspicious fire-initiated features.

Lessons Relearned

However, one interesting incident did occur in this sector only minutes before the sudden, violent increase in fire activity. A DC-4 air tanker carrying 2,000 gallons (7,571 l) of retardant flew along the fire line, circled, then came back and dropped the retardant just south of this sector as the fire intensified. The tanker was flying at less than 400 feet (122 m) and at perhaps 140 miles per hour (225 km/h).

Almost a quarter of a century ago, Davis and Chandler (*2*) published an article in *Fire Control Notes*, "Vortex turbulence—its effect on fire behavior." In it they warned about aircraft vortex turbulence, a sheet of turbulent air left in the wake of all aircraft. It rolls up into a strong vortex pair—two, compact, fast-spinning funnels of air (fig. 1). Unfortunately, this vortex pair is usually invisible. Under certain conditions, the two vortices may stay close together, sometimes undulating slightly as they stretch rearward. The interaction between them tends to make them stay together as they move downward through the air. They usually roll apart as they hit the surface of the ground. This vortex phenomenon was discovered when it caused the crash of several light aircraft caught in the wakes of large airplanes.

Ordinarily, aircraft vortex turbulence does not endanger fire control forces. But, Davis and Chandler warned that under special circumstances, vortex wakes may cause fire behavior to change dramatically.

Figure 1—*Low-flying spray plane. Note funneling effect of spray trailing each wing.*

Vortex severity and persistence vary with several factors. Most important are the type, size, speed, and altitude of the aircraft and the prevailing atmospheric conditions. Other factors being equal, the strongest vortex pair is produced by a large, slow-flying aircraft with a high wingspan loading. The speed is most important before landing or after takeoff. It is also a factor when an air tanker slows down for an accurate airdrop.

Aircraft altitude is important because vortices weaken rapidly with time. Under typical wind speeds, the vortex pair may lose its pòtential impact in less than a minute. But the pair tends to persist in calm air. At high altitude, the two vortices remain separated by a distance slightly less than the aircraft's wingspan. However, the interaction of the vortices causes them to drop at a rate of 300 to 500 feet per minute (5.5 to 9 km/h) depending on various factors.

Winds were light and then became calm. The low flames suddenly began to "climb" up a few trees into the crowns. Within a minute or two the flames became a high wall.

For a more complete description of the action of these vortices, please read Davis and Chandler (*2*) and also Chandler and others (*1*).

Be Aware

Today's fire crews and air tanker pilots would be wise to heed the warnings offered by Davis and Chandler. Fire crews should be alert for trouble in these circumstances:

- The air is still and calm.
- The fire is burning in open land or in scattered or low timber.
- The air tanker is large or heavily loaded.
- The air tanker is flying low and slowly.

Air tanker pilots should be aware of the problem the aircraft can cause and take these precautions:

- Do not fly parallel to the fire line more than necessary.
- Keep high except when making the actual drop.
- Ensure that ground crews are alert to the presence of an air tanker and the intended flight path. ■

Literature Cited

1. Chandler, Craig; Cheney, Phillip; Thomas, Philip; Trabaud, Louis; Williams, Dave. 1983. Fire in forestry. Vol. II: Forest fire management and organization. New York: Wiley & Sons; 240–241.
2. Davis, James B.; Chandler, Craig. 1965. Vortex turbulence—its effect on fire behavior. Fire Control Notes. 26(1): 4–6.

Hands-On Management—the Challenge of ICS at Work

T.C. Harbour, Jr.

District ranger, USDA Forest Service, Pacific Southwest Region, Modoc National Forest, Alturas, CA

Leadership is the pivotal force behind any successful organization. Recent management literature—and much of my experience—supports the view that leadership is a function of involvement. In this article, the type of involvement that leads and inspires is defined as "hands on." Practical application of ability, experience, and knowledge is the foundation of successful management. The ability to apply hands-on skills based on ability, experience, and knowledge and to achieve objectives is extremely important to incident management. Leaders must be informed and involved.

A Challenge to ICS

Incident management skills were severely tested in California during September of 1987 and in the Greater Yellowstone Area in 1988. The rash of large fires and incident management issues growing out of those events were unparalleled.

At the close of the 1987 fire season, considering the enormous commitment of resources and the outgrowth of widely varied concerns, several groups were formed to look at a variety of issues. In the Pacific Southwest Region of the Forest Service, one such group was the Fire, Health, and Safety—Action Now! group. A key concern of the Incident Organization and Management Subcommittee of which I was a member, was the lack of hands-on skills demonstrated by some key operations overhead. One focus was poor performance by some division and group supervisors and strike team and task force leaders. Indicators of weak performance included a lack of presence on critical pieces of line at critical times, a lack of quality decisions, and a lack of time on the division or with a group, strike team, or task force. In addition, some voiced concern that the Incident Command System (ICS) encouraged this approach because of an emphasis on meetings and briefings. Some people concluded that Incident Command and General Staff considered meetings and briefings a higher priority for key overhead than supervision and involved management.

Hands-on management inspires, builds teamwork, improves the quality of decisions, reduces the time to make those decisions, and strengthens the experience base of leaders and subordinates, producing more effective performers.

ICS and Hands-On Management

Meetings and briefings are a part of ICS, but not the focus. The focus of incident management is accomplishing objectives—most effectively done by hands-on management. This type of management is neither overly domineering and controlling nor laissez faire. A hands-on leader recognizes when a situation requires direct involvement and then becomes involved to energize the situation. A hands-on leader steps in when needed and gives counsel, advice, and guidance. To do this, a leader should understand subordinate tasks. The manager, although not expert in doing every job, must have experience to assist in troubleshooting and problem solving. ICS managers, given the requirement for experience, have expertise in a variety of specific areas. They have an ability to coach, teach, instruct, and assist in critical tasks. This is a key link in successfully using incident management skills.

Several approaches mentioned specifically as useful for division supervisors are applicable across the range of ICS managers. Disregard for critical pieces of line (or critical issues) and the poor performance that results is the antithesis of expectations of Incident Command and General Staff. Incident managers need to look at the cause of poor performance and attempt to improve foundation skills. Poor performance simply needs to be improved, while good work should be rewarded! Poor performance can be attributed to a lack of experience, a lack of understanding of how to perform a job, or an unwillingness to be involved in the job. None of these deficiencies is acceptable. However, a lack of experience or understanding can be corrected. Hands-on management, as defined here, can be taught and practiced. A participant's lack of experience or understanding can be remedied, in part, by an effectively involved supervisor or trainer.

Hands-on management is effective and important because it is vital and able to inspire! It pulls together rather than pushes apart. Hands-on management will improve the quality of decisions and lessen the time devoted to making those decisions.

Hands-on leaders get the job done! Hands-on management strengthens the experience base of leaders and subordinates and allows more effective performance at the next iteration. The ability to apply lessons learned to future assignments is a strength of ICS.

ICS is an all-risk, multiagency, incident management system. It is a great system, tried and proven. It is time to reemphasize the need for experience. It is time to teach, instruct, and qualify people in the "how-to" parts of jobs. In several courses I have been associated with, people are asking and looking for the how-to part of things. My personal experience in operations, logistics, and planning courses indicates substantial interest in the how-to aspects of jobs. ICS instructors have substantial hands-on experience and students should enjoy the benefits of this experience. Most students want to know how an expert does the job.

ICS and Hands-On Training

Expert instruction is most valuable when combined with experience. Directed experience is a great teacher, while misguided experience can be expensive and denigrating. Given a changing workforce, many people lack effective ICS experience. We should reemphasize specific position-related experience and instruction. It is time a more determined effort is made to ensure opportunities are available to gain valuable experience. Despite the costs, on-the-job training will lead to greater benefits through its application of hands-on skills.

Experience is a great teacher—it gives standards, feedback, and the opportunity to learn from mistakes. ICS leaders need to learn from the mistakes of the past and give more hands-on attention. This means more inspection of critical hot line areas by division and group supervisors, more involvement and coaching by managers, and further constructive critiquing by all leaders and staff. The result will be better managed incidents.

ICS managers, consider this challenge: Be concerned about experience, training, and people. Realize the ultimate efficiency of investing time and training now to have payoffs down the road. Understand the jobs that need to be done. Ask questions, find answers, work hard, and go the extra mile. Be on the line that needs the attention, help the unit leader that is overloaded, and sponsor a feeling of teamwork. Get involved with hands-on management! ■

Smokechaser, part of a two-person lookout team, preparing to leave for fire on the Coeur d'Alene National Forest in Idaho. 270789

Firefighter Retirement Information

The Fire and Aviation Management and the Personnel and Civil Rights Staffs have jointly prepared a pamphlet on firefighter retirement. The pamphlet, prepared by Jerry Baughman and Jerry Monesmith, defines firefighter retirement under the Civil Service Retirement System and the Federal Employees' Retirement System. Also included is a question-answer section that addresses common questions and gives practical information about the regulations. Some of the questions are: Is there a way to avoid mandatory retirement?, What is the effect of a detail or temporary promotion into or out of a covered position?, or How does firefighter coverage affect disability and death benefits? Single copies may be requested from any Forest Service personnel office or from Jerry Baughman, Personnel and Civil Rights Staff, Washington, DC, DG address: J. Baughman:W01B. ■

Jerry Baughman, *personnel management specialist, USDA Forest Service, Personnel and Civil Rights Staff, Washington, DC*

Twenty-Eight Years of Aviation in the Forest Service

Fred A. Fuchs
Assistant director, USDA Forest Service, Fire and Aviation Management, Washington, DC

There have been many changes in the use of aircraft by the USDA Forest Service from the years 1961 to 1988. Aircraft were used in 1961, just as they are now, to support Forest Service activities when other methods failed to meet logistical, time, or cost limitations. The major categories of aircraft in use have not changed much over the last 28 years, but the actual types of aircraft within those categories have changed dramatically (table 1).

The decade from 1960 to 1970 was a time of increased dependence on aircraft to get Forest Service jobs done within time and cost constraints. Although contractors supplied most of the aviation support, Forest Service employees also flew some missions. Two major considerations limited aircraft use once it was determined that aircraft could furnish support or help get a job done. The first was cost, and the second was risk to human life.

The Cost and Safety Limitations on Use

Costs increased in all areas of aircraft operation more rapidly than costs of alternative methods from the late 1970's through the mid-1980's, including costs for parts, fuel, insurance, and the initial purchase price. The use of aircraft decreased from a peak of 118,000 hours in 1974 to the current levels (fig. 1). This reduction was due to increased aviation costs and several cost-cutting factors such as the elimination of less cost-effective uses.

Aviation safety over the 28-year period adds another dimension to the story. The Forest Service aviation safety record during the 1960's was not good, but the number of accidents began to decline, especially after 1966 (fig. 2). In order to compare past and present Forest Service accident rates as well as make a comparison of Forest Service and civilian aircraft accident rates (fig. 3), the National Transportation Safety Board standard of recording the number of accidents per 100,000 hours of flight was adopted.

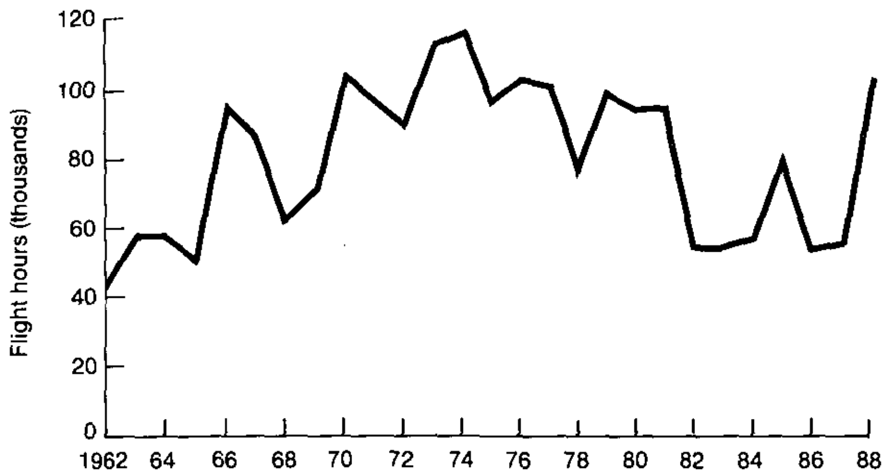


Figure 1—*Total flight-hours for USDA Forest Service aircraft from 1962 to 1988.*

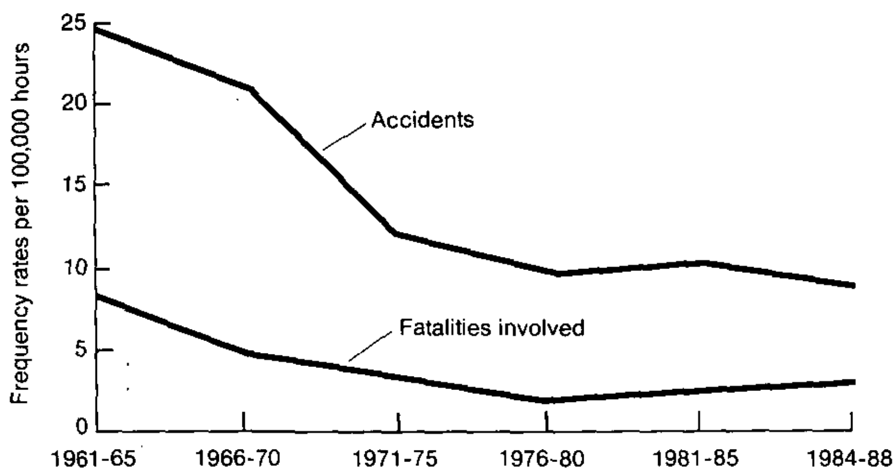


Figure 2—*Comparison of the number of aircraft accidents with the number of accidents that involved a fatality (the 1984–88 measurement was used to keep this time period comparable to the others in the figure).*

Table 1—*Comparison of aircraft used by the USDA Forest Service in 1961 and 1988*

	Aircraft types	
Category	1961	1988
Helicopter	Bell 47 Hiller 12E	Bell 206, 212 MO 500 A-Star Lama
Airtanker	TBM B-17 PB4Y2	DC-4, 6, and 7 P2V
Smokejumper aircraft	Tri-motor Ford DC-3	Twin Otter Beechcraft 99
Spray aircraft	TBM Stearman N3N	Ag Cat Thrush Various types of helicopters

The poor record of performance in aviation safety during the 1960's had drawn considerable attention, including that of the Chief of the Forest Service and his staff. Several actions were taken to change and improve aviation safety within the Forest Service. Aviation management positions were added at the Washington Office and most regional offices of the Forest Service, and both contract pilots and aircraft were inspected before contracts were awarded. However, these steps alone were not sufficient to reduce aviation accidents and fatalities to acceptable levels.

In 1971, the Airtanker Screening and Evaluation Board was established to certify aircraft, set basic standards, improve efficiency, and reduce airtanker accidents. The name was later changed to the Interagency Airtanker Board. A National Aviation Plan, completed and approved in 1972, lay the groundwork for the current organization of the Forest Service aviation program. This plan identified the need for some of the positions and duties in current Forest Service regional organizations as well as the need for a forest aviation officer.

A national helicopter study was also completed, and the plan that was approved in 1974 recommended most of the contract and operational standards in use today. In 1979, the USDA requested a review of Forest Service aviation activities by the Federal Aviation Administration (FAA). Many additional improvements were implemented, such as national contracts for some items, standard contract specifications, several aviation training courses, and national workshops and meetings to recommend program adjustments or implement changes.

Now is the time to intensify efforts to ensure that the Forest Service safety record is not only maintained, but is improved.

Safety Records

One way to evaluate the Forest Service safety record is to compare Forest Service accident records to those of our civilian counterparts. Civil aviation includes all nonmilitary and nongovernmental aviation within the United States. The Forest Service used 5-year averages for displaying accident statistics, mainly to reduce confusion from annual fluctuations and show trends more clearly. The Forest Service flies an average of 100,000 hours or less each year compared with civilian annual flight time of 30 million hours or more. Using the civil aviation records as a benchmark, the Forest Service did not have a very safe aviation program in the 1960's or early 1970's. This safety factor figured prominently in reducing use of aircraft in the 1980's.

The concerns and program changes of the 1970's did show positive results, however, with the Forest Service aviation safety record approaching that of civil aviation over the last 10 years. This becomes more impressive after reviewing the differences in Forest Service and civil aviation use. Forest Service use involves flying in considerably more turbulence and wind, with poor visibility due to smoke, high-density air traffic, and closeness to the ground, each of which adds an extra degree of hazard to a flight. Despite these added flight difficulties, the Forest Service accident record approaches that of civil aviation use, primarily due to higher standards and better inspections. In some instances, the Forest Service requires more pilot experience, performance, and aircraft maintenance than the FAA. Each year, the Forest Service inspects about 1,800 fixed-wing aircraft and

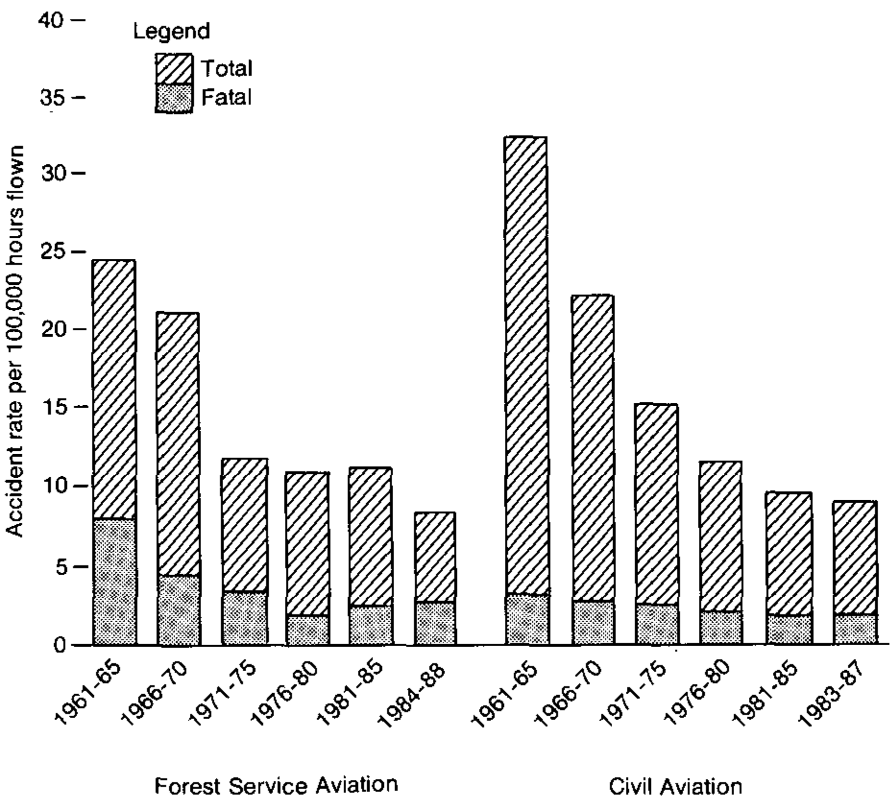


Figure 3—*Accident rate per 100,000 flight-hours for both civilian and USDA Forest Service aircraft (the data for 1984-88 and 1983-87 time periods were used to keep all elements in figure comparable).*

evaluates the qualification and performance of pilots approved by the FAA, but on the average 11 percent do not meet Forest Service standards and are not approved.

The last 8 years have seen a slight increase in the accident and fatality frequency rates for Forest Service aviation. There may be several factors contributing to this increase. Due to the poor economy, Forest Service aviation contractors have had to reduce costs whenever possible to stay in business. Deregulation of the commercial airline industry has resulted in an increase in pilot hiring, while at the same time military and civil aviation have reduced training, so that the average pilot employed by small aviation businesses now has less experience. Manufacturers have reduced aircraft production over the same period of time, resulting in an increase in the average age of aircraft and a shortage of new parts.

Another contributing factor is the reduction in Forest Service aviation inspectors. There has been about a 30-percent reduction in personnel since 1975, with only a 10-percent reduction in the number of aircraft and pilots needing approval. This has also been a time of reduced budgets at the national forest level, decreasing the amount of supervision given contractors as national forests looked for ways to reduce costs. It is impossible to identify any one thing as causing the slight increase in the frequency of aviation accidents; however, the trend needs to be halted.

Major Causes of Accidents

Table 2 summarizes the 10 most prevalent causes of accidents. Pilot error was primarily responsible for 7 of the 10. In addition, the pilot or other personnel may be responsible in accidents due to inadequate maintenance and power failure. This leaves structural failure as the only error among these 10 that the pilot may not be able to control.

Phase of Operation

Knowing in which phase of the flight operation accidents occur can also increase awareness when evaluating flying risks. Table 3 lists accidents by flight phase and indicates that the majority of Forest Service accidents occur in the "other" category, which includes accidents that occur in low-level flight operations. These accidents are the result of inadequate speed control and collision with objects such as trees, wires, terrain, or other aircraft.

Summary

Forest Service policies, procedures, and methods of managing aircraft have led to a significant

Table 2—*Percent of Forest Service and civil aviation accidents attributed to the 10 major causes of accidents*

Cause of accident	Forest Service[1]	Civilian[2]	Civilian helicopter[2]
Pilot errors			
Collision with objects (other than aircraft) during flight	24.0	3.0	7.8
Improper aircraft operation	14.0	13.3	6.6
Inadequate supervision of flight	10.0	9.3	5.4
Inadequate preflight preparation or planning	7.2	3.9	11.7
Adequate air speed or rotor RPM not maintained	5.6	8.4	8.6
Inadequate fuel management	2.4	6.4	6.6
Collision with another aircraft during flight	2.0	1.3	0.1
Other errors			
Inadequate maintenance and inspection by support personnel	11.2	9.5	5.4
Power failures	11.6	19.2	8.6
Structural failures	5.2	4.2	10.9

[1]Percent of total Forest Service accidents.
[2]Percent of total civilian accidents.

Table 3—*Percent of aviation accident occurrence in each phase of flight operation*

Phase	Forest Service[1]	Civilian[2]	Civilian helicopter[2]
Takeoff	10	21.5	16.7
Cruise	14	16.5	57.4
Approach	3	11.7	—
Landing	26	27.1	20.1
Other	47	23.2	5.3

[1]Percent of total Forest Service accidents.
[2]Percent of total civilian accidents.

Observation platform on the top of a high tree, located on the Shasta National Forest in California. Mt. Shasta is in the background. 19412A

reduction in aircraft accidents and fatalities. A reduction in accidents reduces total costs of operation, as accident settlements are very costly and thus have a major impact on cost effectiveness. Over the last 8 years, there have been many changes in the Forest Service aviation program. Now is the time to intensify efforts to ensure that the Forest Service safety record is not only maintained, but is improved. ■

Aerial view looking north across Middle Fork Peak Lookout on the Salmon National Forest at the edge of the Idaho Primitive Area (Lee Prater, 1964). 510186

The Wildland-Urban Interface: What It Is, Where It Is, and Its Fire Management Problems[1]

James B. Davis

Research forester, USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Riverside, CA

Introduction

Almost all persons involved in wildland fire control are familiar with the term "wildland-urban interface." They probably have seen the growing problem in their communities, that is, a dramatic increase during the past 10 to 15 years in the number of people leaving cities and moving into the wildlands (Davis 1986). When we take a close look at where the interface areas are and how they are affected by population growth, we find a complex situation. Consider the marked differences among the following wildland-urban interfaces, fire managers' analyses of their fire protection problems in those interfaces, and approaches to managing those problems.

- A ranger on a national forest in Michigan may view the problem there as one of balancing the protection of the natural resources with the political expediency of giving equal or better protection to summer and vacation homes for which the USDA Forest Service has no legal responsibility.
- A State Forester in New Jersey may lose sleep over the suburban sprawl in the fire-prone Pine Barrens. In addition, the Forester may see the State organization growing at a slower rate than the protection problem and feel the organization will soon be at the lower threshold of suppression effectiveness.
- A California fire chief may worry about large accumulations of flammable native vegetation, steep slopes, and narrow winding roads well within the boundaries of what most of us would consider a metropolitan area.

Not only are the vegetation and structural "fuel" problems variable and complex in these different interfaces, but the location and movement patterns of people in one part of the country differ from another. Furthermore, population trends change rapidly over time (Bogue 1985).

To confront the problem of a rapidly growing number of people moving into wildland areas and develop more effective fire management plans, managers must analyze demographic factors, local land use, and fire protection problems typical of a particular type of interface area.

The problem is further complicated by a patchwork of legal and organizational requirements and constraints. For example, some States have specific legal requirements for the protection of structures in the wildland. Others have no legal responsibility for such protection and do not train their personnel nor purchase the specialized equipment needed for structure protection. On the other hand, many agencies with thousands of acres of wildland within their jurisdictions may be unprepared to fight a wildland fire effectively.

Demography—the study of the characteristics of human populations including size, growth, density, and distribution—is a useful tool for analyzing and predicting fire management problems.

Where is the Wildland-Urban Interface?

The American people, it seems, are as dynamic and shifting as the desert sand. For most of our history as a nation, there has been a flow of people from rural areas into cities (Herbers 1986). Then, during the 1970's, this traditional pattern changed. Americans left the cities in record numbers to live in small towns and rural areas (Kloppenburg 1983). For the first time since the industrial revolution, the population growth rate outside the country's metropolitan areas was more rapid than within (fig. 1).

Now there seems to be another change (Bradshaw 1987). Census information from the first half of the 1980's shows that urban areas are growing again—but for different reasons. Areas that were once classified as rural are rapidly achieving sufficient population to be reclassified as urban. Areas typifying this trend are the Los Angeles Basin and the corridors between Boston and New York and between New Jersey and Washington, DC (Engels and Forstall 1985).

If we look at these trends in more detail from a geographic standpoint, we find some important regional rela-

[1]Previously published in Proceedings of the Symposium on Protecting People and Homes from Wildfire in the Interior West. 1987 October 6–8; Missoula, MT. Gen. Tech. Rep. INT-251. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 160–165; 1988.

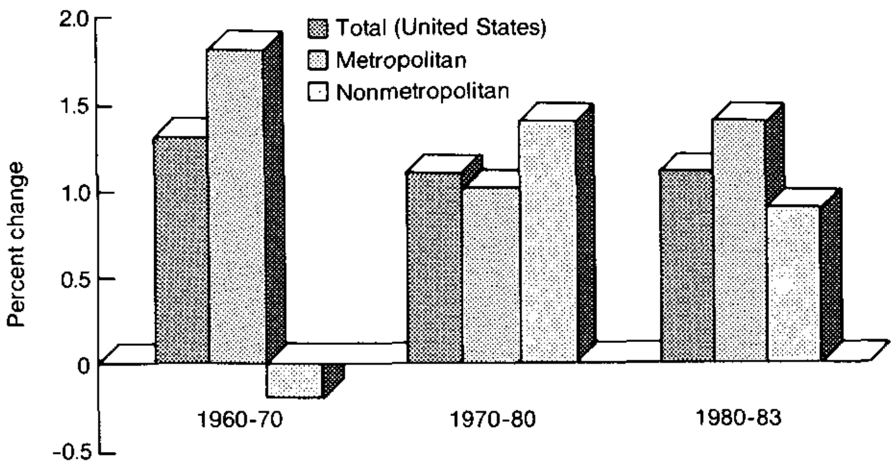


Figure 1—*Average annual percent population change by decade (Sternlieb et al. 1982).*

tionships. Americans are more dispersed across the country than ever before. A majority of people now live in the South and the West (Long and DeAre 1983). All but one of the top 10 growth States of the 1970's were west of the Mississippi River. In 19 States, the nonmetropolitan areas are still growing at a faster rate than the metropolitan areas. Only in the South is the metropolitan population growing at a much faster rate than the nonmetropolitan population (table 1).

These changing patterns of population distribution have important implications on how we fight wildland fires today and how we must plan to fight them in the future. To understand the implications of these patterns, we first need to define what is meant by the "wildland-urban interface." As shown earlier, the term can mean different things to different people.

What is the Wildland-Urban Interface?

The concept of three types of wildland-urban interface areas was first suggested by Charles W. Philpot, the then-Associate Deputy Chief for Research, USDA Forest Service,[2] at a wildland-urban interface meeting in Boston in 1986.

Three general types of interface have been identified (Laughlin and Page 1987):

- Classic interface—where city boundaries and suburbs press against wildland vegetation.
- Mixed interface—where homes and other structures are intermixed with wildland vegetation.
- Occluded interface—where islands of wildland vegetation occur inside a metropolitan area.

[2]Charles W. Philpot is now Station Director of the Pacific Northwest Forest and Range Experiment Station.

The Classic Interface. By far the greatest number of people live in (and are moving into) the classic interface (fig. 2). This is the area where homes, especially new subdivisions, press against the wildland area. Frequently vast, adjacent wooded areas can propagate a massive flame front during a wildfire, and numerous homes are put at risk by a single fire, sometimes overwhelming fire protection forces and water supplies. The classic interface is also where the greatest structural fire loss occurred in the past and is expected to occur in the future.

Once considered only a southern California problem, now no region of the Nation can be expected to escape the problems of the classic interface. In May 1985, 99 homes in Florida's Palm Coast Development were destroyed within a few hours (Abt and others 1987). In 1987, a 900-acre (364 ha) brush fire near Spokane, WA, destroyed 24 homes and damaged at least 30 others. A New Jersey fire warden predicted that should a fire situation develop similar to the one that occurred in that State in 1963, structural fire loss could amount to 1,500 homes with damage in excess of $100 million (Hughes 1987a, 1987b).

There are at least two reasons why the classic interface is growing so rapidly. The first is that suburbs closest to the central cities are becoming more like the cities themselves with many of the cities' traditional problems (Schapiro 1980). New suburbs are spreading farther from the city center, attracting today's younger families. From a demographic standpoint, the World War II "baby

Table 1—*Percent change in State population growth: 1980–83**

State	Metropolitan	Nonmetropolitan
Northeast		
Maine	1.4	2.2
New Hampshire	5.2	2.4
Vermont	3.1	2.6
Massachusetts	0.3	5.2
Rhode Island	0.6	3.5
Connecticut	0.9	2.2
New York	0.6	0.7
New Jersey	1.4	—
Pennsylvania	0.2	0.7
Midwest		
Ohio	-0.5	-0.2
Indiana	0.1	-0.8
Illinois	0.8	-0.9
Michigan	-2.5	-0.3
Wisconsin	0.7	1.5
Minnesota	2.6	0.0
Iowa	0.6	-1.0
Missouri	1.1	1.0
North Dakota	3.7	4.6
South Dakota	4.4	0.7
Nebraska	3.5	0.3
Kansas	3.9	1.3
South		
Delaware	1.5	2.9
Maryland	2.1	1.6
Virginia	4.9	1.4
West Virginia	-0.6	1.6
North Carolina	3.8	2.9
South Carolina	4.8	4.1
Georgia	6.2	2.8
Florida	9.4	11.6
Kentucky	0.2	2.5
Tennessee	2.1	1.9
Alabama	2.0	1.1
Mississippi	4.6	1.9
Arkansas	2.1	1.6
Lousiana	5.9	4.7
Oklahoma	10.3	7.4
Texas	11.3	7.3
West		
Montana	4.6	3.6
Idaho	6.5	4.4
Wyoming	7.4	9.9
Colorado	8.5	9.1
New Mexico	6.1	8.5
Arizona	9.6	5.3
Utah	10.1	13.3
Nevada	11.2	11.9
Washington	4.5	2.3
Oregon	1.3	0.6
California	6.2	8.7
Alaska	21.1	17.8
Hawaii	4.8	11.0

*Source: Engels and Forstall 1985.

boom'' is now today's young-to-middle-aged adults with families. By past standards, this is a relatively large and affluent group (Sternlieb et al. 1982).

When Americans can afford to move out of the cities or older inner suburbs, they frequently do (Newitt 1983). The Washington, DC, area is an example of the relationship between moderate wealth and the demand for space. New subdivisions are spreading across the rural, frequently flammable Virginia and Maryland countryside—some of them as much as 50 miles (80.5 km) or more from downtown Washington, DC.

The second reason for the rapid growth of the classic interface is the development of ''super cities.'' One of the terms used by the Census Bureau is ''urbanized area'': a city with a population of 50,000 or more together with all the contiguous built-up land that has a population density of at least 1,000 people per square mile. Much of the increase in ''urban'' growth during the 1980's has been a rapid change from rural to urban status for many communities. Usually this takes place near—often between—major cities, resulting in what has been called the ''closing of the megalopolis.'' Between 1970 and 1980, these areas grew at a rate 10 times that of the inner city (Long and DeAre 1983).

The classic interface is where the built-up quality of the subdivision may give a false sense of security. Paved streets, fire hydrants, and green lawns may give the impression that there is no fire threat from nearby wildlands. Yet as shown in

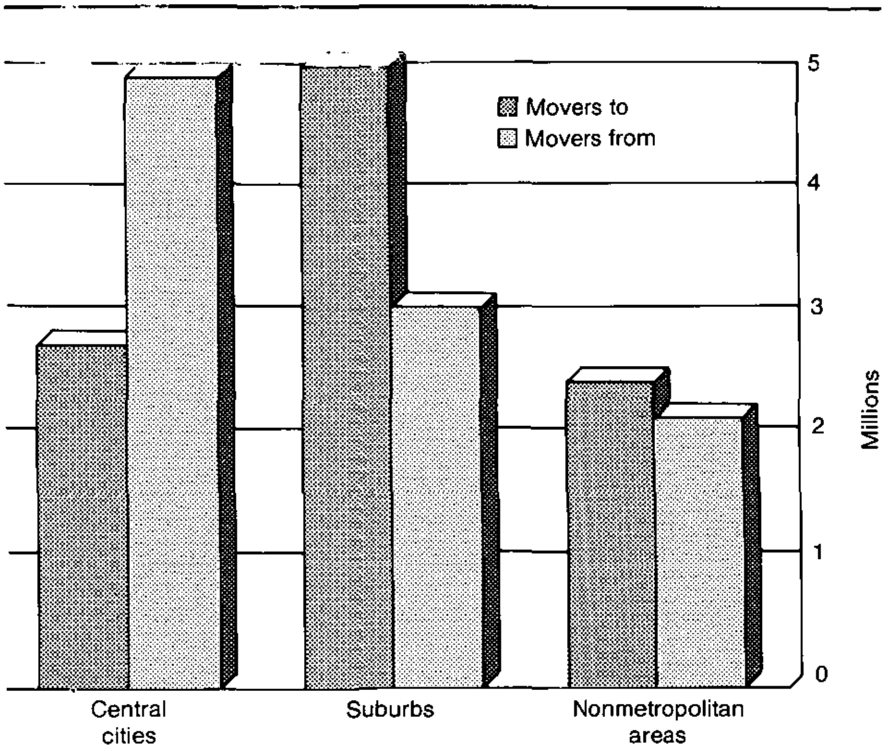


Figure 2—*Declining cities and growing suburbs: Metropolitan migration, 1980–81. While the nometropolitan areas continue to grow, it is the suburbs that attract most movers. This population growth affects both the classic and occluded interfaces (Data from U.S. Bureau of the Census 1982).*

many fires, embers, burning shakes, and shingles flying through the air have ignited roofs a half mile (0.8 km) or more from the nearest wildland vegetation.

The Mixed Interface. The mixed interface (sometimes called intermix) usually consists of homes or other buildings scattered throughout the wildland area. Small and occasionally medium-sized subdivisions may also be included. Typical are summer homes, recreation homes, ranches, and farms in a wildland setting. Usually these isolated structures are surrounded by large areas of vegetation-covered land. In a fire, the structures are very hard to protect because of the large area that may be burning, but relatively few homes may be at risk.

While these areas are not growing as rapidly in many cases as they once were, the growth rate and infrastructure problems involving schools, roads, water and sewage systems, and fire protection are still formidable. For example, between 1970 and 1978 the five California counties with the highest percentage growth rate in population were in the wildlands of the Sierra Nevada (Irwin 1987a, Sweeney 1979). The population of one of these counties (Alpine) jumped 107 percent between 1970 and 1978. Population growth in the Blue Ridge Mountains of Virginia has been even more rapid. The homes exposed to wildfire loss in portions of the Blue Ridge increased more than 400 percent between 1979 and 1984 (fig. 3).

Frequently the people moving into the mixed interface bring with them a perception of forestry that often clashes with ecological reality. They are much more concerned with their conception of "forest preservation" than with the forester's or fire manager's idea of forest management and conservation. There is often a desire by both homeowners and county planning departments to provide open space areas. One California planning commissioner stated, "We regularly review two or three proposals a month that contain either open space or wildlife-corridor zoning designations. Past county (Tuolumne) policy has been to word the conditions of the zoning so that no vegetation will be removed" (Irwin 1987b). However, relatively few California counties include fire concerns or fuel management in their open space zoning, allowing fuel corridors to develop that may run through residential developments.

In addition to the newly arriving residence's vulnerability to wildfire, there is the ecological impact on the forest itself (Rice 1987). People try to retain the forested quality of the site not realizing that it is still subject to fire, insects, and disease as

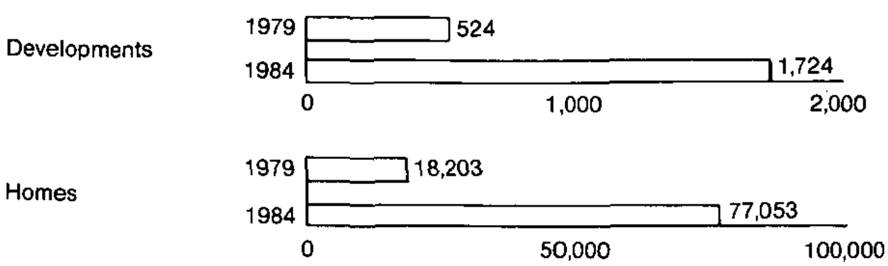


Figure 3—*The increase in the number of homes and subdivisions exposed to loss from wildfire in Virginia between 1979 and 1984 (Graff 1986).*

before, but is threatened now by the effects of urbanization as well. The root systems of many trees are cut by road construction, compacted, or paved over. Native trees may be adversely affected by watering of lawns and nonnative shrubbery or in some cases, so weakened they are readily attacked by insect pests. Near Lake Arrowhead, in southern California, 50 percent of the pines are damaged by such "people pressure" (Walt 1986). Leaving old declining trees, the weakening or killing of others, and adding houses and other buildings to the list of combustibles in the forest cause a growing load of fuel.

The people moving into the mixed interface are a varied group. In one locality, the newcomers were found to include five categories (Herbers 1986, Sweeney 1979):

- Commuters, more and more of whom are willing to travel long distances from a mountain setting to jobs in urban areas.
- The retired, who want to trade in urban problems such as crime and smog for a remote and more peaceful home in the mountains or foothills.
- Younger dropouts from the urban rat race. Many of these with families want to raise their children in a simpler, less pressured lifestyle, away from the problems of city schools and rush-hour traffic jams.
- Older, successful corporate executives who wish to exchange long hours spent in often well paying jobs for even longer hours spent launching their own small businesses.
- The poor, who may find that it is the only place they can afford to live. In many cases, a home (or mobile home) in the wildland is far less expensive than similar accommodations in more developed places.

Many of these newcomers possess at least two characteristics in common: they are very aware of their environment, and they are very much interested in getting involved in what has been called "stewardship of the land." Every Forest Service manager responsible for a forest plan knows very well the extent of this wish for involvement and participation.

Complicating the fire problems in the mixed interface is the often inadequate fire protection. Frequently the only fire protection available is either forestry agencies that are budgeted, equipped, and trained only for wildland firefighting or poorly staffed and poorly equipped volunteers. Fire managers must make the tough decisions about sacrificing natural resources to protect homes and other structures, usually with personnel and equipment not particularly suitable for the job. This conflict leads to a mismatch between property owner's fire protection expectations and fire agency protection strategies, which in turn frequently leads to lack of trust, and—on occasion—to litigation.

The Occluded Interface. An occluded interface is characterized by isolated (either small or large) areas of wildland within an urban area. An example is an undeveloped or primitive city park surrounded by homes trying to preserve some contact with a natural setting.

The same demographic trends affecting the classic interface also influence this interface. As the megalopolis closes to make a super city, islands of undeveloped land get left behind. In some cases, these are specifically set aside as parks. In other cases, they may be steep, difficult places that are unsuitable as building sites. The occluded interface may even occur in portions of inner cities as parks or as intractable terrain left behind by developers.

Many homes and other buildings may be at risk, but the relatively small wildland areas are not as subject to large-scale fire. This does not mean that fires cannot be deadly. In 1985, three homeowners died when an 8-acre (3.2-ha) fire, well within the Los Angeles metropolitan area, swept up a steep slope and overran their homes. Fires in the occluded interface can be dangerous and difficult to fight because of steep, inaccessible terrain and limitations on suppression methods due to the proximity of structures. The Los Angeles County Griffith Park Fire of 1933, a typical occluded interface fire, was the most tragic—forest or structural—in the Nation's history from the standpoint of firefighter casualties, with 25 killed and another 128 injured (Wilson 1977). More total lives, however, have been lost on several large historical fires. These include the 1871 Peshtigo Fire in Wisconsin where 1,500 people perished, the 1894 Hinkley Fire in Minnesota with 418 fatalities, and the 1881 Michigan Fire in which 169 people died (Davis 1959).

Implications for Fire Management and Research

The wildland-urban interface is complex from the standpoint of fire planning and management. Each type of interface—mixed, classic, and occluded—has its unique demographic characteristics and fire protection problems.

Demographic analysis can help managers to—

- Identify each type of interface.
- Identify the occupants of each interface.
- Track population trends affecting an interface.

By examining and understanding how these future population trends will affect fire protection tactics and strategy in each of the interfaces, managers should be able to plan ahead—to be proactive rather than reactive in their relations with the public and its leaders in managing the wildland-urban interface fire problem.

A recent survey of California fire managers assessed the research needs of the interface fire problem. The highest priority for research was for an effective method to communicate with the public and, particularly, public policy leaders before there was commitment to a course of land development that might be contrary to good fire protection (Davis 1987). ■

Literature Cited

Abt, Robert; Kelly, David; Kuypers, Mike. 1987. The Florida Palm Coast fire: an analysis of fire incidence and residence characteristics. Fire Technology. 23(3):186–197.

Bogue, Ronald J. 1985. The population of the United States, historical trends and future projections. New York: The Free Press. 350 p.

Bradshaw, Ted K. 1987. The intrusion of human population into forest and rangelands of California. In: Proceedings of the Symposium on Wildland Fire 2000; 1987 April 27–30; South Lake Tahoe, CA. Gen. Tech. Rep. PSW–101. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 15–21. 258 p.

Davis, James B. 1986. Danger zone: the wildland/urban interface. Fire Management Notes. 47(3):3–5.

Davis, James B. 1987. Assessing subjective preferences for future fire research. In: Proceedings of the Symposium on Wildland Fire 2000; 1987 April 27–30; South Lake Tahoe, CA. Gen. Tech. Rep. PSW–101. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 121–127. 258 p.

Davis, Kenneth P. 1959. Forest fire control and use. New York: McGraw Hill Book Company, Inc. 584 p.

Engels, Richard A.; Forstall, Richard L. 1985. Metropolitan areas dominate growth again. American Demographics. 7(4):23–39.

Graff, John. 1986. Personal communication. Charlottesville, VA: Fire Management, Virginia Department of Forestry.

Herbers, John. 1986. The new heartland. New York: Times Books. 228 p.

Hughes, Joseph B. 1987a. Development in the Pine Barrens: a design for disaster. Fire Management Notes. 47(4):24–27.

Hughes, Joseph B. 1987b. New Jersey, April 1963: *Can it happen again? Fire Management* Notes. 48(1):3–6.

Irwin, Robert L. 1987a. Local planning considerations for the wildland-structural intermix in the year 2000. In: Proceedings of the Symposium on Wildland Fire 2000. 1987 April 27–30; South Lake Tahoe, CA. Gen. Tech. Rep. PSW–101. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 38–46. 258 p.

Irwin, Robert L. 1987b. Personal communication. Riverside, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station.

Kloppenburg, Jack. 1983. The demand for land. American Demographics. 5(1):34–37.

Long, Larry; DeAre, Diana. 1983. The slowing of urbanization in the U.S. Scientific American. 249(1):33–41.

Newitt, Jane. 1983. Behind the big-city blues. American Demographics. 5(6):27–39.

Laughlin, Jerry; Page, Cynthia, eds. 1987. Wildfire strikes home!: The report of the National Wildland/Urban Fire Protection Conference; 1986, September; Denver, CO. Quincy, MA: National Fire Protection Association. 90 p.

Rice, Carol L. 1987. What will the western wildlands be like in the year 2000? future perfect or future imperfect. In: Proceedings of the Symposium on Wildland Fire 2000; 1987 April 27–30; South Lake Tahoe, CA. Gen. Tech. Rep. PSW–101. Berkeley, CA:

U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 26–31. 258 p.
Schapiro, Morton Owen. 1980. Filling up America: an economic-demographic model of population growth and distribution in the nineteenth-century United States. Greenwich, CN: JAI Press Inc. 425 p.
Sternlieb, George; Hughes, James W.; Hughes, Connie O. 1982. Demographic trends and economic reality: planning and marketing in the '80s. Center for Urban Policy Research. State University of New Jersey. 154 p.
Sweeney, Joan. 1979. Sierra lure—urban dropouts bring urban problems. Los Angeles Times. March 25.
U.S. Bureau of the Census. 1982. Geographical mobility: March 1980 to March 1981. Current Population Reports, Series P–20, No. 377. 143 p.
Walt, Harold R. 1986. Problems in the urbanized forest. The Christian Science Monitor. March 17.
Wilson, Carl C. 1977. Fatal and near fatal forest fires: the common denominators. International Fire Chief. 43(9):9–15.

Former Military Aircraft in Fire Protection

Since the late fifties, the USDA Forest Service has acquired former military aircraft for loan to State forestry agencies for wildfire protection. A wide variety of small fixed-wing aircraft and helicopters have been used for fire detection, movement of equipment and firefighters, retardant and water drops, and a host of other fire jobs.

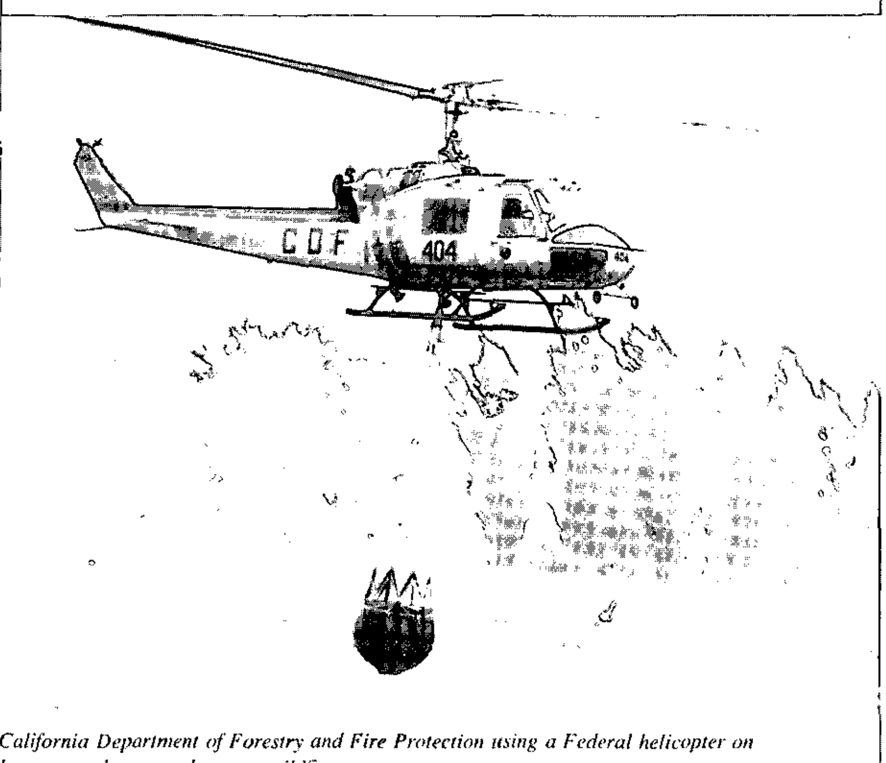
The loan of Federal Excess Personal Property, including former military aircraft, is viewed by Congress as a partial redemption of the Federal role/National interest in the protection of State and privately owned land from wildfire. Congress decided some time ago, and periodically reaffirms, that the Forest Service should continue lending this valuable resource to the State Foresters.

Currently, there are about 250 aircraft on loan to the State Foresters. Some of the more popular aircraft are the propeller-driven training aircraft like the Beachcraft T–34, Cessna T–41, and the North American Rockwell T–28. Also popular are the Grumman S–2, Beach Baron, and several other Cessna models.

The utility and popularity of helicopters also continue to grow. The States at one time used only a few Bell 47B–G–3 and Hiller OH–23G helicopters. Nine States now operate larger Bell UH–1 helicopters for a variety of fire protection chores.

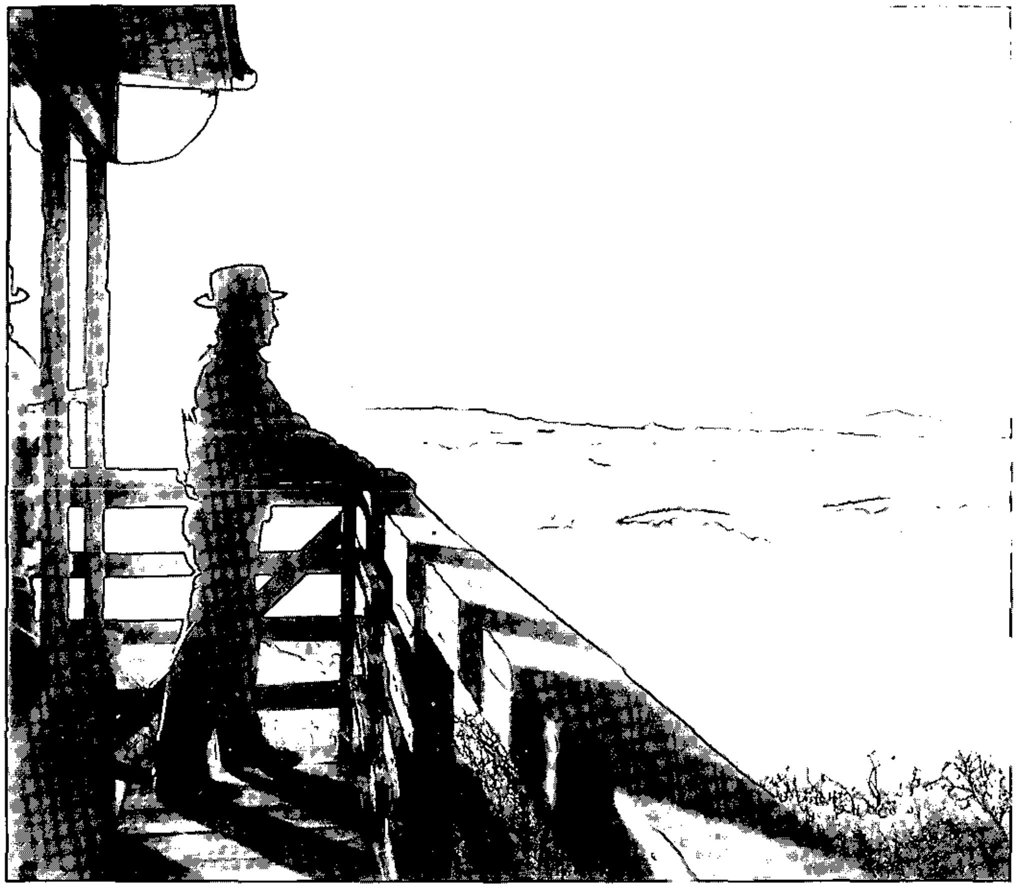
When the military phases out a particular model of aircraft, the taxpayers win again, since the former military aircraft are ideally suited for fire protection by the State Foresters. The States get the benefit of equipment purchased by their taxpayers. They may also benefit from the training invested in the personnel who are experienced in the operation of that equipment. In fact, many of the State forestry pilots are former military fliers. ■

Francis R. Russ, *Property management specialist, USDA Forest Service, Fire and Aviation Management, Washington, DC*



California Department of Forestry and Fire Protection using a Federal helicopter on loan, to make water drops on wildfire.

A Room (Sometimes) with a View (Always)



Assistant Supervisor Art Grumbine looking north from Black Mountain Tower into the Blue Ridge Range on the Chattahoochee National Forest views cloud-sea swirling around the mountain peaks below (Daniel O. Todd, 1952). 470978

"It was a great life. You woke up in the morning to the finest views of all. You breathed the freshest air in the world. You ate and did the chores when the spirit moved you. You had a whole mountain to call your own. And the Government even paid you to be there!

"That's how it was back in the 1930's when the U.S. Forest Service was working frantically to put a firewatcher on every mountaintop.

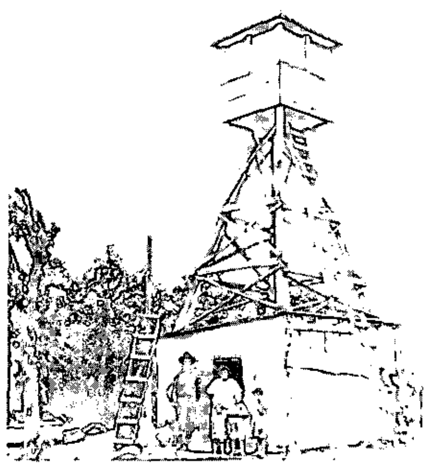
"It was a time when you couldn't go into the hills without constantly being under the watchful eye of the spies on the mountaintops. Rangers counted on them to save the forests during the dry season each summer. Creatures depended on them. Farmers, loggers, and sportsmen were more cautious because of them. Firebugs hated them.

"Yet, it would take only a single generation before fire towers across the country were to face extinction...."

—Ray Krezek, *Fire Lookouts of the Northwest*[1]

[1]Many thanks to Ray Krezek for so kindly allowing us to quote liberally from his book, *Fire Lookouts of the Northwest*, published by Ye Galleon Press, Fairfield, Washington, in 1984. We direct inquiries concerning this book to Historic Lookout Project, West 123 Westview, Spokane, Washington 99218.

Anderson Butte Lookout on the Olympic National Forest in Washington. Staff officer Wallace Wheeler ascending trail, last 75 yards of which has a cable handrail (Frank Flack, July 1952). 470653

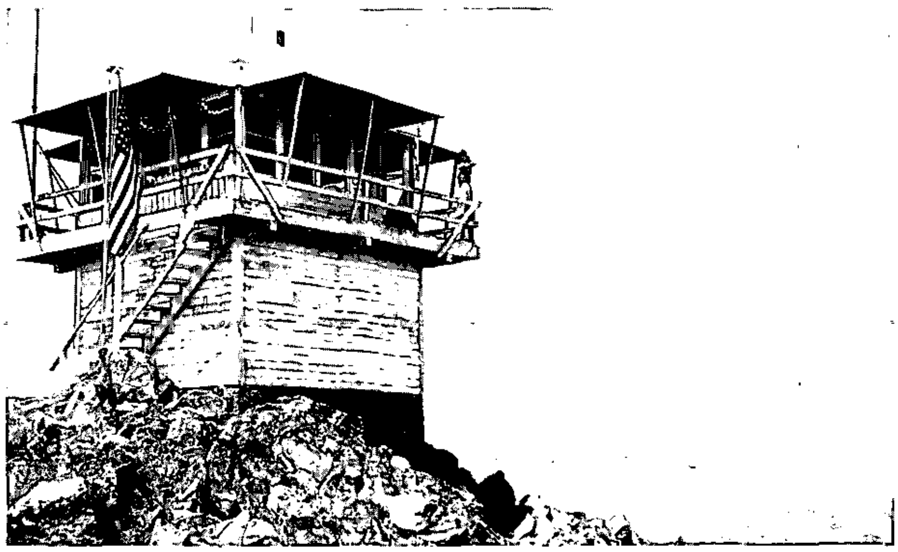


Lookout C.A. Egger and his family in front of Rich Mountain Lookout Tower on the Ouachita National Forest in Arkansas (George Plymale, October 1924). 192078

Striped Peak Lookout on the Coeur d'Alene National Forest in Idaho. At the time the photograph was taken, this observatory and living quarters was the latest type of lookout (K.D. Swan, 1924). 187461

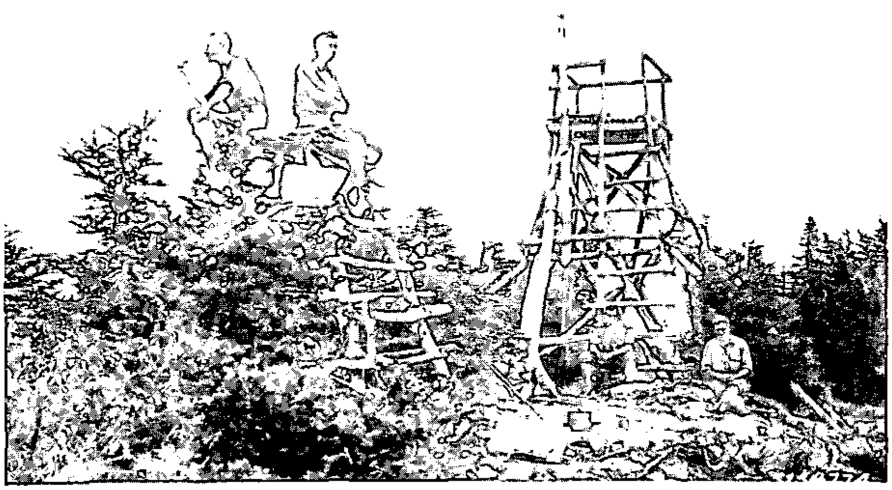
The Watchers

"Folks often ask what kind of a person would ever want to live a dozen miles from his nearest neighbor. This rare breed of men and women have little desire for money or power. More are already in love with nature; the rest by summer's end will find companionship, making friends with squirrels, deer, chipmunks, ravens, even gophers and spiders. Many are young students of forestry, or perhaps music, earning money to return to college. A few are dreamy-eyed honeymooners, or old-timers from the local area, or from across the country."



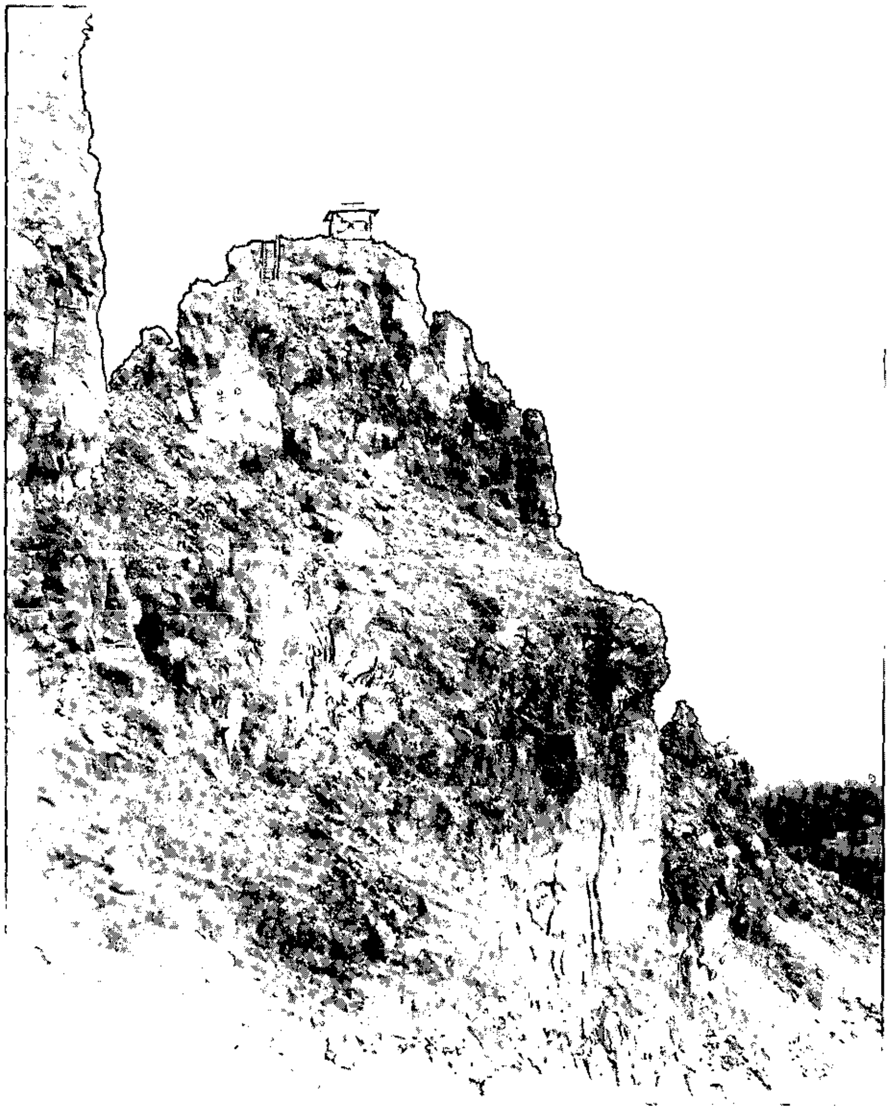
Lookout Mary Kelly at Smith Peak Lookout on the Plumas National Forest in California (R. Overstreet, 1954). 437787

Mrs. Earl Hupp, lookout on Kings Mountain on the Kootenai National Forest in Montana, during the summers of 1943-44, and her daughter, Hollianne. 434429

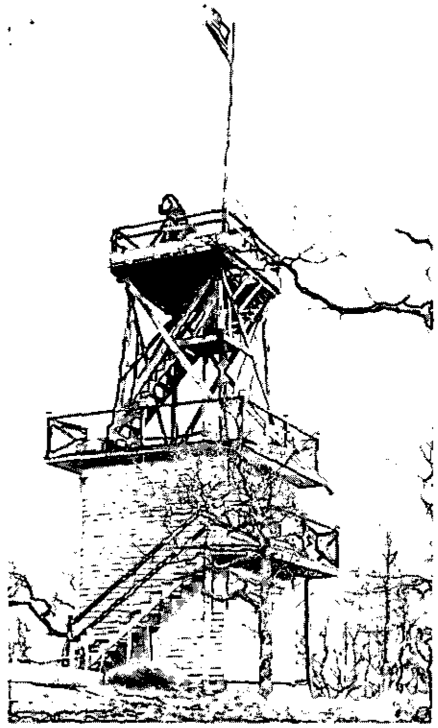


Lookout tower on Mt. Carrigain on the White Mountain National Forest in New Hampshire. Mr. Kneipp (left) and Col. Greeley seated on the old tower. Messrs. Reed, Davis, and Beals at the base of the present tower (J.J. Fritz, 1921). 154774

Lookout Tree in the Lincoln National Forest near Russia, NM (E.S. Shipp, 1928). 23319



Castle Peak lookout on the White River National Forest in Colorado. 35241A

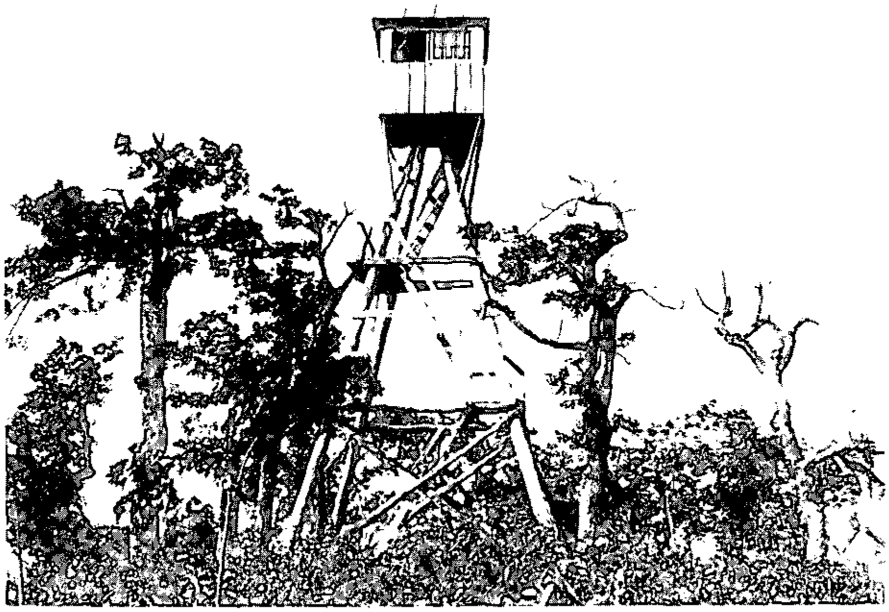


Fire Lookout Tower at Camp Parrydice in North Carolina. The tower and camp belonged to Mr. Parry of Atlanta but was used by the Forest Service (E.S. Shipp, 1916). 27292A

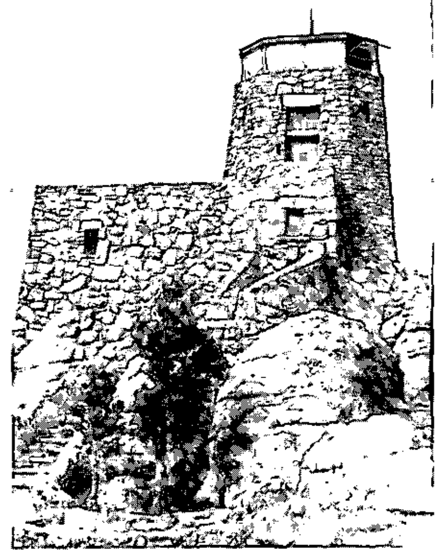
Lookout on Arapaho National Forest in Colorado tightens connections from lead-off spike to beginning of lightning protection cage (Jay Higgins, 1949). 457737

Cold Knob Fire Tower on the Allegheny National Forest in Pennsylvania (E.S. Shipp, 1926). 211642

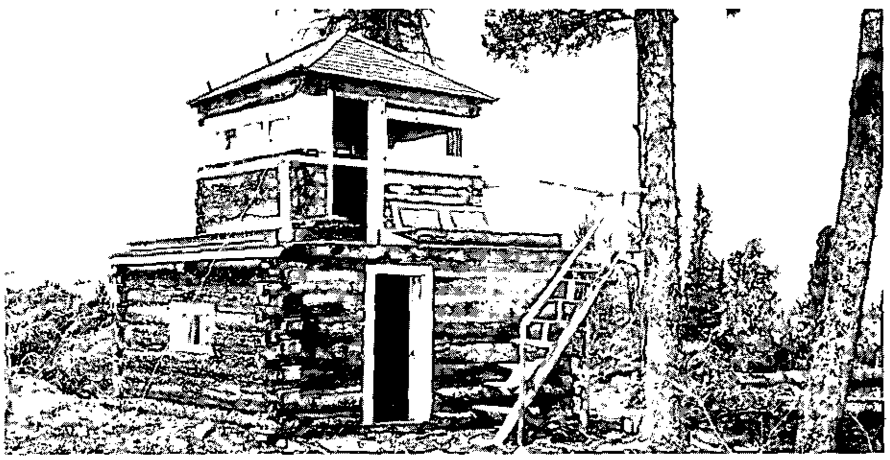
Lookout Eli Hemrick and Federal Inspector J.A. Mitchell in lookout tree on Turkey Knob in Webster County, West Virginia (J.A. Mitchell, 1919). 40806A



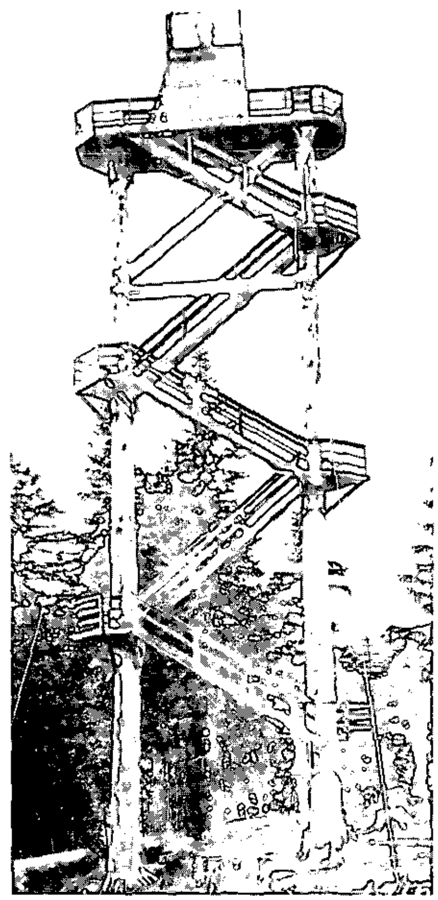
Bald Mountain Lookout Tower in the George Washington National Forest in Virginia (E.S. Shipp, 1925). 201641



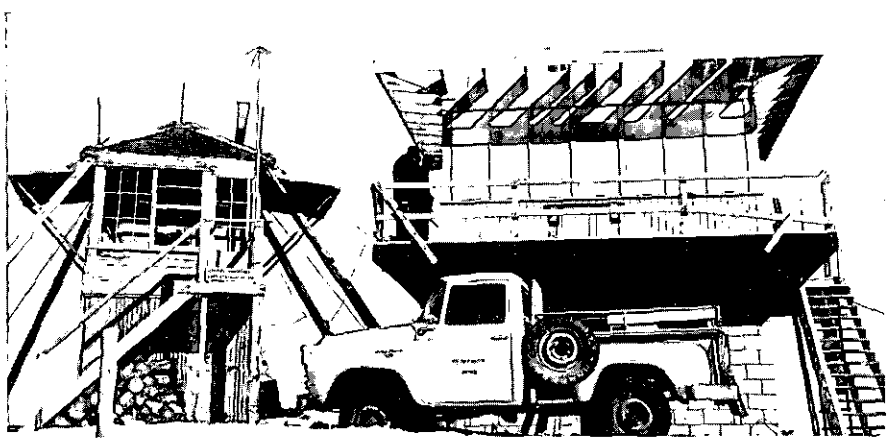
Southside of Harney Peak Lookout, located on the then-Harney National Forest in South Dakota. The lookout was completed in 1941 (Jay Higgins, September 1941). 412812



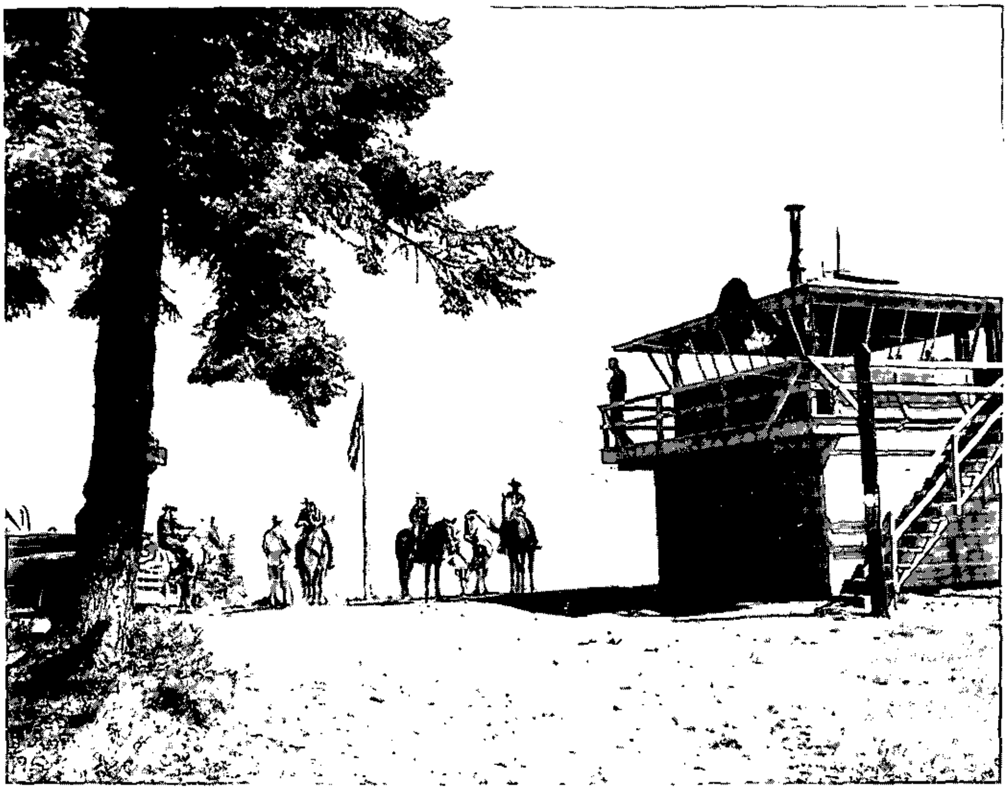
Fire observatory and living quarters at Hunter Peak in Wyoming (1918). 42459A



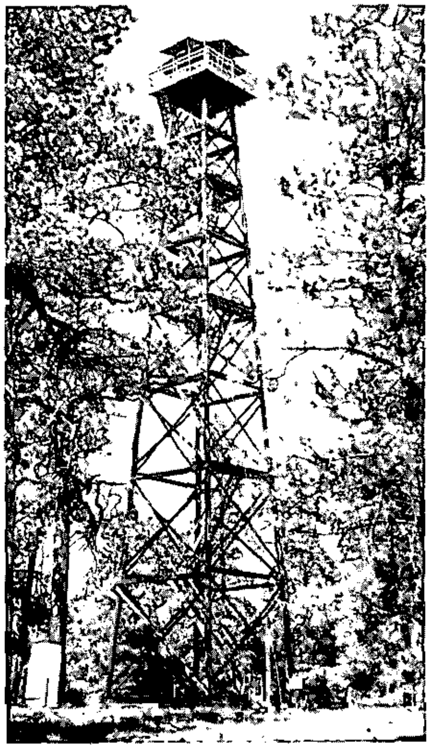
Larch Mountain Fire Tower on the Mount Hood National Forest in Oregon (1920). 151626



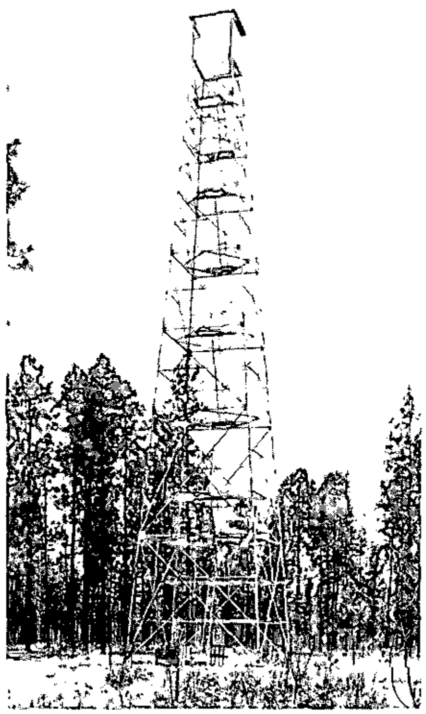
Old and new lookouts on Garnet Mountain on the Gallatin National Forest in Montana. The old lookout was erected in 1949; the new two-story flat, in 1962 (Lew Peck, 1962). 503633



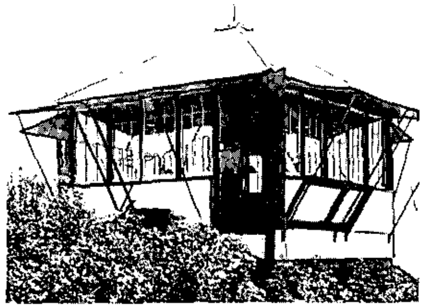
Visitors on horseback at Flat Top Lookout on the Gifford Pinchot National Forest in Washington with Mount Adams as a backdrop. The windows of the lookout are slanted out and have a yellow-green tint to reduce glare inside the cabin (Leland J. Prater, 1949). 456960



Dutch Joe Lookout Tower on the Sitgreaves National Forest in Arizona is a Teco-connected R-6 design, 100-foot timber tower fabricated by Geeson Bros. and built by the Civilian Conservation Corps in 1940 (Richard H. Lewis, 1948). 454121



Steel lookout tower on State Forest No. 4 near Warren, TX. One of 70 steel lookout towers erected by the Texas Forest Service in East Texas. 360790



Red Top Lookout on the Santa Fe National Forest in New Mexico (W.A. Jackson, 1936). 324077

The Lookout Towers and Cabins

"The years 1902-14 brought out the ingenuity in early foresters. Lookout stations varied widely, from pup tents to spacious log houses," reports Ray Krezek. Here's a list of some of the lookout tower types he describes:

Lige Coalman's D-6 cupola: A 12-by-12-foot frame house and cupola observatory, both with windows on all sides. (Its prototype was placed on Mount Hood in 1915.)

The D-1 cupola house: A 14-by-14-foot log cabin with framed-glass cupola. (It evolved on the Flathead in 1922.)

The L-4: This 14-by-14-foot frame cabin came in a kit that could be hauled by mule to the lookout site and built on tall poles cut from the site. The earliest L-4's, available in 1929, have gabled, shingled roofs; the 1933-53 models have hip roofs. The L-4's were built on rocks, cinder block basements, and on towers of all types.

The L-5: A 10-by-10-foot tower erected at some secondary patrol points. Only a handful were lived in.

L-6: An 8-by-8-foot cabin placed on 80- to 100-foot wooden towers. In the 1930's, mainly boosted by Civilian Conservation Corps labor, many galvanized steel 7-by-7-foot towers, ranging from 35 to 175 feet tall, were built.

Photographs:
Courtesy of National Agricultural Library, Forest Service Photo Collection

After the Terra Torch, What's Next?

Ted Tveidt

Fire management officer, USDA Forest Service, Flathead National Forest, Tally Lake Ranger District, Whitefish, MT

The world of fire is changing. We have progressed from fire control to fire management. Along with this transition, procedures, methods, and equipment have evolved to a point that one wonders, "What's next?"

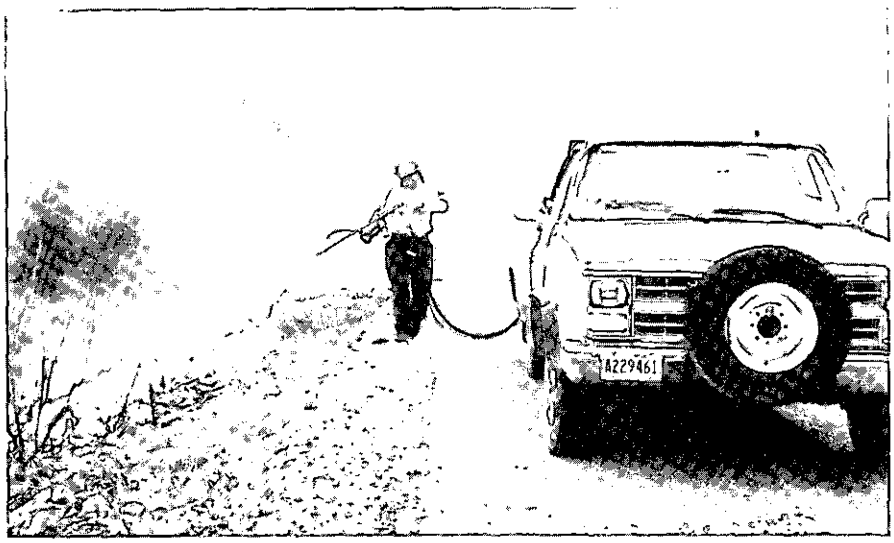
Prescribed-Fire Ignition System

In the prescribed-fire area of fire management, there have been radical changes and steady improvements in equipment over the past 10 years. New, sophisticated ignition systems are being developed and tested annually. Aerial ignition systems such as the helicopter drip torch and the aerial ignition dispensing system are now widely used throughout the Forest Service by fire managers to facilitate the prescribed-fire workload.

The terra torch is a relatively new system being used by some fire managers. The Bureau of Land Management (BLM) began working on a terra torch project in 1981. The intent was to develop a system that gave a safe, state-of-the-art alumagel application from a ground vehicle and decreased operational costs compared with the helicopter drip torch system. (At the present time, terra torches are not on a Government contract.)

Characteristics

The type of terra torch currently being constructed is a one-piece aluminum structure with a 50- to 250-gallon (189.3- to 946.3-l) closed-fuel, mixing tank. Most units now have an 11 horsepower engine and pump system, a Mapps gas applicator and 100 feet (30.5 m) of hose. The empty weight of the unit is 600 pounds (272 kg) and will fit in the back of most 3/4-ton pickup trucks or may be trailer mounted. Additional storage is needed for necessary and recommended equipment accompanying the unit.



Using the terra torch to ignite fuels below the road.

The intent was to develop a system that gave a safe, state-of-the-art alumagel application from a ground vehicle and decreased operational costs compared with the helicopter drip torch system.

When the terra torch is properly adjusted and the unit is running to its full capability, ignited, gelled fuel can be sprayed up to 100 feet (30.5 m) on level ground. The fuel comes out of the wand in a solid stream and then breaks up into multiple burning particles. The gelled fuel will stick to any fuel component that it comes into contact with. Gel thickness and delivery distance is a function of gel thickness and orifice opening size. The size of the opening is controlled by small bushings at the top of the wand where the fuel exits the system.

Extra nozzle bushings for the wands are available from the manufacturer and several sizes should be on hand. These bushings come in several sizes and control the amount of fuel dispensed and the distance it can be sprayed. To create a solid ignition pattern on wet fuel beds, the larger bushings, dispensing more fuel over a shorter distance, work best. Even with this ignition capability and flexibility, the terra torch will only be as effective as the burning plan and the operator running the unit.

Specialties of the Terra Torch

Burning crews normally have to leave the road to ignite road right-of-way piles and landing piles. Ignition with a terra torch saves time and money in these situations. Use of the terra torch to ignite the top and bottom of broadcast burns with road access is also possible; however, caution is necessary due to the potential extreme heat intensity and flame length. Also, broadcast burn units or piled material consisting of large diameter fuels will be more easily ignited with the terra torch.

One of the most effective and efficient applications we have experienced in using the terra torch is the early or late season burning of tops or sides of broadcast burn units where critical burning or holding situations exist. This burning is accomplished when the fuel moistures are high enough that risk of escaped fire is greatly reduced. If the tops and sides of critical burns are ignited one season prior to the planned ignition, it can save the fire manager time and money (due to the smaller holding crews needed) and reduce the risk of escaped fire. Preburning critical areas may also increase the opportunities for multiple burns to be accomplished in one day.

Use of terra torch in a broadcast burn.

Preburning in larch, douglas fir, and lodgepole types with 10-hour fuel moistures in the 18- to 25-percent category has proven to be an effective use for the terra torch. These fuel types will burn at this moisture but will not spread. Should the fuelbed have a high fuel moisture content and ignition is a problem, the terra torch operator may presaturate the fuelbed and then use the ignited terra torch to burn these areas. This double application will usually burn the fine fuels and leave the larger diameter fuels. This is not a complete disposal method in these areas, and there may be a potential for reburn during the second ignition phase, but fire intensities and burning duration will not be as great as in a single-stage burn.

The terra torch has also proven to be very effective in burnout operations on large wildland fires. Several of the units were used in Regions 5 and 6 during the 1987 fire season.

When preburning in fuel moistures of 20 to 25 percent, using a mid-sized wand bushing with the torch running at full capacity, the fire manager can ignite an approximately 1/2-mile-long (0.8-km) strip, 2 chains (40.23 m) deep with 80 gallons (302.8 l) of fuel. This distance is based on a solid ignition pattern for the 1/2 mile (0.8 km) in larch and douglas fir timber types.

Capital Cost and Cost of Operation

Cost of terra torches available on the open market will vary from $5,000 to $7,000. BLM's fire management section at Boise Interagency Fire Center has several available for loan. They may also be purchased from Simplex, Inc., and Firecon.

Cost for application on an area, 1/2 mile long (0.8 km) and 2 chains deep (40.23 m) are as follows:

Item	*Cost*
Fuel (80-gal raw diesel gasoline @ $0.89/gal)	$71.20
Surefire gas-gelling agent @ $4.25/lb	14.89
Setup and mixing time (wages for 1/2 hr)	12.00
Wages for 3 people @ $8.00/hr	24.00
Total	$122.09

The above costs do not include costs for the vehicle or any employee wages expended for transportation to or from the burn unit.

Operation of Terra Torch

Correct mixing is critical to the efficiency of the terra torch operation. All terra torch units are set up to mix raw diesel and gas with a gelling-agent compound within the sealed unit. One effective gelling agent (Surefire) consists of aluminum soaps and other compounds. The first step in mixing is to fill the terra torch tank with 60 percent gasoline and 40 percent diesel fuel. The pump motor can then be started and the unit can then be put into the mixing or recirculating mode. As the fuel is agitating, the gelling agent should be added at a moderate rate. All lumps of powdered-gelling agent should be broken up before adding to the fuel. It normally takes about 15 minutes to gel the fuel. Colder gasoline temperatures will lengthen the time needed to gel the fuel.

Safety

The most important factor in any terra torch operation is *safety*. Anytime the fire manager is dealing with flammable liquids there is the potential for serious injury or accident. On all terra torch operations, it is important that the number of people conducting the burn be kept to a minimum. It is recommended that three people be assigned to the terra torch for its operation. These three would be the driver, the operator, and the operator's helper. The operator must have complete control of the terra torch operation at all times.

These safety precautions should be taken:

- All holding personnel must be kept back at least 150 feet (45.7 m) due to the distance that the gel can be sprayed. There is always the possibility of someone wandering into an area where the gelled fuel will be sprayed.
- Protective fire clothing is recommended during all burning operations. Safety briefings should be conducted before any ignition.
- Three 20-pound (9-kg) fire extinguishers should be mounted on the vehicle and be readily available to the driver, operator, and operator's helper.

The safety of the operation will only be as good as the burning boss and the terra torch crew are willing to make it.

As with any other piece of equipment, the terra torch is just one more tool to make the fire manager's job easier and safer. The terra torch can provide the fire manager, who understands and is well trained in its use, increased flexibility in fuel management programs and extension of the burning season and prescription window.

"What's next?" I am sure that more high-tech equipment is on the way. Try it, you might like it! For additional information and copies of the operational guidelines, contact Ted Tveidt, fire management officer, c/o Tally Lake Ranger District, 1335 Highway 93 West, Whitefish, MT 59937.

Toss That Old Fire Shelter and Protect Your New One!

The improved fire shelter, product of a new technology, is now available. Be sure to get yours!

The technology on shelters and the new materials in them is changing constantly. The fire community must be certain protective equipment used by its firefighters is the best available. The only shelters a fire cache should have on hand are those manufactured by Anchor Industries. Fire supply managers: If you have others in stock, remove them from service and order new ones. Firefighters: Be sure to exchange your old one for a new one. New shelters, as listed in the Wildfire Protection Equipment and Supplies Catalog, are available from your regional General Services Administration office. Enough inventory is on hand to fill your orders. Shelters that have been removed from service can be used for a training tool. Be sure you mark those removed as follows: **For Training Purposes Only.**

Firefighters, protect that fire shelter—carry it in a hard plastic liner. Carrying your fire shelter in a hard plastic carrying case will prolong its life. Investigation into reports of cracks showing up on shelters revealed that shelters carried in fire suppression work for prolonged periods developed cracks when firefighters leaned or sat on them during rest periods. The hard plastic liner will protect the shelter from being squashed by tired bodies. Boise Interagency Fire Cache now has the liners in stock. The order number is: NFES No. 0199. The cost is minimal and is well worth the investment to keep the shelters in usable condition. The address and telephone number are: 3905 Vista Avenue, Boise, ID 83705; FTS 554-2525; commercial (208) 389-2525. ■

William Shenk, *fire equipment branch chief, USDA Forest Service, Fire and Aviation Management, Washington, DC*

A Lightweight, Inexpensive, Portable Pump Foam Induction System

Tom French

Warehouse foreman, Payette National Forest, McCall, ID

Portable pump foam systems are here to stay!

During the 1988 fire season, personnel on the Payette National Forest developed, tested, and used a portable pump foam induction system. The system weighs 2 pounds (907.9 gm) and has been calculated to cost $29.17 (fig. 1).

The Payette National Forest used this foam system to protect 38 structures at 6 private locations within the Frank Church-River of No Return Wilderness in Idaho. On September 6, 1988, the 69,400-acre (28,079-ha) Silver Creek Fire burned over the Root Ranch, a private recreation ranch in the middle of this Idaho wilderness. The portable pump foam system was used and successfully protected all structures at the Root Ranch. After our success with this foam system during our worst fire season on record, we decided to include it in our portable fire pump kits.

The System

The system consists of the following items:

Induction system (fig. 2)	*Cost*
Tee 1 1/2 in (3.8 cm), NH–F × 1 1/2 in (3.8 cm) NH–M × 1 in (2.54 cm) NPSH	$13.63
Valve 1/2 in (1.27 cm) gate	2.99
Nipple 1/2 in (1.27 cm) close × close	0.29
Reducer 1/2 in (1.27 cm) × 1/4 in (0.64 cm)	1.20
Nipple hose 1/4 in (0.64 cm) for tubing	0.75
Tubing (clear) 5/16 in (0.79 cm) id × 40 in (101.6 cm long)	1.35
Total	$20.21

After our success with this foam system during our worst fire season on record, we decided to include it in our portable fire pump kits.

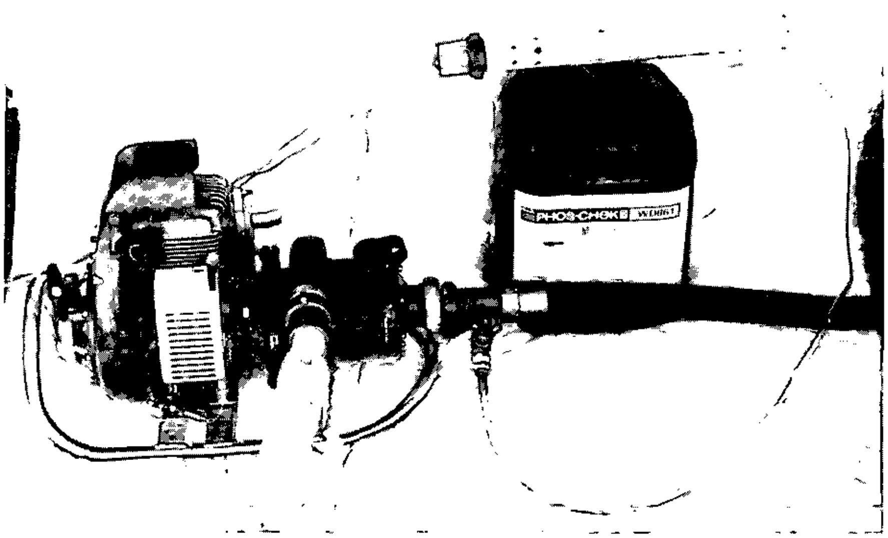


Figure 1—*Complete portable pump foam induction system.*

Aspirating nozzle (fig. 3)	*Cost*
1 1/2 in (3.8 cm) SCH 40 PVC pipe × 18 in (45.7 cm) long	$0.95
1 in (2.54 cm) NPSH × 3/4 in (1.91 cm) GHT reducer	3.75
1/4 in (0.64 cm) straight-stream tip	3.86
8 1/8 in (0.32 cm) machine screws (optional)	0.40
Total	$8.96
Foam system total	$29.17

**Key to acronyms: NH–F and NIH–M = American National Fire Hose coupling threads; NPSH = American National Hose coupling threads; SCH = schedule; PVC = polyvinyl chloride; GHT = garden hose thread.*

How to Assemble

To assemble the induction system, follow the diagram in figure 2. Assembly instructions for the aspirating nozzle (fig. 3) are as follows:

- Drill six 5/16-inch (0.79-cm) holes in PVC pipe 2 inches (5.08 cm) from base.
- Drill six 7/16-inch (1.11-cm) holes 3 3/16 inches (8.1 cm) from PVC base.
- Cut off the ears of the 1-inch (2.54-cm) × 3/4-inch (1.91-cm) reducer.
- Attach the 1/4-inch (0.64-cm) nozzle tip to the reducer, and press it into the PVC pipe base.
- Drill four 1/16-inch (0.2-cm) holes 7 inches (17.78 cm) from base.
- Drill four 1/16-inch (0.2-cm) holes 17 inches (43.1-cm) from base, and insert the eight 1-inch (2.54-cm) machine screws (optional).

This sounds difficult, but assembly only takes about 15 minutes.

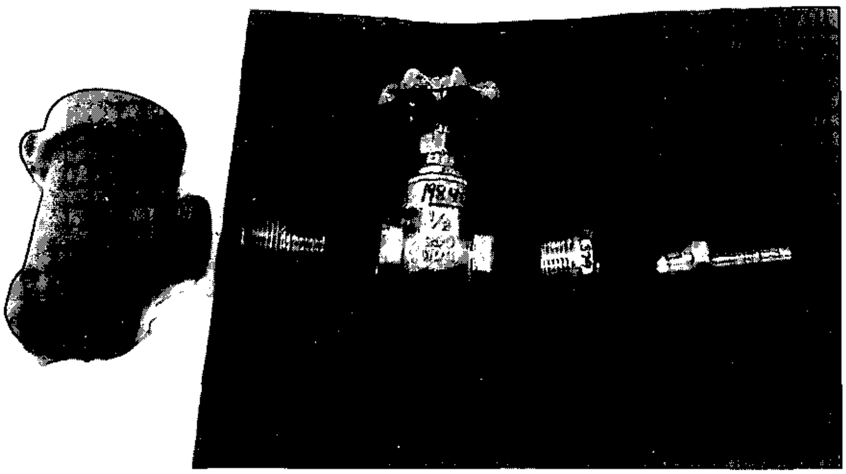


Figure 2—*The induction system.*

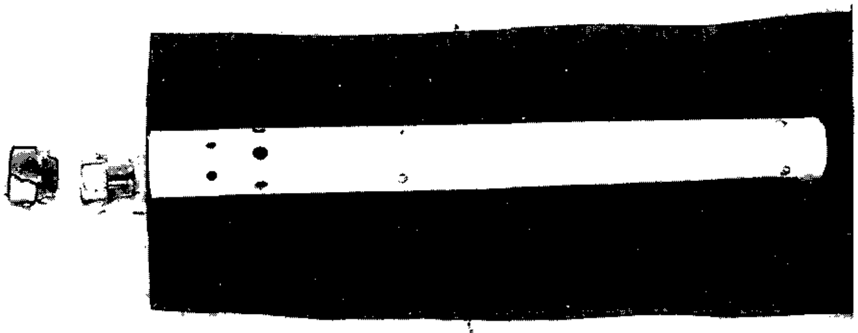


Figure 3—*The aspirating nozzle.*

How to Use

To set up and use the foam system pictured in figure 1, follow these steps:

- Attach the 1 1/2-inch (3.8-cm) tee to the suction side of the pump.
- Place the suction hose in any water source.
- Attach the aspirating nozzle to the end of the hose.
- Place the clear tube in a bucket of any wildland fire foam.
- Start the pump and adjust it to the desired pressure of operation (100 psi (689.47 kPa) and above worked best for us).
- Open the gate valve until the foam concentrate moves slowly up the clear tube.

With good communication between the pump operator and the nozzle operator, you can adjust the foam by closing or opening the valve to produce a thinner or thicker foam. You now have foam capability with any portable fire pump.

After field testing, the foam system can possibly be used in the following circumstances:

- Back country or wilderness fire locations where protecting structures and property is a priority.
- Any wildland fire not accessible by fire engine, where there is a natural or provided water source.
- Subdivisions or urban interface areas where swimming pools, irrigation ditches, creeks, fold-a-tanks, or any water source and a portable fire pump can be used, freeing the fire engines to be more mobile.
- Prescribed burns—to control perimeter and suppress spots.
- For constructing a control line from which to backfire.

In addition to these uses for the foam system, the induction tee can be used to introduce disinfectant, detergent, or most liquid solutions into the water stream of fixed or portable pumps, and the aspirating nozzle can be used on any engine with foam capability. This system could be enhanced and modified by varying the size of the nozzle tip or PVC pipe to produce different foam patterns and by placing a check valve on the induction tee.

We believe that many wildland and structural fire agencies or departments will find that a lightweight (2-lb or 0.91-kg), inexpensive ($29.17), portable pump foam system would be applicable to their fire protection needs. ■

The USDA Forest Service's Water-Bombing Beavers

Robert S. Grant

Aviation journalist, Thunder Bay, ON

Most Canadians recognize de Havilland's Beaver and appreciate the versatility of this pug-nosed wonder. However, few Canadian operators understand how these seven-place aircraft are used south of the border.

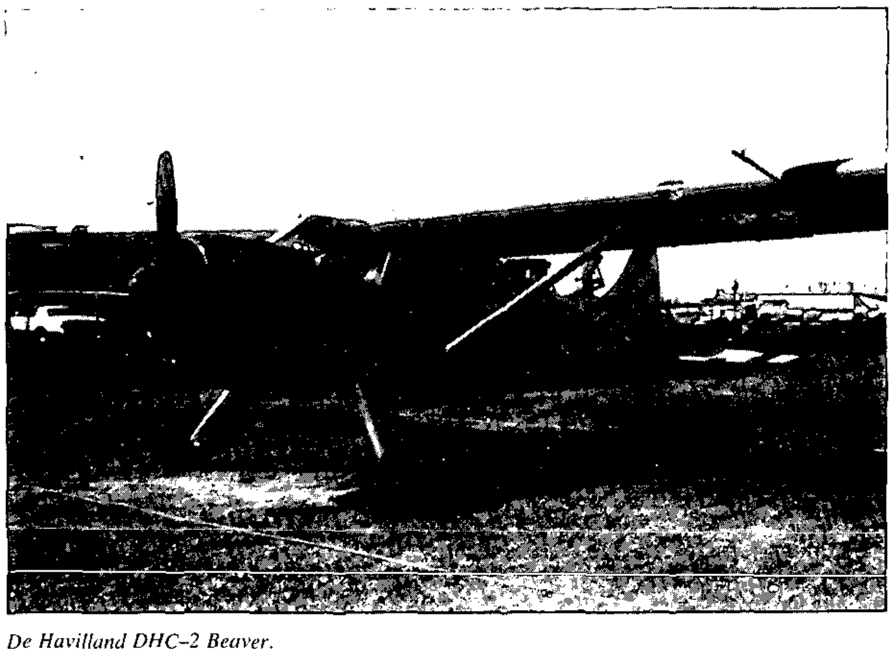
The Need for Aircraft

At Ely, MN, 115 nautical miles southwest of Thunder Bay, ON, the USDA Forest Service or USFS, as the locals and many others call it, administers and protects over 3 million acres (1.2 million ha) of the Superior National Forest. As in Canada, hundreds of lakes and few roads necessitate the use of aircraft. Their first—a Stinson SR-6A in 1938—was followed by Cubs, Seabees, Cessnas, and Noorduyn Norsemen until the purchase of a Beaver in 1956. Two more came later, and today three of these red and white aircraft remain in service.

In 1956, USDA Forest Service personnel attached a water pick-up pipe to a motorboat to determine if liquid could be forced through a tube in motion. It could. Consequently, they installed a 125-gallon[1] (473 l) fish-planting tank inside a Noorduyn Norseman. Two years later, they tested the apparatus in a Beaver but discovered water could not be discharged rapidly enough through the aircraft's standard 17-inch (0.43-m) belly hatch.

No question about the de Havilland Beaver south of the Canadian border—it's a 450-horsepower, goodwill ambassador for Canada.

[1]Refers to U.S. gallons.



De Havilland DHC-2 Beaver.

How the Water-Dropping System Works

Eventually, with surplus jet fuel tanks, they devised a unique water-dropping system still used on the Ely Beavers. Mounted on the belly for the float season, the cut-down tank holds 125 gallons (473 l). A single snorkel tube, installed by the pilots in the field, acts as a conduit for the water. In cruise, the aircraft loses only 6 miles per hour (9.7 km/h).

"Tank and struts weigh 70 pounds (31.6 kg), and it takes from 10 to 14 seconds to fill while taxiing at about 40 miles per hour (64.4 km/h). When full, water flows out of an overflow hole at the top of the tank," explained Doug Bohman, who has flown with the USDA Forest Service at Ely since 1977. "Release and closure's done by a mechanical pulley arrangement in conjunction with a control rod in the cockpit."

Six doors provide more than 700 square inches (0.45 m^2) for fast clean drops. When the aircraft is at rest, pilots leave them open to relieve seal pressure. In flight, however, doors must be closed, or flutter can cause damage. Tests have shown average total pattern lengths of 211 feet (64.3 m). In Canada, the Ontario Ministry of Natural Resources' Aviation and Fire Management Branch, used a similar tank but with four openings instead of six.

System Versatility

With the external tank clear of the Edo 4580 floats, the Beavers can be freely used for other duties including cargo dropping. Since most containers used in firefighting are too large to fit through the standard belly opening, USDA Forest Service staff developed special racks and attached them to the top of each float.

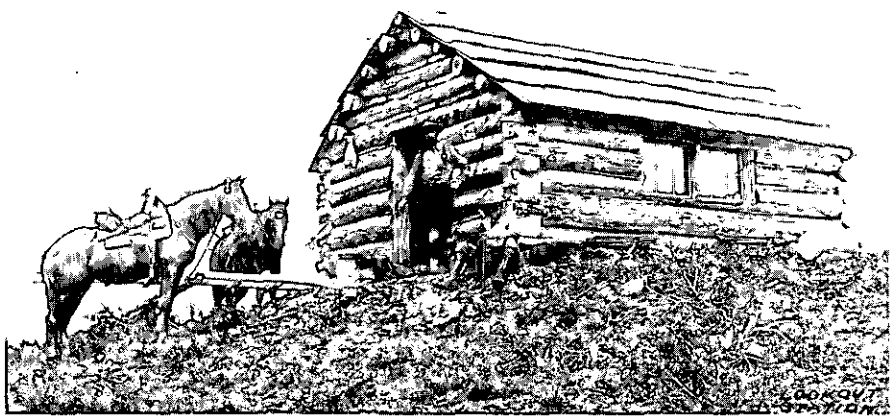
Steel drums welded together serve as containers, but fiber and plywood units have also been tried. Each has a maximum of 175 pounds (79.4 kg); the total external load was placarded in August 1961 at 700 pounds (317.5 kg).

"Four containers can be dropped by paracargo, either individually or collectively," explained Bohman, who estimates his Beaver time to be over 6,000 hours. "Selective dropping's possible with four instrument panel switches, and the manual emergency release lets them all go at once—far cheaper than helicopters."

Year-round operation keeps full-time pilots Bohman and Carlo Palombi and part-time pilot Joe McHenry busy. One Beaver flies on wheels during winter at the local airport while one works from the USDA Forest Service lakefront base at Shagwa Lake on wheels or skis. The remaining Beaver usually goes into storage at freezeup.

"We do moose survey in the winter, snowmachine patrols over the Boundary Waters Canoe Area, and often fly out to Isle Royale in Lake Superior for crew changes," said Bohman. "When spring comes around, we're into fish planting, tree seeding, photo work, and core sampling from the bottom of lakes."

No question about the de Havilland Beaver south of the Canadian border—its ruggedness and ability to adapt to a wide variety of tasks has made it a 450-horsepower, goodwill ambassador for Canada. ■



Eddy's Gulch Lookout Station on Klamath National Forest in California. 96405

National Advanced Resource Technology Center Course Schedule for Fiscal Year 1990[1]

Course	*Date*
National Fire Danger Rating System (NFDRS)	December 4–14, 1989
Multiagency Coordination (MAC) Group Coordination	January 16–19, 1990
Senior Level Aviation Management	January 21–26, 1990
Aerial Retardant Application and Use	February 20–23, 1990
Fire Management for Line Officers	February 25–March 2, 1990
National Fire Management Analysis System (NFMAS) Technical Course	March 18–23, 1990
National Fire Management Analysis System (NFMAS) Manager Course	March 26–30, 1990
Fire in Resource Management	April 2–12, 1990

[1]For information, contact the Director, NARTC, Pinal Air Park, Marana, AZ 85653. FTS 762-6414; Commercial (602) 629-6414; DG—NARTC: W06A.

Use of Posters for Interpreting Fire Behavior and Danger Research[1]

Forestry Canada Forêts Canada

Northwest Territories

Martin E. Alexander, William J. De Groot, Kelvin G. Hirsch, and Rick A. Lanoville

Respectively, fire research officers, Forestry Canada, Northwest Region, and fire behavior/science officer, Government of the Northwest Territories[2]

During the 1970's, Forestry Canada (then the Canadian Forestry Service) published three wall maps illustrating wildfire occurrence and fire climate patterns (*6, 7, 10*) that proved very popular among Canadian fire managers. More recently, five wall posters (*1, 2, 3, 4,* and *5*) pertaining to the two major subsystems of the Canadian Forest Fire Danger Rating System (CFFDRS) (*11*) have been produced that illustrate how fire danger is assessed and wildfire behavior predicted in the boreal forest region of Canada (figs. 1–2). Four of the posters were authored solely by Forestry Canada fire research personnel or with the assistance of a cooperator. The first author also supervised the preparation of the two posters illustrating the fuel type classification scheme associated with the CFFDRS (*3, 4*).

"The old cliche that a 'picture is worth a thousand words' certainly holds true for these posters."

—Headquarters manager, Regional Services, Manitoba Natural Resources, Winnipeg, MB

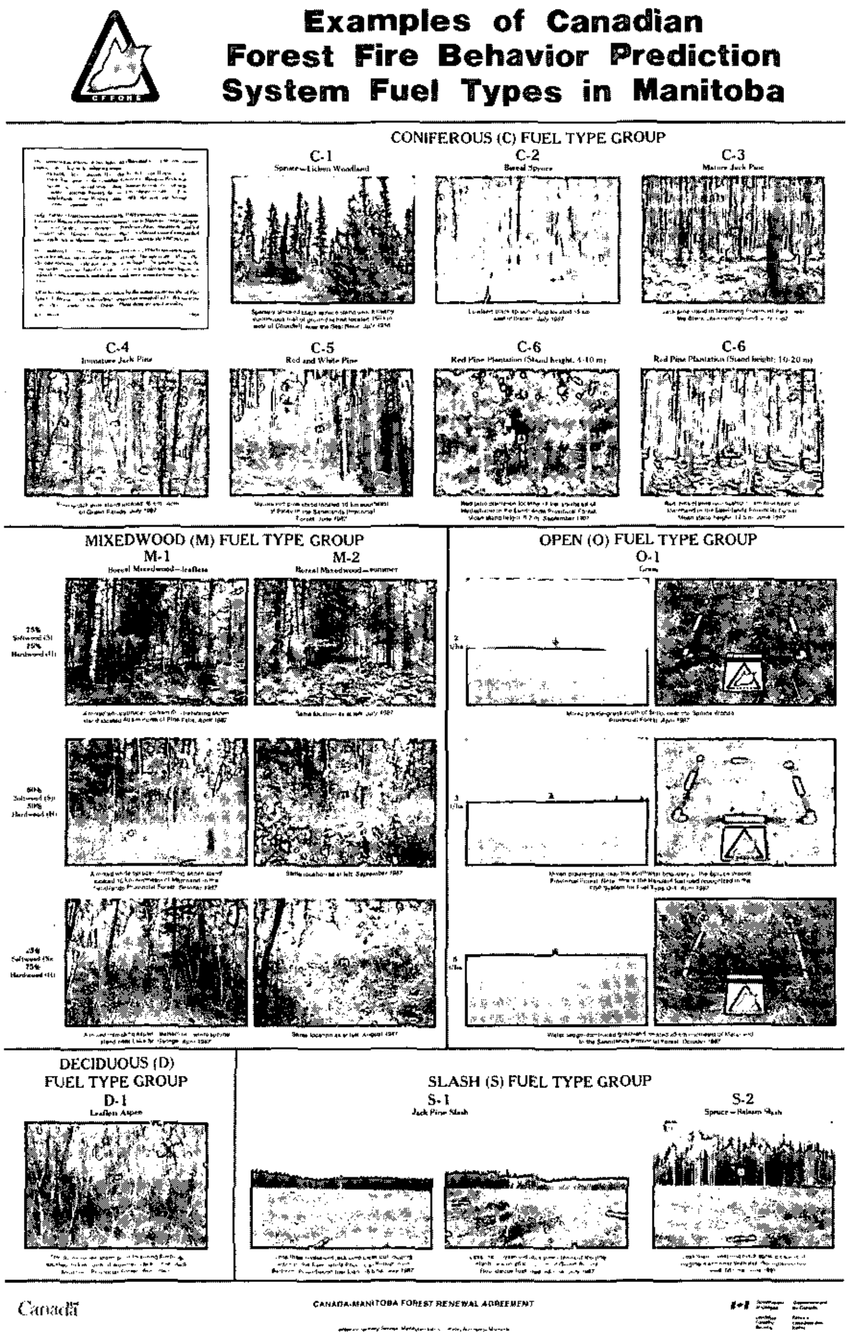


Figure 1—*Photographic identification of fuel types in the province of Manitoba (4), based on the national classification scheme used in Canada for predicting fire behavior. A similar poster has been prepared for the province of Saskatchewan (3) and reproduced in the January 1988 issue of* Forest Fire News.

[1]Based on an educational display used at the International Conference on "Meeting Global Wildland Fire Challenges: The People, the Land, the Resources," July 23–26, 1989, Boston, MA.

[2]The three fire research officers of the Northwest Region are stationed at the following locations: M.E. Alexander, Northern Forestry Centre, Edmonton, AB; W.J. De Groot, Saskatchewan District Office, Prince Albert, SK; and K.G. Hirsch, Manitoba District Office, Winnipeg, MB. R.A. Lanoville is stationed at the Department of Renewable Resources' Territorial Forest Fire Centre, Fort Smith, NT.

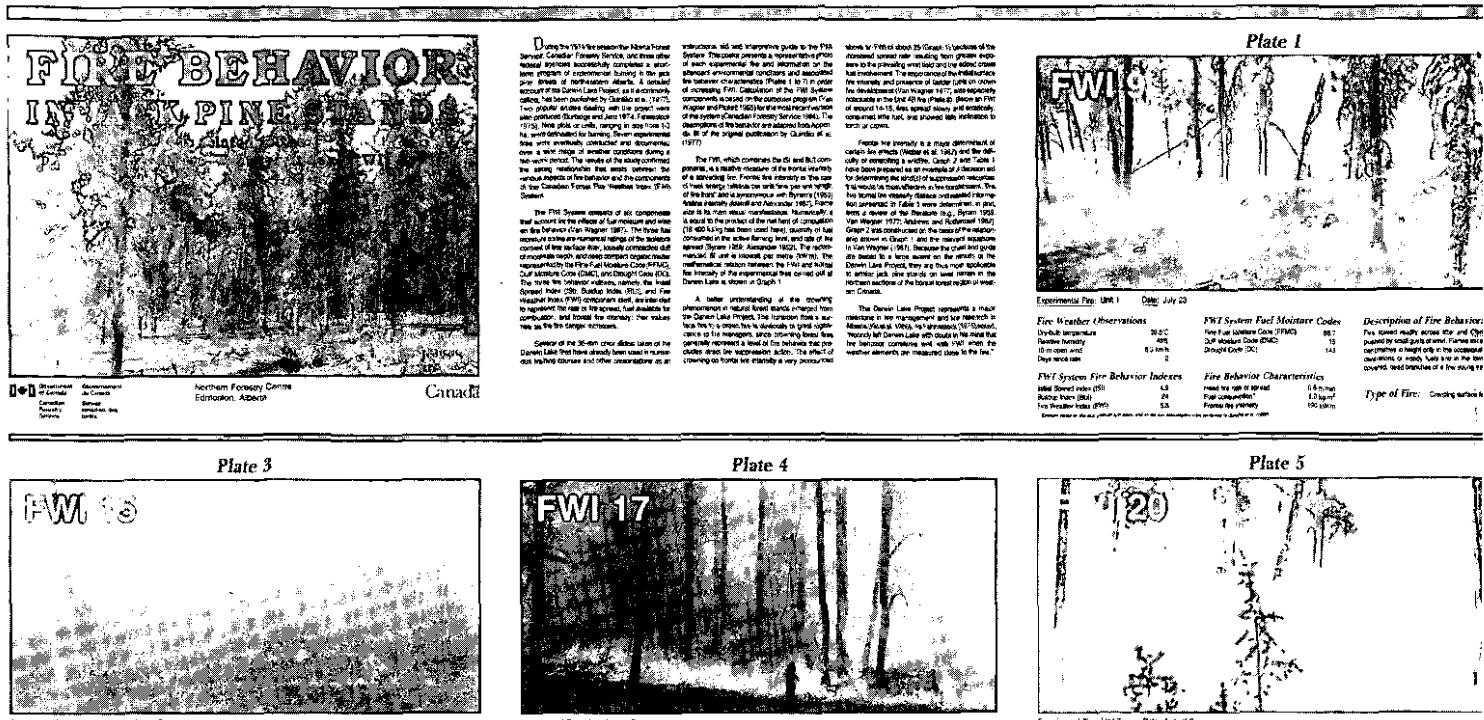
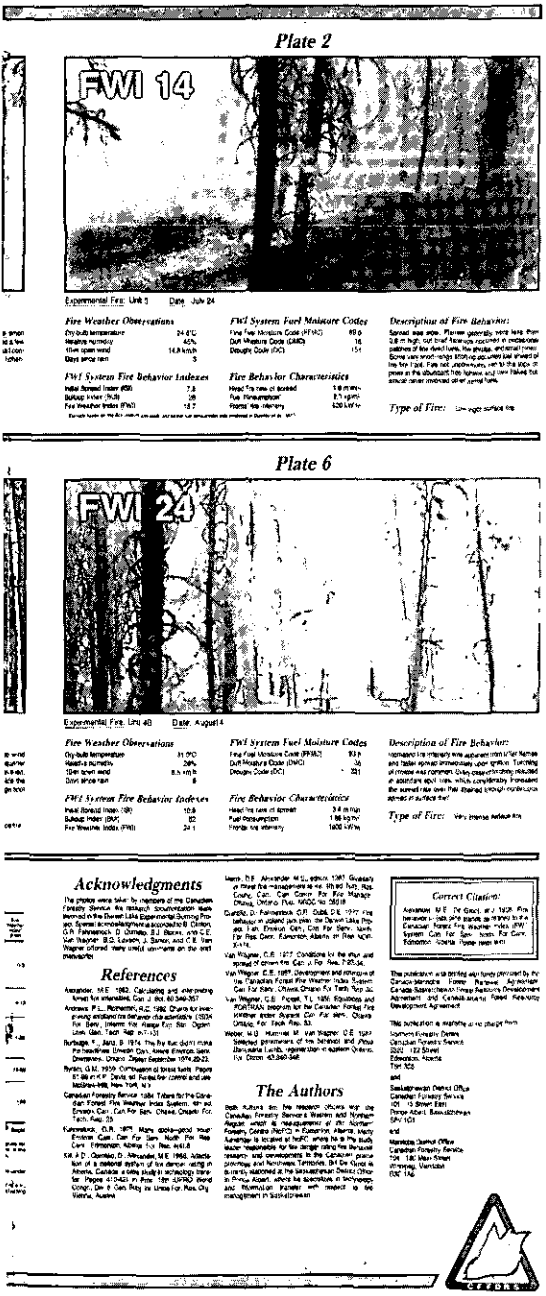


Figure 2—*Relationship between the general index of fire danger used throughout Canada and fire intensity (1). A similar poster has also been prepared as a fuel type-specific guide to the quantitative prediction of fire behavior in the subarctic region of northwestern Canada (2).*



The fifth poster, entitled "Fire Behavior Characteristics and Suppression Interpretation Chart," is related to the Forest Fire Preparedness (FFP) System developed by fire management staff in the Northwest Territories for determining daily initial attack requirements (*5*). The FFP System, which is based in part on the CFFDRS, and the associated poster (issued in 1987) were both prepared with the technical assistance of the first author.

Response to the poster concept from the fire management community in Canada has been extremely positive. Some of these responses are reprinted following this article.

All five posters employ color photographs to depict representative fuel types or to illustrate readily observable fire characteristics (i.e., flame size and degree of crowning activity, if any). The posters vary in size from 16 x 34 inches (41 x 86 cm) to 34 x 40 inches (86 x 102 cm). The question of whether to produce a flat or folded version of a poster depends largely on mailing preference, such as the use of envelopes or mailing tubes. We published some of the posters in both formats.

Wall posters and maps appear ideally suited as interpretive aids of fire behavior and fire danger research and perhaps other kinds of forest fire research. In fact, several wall posters are being considered by the Ontario Region of Forestry Canada to depict some of the fire management applications of the extensive experimental burning program conducted during the past 20 years (*9*) (e.g., fire potential in jack pine slash in relation to woods closure guidelines, crown fire behavior in mature versus immature jack pine stands, and fire hazard in spruce budworm-killed balsam fir stands) (*8*). Because of their general attractiveness and semipermanent presentation, a well-designed poster or map can be a highly effective mechanism for technology and information transfer, perhaps in many cases more so than other innovative media such as user-friendly computer programs and videotape productions. The unit cost is only slightly higher than that of more conventional publications. ■

Literature Cited

1. Alexander, M.E.; De Groot, W.J. 1988. Fire behavior in jack pine stands as related to the Canadian Forest Fire Weather Index (FWI) System. [Poster with text.] Edmonton, AB: Canadian Forestry Service, Northern Forestry Centre.
2. Alexander, M.E.; Lanoville, R.A. 1989. Predicting fire behavior in the black spruce-lichen woodland fuel type of western and northern Canada. [Poster with text.] Edmonton, AB, and Fort Smith, NT: Forestry Canada, Northwest Region, Northern Forestry Centre, and Government of the Northwest Territories, Department of Renewable Resources, Territorial Forest Fire Centre.
3. De Groot, W.J. 1987. Example of Canadian Forest Fire Behavior Prediction System fuel types in Saskatchewan. [Poster with text.] Prince Albert, SK: Canadian Forestry Service, Saskatchewan District Office.
4. Hirsch, K.G. 1988. Examples of Canadian Forest Fire Behavior Prediction System fuel types in Manitoba. [Poster with text.] Winnipeg, MB: Canadian Forestry Service, Manitoba District Office.
5. Lanoville, R.A.; Mawdsley, W.M. 1989. Systematic assessment of daily fire preparedness requirements. *In*: Alexander, M.E.; Bisgrove, G.F., tech. coords. The art and science of fire management: Pro-

ceedings of the First Interior West Fire Council Annual Meeting and Workshop; 1988 October 24–27; Kananaskis Village, AB. Inf. Rep. NOR–X– [in press]. Edmonton, AB: Forestry Canada, Northern Forestry Centre.
6. Simard, A.J. 1973. Forest fire weather zones of Canada. [Map with text.] Ottawa, ON: Environment Canada, Canadian Forestry Service.
7. Simard, A.J. 1975. Wildland fire occurrence in Canada. [Map with text.] Ottawa, ON: Environment Canada, Canadian Forestry Service.
8. Stocks, B.J. 1988. Personal communication. Sault Ste. Marie, ON: Forestry Canada, Ontario Region, Great Lakes Forestry Centre.
9. Stocks, B.J.; Alexander, M.E. 1980. Forest fire behaviour and effects research in northern Ontario: a field oriented program. In: Martin, R.E.; Edmonds, R.L.; Faulkner, D.A.; and others, eds. Proceedings, Sixth Conference on Fire and Forest Meteorology; 1980 April 22–24; Seattle, WA. Washington, DC: Society of American Foresters: 18–24.
10. Stocks, B.J.; Hartley, G.R. 1979. Forest fire occurrence in Ontario. [Map with text.] Sault Ste. Marie, ON: Environment Canada, Canadian Forestry Service, Great Lakes Forest Research Centre.
11. Stocks, B.J.; Lawson, B.D.; Alexander, M.E.; Van Wagner, C.E.; McAlpine, R.S.; Lynham, T.J.; Dube, D.E. 1989. The Canadian Forest Fire Danger Rating System: an overview. Forestry Chronicle 65(4): 258-265.

Feedback from Users

"The whole idea of using posters like this is excellent. A great way to get valuable information to field people."*—Director, Fire Operations, Department of Renewable Resources, Territorial Forest Fire Centre, Fort Smith, NT*

"I think they're a great way to convey a lot of research data in a readily comprehensible form."*—Research and development supervisor, Ontario Ministry of Natural Resources, Aviation and Fire Management Centre, Sault Ste. Marie, ON*

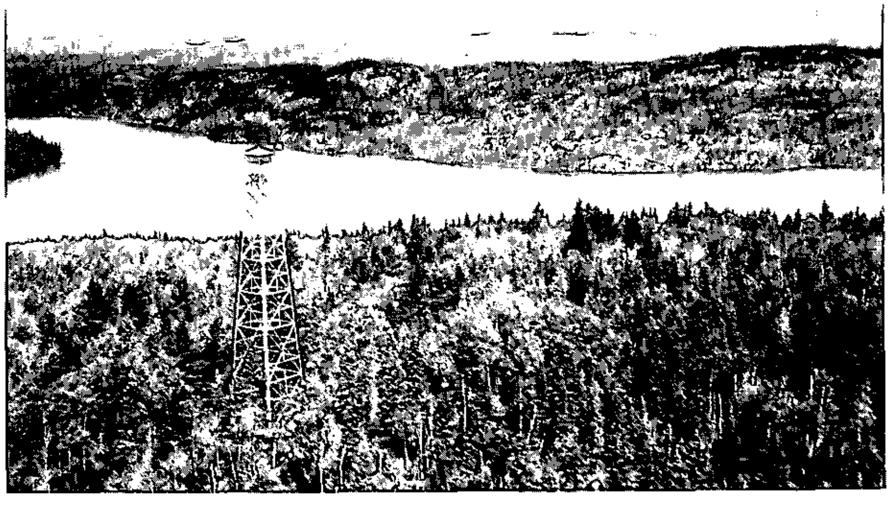
"I particularly like the format of a poster versus a manual for quick reference and continual display."*—Forest protection officer, Alberta Forest Service, Bow/Crow Forest, Calgary, AB*

"I am of the opinion that the term 'user friendly' was coined to describe these posters. I have used them frequently since I received them and like the fast access to information that they offer."*—Conservation officer, Saskatchewan Parks, Recreation and Culture, Buffalo Narrows District, Buffalo Narrows, SK*

"They ... have a high educational value for field staff and even the public. These posters are the most effective media for relaying research information to field staff.... It is a very creative way of illustrating a difficult subject."*—Operations supervisor, Manitoba Natural Resources, Whiteshell Region, Rennie, MB*

"I am always pleased to see these kinds of aids. They allow me to refresh my memory quickly at the beginning of the fire season and help me understand the concerns of forestry personnel."*—Senior meteorologist, Atmospheric Environment Service, Western Region (forecast operations), Edmonton, AB*

"The pictures of fuels and fire behavior related to the CFFDRS are invaluable in teaching fire management, particularly since I put a great deal of emphasis on the CFFDRS in my courses. I also put on short courses for professionals and technicians, and I find the posters equally useful in this context. If we are serious about technology transfer then these are the kinds of tools we have to use."*—Professor, Department of Forest Resources, University of New Brunswick, Fredericton, NB.* ■



Kekekabic Lookout Tower with Lake Kekekabic in the heart of the wilderness country, Kawishiwi Ranger District on the Superior National Forest in Minnesota. Communication is by radio, and supplies are brought in either by canoe and portage or by plane. 400723

Natural Fires in Parks—What Does the Record Show?

Jason Greenlee and Julia Gaudinski

Respectively, director and research assistant Fire Research Institute, Santa Cruz, CA

Before 1968, immediate suppression was the only acceptable response by the National Park Service (NPS) to the occurrence of wildfire in national parks. The Wilderness Act of 1964 stated, however, that land managed under the National Wilderness Preservation System will be "managed as to preserve natural conditions." Research in the parks has shown that, to be consistent with the Wilderness Act and move toward preservation of natural ecosystems, lightning fires should be allowed to continue to burn in the national parks under certain conditions (van Wagtendonk 1986). As a result, NPS policy, developed early in the 1970's, recognizes fire, both scheduled ignition fires (prescribed fires) and unscheduled ignition fires (natural-prescribed or lightning fires), as a useful tool in reestablishing and preserving natural processes.

Fire is not fully predictable. When trying to manage it, perfection is an unrealistic goal. In using any new natural resource management system, a certain leeway for mistakes and losses should be accounted for in the cost of the policy and be anticipated before the policy's implementation. After a trial period, managers can reevaluate the new program. How many mistakes were made? Were they within an acceptable limit relative to the gains? When this is done, a decision can be made concerning the success of the policy.

In order to facilitate such an evaluation of the NPS policy, we examined the failure rate of all fires managed during the 1970's and 1980's under the Natural Prescribed Fire Management Program (NPFMP).

Methods

A questionnaire was sent to all national parks and monuments (excluding historic monuments) inquiring about the management of lightning fires. If the unit had a NPFMP, fire managers were asked how many lightning fires had occurred within their unit since the establishment of a NPFMP, how many were suppressed immediately, and how many were allowed to burn. Of the number of fires allowed to burn, we asked how many burned unimpeded until extinguished naturally, how many required some degree of suppression action, and, finally, how many required an all-out suppression effort.

As the experience and expertise of fire managers increases and as fuel loads decrease, the number of management failures is likely to decrease.

We defined an unsuccessfully managed fire as one that required unexpected suppression action. We did not consider "herding" on one or more sides of a fire as being an unexpected suppression action.[1] We were not concerned about which phase in the history of the fire a decision to herd the fire was made. If suppression was decided upon first detection, the fire was not counted at all in the failure calculation.

Results

Of the 88 questionnaires mailed, all were completed and returned. Thirty-nine of the units have an NPFMP in operation (table 1). Of the 49 units that do not have a NPFMP, 6 have an NPFMP program currently under draft.

Less than 2 percent of the fires allowed to burn after first detection eventually required all-out suppression (table 1). The trend seems to be for conservative use of the new policy. The data show that 39 percent of all lightning-caused fires are still suppressed immediately.

Discussion

Our analysis focused on NPS fire policy failure rate, one of several methods of evaluating fire policy. The failure rate of the 2 percent we present here does not seem unreasonable, especially when all the factors involved in administrating the policy are considered. In the 1970's, the fire management personnel making decisions about individual fires had less information and experience from which to draw than they do today. Since the NPFMP differs radically from the old policy, mistakes should be expected as part of the learning process. Many of the NPFMP fires that burned in the 1970's occurred under conditions of unnaturally high fuel loads created by the old suppression policy. As the experience and expertise of fire managers increases and as fuel loads decrease, the num-

[1]Herding is illustrated by the following example. A fire is burning in the wilderness. There is a possibility of it moving eastward toward property under another ownership. A decision is made to line the fire on the east flank to prevent movement of the fire in that direction. Thus, the fire is still allowed to burn itself out and is simply "herded" in a desired direction.

Table 1—*Data on approved Natural Prescribed Fire Program in national parks and monuments since establishment*

Name of unit	Date policy established	Number of lightning fires occurring: Total	Immediately suppressed	Allowed to burn	Number of lightning fires allowed to burn: Extinguished naturally	Required herding	Required full suppression
Arches National Park	1987	5	0	5	4	1	0
Badlands National Park	1987	2	2	0	0	0	0
Big Bend National Park	1980	36	4	32	30	2	0
Canaveral National Seashore	1987	17	0	17	16	1	0
Canyon Lands National Park	1985	11	3	8	8	0	0
Cape Hatteras National Seashore	1986	2	0	2	1	0	1
Cape Krusenstern National Monument	1984	0	0	0	0	0	0
Capulin Volcano National Monument	1985	0	0	0	0	0	0
Carlsbad Caverns National Park	1983	44	18	26	16	8	2
Chiricahua National Monument	1982	2	2	0	0	0	0
Crater Lake National Park	1976	132	27	105	102	2	1
Denali National Park	1982	23	6	17	16	1	0
Dinosaur National Monument	1980	172	24	148	143	5	0
Everglades National Park	1972	245	0	245	245	0	0
Gates of the Arctic National Park	1984	22	1	21	21	0	0
Glacier National Park	1983	50	45	5	5	0	0
Grand Canyon National Park	1978	102	0	102	102	0	0
Grand Teton National Park	1972	76	46	30	26	4	0
Guadalupe Mountains National Park	1985	0	0	0	0	0	0
Isle Royale National Park	1981	4	1	3	3	0	0
Joshua Tree National Monument	1987	38	25	13	12	0	1
Kobuk Valley National Park	1984	0	0	0	0	0	0
Lassen Volcanic National Park	1983	119	99	20	16	0	4
Lava Beds National Monument	1986	7	6	1	1	0	0
Mt. Rainier National Park	1988	0	0	0	0	0	0
Muir Woods National Monument	1984	0	0	0	0	0	0
Noatak National Preserve	1984	20	0	20	20	0	0
North Cascades National Park	1981	38	10	28	28	0	0
Olympic National Park	1985	4	3	1	1	0	0
Pinnacles National Monument	1986	0	0	0	0	0	0
Redwood National Park	1985	0	0	0	0	0	0
Saguaro National Monument	1970	167	93	74	37	27	10
Sequoia and Kings Canyon National Park	1968	381	39	342	338	4	0
Voyageurs National Park	1987	2	0	2	2	0	0
Wrangell St. Elias National Park	1983	5	0	5	5	0	0
Yellowstone National Park	1972	369	136	233	217	12	4
Yosemite National Park	1972	985	602	383	371	8	4
Zion National Park	1985	40	24	16	12	2	2
Total		3,120	1,216	1,904	1,798	77	29
Percentage of total			38.97	61.03	94.43	4.04	1.52

ber of management failures is likely to decrease.

"Risk" is the potential for realization of unwanted negative consequences (Rowe 1977 as quoted in Saveland 1986). The 2 percent failure rate we found in this study indicates to the manager the risk he or she takes when implementing a natural fire policy.

Postscript

Although failure rate is important to track when evaluating a fire management policy, social response must also be considered. The public is more aware of the beneficial aspects of fire than they were 15 years ago (Taylor and Mutch 1986). However, during a large-scale event, people still have negative reactions to the conditions caused by local inconveniences:

> These differences between [the] public's conceptual and perceptual response are at the heart of the fire manager's dilemma: "You can hold public meetings, explain your fire policy and program, and get strong support. But when the smoke hits town, you better expect very different reactions!" [Taylor and Mutch 1985.]

While some managers discount local outrage as a short-term problem, such situations can be blown out of proportion. Certainly, public comment can become an important factor in the success of a policy.

In the summer of 1988, natural-prescribed fires escaped boundaries selected by management in Yellowstone National Park, causing public outcry and eventually costing millions of dollars in all-out suppression efforts. In social terms, this fire turned into a catastrophic event.

What does this event indicate about the soundness of the fire management policy of the NPS? Taken in context with the data in table 1, the Yellowstone fire was one of only 29 management failures under NPFMP out of 1,875 successes in the national parks and monuments. ■

Literature Cited

Saveland, J.M. 1986. Wilderness fire economics: The Frank Church-River Of No Return Wilderness. In: Proceedings of the National Wilderness Research Conference: Current Research; 1985 July 23–26; Fort Collins, CO. Gen. Tech. Rep. INT–282. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 39–46.

Taylor, J.G.; Mutch, R.W. 1986. Fire in wilderness: public knowledge, acceptance, and perceptions. In: Proceedings of the National Wilderness Research Conference: Current Research; 1985 July 23–26; Fort Collins, CO. Gen. Tech. Rep. INT–282. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 49–59.

Rowe, W.D. 1977. The anatomy of risk. New York: John Wiley and Sons. 488 p.

van Wagtendonk, J. 1986. The role of fire in the Yosemite Wilderness. National Wilderness Research Conference: Current Research; 1985 July 23–26; Fort Collins, CO. Gen. Tech. Rep. INT–282. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 2–9.

United States
Department of Agriculture

Washington, D.C.
20250

OFFICIAL BUSINESS
Penalty for Private Use, $300