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Special Features

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Enrollees gathered around campfire on the Lassen National Forest in California. 285391

Back Cover: Region 1 highway fire prevention signs manufactured by CCC sign shop. Tenant, E. 1941. Highway fire-prevention signs. Fire Control Notes. 5(2): 98-99.

Upcoming Workforce Diversity Projects

Here is an update on workforce diversity projects on the agenda for fiscal year 1990:

- Publication and distribution of recruitment desk guide for fire management officers.
- Compilation and publication of actions and plans for the "Model for Workforce Diversity."
- Development of an action plan based on input and recommendations from the "Workforce Diversity in Fire and Aviation Management: A Mosaic for the Future" conference in Denver, CO.
- Kickoff of a promotional campaign on appropriate behavior.
- Selection for funding of special diversity project proposals submitted by the regions.

Fire and Aviation Management Director Lawrence (Mic) Amicarella presenting the Director's Award for Workforce Diversity Achievement to Gordon Reinhart.

To Gordon Reinhart—the Director's Award for Workforce Diversity Achievement

At the Workforce Diversity in Fire and Aviation Management conference held in April in Denver, CO, Gordon Reinhart was awarded the first-ever Director's Award for Workforce Diversity Achievement. This was a "vanguard" award, made to a leader who takes risks and by doing so shows others the way. Director Lawrence (Mic) Amicarella instituted this special award to identify and recognize outstanding achievements in promoting diversity in the Fire and Aviation Management workforce.

Gordon Reinhart, fire management officer on the Umatilla National Forest, is recognized by his peers for his exemplary leadership and attitude. His exceptional commitment to furthering workforce diversity goals is evident in all elements of his activities as a national Incident Commander and as a leader in numerous workshops and training sessions at the national, regional, and forest level.

Through Reinhart's influence, the Umatilla National Forest has achieved a healthy, diverse fire organization with over 20 percent women at the GS-5 through GS-9 grade level. The lower grades are represented by an even higher percentage of females and minorities. Through Reinhart's influence, the first female district fire management officer in the Nation was placed on the Umatilla.

At a national Incident Command level, Reinhart's teams have always had a well-balanced workforce mix that included females and minorities in nontraditional positions such as division supervisor. His support for trainee positions, unique among national Incident Commanders, has helped qualify many women and minorities for nontraditional fire jobs. On one incident, 61 trainee assignments were carried out and documented. Feedback from nonteam member women and minorities reveals the fair treatment and opportunities provided for special training and advancement on large incident assignments. His 1989 team (including trainees) was made up of approximately 50 percent women and minorities.

In an effort to ensure that all forms of discrimination and harassment on large fire incidents were identified and dealt with in a positive manner, Reinhart suggested and obtained approval to assign an Equal Employment Opportunity specialist/training officer permanently to his team. The specialist was used by his team on several large incidents to resolve smoothly and effectively occurrences of inappropriate sexual and ethnic behavior.

Reinhart has taken the initiative to set up workshops to give women and minorities the opportunity to come and talk with him and others on how to become involved in fire management, both as a career and as an emergency fire participant. He also has spoken at several workforce diversity conferences about the importance of mentoring.

Reinhart has demonstrated unique leadership among fire managers by personally committing himself to workforce diversity. His is an example of the type of leadership and attitude that will successfully lead us to meeting the 1995 workforce diversity goal for Fire and Aviation Management. ■

Kimberly Brandel, *fire planning assistant and conference coordinator, USDA Forest Service, Fire and Aviation Management, Washington, DC*

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

Computerized Infrared System for Observation of Prescribed Fires

C.J. Ogilvie and R. Fitch

Respectively, fire research technician, Northern Forestry Centre, Forestry Canada, Edmonton, AB, and director, Compuheat Services Canada, Inc., Calgary, AB

Forestry Canada Forêts Canada

Smoke from forest fires has always presented a barrier to efficient fire detection, mapping, and behavior research. Thermal infrared (IR) sensors mounted in fixed- or rotary-wing aircraft have been used for more than 25 years to overcome the information-gathering barrier in a smoke environment (Artsybashev et al. 1971; Green et al. 1984; Hanks et al. 1986; Lacey and Friedrich 1984; Lawson 1975; Warren and Wilson 1981). Further technological improvements and developments will no doubt continue (Nichols and Warren 1987). In response to our immediate need for a flexible, relatively inexpensive and reliable method of monitoring the behavior of large-scale prescribed fires (McRae and Stocks 1987), a new system was evaluated in northeastern Ontario during August 1987. The prescribed fires were conducted by the Ontario Ministry of Natural Resources with Forestry Canada's Great Lakes Forestry Centre (GLFC), carrying out some of the instrumentation and monitoring of the fires as well as the coordination of the numerous U.S. agencies gathering data from the fires. Forestry Canada's Northern Forestry Centre (NoFC) and Compuheat Services Canada, Inc., gathered IR data from the fires, using a high-quality, forward-looking infrared (FLIR) scanner interfaced with a computer analyzer mounted in a Bell 206L helicopter. The objective of this paper is to present a system overview and describe results obtained from the trial.

System Description and Capability

Figure 1 is a schematic of the system with the main components described below. The scanner is manufactured by Barr and Stroud, Ltd., of Glasgow, Scotland, with the following specifications:

- Field of view—38° × 25.5° (other lenses are available).
- Resolution—1.73 milliradians.
- Spectral band width—8 to 13 micrometers.
- Detector—Mulland sprite.
- Video output—standard.

The results of the 1987 trial clearly show the potential for gathering infrared data, using a high-quality, forward-looking infrared (FLIR) scanner interfaced with a computer analyzer mounted in a Bell 206L helicopter.

The scanner is cooled by compressed air and costs approximately $171,040 ($200,000 Canadian).[1] The rental costs were $4,256 ($5,000 Canadian)[1] per week. The computer analyzer is manufactured by Compuheat Services, Inc., of Calgary, AB, and is designed to convert continuously any standard video signal to digits during flight as well as perform a number of specialized functions and calculations such as follows:

- Calculating geographic areas and distances on single video frames and geographic areas continuously on successive frames.
- Storing video frames in random access memory and on floppy disk.
- Density slicing digital images to allow the selection of a single intensity level or range of intensity levels (the analyzer is capable of

[1]Foreign Exchange, New York prices ($0.8552), as of August 9, 1989.

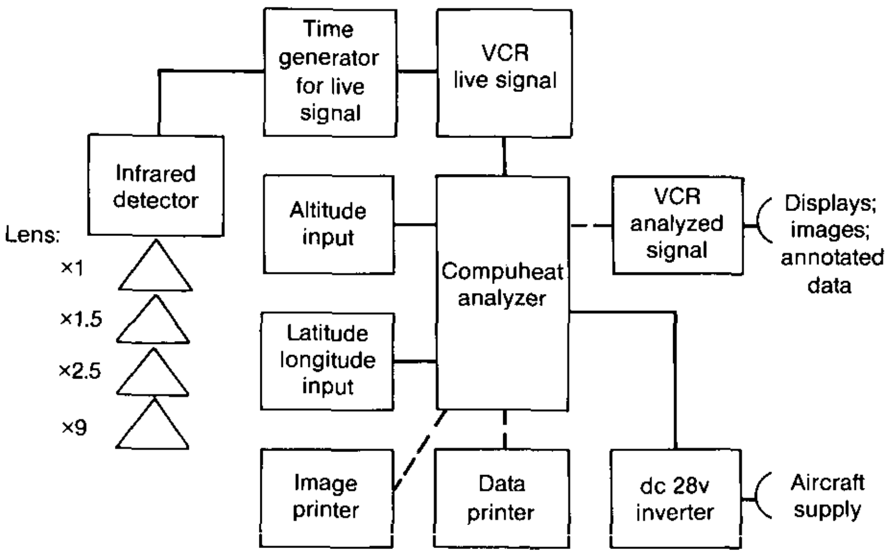

Figure 1—*Schematic of computerized infrared system.*

differentiating 128 intensity levels and calculating the area covered by each).

- Recording positional data continuously (longitude and latitude).
- Recording the time and date continuously.
- Manipulating the images in memory or on disk (by reducing, enlarging, superimposing, and presenting two images on the same screen).
- Annotating the images.

Operating Procedures

The scanner was mounted vertically on a steel plate fastened to the rear seat platform of the helicopter. The plate protruded far enough through the door opening to allow a clear field of view between the fuselage and the landing skid (fig. 2). The computer analyzer was mounted on the rear-facing seat platform of the aircraft and secured with seat belts. After the initial preparations were made, installation of all equipment could be made in 30 minutes.

The requirements for monitoring fire behavior called for hovering the helicopter within its capabilities at whatever altitude was necessary to keep as much of the actively burning area as possible in the viewing screen at one time. The scale of the displayed image was therefore controlled by aircraft altitude. It was assumed that the fire-generated condensation cap that would attenuate the IR signal would be offset from the fire due to winds aloft and that these same upper-level winds would assist in stabilizing the hovering aircraft. The live imagery was to be used by the IR team to provide ground reference to the pilot to assist him in holding a steady hover.

Performance to Date

The system was first tested on a 1,483-acre (600-ha) prescribed fire near Timmins, ON, in August 1987. At the time of ignition, there were virtually no upper-level winds. As a result, the condensation cap formed directly over the fire area, which necessitated operating the aircraft beneath the cap on the very edge of

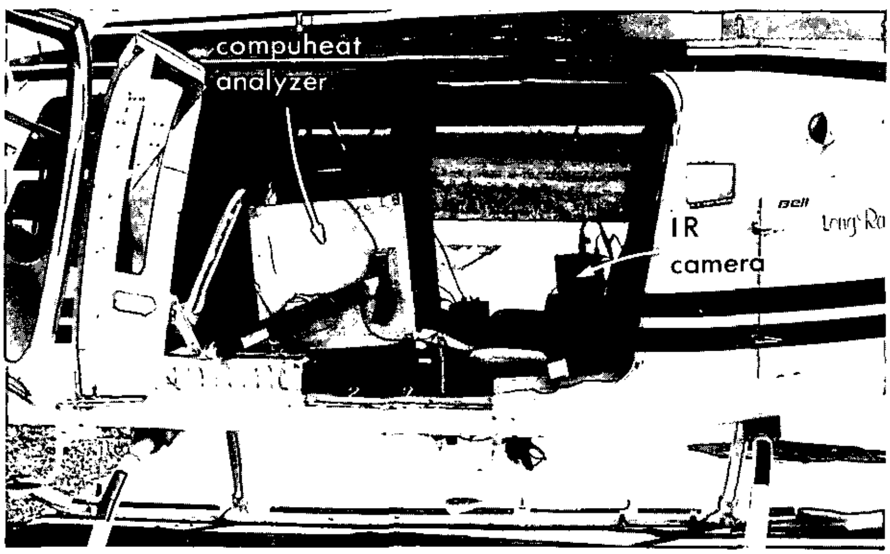

Figure 2—*Placement of scanner in the helicopter.*

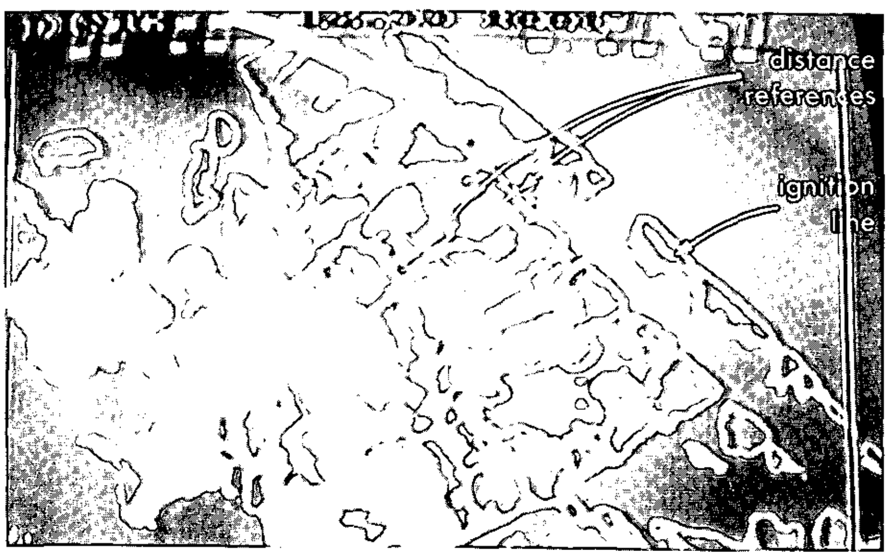

Figure 3—*Imaging of ignition patterns, fire growth, and interactive fire behavior.*

the smoke column. The strong up-and-down drafts close to the fire convection column made it somewhat difficult to hold the aircraft stationary. It was therefore necessary to record altitude changes constantly and to brief the pilot on aircraft position. In spite of these problems the helicopter was operated in a hover of up to 9,500 feet (2,900 m) above ground level over the active fire area, permitting the continuous imaging of ignition patterns, fire growth, and interactive fire behavior (fig. 3).

During postprocessing of the imagery, rates of spread were calculated, which when related to fuel loads and condition will be instrumental in predicting the growth rates of prescribed fires in the future. Ignition patterns were accurately chronicled in order to provide data on the most efficient configuration. Relative fire intensities were calculated for selected times and locations and were related to the smoke content monitoring that was also taking place during the fire. This involved isolating and determining the extent of the areas that were actively flaming, smoldering, or unlit. In addition, a large fire whirlwind tracking through the fire for up to 1.5 minutes was noted on the imagery during postprocessing.

Conclusion

The 1987 trial was of an exploratory nature and has clearly shown that the system and method of application has great potential for applications such as calculating rate of spread, recording ignition pattern, determining change in fire intensities, and evaluating fire suppression activity. The continuous real-time aspect ensures that no activity is missed, while the analyzer can be used to thoroughly investigate any moment in time. For 1988, the equipment and methods were developed further by incorporating a aeronautically approved camera pod and a radar altimeter (Hall and Walsh 1986; Spencer and Hall 1988), an 87° lens, and a separate monitor for the pilot. ■

Literature Cited

Artsybashev, E.S.; Mel'nikov, V.F.; Shilin, B.V. 1971. Infrared aerial photography of forest fires from high flying aircraft and artificial earth satellites. [In Russian.] Lesnoye Khozyaistvo. 5:60–64. [Translation OOENV TR-71. Ottawa, ON: Fisheries and Environment Canada Library. 11 p.]

Green, Al; O'Brien, M.; Roberts, G.; Churchill, J.; Cheney, P. 1984. Infrared linescan techniques for monitoring the spread of bushfires (Project Aquarius). In: Walker, Eric, ed. Proceedings of the third Australasian remote sensing conference; 1984 May 21–25; Gold Coast, Queensland. Brisbane, Queensland: Organizing Committee LANDSAT 84: 282–293.

Hanks, R.; Warren, J.; Pendleton, D. 1986. Alaska Division of Forestry goes TROLLing. Fire Management Notes. 47(1):32–36.

Lacey, G.M.; Friedrich, J. 1984. Detection and mapping of fires using an airborne thermal infrared scanner. In: Walker, Eric, ed. Proceedings of the third Australasian remote sensing conference; 1984 May 21–25; Gold Coast, Queensland. Brisbane, Queensland: Organizing Committee LANDSAT 84: 294–303.

Lawson, B.D. 1975. Forest fire spread and energy output determined from low altitude infrared imagery. In: Proceedings of symposium on remote sensing and photo interpretation; 1974 October 7–11; Banff, AB. Ottawa, ON: Canadian Institute of Surveying and International Society for Photogrammetry, Commission VII: 363–378. Vol. 1.

McRae, D.J.; Stocks, B.J. 1987. Large-scale convection burning in Ontario. In: Proceedings of the ninth conference on fire and forest meteorology; 1987 April 21–24; San Diego, CA. Boston, MA: American Meteorological Society; [postprint vol.]: 23–30.

Nichols, J.D.; Warren, J.R. 1987. Forest Fire Advanced System Technology (FFAST): a conceptual design for detection and mapping. In: Davis, J.B.; Martin, R.E., tech. coords. 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 Forest and Range Experiment Station: 85–91.

Warren, J.; Wilson, R.A. 1981. Airborne infrared forest fire surveillance—a chronology of USDA Forest Service research and development. Gen. Tech. Rep. INT-115. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 8 p.

Hall, R.J.; Walsh, T.J. 1986. The Yukon and Canadian Forestry Service large-scale aerial photo camera system: general description, installation, operation, and maintenance manual. [File Report.] Canadian Forestry Service, Northern Forestry Centre, Edmonton, AB. 32 p.

Spencer, R.D.; Hall, R.J. 1988. Canadian large-scale aerial photographic systems (LSP). Photogrammetry Engineering Remote Sensing. 54(4):475–482.

Could the 1988 Fires in Yellowstone Have Been Avoided Through Prescribed Burning?

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Could a program of planned-ignition, prescribed fires have eliminated the undesirable consequences of wildfire in Yellowstone National Park in 1988? Planned ignitions are prescribed fires ignited by managers rather than by uncontrolled sources such as lightning. The question can be better answered as two parts:

- Would the threat to major visitor facilities and wilderness or administrative boundaries have been reduced?
- Would the fires have been of smaller size and less intense?

The answer to this question hinges on an analysis of fuel characteristics, fire behavior potentials, fire prescription, logistics, and prescribed-burning costs.

Fuel Types and Fire Behavior

Major cover types from low to high elevation in Yellowstone include sagebrush-grass, Douglas-fir, lodgepole pine, spruce-subalpine fir, and whitebark pine. These cover types can be grouped into three fuel classes that possess different fire behavior potentials:

- Sagebrush-grass.
- Continuous forest.
- Open forest at high elevations.

The potential for using prescribed fire in these fuel groups varies substantially.

The answer hinges on an analysis of fuel characteristics, fire behavior potentials, fire prescription, logistics, and prescribed-burning costs.

The sagebrush-grass type occurs in the northern portion of Yellowstone. It is composed of fine fuels and supports rapid rates of fire spread when the grasses are cured. Fire intensities are intermediate among wildland fuels and depend partly on the amount of sagebrush present. The practice of prescribed fire is well developed in this type of cover. Opportunities to use prescribed fire occur annually, except where intensive grazing has markedly depleted the herbaceous fuels. Grass fuels recover after one growing season. Benefits of hazard reduction arise primarily from reduced fire intensity, because fire can still spread rapidly in areas burned the previous years.

Continuous forest, primarily of lodgepole pine, occupies nearly 80 percent of Yellowstone. Potential for development of high-intensity fire and spread of fire vary greatly, depending upon the amount of dead vegetation present and vertical continuity of live fuels, particularly understory conifers. Fires typically spread very slowly in lodgepole pine and spruce or fir types until severe burning conditions resulting from long-term drying and sustained winds are reached. Then fire behavior changes abruptly, and fires spread by high-intensity crowning and spotting. We have limited experience using prescribed fire in this cover type in the absence of tree harvesting. Dry-site, Douglas-fir stands occupy a small portion of Yellowstone. Fires in this cover type burn readily beneath tree canopies in grass and small twig fuels.

High elevation forests of whitebark pine and spruce or fir hummocks are typically of low flammability due to sparse fuels and high fuel moisture. Prescribed fire would be impractical in most of this type because burning conditions occur infrequently and hazardous fuels are seldom a problem. The major wildfire threat to villages, improvements, and wilderness boundaries lies with the lodgepole pine forest.

Lodgepole Pine Fuels

Fuels and potential fire behavior change dramatically over the lifespan of lodgepole pine, depending upon establishment, growth, mortality, site characteristics, and fire frequency. The major fuel components are needle litter (01 horizon) and duff (02 horizon); downed woody material; and understory herbs, shrubs, and small conifers. These components increase and decrease differently over time. Following stand-replacement fire, grasses and forbs are the primary ground cover until a new stand of trees is established and crowns begin to close. Herbaceous vegetation then declines. Shrubs appear slowly and are never abundant. Understory herb and shrub biomass in Yellowstone lodgepole pine stands is several times less than that found in other lodgepole pine stands of the northern Rocky Mountains (Brown

[1]This paper was presented at the annual meeting of the American Association for the Advancement of Science in San Francisco, CA, January 19, 1989. The help of the following individuals in developing this paper is greatly appreciated: Dave Thomas, Lolo National Forest; Steve Frye, Yellowstone National Park; John Krebs, Idaho Panhandle National Forests; John Chapman, Bridger-Teton National Forest; Dennis Quintilio, Alberta Department of Energy-Forestry, Lands and Wildlife; Rod Norum, National Park Service; and Ron Pierce, Kootenai National Forest.

and Bevins 1986). A sparsity of herbaceous and shrub fuels is characteristic of most lodgepole pine in Yellowstone. In mature-to-overmature lodgepole pine, spruce and subalpine fir often develop in the understory and contribute to torching, crowning, and spotting. In climax stands of overmature lodgepole pine, young lodgepole pine trees become understory fuel.

Needle litter and duff begin to accumulate after trees dominate the site. The forest floor layer gradually thickens and reaches an average of 1 to 1.5 inches (2 to 4 cm) in depth in older stands. Downed woody material increases substantially following fire as the old fire-killed stand falls to the ground. Most of the trees fall within 20 years. The quantity of downed woody material and related flammability decline over the next 100 years or so as the woody material decays and settles into the forest floor. After lodgepole pine matures, it becomes increasingly susceptible to mortality from mountain pine beetle and other natural agents. Woody fuels begin accumulating again as trees die. Downed woody fuel mostly larger than 3 inches (8 cm) in diameter is probably the most significant fuel component in lodgepole pine forests. It accumulates to large quantities, ignites easily, provides heat to ignite other fuels, generates high-intensity fire behavior, and holds fire for extended time periods. This results in crowning, spotting, and large fire growth. The dynamics of fuel accumulation in Yellowstone differ somewhat from lodgepole pine in other areas due to factors such as degree of cone serotiny, site productivity, and longevity.

The following classification of succession in lodgepole pine based on Don Despain's work (Despain 1989), with some deviation in the immature stage, illustrates fire behavior at different time periods in lodgepole forests.

Young stands (0 to 40 years). Herbaceous plants comprise the major plant cover. Seedlings and saplings are present. Fire-killed trees from the previous forest have fallen throughout the period. Litter and duff are absent. Fire spread through this type is rare, although some downed logs, partially rotten, will burn.

Immature stands (30 to 150 years). Dense stands of small-diameter lodgepole pine occupy the site. Understory vegetation is sparse. Needle litter is nearly continuous. A duff layer is developing but is shallow during most of this period. During the early portion of this period, downed woody material from the previous stand ignites readily. Under dry conditions it supports fire spread on the surface and initiates crowning in the young stand. A wildfire that occurs now (a so-called double burn) eliminates the woody fuels, and the next stand develops through the immature stage free of large woody fuels. In the latter part of this period, the downed logs from the previous stand have largely decayed, the trees are taller with crowns well above the ground, and flammability is reduced. The chance of crowning supported by surface fuels is nil.

Mature stands (150 to 300 years). Closed canopy stands dominated by lodgepole pine occupy the site. Engelmann spruce and subalpine fir seedlings and saplings are frequently present. The forest floor is well covered with herbaceous vegetation and grouse whortleberry. Litter and duff are continuous. Downed woody fuels are normally sparse. Fire spread is slow and potential for crowning is slight. Occasional pockets of understory fuels will support torching and crowning. In the latter part of this period, mountain pine beetle may kill many trees and increase flammability.

Overmature stands (300 plus years). The overstory is predominately occupied by lodgepole pine but some Engelmann spruce, subalpine fir, and whitebark pine are present. The canopies are ragged; understory fuel components are usually well developed. Large-diameter downed woody fuels from recent mortality have accumulated. Duff is 1 to 2 inches (2 to 5 cm) deep. Ladder fuels are present, namely understory spruce and fir and lichens in older trees. Fuels ignite readily and support torching, crowning, and spotting. Extreme fire behavior occurs typically in this successional stage.

Although the successional stages of lodgepole pine vary in flammability, crowning fires spread with little regard to fuel types during periods of extreme dryness and high-wind velocities, such as experienced in 1988. Fuels become more important in determining fire behavior when fire weather is less extreme. The successional scenario described here occurs much more rapidly in lodgepole pine in most other parts of the United States and Canada.

Fire Prescription

A fire prescription is a statement of objectives for the fire and a description of the required fire and environmental conditions under which the objectives can be met. The following sections set forth a reasonable fire prescription approach for Yellowstone.

Objectives. The reason for using planned-ignition, prescribed fire in Yellowstone is to reduce greatly or eliminate threats to villages and park boundaries. These planned-ignition, prescribed fires to reduce hazard in critical areas so that lightning fires may be allowed to burn should mimic a natural biological process. These goals are compatible with Yellowstone management objectives to maintain a wilderness quality by allowing natural processes to occur as long as they do not threaten lives or property. Under the fire management plan, prescribed fire is permissible to reduce hazardous fuels. To meet these management goals, prescribed fires should substantially reduce the potential for high-intensity fire behavior, including crowning and spotting. To reduce this potential, prescribed fires should accomplish the following:

- Consume 80 percent or more of 1- to 3-inch (2- to 8-cm) downed woody fuel and 50 percent or more of 3-inch (8-cm) and larger downed woody fuel.
- Consume at least 70 percent of the litter and duff.
- Kill at least 60 percent of understory spruce, fir, and lodgepole pine.

Accomplishing these objectives will greatly reduce surface fuels and high-intensity fire behavior potential. But under extreme dryness and high-velocity winds, crown fires will spread even without well-developed surface fuels. To lessen the threat of crown fire under these conditions, crown canopies must be opened up near villages by mechanical thinning and fuel removal.

Fire treatment. Areas for burning should be chosen where high-intensity wildfire could lead to threats on villages or escapes across park boundaries. Areas of overmature lodgepole pine, particularly support-

Fire in Yellowstone National Park in 1988.

Area with reduced fuel load was recently burned by prescribed fire.

ing understory fir or lodgepole pine, and areas having fuel loadings that exceed 15 tons per acre (34 t/ha) for material averaging 6 inches (15 cm) in diameter (Aldrich and Mutch 1973) are good candidates. Treatment areas of 2,000 to 5,000 acres (800 to 2,000 ha) should be identified and ignited using helicopter application of alumagel. The areas should be approximately 1 mile (1.6 km) wide and several miles long. The 1-mile (1.6-km) width is recommended to eliminate risk of spotting, which commonly occurs over a ½- to ¾-mile width (0.8 to 1.21 km) and occasionally further under high wind speeds.

A massive ignition effort will be required to achieve ignition and good burnout of woody fuels. Within the general fire perimeter, ignition can probably be bypassed in old immature stands and young mature stands because sparse woody fuels are expected.

Fires will spread slowly in the surface fuels. Considerable torching and occasional crowning of clumps of trees and entire areas of several acres in size will occur. Spotting can be expected up to ¼ to ½ mile (0.4 to 0.8 km).

Environmental conditions. The important environmental conditions to be met in conducting the prescribed fires are listed in table 1.

Moisture content of large fuels and related National Fire Danger Rating System (NFDRS) 1000-hour timelag moisture content are considered to be the most critical conditions affecting whether objectives can be met, because they control consumption of large woody fuel. In all likelihood, if large fuel moisture contents meet the prescription, duff moisture contents will be acceptable also. Early summer fires are not considered because of the risk of prolonged wildfire conditions as experienced in 1988 and because cured herbaceous vegetation is needed to assist in fire spread.

The fire prescription was assembled by integrating conditions suggested by seven fire behavior experts and conditions derived from several fuel consumption equations (Brown et al. 1985, Ottmar 1984, Sandberg 1980).

Probability of Meeting Prescription Conditions. Weather records covering the period from 1965 to 1987 from the weather station at Old Faithful were analyzed to determine the probability of being in prescription. Although records for one year, 1971, were missing, 22 years of data were available. This is a rather short period of time, but enough to provide an idea of weather probabilities. Although precipitation and related fuel moisture vary substantially from the relatively wet southwest corner to the dry northern portion, Old Faithful weather should represent fire weather reasonably well for the lodgepole pine forest. The number of years in which 3 or more consecutive days in the specified time period satisfy the prescription by NFDRS 1000-hour moisture content within the time periods are set forth in table 2.

The frequency of being in prescription from the middle of August to the end of September and NFDRS 1000-hour moisture content is 1 in 4 years for preferred conditions and 3 in 4 years for acceptable conditions. If the prescription was restricted to September, preferred conditions were met 3 out of 20 years and acceptable conditions 2 out of 3 years.

The number of days from August 1 to September 30 that relative humidity, 10-hour timelag moisture content, and wind speed were simultaneously in prescription averaged 4 days or 9 percent of that period for preferred conditions and 12 days or 24 percent of that period for acceptable conditions. The probability of all prescription parameters being in prescription simultaneously could not be calculated with the available computer programs. But the probabilities obviously would be less than calculated just for the probability given in table 2. Although exact probabilities of meeting all prescription conditions remain uncertain, it is apparent that successful prescribed burning could only be carried out on an average of once every several years.

Burning Plan

What are the logistics to carry out a program of prescribed fires and how much would it cost? To answer this, first, the number of prescribed fires, approximately 3,500 acres or 1,416 hectares (1 × 5 mi or 1.6 × 8 km) in size, needed to protect villages and park boundaries was estimated. To protect Old Faithful Inn, Lodge, and Visitor Center, Grant Village, Lewis Campground, and Canyon Village from spread of fire by crowning and spotting, approximately 10 prescribed fires located to intercept prevailing winds would be needed. To reduce heavy fuel accumulations within 1 to 2 miles (1.6 to 3.2 km) of all boundaries, approximately 40 fires would be needed. Not all boundaries are equally vulnerable to escapes, so this

Table 1—*Preferred and acceptable conditions for prescribed-fire burning*

Parameter	Preferred	Acceptable
Moisture content of fine fuel (1- and 10-h timelag fuels) (percent)	5 to 8	5 to 12
Moisture content of large fuel (1000-h timelag fuel) (percent)	10 to 15	8 to 20
National Fire Danger Rating System (1000-h timelag moisture) (percent)	<16	<19
Lower duff moisture content (percent)	<60	<80
Wind speed (20-ft height) (mi/h)	2 to 10	1 to 15
Relative humidity (percent)	18 to 30	15 to 35
Time of year	After 8/15	After 8/1

Table 2—*Number of years in which 3 or more consecutive days in specified period satisfied the NFDRS 1000-hour moisture content prescription condition*

	Frequency of satisfying NFDRS 1000-h moisture content in specified time period			
	Preferred (<16%)		Acceptable (<19%)	
Item	Aug. 1– Sept. 30	Aug. 15– Sept. 30	Aug. 1– Sept. 30	Aug. 15– Sept. 30
Number of years satisfying prescription	8	5	20	16
Percentage of total years	36	23	91	73
Ratio of years in prescription	1:3	1:4	9:10	3:4

number could be reduced by concentrating prescribed fires on the most likely boundaries to be threatened. Still 25 to 30 prescribed fires would be needed.

Two or three prescribed fires are probably all that could be conducted in a single season without risking too much fire. Assuming fires could be conducted ever third year, which is probably optimistic, 30 to 50 years would be required to safeguard villages and boundaries. The program could be carried out in about 10 years to safeguard just the villages. Speeding up the program by conducting many burns in a single season is possible, but logistically very difficult and risky.

Fuel Reduction Other Than Prescribed Fire. All of the prescribed fire experts consulted in this exercise agreed that some fuel reduction around villages would be necessary before conducting any prescribed fires near them. The prescribed fires would involve some high-intensity fire behavior that could also threaten the villages unless fuels are mechanically reduced.

Fuel reduction without the additional program of prescribed fires would, itself, greatly mitigate the threat of wildfires. Mechanical fuel reduction is free of the risks associated with uncontrolled fire behavior and can be carried out at any time, such as during low-use visitor periods. It can be used effectively to reduce crown fire potential.

A recommended fuel reduction is construction of shaded fuel breaks completely around the villages and vulnerable campgrounds. A fuel-break strip at least 0.1 mile (0.16 km) wide and preferably 0.2 mile (0.32 km) wide is needed. Within the strip, all standing and downed dead woody fuels larger than about 1 inch (3 cm) should be removed. The live trees should be thinned to break up continuity of the crown canopy. Thinning can be feathered into the stands with the widest tree spacing occurring toward the protected areas. Approximately one-third to occasionally one-half of the trees would require removal.

Costs of fuel reduction could vary greatly depending upon the method used and constraints imposed to protect the environment. Costs would probably range from $400/acre ($162/ha) for a mechanized operation to $1,500/acre ($607/ha) for hand labor. To construct fuel breaks around the three major villages with minimal disturbance to the site probably would cost $300,000 to $500,000. To treat fuels in the vicinity of all facilities and powerlines would cost substantially more. These costs could be offset somewhat by selling trees from the thinnings.

Fuel Reduction Through Burning. For an individual burn, it was assumed that two helicopters would be used for ignition, each igniting 500 acres (202 ha) per day. A massive ignition effort would be required because surface fire could not be relied upon to ignite critical fuels adequately. Surveillance with a small airplane would be necessary during and after the ignition period until the fire was no longer active. A 20-person holding crew should be available for a 10-day period. Under these assumptions, cost for a 3,500-acre (1,416 ha) burn was estimated to be $67,350 (about $19/acre or $7.69/ha).

An acceptable contingency plan for each prescribed fire would be necessary to cover the likely possibility of fire moving beyond its expected perimeter. Passage of one or two dry cold fronts with highspeed winds, crowning, and spotting for three-quarters of a mile (1.2 km) or more should be assumed. The prescribed fire could easily grow to several times its planned size and even considerably larger. To guard against this event, prescribed fires should not be ignited before September in drought years such as 1988. Presumably, a severalfold increase in fire size would be acceptable in most areas of Yellowstone. But on some fires, suppression action involving a large fire organization may be required. This could add several million dollars to the cost.

The estimated direct operational costs for a program of prescribed burning and presuppression fuel treatment needed to mitigate the wildfire threat to villages and boundaries is as follows:

Item	*Cost*
Fuel breaks around villages	$ 500,000
Prescribed fires near villages	675,000
Prescribed fires near boundaries (40 fires)	2,695,000
Total	$3,870,000

Nearly $4 million would be required for this program. Costs of conducting individual prescribed fires could be reduced by one-half or more, once experience is gained, particularly for low-risk fires near boundaries. In this case, the program could be carried out for a minimum of $2.5 million. But the costs could be considerably greater if fire suppression was required to quell unexpected threats from the prescribed fires. Nonetheless, compared with the fire suppression costs in 1988 of nearly $100 million within Yellowstone, the cost of this program would be relatively small.

Conclusion

What are the answers to the questions we started with? The 1988 fires in Yellowstone could not have been avoided with a program of prescribed burning. But assuming the program had been initiated in 1972, with considerable additional funding in the Yellowstone fire management budget, threats to villages may have been prevented or greatly reduced. Some escapes across park boundaries may have been avoided but not to a significant degree, because the program could not have been completed by 1988 even with adequate funding. The amount of area burned also would not have changed significantly. If the program had been completed, however, escapes on the east and west sides of the park would probably have been significantly reduced but not eliminated. Less area outside of the park would have burned.

It is important to consider the original question more generally because it is relevant to managing fire in wildernesses and the national parks throughout the West. Can planned ignitions be effectively used to reduce hazard in subalpine forests such as lodgepole pine? Prescribed-fire programs do appear to be feasible to achieve such results but would require substantially more funding than currently available to agencies. Such programs would probably require a specially trained and experienced interagency team to assist in planning and conducting the burns. Meeting objectives of these prescribed fires could be difficult and tricky because severe burning conditions are required. The threshold between surface fire and crowning fire behavior is narrow. Skillful and experienced prescribed burners are necessary to manage this type of fire potential successfully. The irregular burning opportunities in any one location make it difficult for local managers to maintain needed skills. An interagency team able to provide assistance throughout the West could overcome this problem. An informed and supportive public would also be needed.

The effectiveness of a prescribed-burning program depends on achieving the desired reduction of fuels, selecting the right areas for burning, controlling the fires, and later reburning some of the heavy fuel accumulation created by the first prescribed fires. Because current fire managers lack substantial experience with this type of prescribed burning, a research and development program is needed if managers are to meet natural fire objectives and to avoid the undesirable consequences of fire seasons similar to 1988. The program would need to be undertaken soon to provide guidance for managing fire in the national parks and wildernesses. ■

Literature Cited

Aldrich, David F.; Mutch, Robert W. 1973. Wilderness fire management planning guidelines and inventory procedures. Missoula, MT: U.S. Department of Agriculture, Forest Service, Northern Region. 36 p.

Brown, James K.; Bevins, Collin D. 1986. Surface fuels loadings and predicted fire behavior for vegetative types in the Northern Rocky Mountains. Res. Note. INT–358. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 9 p.

Brown, James K.; Marsden, Michael A.; Ryan, Kevin C.; Reinhardt, Elizabeth D. 1985. Predicting duff and woody fuel consumed by prescribed fire in Northern Rocky Mountains. Res. Pap. INT–337. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 23 p.

Despain, Don G. 1989. Unpublished data. U.S. Department of the Interior, Yellowstone National Park.

Ottmar, Roger D. 1984. Predicting fuel consumption by fire stages to reduce smoke from slash fires. In: Proceedings of the 1983 annual meeting of the Northwest Forest Fire Council; 1983 November 21–22; Olympia, WA. Olympia, WA: Northwest Forest Fire Council: 87–106.

Sandberg, David V. 1980. Duff reduction by prescribed underburning in Douglas-fir. Res. Pap. PNW–272. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 18 p.

Thanks, Earl Nelson

On December 30, Earl Nelson, Fire Management Notes' printing specialist, retired from the Forest Service, drawing to a close a 35-year career in the Federal workforce, 29 of them with the Forest Service. He also served in the U.S. Army infantry during the Korean War and later with a unit in Alaska.

During 16 of those years, Earl worked on Fire Management Notes production in many capacities: printing, layout and design, reviewing contracts, and serving as a liaison between the USDA printing and design offices and the editors and Fire and Aviation Management general managers.

Earl sees Fire Management Notes, a publication he has spent so much time helping to produce, this way: "It keeps people in the fire community communicating; new ideas are disseminated to everyone involved in fire protection—from those on the ground to those who make decisions."

Earl was not a printer before joining the Forest Service, but his experience in the Forest Service printing shop, first as a platemaker and then as an operator of an offset press, whetted his interest. He rounded out his on-the-job training in printing through coursework (personally financed—this was before employer-paid training) at the USDA Graduate School and the Washington School of Printing, a well-known printing school now tied to Montgomery County Community College.

Forest Service employees also know Earl for his tenure of service (since 1978) as president of the National Federation of Federal Employees (NFFE), otherwise known as the "union." Reflecting on his work with the NFFE, he states: "The major accomplishment for employees during my presidency, through long-standing NFFE efforts and Pilot Eagle impetus, has been the establishment of the maxiflex work schedule." For the legacy of his efforts, each Forest Service employee owes Earl a measure of gratitude.

Thank you, Earl Nelson, for helping the fire community keep in touch. Thank you for caring about your coworkers enough to have devoted so much time to help them create a better workplace. You will be missed. ■

Earl Nelson, printing specialist (center), discusses the printing of Fire Management Notes *with Francis Russ, general manager, and Doris Celarier, editor.*

Workforce Diversity: A Mosaic for the Future

Jerilyn Levi and Kimberly Brandel

USDA Forest Service, respectively, fuels/recreation forester, Siuslaw National Forest, Alsea, OR, and fire planning assistant, Fire and Aviation Management, Washington, DC

Diversity! Mosaic! Change! Challenge! These words came alive for over 400 people from across the Nation this past April at the "Workforce Diversity in Fire and Aviation Management: A Mosaic for the Future" conference in Denver, CO. This event, a component of Fire and Aviation Management's Model for Workforce Diversity, gave Fire and Aviation Management employees from every level of the Forest Service workforce and others in the fire management community a forum to discuss how to achieve workforce parity by 1995.

What the Conference Wanted to Accomplish

The conference was organized to make progress toward building a diverse workplace in Fire and Aviation Management. To do this, the conference planners and organizers established some very specific goals:

- Reenforce national commitment to the value of a diverse workforce in Fire and Aviation Management.
- Increase awareness of career opportunities in Fire and Aviation Management.
- Promote interaction and communication between all levels of the organization necessary to meet today's management challenges.
- Develop national and regional recommendations for improving the recruitment, retention, and development of a diverse workforce in Fire and Aviation Management.
- Provide the expanded fire community with "tools for success."
- Recognize outstanding achievements of individuals who have worked to increase the participation of women and minorities in Fire and Aviation Management.

A Diverse and Energetic Group

Energetic and positive, participants came from all levels of the Fire and Aviation Management organization, from managers at the national, regional, and forest levels to on-the-ground personnel and seasonal employees. Representatives from other Government agencies—State forestry agencies and USDI's Bureau of Land Management and National Park Service—and colleges and universities also joined this mix. Interagency participation was integral to the work of the conference since fire management is a cooperative effort of many agencies and all members of the fire community must work closely together. Interaction between individual participants and among all segments of this representative group was vigorous and extensive.

Management's Commitment

Al West, Deputy Chief for State and Private Forestry, opened the conference by emphasizing his personal commitment to workforce diversity. Deputy Chief West asserted in his remarks that "what we permit, we promote." He stressed that by not taking action on controversial or difficult matters regarding inappropriate behavior in the workplace, we condone such actions by default. He further stated that we are all responsible for maintaining a workplace free of harassment, hazing, and inappropriate behavior. Introducing each Regional Fire Director, Deputy Chief West issued a challenge to them: Be the first to sponsor a woman as a forest fire management officer.

"Workforce diversity is not the problem. It is the solution."

—Lawrence (Mic) Amicarella, Director of Fire and Aviation Management

Workforce Diversity Topics

Over 50 speakers, 9 panel discussions, and 20 issue-workgroups, in general and concurrent sessions, explored difficult, sensitive, or complicated topics such as recruitment

Dr. Byron Kunisawa, Director of Operations for the San Francisco Multicultural Training Resource Center.

and retention, career considerations and opportunities, cross-cultural human relations, training, coworker backlash, family considerations, the challenges of diversity, working with difficult people, the Region 5-Pacific Southwest Forest and Range Experiment Station Consent Decree, and the "how-to" of getting the job you want.

Dr. Byron Kunisawa from the Multicultural Training Resource Center in California delivered a hard-hitting keynote address. Dr. Kunisawa spoke about the changing composition of our Nation's workforce. He pointed out that by 1995, 85 percent of those entering the workforce will be minorities and women. Workforce diversity is here for us to deal with now. Our future success depends on it. Dr. Carla Gary, Assistant Director of Minority Education at the University of Oregon, focused her remarks on "appreciating diversity," and Dr. Henri Mann Morton, Director of Native American Studies, University of Montana, expanded and reenforced Drs. Kunisawa's and Gary's observations. Of the panel discussions, the session, "Career Considerations and Opportunities," evoked an extraordinarily active response with many questions. The panelists were Mary Jo Lavin, Deputy Regional Forester, State and Private Forestry, Portland, OR; Chip Cartwright, Forest Supervisor, Jefferson National Forest, Roanoke, VA; DeNise Cooke, District Ranger, Tuskegee Ranger District, National Forests in Alabama; Mike Edrington, Deputy Forest Supervisor, Willamette National Forest, Eugene, OR; and Gordon Reinhart, Fire Management Officer, Umatilla National Forest, Pendleton, OR.

Issues and Action

Participants spent the third day of the conference in small groups working on issues. Before the conference, the conference organizers or "cadre" surveyed individuals in Fire and Aviation Management to identify issues that are barriers to women and minorities. The cadre compiled the survey results into 11 categories: training, dealing with diversity, recruitment, retention, career and family, inappropriate behavior (ethnic harassment), inappropriate behavior (sexual harassment), coworker backlash, career advancement (self-initiated), career advancement (agency commitment), and self-esteem.

After preparing problem, vision, and solution statements for each issue, the workgroups recommended action for achieving this vision. All of the participants at the conference had the opportunity to vote on the action that they felt would most help achieve diversity goals by 1995. Not surprisingly, due to high representation from Region 5, the actions that received the most support concerned advertising fire positions as GS-401/460/462 interchangeable. This would have the effect of making more women and minorities eligible to apply for vacancies. They also placed a priority on resolving the pay disparity that currently exists between State and county firefighters and Federal firefighters and establishing a separate wildland firefighter series. The recommendations, currently being reviewed by Personnel Management in the Washington Office,

Director Lawrence (Mic) Amicarella with members of Gordon Reinhart's Incident Management Team during awards presentation.

will be tracked by an ad hoc committee.

Recognition for a Leader

A highlight of the conference was the presentation of the Director's Award for Workforce Diversity Achievement. Lawrence (Mic) Amicarella, Director of Fire and Aviation Management, presented the award to Gordon Reinhart, fire management officer on the Umatilla National Forest.

The Final Word

The conference helped change attitudes. It was a step forward. One of the participants observed, "It was a great opportunity to share information and interact. It changed my attitude 100 percent! Go for it!" In closing the conference, Director Amicarella made the direction ahead clear when he stated that at the national, regional, and local level, he is confident that we will aggressively and creatively meet the workforce challenges at hand and those ahead. "Workforce diversity is not the problem," he said; "it is the solution!" ■

Workforce Diversity: Special Recognition

Besides presenting the Director's award, the conference recognized many employees for their work in building a more diverse workforce. A plaque with the inscription "In recognition of contributions to achieving workforce diversity in Fire and Aviation Management" was given to the Region 1 Aviation and Fire Management Staff: Rick Belnap, Ed Allen, Glenn Johnston from the Payette National Forest in Region 4; Fred Roach, Al Driesbach, Dana D'Andrea, Doug Aversano, and Wes Shook from the Los Padres National Forest in Region 5; Jerry Stephens from the Daniel Boone National Forest in Region 8; and the Region 9 Aviation and Fire Management Staff.

Occupational Training Course for High Schoolers

Fred Roach, Dana D'Andrea, Wes Shook, Al Driesbach, John Crotty, and **Doug Aversano** from the Santa Lucia Ranger District on the Los Padres National Forest took a creative approach to broadening their job applicant pool by targeting high school students before they enter the job market. They initiated a wildland firefighting training course for high school students through the County Superintendent of Schools Regional Occupational Program. The course involves 139 hours of class and field work. Students who complete the class are eligible for employment with the Forest Service. The ranger district "fire shop" went all out to recruit women and minorities into the program. They showed up at participating high schools after school hours with a model 51 engine and a diverse crew of employees to discuss and explain the program to potential applicants. Women and minorities have made up half the student enrollment in the program. Several of the top graduates have been placed in seasonal positions and one has accepted a TAPER (Temporary Appointment Pending Establishment of a Register) appointment. The program was funded by the ranger district the first year. The school district is now reimbursing the Forest Service for teaching the class.

Al Driesbach, Dana D'Andrea, Fred Roach, Doug Aversano, and Wes Shook of the Los Padres National Forest holding award.

Smokejumper Career Day

The **Region 1 Aviation and Fire Management Staff** implemented a smokejumper recruitment day targeted for women and Native Americans. Kim Maynard, a Missoula smokejumper, was assigned as regional smokejumper recruiter. She organized the first Smokejumper Career Day in 1987. Activities included a tour of the Aerial Fire Depot, jump demonstrations, and mini-workshops on the application process, physical training, and experience requirements. As a result of the day's activities, 15 women applied to be smokejumpers, with one woman successful in passing rookie training. Since the dropout rate was high, the region sponsored a physical fitness clinic that focused on giving direction to attain the physical fitness level required of a jumper.

The second career day, held in 1988, was expanded to include recruitment of Native Americans. For the past 4 years, the Aerial Fire Depot outreach program has been using Public Law 94–148 as the authority for training Native Americans from Montana to be smokejumpers.

Fire and Aviation Management Director Lawrence (Mic) Amicarella with Leslie Anderson, Kim Maynard, Margarita Phillips, and James Mann of the Region 1 Fire and Aviation Management Staff.

The Helitack Program and Workforce Diversity

Rick Belnap, Ed Allen, and **Glenn Johnston** from the Krassel Ranger District on the Payette National Forest have made concerted efforts toward achieving workforce diversity in their helitack program without compromising the quality or safety record of the base. In 1987, 50 percent of the 17 helitack positions on the ranger district were filled by women or minorities; in 1988 the figure increased to 64 percent. The base recorded record-setting hours and days on fires during both seasons without a single accident.

Belnap, Allen, and Johnston have used many different methods to recruit quality candidates. They have used Public Law 94–148 as the authority under which Native Americans were recruited and hired. This process has heavily involved the tribes in recruiting, screening, and recommending individuals for employment. They have contacted potential Hispanic employees through the local State Job Service and migrant councils. Several Hispanics have been employed under a contract until they have enough experience to compete under regular Government Civil Service. employment. They have established "trainee" positions at lower than traditional grades that allow women and minorities to be more competitive and have converted some positions from temporary to short-term WAE's (when actually employed) and recruited and filled them with women and minorities.

Training for Cherokee Nation Firefighters

Jerry Stephens from the Somerset Ranger District on the Daniel Boone National Forest took the initiative in recruiting and training members of the Western Band of the Cherokee Nation as emergency firefighters. Stephens presented the tribe, whose members reside in an economically depressed area, with the possibility of an additional source of income. Through his efforts, the relationship between the Cherokee Nation and the Forest Service has significantly improved. A contract was signed by the Chief of the Western Band and the Director of Aviation and Fire Management in Region 8 that provided fire training for tribal members and emergency firefighters for the Forest Service. Stephens made sure that Cherokee crews were trained, equipped, and used on fires in Region 8 and in the western States. Since the original agreement was signed, three Cherokees have served on the Region 8 hotshot crew, Cherokee contractors have successfully bid on timber contracts, and the agreement has been extended to five other tribes in Region 8.

Jerry Stephens of the Daniel Boone National Forest.

Glen Johnston, Ed Allen, and Rick Belnap of the Payette National Forest.

Recruiting and Training

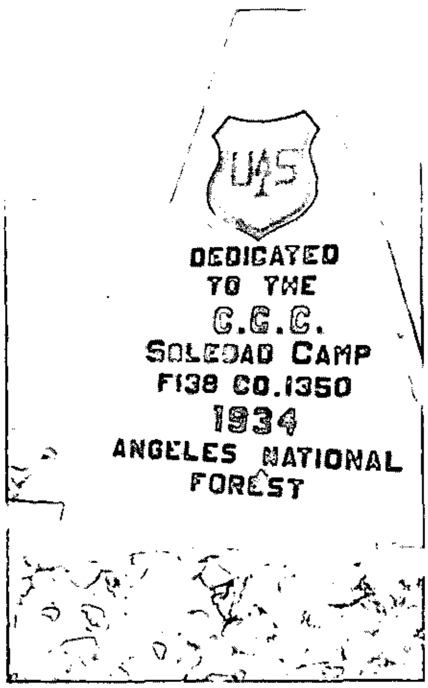
Region 9 employees, under the leadership of the **Regional Office Coordinating Organization,** recruited and trained inner-city residents of Milwaukee as emergency firefighters. In addition to developing 12 crews of firefighters, the effort increased community awareness of the Forest Service's work, improved community spirit, boosted the local economy and introduced inner-city residents to resource management activities. Of the 215 people who completed training and were used on western fires, 88 were minorities.

After the fire season was over, the regional office sponsored a "Celebration of Success" to which all crew members were invited. Presentations were given on how to apply for temporary or seasonal employment with the Forest Service. In addition, four other potential employers, including the Milwaukee City Fire Department, were invited to the event and talked to interested jobseekers. Several firefighters have found employment as a result of the references that the Forest Service provided.

The Region 9 leadership also promised the firefighters that the Forest Supervisors in the region would be encouraged to hire the 30 top performers for seasonal jobs. Many forests have requested these people. As a result of the efforts of Region 9 employees, disadvantaged minorities have been introduced to the possibility of working in natural resource management. ■

Kimberly Brandel, *fire planning assistant and conference coordinator, USDA Forest Service, Fire and Aviation Management, Washington, DC*

With a Lot of Help From a Friend—the Civilian Conservation Corps



Road monument on the Angeles National Forest in California (C.A. Lagerstrom, 1935). 308472

Enrollee ringing fire alarm on the White Mountain National Forest in New Hampshire (B.W. Muir, 1939) 379945

CCC firefighters on a Malibu Fire fireline near Angeles National Forest (F.E. Dunham, 1935) 342636

The Civilian Conservation Corps (CCC), Roosevelt's Tree Army, tree troopers, soil soldiers—the names tell the story: the conservation of our natural resources—the forests, the soils, the rivers and streams, and, in a real way, the people themselves. As President Roosevelt said in a 1933 radio address,"...I think of you as a visible token of encouragement to the whole country." CCC histories faithfully report its legacy of tangible accomplishments: forest trees planted (2.4 billion), trails and minor roads constructed (126,000 miles), telephone lines laid (89,000 miles), firefighting (6.5 million mandays), erosion control and check dams (6.7 million, number), and tree and plant disease and pest control (21 million acres).

Less easy to quantify, however, but nevertheless real, was the CCC's broader impact. For instance, in its 9 years of existence, 1933 to 1942, the CCC changed the way the Forest Service fought fire. Stephen Pyne in *Fire in America* concludes: "It was amid this unprecedented outpouting of men and material that the Forest Service launched a complete modernization of its fire program. In the three years between 1935 and 1937 the Service sought to complete in full the program with which it had struggled piecemeal for three decades."

In reporting on fire events, issues, techniques, and equipment, *Fire Control Notes*[1] reflected this change and informally—in this article and that one—passed along the story of the CCC's enormous contribution to forest protection from fire: CCC's participation in firefighting, fire prevention and presuppression work (tractor trail building, cutting snags, building firebreaks, fire patrol, and lookout building), fire research such as experimenting with new techniques, materials, and organization (the progressive step-up and the one-lick methods of line construction and the use of foam), testing for physical effects from firefighting, and law enforcement. Contributors also exposed controversies: the effect of the CCC firefighting crews—ready, trained, and organized—on the cooperators who had usually manned the Forest Service firelines and of the CCC-built fire protection trail and road system reaching into the backcountry. In 1942, nearing the sunset of the CCC, the questions surface in print: How much fire protection is justifiable? What is the cost?

But most unforgettable by far is the quiet, unfailing courage and commitment of these young men, economically hard-pressed and far-removed from their families and communities, in the face of harrowing danger. *Fire Control Notes*, a spokesman, so to speak, for the entire Forest Service, paid tribute to this courage. Nowhere was the undaunting spirit of the CCC more dramatically manifested than at the Blackwater Fire on the Shoshone National Forest on August 21, 1937. There 10 CCC men along with a Bureau of Public Roads and 3 Forest Service crew members lost their lives in a surprise blowup. There also, as Forest Supervisor John Sieker reports (see reprint), CCC firefighters, fatigued and saddened, returned the next day to the fireline to corral the fire that had extracted such a high cost and eluded control the day before. ◘

Doris Celarier, *editor, Public Affairs Office, Washington, DC*

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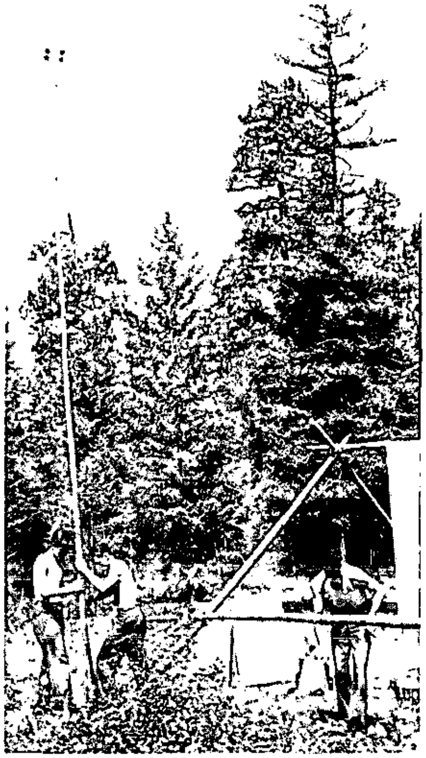
[1]Articles in *Fire Control Notes* from 1937 to 1942.



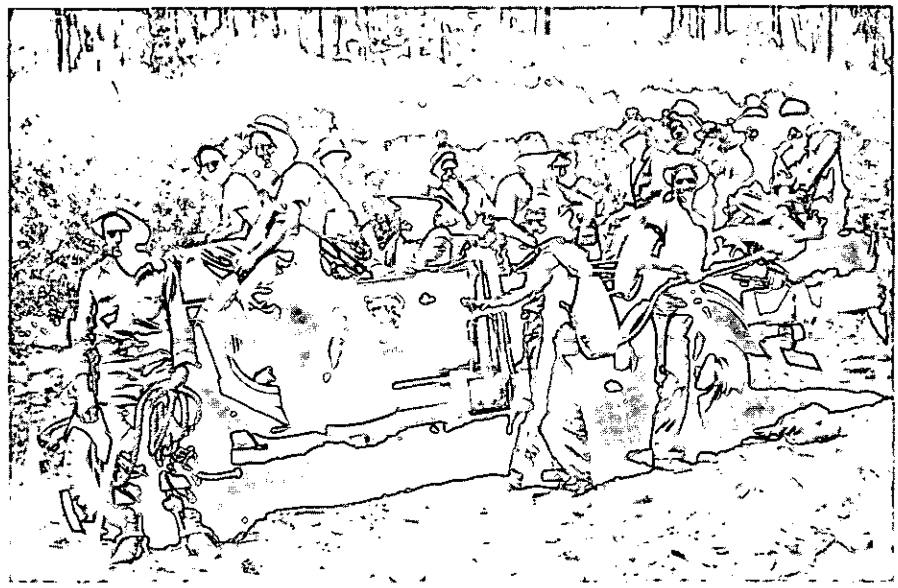
Forest Service radio technician and enrollees installing anemometer to measure wind velocity near forest fire base camp on Lolo National Forest in Montana (W.J. Mead (a CCC photographer), 1941). 413892

Enrollee driving truck carrying 25 firefighters to a forest fire on the Boise National Forest in Idaho (Paul S. Bieler, 1941). 407331

CCC fire crew on its way to a fire on Boise National Forest, near Idaho City, ID (Paul S. Bieler, 1941) 407335

Enrollees felling snags on a firebreak at Wind River on Gifford Pinchot National Forest in Washington (G.A. Bright, 1933). 280392

CCC fire patrol inspecting Eagle Creek Campground on Mt. Hood National Forest in Oregon (Ernest Lindsay, 1940). 392902



CCC fire suppression crew in California, with Forest Service fire truck (Capt. Daniel Sheehan, 1933). 285451

CCC firefighters on the Hughey Fire on the Chequamegon National Forest in Wisconsin getting fed (R. Dale Sanders, 1040). 396173

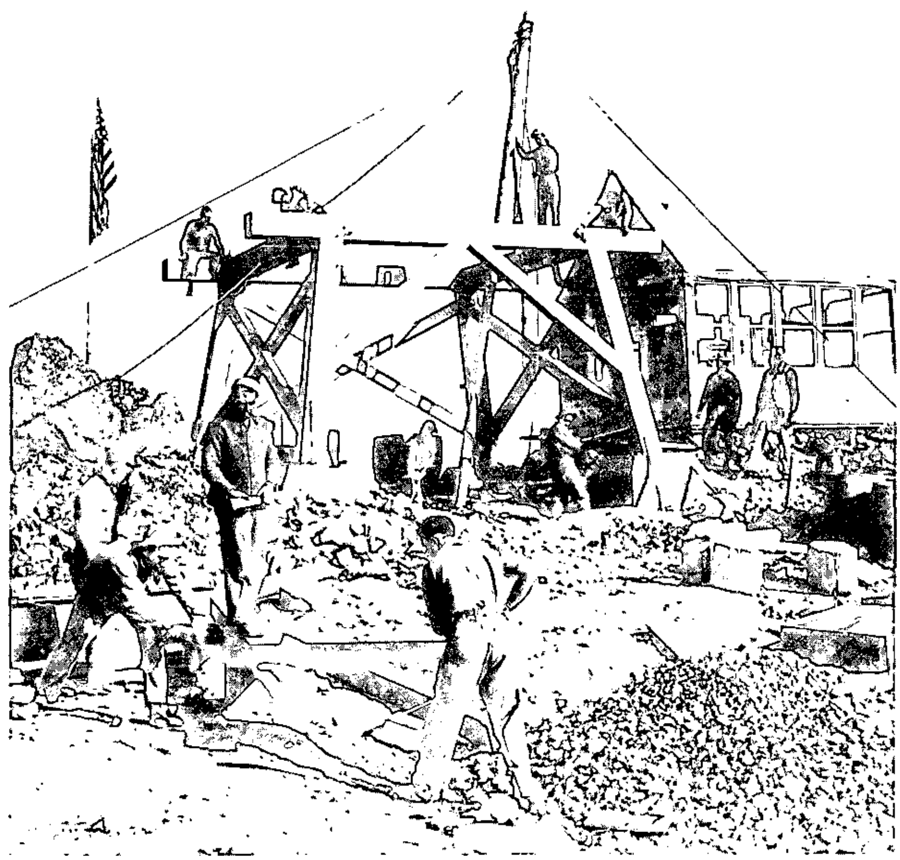
CCC fire crew resting after work on the Deadwood Creek Forest Fire on the Challis National Forest in Idaho (W.H. Shaffer, 1937). 354022

Jefferson National Forest class instruction in telephone line maintenance and operation at the specially constructed telephone line at CCC Camp F-24 at Covington, Va (B.W. Muir, 1938). 367212

Enrollees arriving at and waiting for orders at Dutchman Gulch sawmill camp where September 20, 1933, fire on the Black Hills National Forest started (Fred R. Johnson, 1933). 283144

Lyons Valley CCC field kitchen in Barber Mountain in California (1934). 289370

Sharpening axe at Camp Roosevelt on the George Washington National Forest in Virginia (W.H. Shaffer, 1933). 277007



Enrollees building Mt. Bradley Lookout on the Shasta National Forest in California with Mt. Shasta in the background (Capt. Daniel Sheehan, 1933). 285294

CCC Determination

One bright memory in the midst of all the tragedy surrounding the Blackwater Fire was the response of the CCC crews the morning following the blow-up.

Naturally, all fire suppression work had ceased during the night. All available foremen and men were on searching parties looking for injured men. At daylight a 150-man crew was again out searching for any that might have been missed during the night, and arranging for removal of the dead. But tragedy or not, there was still 1,200 acres of fire running around loose, and the humidity was below 10. Scouting and line construction had to be done, and there were only tired, depressed men left to do it.

The CCC men rose to the occasion like veterans, and at daylight three crews were on the fire line carrying on—determined to whip the fire that had beaten them so terribly the afternoon before. These boys put through difficult line that day and held it through a very critical afternoon. Most of them had seen horrible burns the night before, and many saw corpses packed out during the day, but they did not let that deter them in their attack on a stubborn fire.

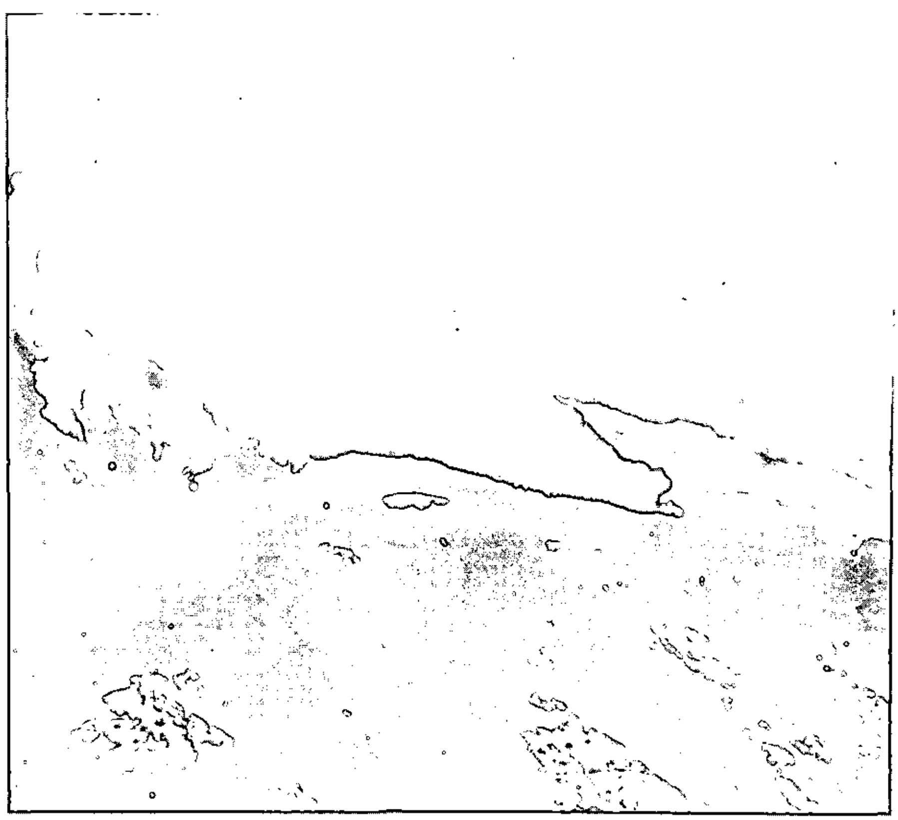
The CCC responded to an emergency in a very noble and courageous manner, and the Shoshone and the entire Forest Service appreciated it.

John Sieker, *supervisor, Shoshone National Forest, Cody, WY*

[1]Reprinted from December 6, 1937, issue of *Fire Control Notes.*

View up Rock Gulch (Clayton Gulch) where Ranger Alfred Clayton, James Saban, Rex Hale and four CCC enrollees died on the Blackwater Fire on the Shoshone National Forest in Wyoming (W.H. Shaffer, 1937). 351254

Another view of Rock Gulch from below (W.H. Shaffer, 1937). 351257



Wind still blowing toward the more easterly direction. Time of taking definitely known to have been 4:30 p.m. on August 21, 1937. Note fires on Plateau on Double (Clayton) Mountain and persistence of wind in more easterly direction (Gibson, 1937). 355903

Protecting the Interface: A New Training Program

Mark R. Reynolds[1]

Chief project officer for contractor, Federal Emergency Management Agency, National Fire Academy, Emmitsburg, MD

The 1988 fire season ranks as one of the most costly in the Nation's history. By October 1988, almost 70,000 wildfires had burned well over 4 million acres (1,618,800 ha) across the country. The cost to the Federal Government for fire suppression efforts alone totalled almost $400 million—this does not include the billions of dollars lost in property, business, and natural resources.

No one appreciates the truth behind these statistics more than those in the fire service who have a professional responsibility and personal commitment to avert the loss of life and property. The fire service is on the front lines in these emergencies. They see the destruction and the loss firsthand. They also feel the frustration when their training, experience, and commitment are no match for a major wildland fire event. Charged with the responsibility for protecting lives and property, firefighters too often find themselves in the no-win situation of having to decide which houses to protect and which to abandon to an approaching wildfire.

Focus of New Course

In 1989, the National Fire Academy offered a new training program specifically tailored to provide small and volunteer fire departments with the resources they need to help protect their communities from wildland fires. The program, "Wildland/Urban Interface Fire Protection: A National Problem with Local Solutions," is designed as a self-study course that individuals or departments can complete in the field at their own pace and apply specifically to the needs of their own communities.

The National Fire Academy's new training program is specifically tailored to provide small and volunteer fire departments with the resources they need to protect their communities from wildland fire.

Course Goal

The goal of the new course is increased protection in the wildland-urban interface—that point where manmade structures meet flammable vegetation. The increasing number of people moving to wildland areas and the continual expansion of cities and other communities out into traditional wildland areas have led to a concomitant increase in wildland-urban interface fires. By stressing a proactive protection approach, the National Fire Academy hopes to build awareness that traditional suppression efforts frequently are not enough to combat interface fires. The fire service must take the lead to alert leaders and citizens to potential dangers, to educate the public about the need for fire safety, and to implement community programs that can stop these disasters from ever occurring.

Course Content

The content of the new course includes the following major areas:

- Assessment.
- Solutions or options.
- Support building.
- Action planning.

Assessment. A critical component involves assessing the fire threat in your local wildland-urban interface. Historically, the wildland-urban interface problem has been associated with the western United States where interface fires are an annual threat. However, statistics show that interface fires respect no such geographic distinctions. Serious wildfires in the wildland-urban interface are now a problem in virtually every State—the threat exists anywhere people and businesses exist within or adjacent to wildlands. In designing this course, the National Fire Academy recognized that, while interface fires are a national concern, solutions must be geared to specific local problems. A solution that may work in California may not be appropriate for Virginia or New Hampshire. This portion of the curriculum offers effective tools for assessing the risks, hazards, and values in local jurisdictions as a critical first step in tackling the problem.

Solutions or Options. The core of the curriculum offers a wide variety of activities, approaches, and strategies that local fire service agencies can employ to reduce the potential for wildland-urban interface fires. The chapter focuses on five major areas: structural options, vegetation management, elements of the infrastructure, public education, and enforcement. In each of these sec-

[1]Mr. Reynolds of University Research Corporation, Bethesda, MD, assisted NFA in the development and production of this new training program.

tions, the course offers examples, advice, and resources that can be tailored to the needs of individual communities or agencies.

Building Support. Effective fire protection involves not only members of the fire service, but also a wide variety of individuals and agencies that have an interest in the wildland-urban interface. The curriculum identifies the key organizations, agencies, and individuals that can help in designing and implementing an interface fire protection program. Particular emphasis is given to identifying the interests and motivations of these groups as a first step toward gaining their support.

Action Planning. The whole purpose of the Academy's new program is to support protection initiatives at the local level. Thus, the last stage in the course assists participants in defining their specific problems. Again, the focus is on building a problem-solving strategy that will work in a participant's community, based on solutions and mitigation options that have proved effective in other parts of the country. ■

Release of National Wildland-Urban Interface Training Package

The National Fire Academy (NFA) began a nationwide distribution of its new wildland fire protection training course in mid-April. This innovative, self-paced, self-study course is designed to assist local fire service and forestry personnel in combating destructive wildland fires occurring more and more frequently in the wildland-urban interface.

To ensure national distribution of the much needed course, NFA has sent copies of the training package to fire service training and forestry organizations in each State. The training package contains a textbook, a workbook, and a video tape. A mailback form requesting a copy of the final examination and camera-ready copy of the materials for reproduction was enclosed in each package.

The American Council on Education will award one semester hour of credit upon successful completion of the final examination.

Copies of the kit are also available through the National AudioVisual Center (NAC), 8700 Edgeworth Drive, Capitol Heights, MD 20743-3701. The NAC can be reached on 1-800-638-1300. A complete kit costs $30 with discounts available for quantities over six copies. Components of the kit are for sale individually. All materials are in the public domain and may be copied or reproduced as desired.

For further information on the wildland course, call Mary Ellis, National Fire Academy, (202) 646-2692 or write the Office of the Superintendent, National Fire Academy, 16825 South Seton Avenue, Emmitsburg, MD 21727. ■

Sexual Harassment—What's It All About?

What is it? What are the costs of sexual harassment? What does the law say? What should I do? These are but a few of the questions answered by a set of five video tapes and accompanying guidebooks that the USDA Forest Service, Fire and Aviation Management, has made available to all Forest Service regions and the Northeastern Area State and Private Forestry office. In the videos, titled "Shades of Gray," Susan L. Webb of the Pacific Resource Development Group, Inc., presents the material in such a way that people pay attention and learn—getting through their initial defensiveness or resistance. The information is complete, thorough, and accurate. The presentation is for all employees, including managers and supervisors. The goal of the video tape series is simple: To provide all the information necessary to stop and prevent harassment.

The purchase and distribution of these videos completes another slated action item of "A Model for Workforce Diversity," a proactive, end results-oriented plan to increase and improve workforce diversity. All employees are strongly urged to see the videos and discuss the issues and situations presented.

Copies are available for short-term loans from the employee relations sections of the Forest Service regional offices and the Northeastern Area State and Private Forestry office in Broomall, PA. Additional copies are available through direct purchase with the Pacific Development Group, Inc., 4044 Northeast 58th Street, Seattle, WA 98105; telephone number (206) 782-7015. ■

Harry Croft, *budget coordinator, USDA Forest Service, Fire and Aviation Management, Washington, DC*

Conflagration Prevention Systems at the Urban-Wildland Interface

James L. Murphy and Troy Kurth

Respectively, president, Fire Science Systems Corporation, Benicia, CA, and forester, USDA Forest Service, Aviation and Fire Management, Missoula, MT

The conflagration potential is 200 percent above normal for the time of year!

This was the situation on the four southern California national forests in September 1979 when the first ever conflagration prevention plan was implemented. Saturation prevention action was taken as the fire danger worsened to prevent conflagration potential wildfires from starting.

Conflagrations or large disaster fires are a primary concern of wildland firefighting organizations everywhere. Suppression costs on wildland fires in California, for example, are frequently in excess of $150,000 for a 300-acre (121-ha) fire and can exceed $2.5 million for a 10,000-acre (4,047-ha) fire. Conflagration fires occur all too frequently in high-value watershed and areas of urban development where losses of $3,500 per acre are not uncommon.

Conflagration fires in southern California most often occur during conditions that are predictable, such as low fuel moisture and high-velocity dry winds. These conditions are associated with well-understood weather and other physical phenomena. This same predictability is true for the Intermountain West.

Experienced fire managers know that the surest way to control conflagration fires is to prevent them in the first place. Yet, wildland fire prevention is given only token emphasis in terms of allocation of resources and financing in most wildland management agencies in the United States.

Historically, when conflagration conditions occur, some fires start and the prevention organization is quickly assigned to fire suppression duty. Preventing fires is then nearly impossible.

When conflagration potential is high, will saturation prevention action prevent conflagration potential wildfire from starting?

One reason for this lack of emphasis on fire prevention is that, in the past, predicting the chance of a wildfire starting has not been possible with any reliability. As a result, efficient operational systems for fire prevention have not been developed and applied.

This paper describes a first-time test of a conflagration forecasting system and the application of the total mobility concept to the prevention of conflagration fires; that is, the total fire management personnel and equipment are made available to problem areas.

Conflagration Fire Prevention Coordination Plan

In August 1978, the USDA Forest Service's Pacific Southwest Regional Forester approved the Conflagration Fire Prevention Coordination Plan.

The plan focused on the four southern California national forests:
- Angeles National Forest.
- San Bernardino National Forest.
- Cleveland National Forest.
- Los Padres National Forest.

The plan outlined the criteria for its implementation and the action to be taken by intensified fire prevention systems during periods of extreme fire danger. The overall objective of the plan and proposed action was to reduce the likelihood of the occurrence of large disaster wildfires—the conflagrations.

Conflagration Early Warning System

Each of the four southern California national forests was separated into areas classified low, moderate, high hazard, and exempt areas.

Exempt areas were those that were relatively "fire safe" such as large expanses of rock or barren ground.

Hazard areas were classified on the basis of the following:
- Predicted rate of spread.
- Spot fire potential.
- Presence of fine ground fuels, easily ignited.
- Continuity of fuels that would permit spread over large areas.
- Presence, or absence, of manmade barriers.
- Resistance to suppression factors, such as machine operability or difficulty in accessing.
- First-run damage potential of a fire.

Criteria for Plan Activation

Criteria for activation were based on the hazard areas, previously discussed, the two principal southern California fuel models, rate-of-spread potential, and the computer-based analysis of fire report data.

The potential rate of spread was set at 80 chains (1,609 m) per hour. This spread rate could be expected to result in a 300-acre (121-ha) fire in 1 hour when average slope percent and spotfire potential was included.

The two computer-assisted programs are as follows:

- "Crosstabs"—allows for cross-tabulated analysis of Forest Service fire report data. A constant (number of smoker fires) is analyzed using several variables such as time of day, fuel type, or location. The analysis is helpful for longer range planning purposes.
- "Prevent Query"—allows for continuous monitoring of day-to-day fire occurrence within each of 300 fire prevention units in the national forests in California. "Prevent Query" makes possible the comparison of current fire occurrence trends with the historic trends obtained from "Crosstabs" analysis of individual fire reports.

Implementation of the Prevention Action Plan

On September 15, 1979, worsening fire danger conditions in southern California resulted in high hazard national forest areas meeting the criteria for the implementation of the conflagration prevention plan. Ninety-eight prevention specialists from the Forest Service's Pacific Southwest Region North Zone (northern California) and the Pacific Northwest Region (Oregon and Washington) and from the Bureau of Land Management were dispatched to southern California for saturation wildfire activities.

Prevention Coordination Center

A Prevention Coordination Center was set up by the South Zone coordinator in the Pacific Southwest Region at Riverside, CA. National forest fire prevention officers requested prevention task force units through the coordinator.

Prevention Task Forces

The 98 prevention specialists were organized into task forces and units. A task force consisted of five fire prevention units. In each fire prevention unit were two prevention specialists in a pickup/pumper with radio communication and fire suppression tools.

Risk Forecasting Center

The Risk Forecasting Center was based at Riverside Fire Research Laboratory. The forecasting operation consisted of a team of analysts (statistical and computer specialists) and a team of strategists or tacticians (fire behavior officer and weather forecaster). The team of analysts using special computer programs forecasts fire occurrence by national forest, ranger district, and cause. The team of strategists then prepares a problem summary and recommends a prevention action. Tables 1 and 2 and the analysis on the following page illustrate a fire occurrence forecast and problem summary.

Fire Prevention Task Force Action

The task force teams were assigned to prevention activities on the basis of the occurrence forecasts and carried out saturation prevention measures. These teams augmented

Table 1—*Fire occurrence forecast summary for the week of September 29 to October 6, 1979, on the San Bernardino National Forest**

Item	Probability or cause
Chance of one or more fires	0.947
Chance of one or more fires on Saturday or Sunday	0.812
Chance of one or more fires on a weekday	0.732
Most likely number of occurrences of fire	1 to 5

*Most likely causes of fire: equipment, smoking, campfires, incendiary, or children.

Table 2—*Chance of fire occurrence (percent) by cause in ranger districts of the San Bernardino National Forest for week of September 29 to October 6, 1979*

Cause	Arrowhead	Big Bear	Cajon	San Gorgonio	San Jacinto
Equipment	10	—	30	—	—
Smoking	59	32	10	—	—
Campfires	—	35	13	12	—
Debris	—	—	—	—	—
Railroad	—	—	14	—	—
Incendiary	46	—	42	43	10
Children	56	55	—	—	—
Miscellaneous	20	—	—	—	—
All causes	86	76	70	45	22

the regular forest prevention crews in these areas:

- Saturation patrol.
- Public contact in high risk areas.
- Road closure.
- Contact with local newspapers and television.

The Program Payoff

What was the payoff from this first-time conflagration prevention program?

- Arson fires, which were of high frequency on at least two of the forests, were eliminated during the high fire danger period.
- The prevention units had an "implied enforcement" effect on all four of the forests, as reported by the forest prevention officer.
- On one national forest, the prevention units discovered three incipient wildfires and carried out successful initial attack. On another forest, fire prevention units made successful initial attack on 10 wildfires. Each prevention unit could act as a fire suppression unit also.
- The estimated suppression costs saved by the intensified prevention action totaled $2.3 million. The cost of this first-time experimental conflagration prevention project was $235,000. ■

Fire Prevention Problem Analysis Summary; San Bernardino National Forest for Week of September 29 to October 6, 1979

Problem Summary

The chance of one or more fires starting on the forest during the following week is almost certain. There is a high probability of incendiary fires based upon trends of the last week. Equipment-use fires and smoker fires show moderately high chances of occurrence. Incendiary fires will most likely occur on the San Jacinto and Arrowhead Ranger Districts and the Santa Ana River drainage of the San Gorgonio District. The chance of equipment-use fires is highest on the Cajon District. Campfires and smoker fires may occur on the Arrowhead, Big Bear, San Gorgonio, and San Jacinto Districts.

Analysis of historical data indicates:

- The chance for an incendiary fire over 300 acres (121 ha) is greatest on the San Jacinto District.
- Transients cause 58 percent of all incendiary fires. Local permanents and visitors each cause 17 percent.
- The odds are that most incendiary fires will start between 1100 and 1700. The chances are 3 out of 10 that an incendiary fire will be started between 0300 and 0600, however.
- Though 84 percent of all incendiary fires had little or no "degree of preventability," 16 percent of them might have been prevented. Personal contact was the recommended activity.

Prevention Action

Fires caused by equipment use, cigarettes, and campfires can be prevented by the use of the following:

- Check stations on the San Gorgonio and San Jacinto Districts.
- Campground patrol.
- Personal contact on all industrial operations.

Some incendiary fires can be prevented through the following measures:

- Intensify patrols between the hours of 1100 and 1700 and 0300 and 0600.
- Contact local permanents, especially on the San Jacinto and San Gorgonio Districts.
- Establish check stations with the help of the local sheriff's office. ■

CFES—a PC-Based Fire Planning Tool for the 1990's

Wayne Mitchell and Glen Lee

Respectively, fire protection analyst and fire economics analyst, California Department of Forestry and Fire Protection, Sacramento, CA

Introduction

The California Department of Forestry and Fire Protection (CDF) in cooperation with the University of California is developing a fire planning model called the California Fire Economics Simulator (CFES). At this stage, an initial attack simulator, the California Fire Economics Simulator—Initial Attack Module (CFES–IAM) has been developed. The CFES–IAM version 1.2 is a derivation of the USDA Forest Service's Initial Attack Assessment model (IAA) and is being implemented in CDF's 23 administrative units.

Historical Perspective

In California, the CDF is responsible for vegetation fire protection on roughly 30 million acres (12,141,000 ha) of private property. To carry out its work, the CDF supports over 470 engines, 225 handcrews, and 70 bulldozers and manages a fleet of over 30 fixed- and rotary-wing fire suppression aircraft with a budget of over $200 million annually.

Despite this impressive collection of resources, the CDF has not developed a comprehensive planning process for the allocation of these resources since the 1940's. Changes in resource allocations are rare and usually based on local managers' intuition and experience. The CDF was involved in the development of Fire Operational Characteristics Using Simulation (FOCUS) (*1*) in the mid-1970's, but this analysis tool was never used in CDF's budget planning process.

In 1985, the California Board of Forestry, responsible for forest and fire policy, asked CDF managers to develop a Statewide analysis capability (2). The Board asked for an analysis tool that would integrate the effectiveness of various firefighting resources such as engines, bulldozers, hand crews, and airtankers and evaluate CDF's ability to meet its legal mandate to provide equal protection to lands of similar type. Using this capability, the Board and the Department would develop strategic plans for resource allocations beginning in the early 1990's.

The CDF first elected to test the use of the National Fire Management Analysis System's IAA model in six of its administrative units. CDF managers involved with IAA quickly realized that initial attack simulation would be a very valuable management tool, both at the local and State level.

The California Department of Forestry and Fire Protection managers involved with Initial Attack Assessment quickly realized that initial attack simulation would be a very valuable management tool, both at the local and State level.

Unfortunately, the six units implementing IAA faced two significant difficulties. First and foremost, the CDF had not automated its fire reports and could not correlate fire activity with fire behavior. Without automated fire activity or fire behavior data, these units were not able to generate information necessary to operate IAA. Only three of the original six test units were able to automate fire reports and obtain credible historical fire behavior data during the test period. Second, the CDF did not have the computer hardware, database software, or training capabilities to implement IAA. Even when the Department settled on a microcomputer-based system, database application development and supporting software development problems remained to be solved.

Headway has been made to resolve these difficulties. The CDF has now successfully automated its fire incident reporting system. This has been, to say the least, a heroic effort. The CDF is also using recently acquired National Fire Weather Data Library weather data to provide fire behavior information necessary for initial attack modeling.

For the second problem, CDF managers decided to seek assistance from researchers at the University of California at Berkeley. The CDF needed an initial attack simulator that would run on microcomputers, could be taught to personnel without any computer experience within 8 hours of training, and would have an immediately interactive user-interface (for both input and output data).

The Simulator—What It Is and What It Does

Recognizing the need for a microcomputer-based, easy-to-use simulator that could be designed around CDF's mandate to provide equal protection for lands of similar type, the CFES–IAM was created. The first step was to re-write the IAA FORTRAN computer code in Turbo PASCAL and build a modern user-interface. In adapting the IAA model, the internal equations and many analysis concepts were retained. Figure 1 describes the CFES–IAM simulation process. The CFES uses the Fire Management Analysis Zone (FMAZ) and Representative Fire Location (RFL) systems and the basic fire containment production rate of various firefighting resources.

The CFES program is designed around two closed loops of data screens. The first set is a series of interactive data entry screens. In this series, the fire manager describes the fire management unit, the fire history, and the firefighting resources. A sample resource description screen is shown in figure 2. By pressing a single key, the [F2] function key, the program runs the analysis and displays the output screen series. The output screens display summaries of fire activity by RFL (fig. 3) by size class (fig. 4), and by cost breakdown.

Pressing the [F2] function key a second time returns the fire manager to the input screens. "What-if" changes can then be made and the analysis can be run again. The processing time is very short, running from a few seconds to a couple of minutes. The time depends on the computer hardware being used and the complexity of the analysis.

In the data entry screen series, the cursor keys move from data entry box to data entry box within a screen, whereas the page-up [↑] and page-down [↓] keys move from screen to screen. This allows for maximum user flexibility while entering data. It is easy to go back and change earlier entries. This helps the less computer-proficient fire managers feel more comfortable at the

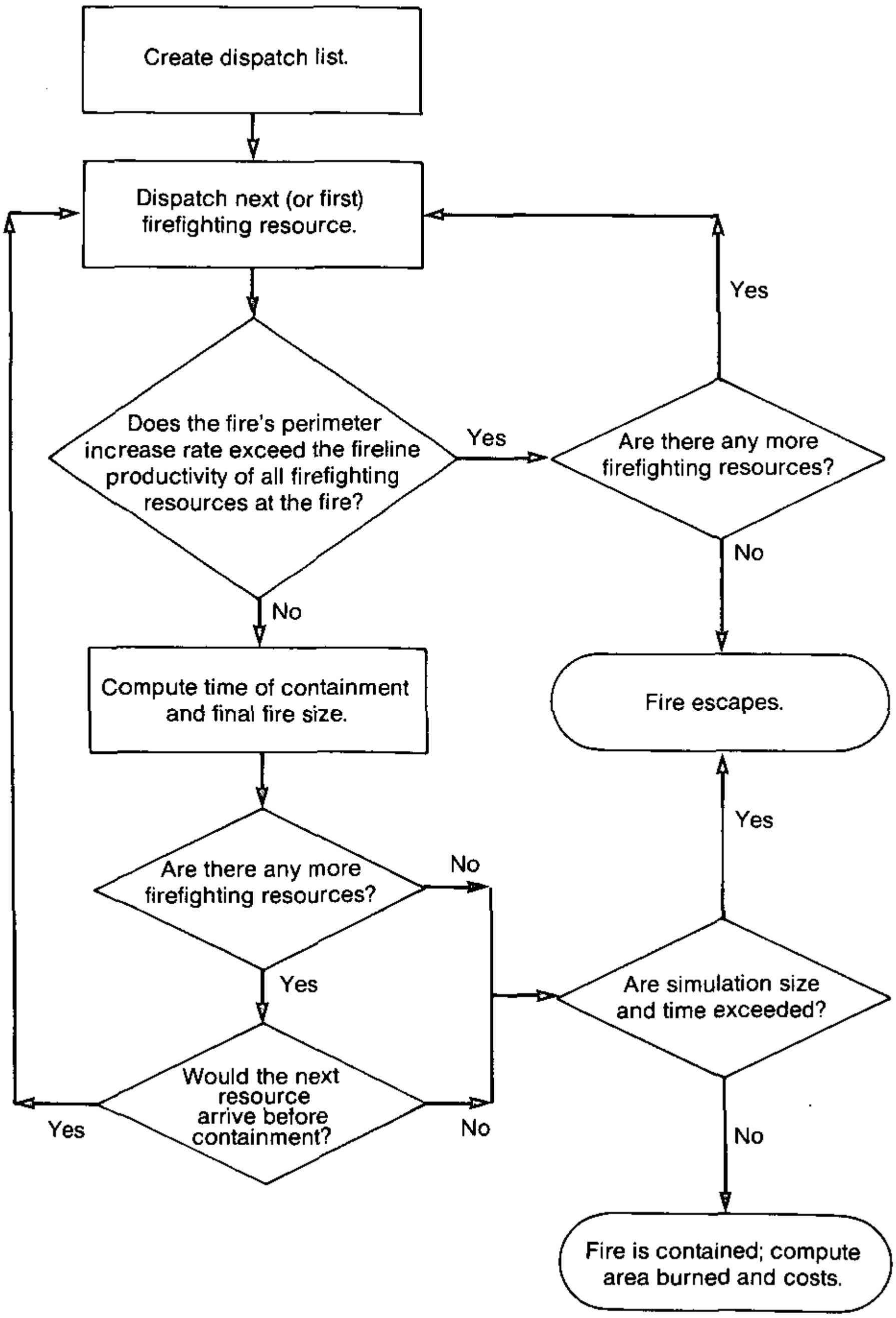


Figure 1—*Initial attack simulation process.*

keyboard. They quickly realize that they can't "break" the program, and they can change any entries that are incorrect.

In addition to the comprehensive user's manual (*4*), on-line help is always available. By pressing the [F1] function key, a help message appears and describes the current screen. After reading the help message, a single key stroke returns the fire manager to his or her previous place in the program.

The CFES–IAM has other features that enhance its use. Input data can be saved to files and re-used in later analyses. Output reports can be written to a data file or printed on paper. Function keys are used to move quickly through the program and to perform other utility chores. An audible siren has been included in the program for the crusty fire managers who suffer from "compuphobia." If it sounds like a fire engine, it can't be all bad. The siren can be turned off when it gets on your nerves.

Using the Model

The CFES–IAM is designed to be used as an operational planning tool. The general function will be to help the CDF analyze its legislated mandate where "all land of each type shall be assigned the same intensity of protection" (*3*). To accomplish this analysis, the CDF is developing a relative "level of protection" analysis process rather than a "cost plus net-value change" analysis.

Operationally, similar FMAZ's

Fire Management Analysis Zone: YRW — CFES-IAM Entry Screen No. 12

Resource Description

Resource No. 1

Description: Corralitos Engine No. 1 (B)

Identity code: CZUB4180 — Size code: G

Are values same for all representative fire locations (RFL)? ↓		RFL No. 1 / RFL No. 7	RFL No. 2 / RFL No. 8	RFL No. 3 / RFL No. 9	RFL No. 4 / RFL No. 10	RFL No. 5 / RFL No. 11	RFL No. 6 / RFL No. 12
Production rate (chains/hour)	↓ Y	12	12	12	12		
Response time (minutes)		45	0	0	0		
Mission cost ($)	↓ N	69.00	0.00	0.00	0.00		

[PgDn], [PgUp]—Next, Previous screen; (F2)—Simulate; (F1)—Help.

Figure 2—*Data entry for suppression resources. (CFES–IAM = California Fire Economics Simulator—Initial Attack Module; Y = yes; N = no; G = 5,000 acres or more.)*

CFES-IAM Output Screen No. 100

Event list for Representative Fire Location No. 1

Fire dispatch level/ rate of spread (percentage)	Rate of spread (chains/hour)	Perimeter increase rate (chains/hour)	Time to containment (minutes)	Acreage final or on arrival of last resource	Number of resources used/ available	Uncontained perimeter on arrival of last resource	Aggregate production on arrival of last resource	Number of fires per year	Suppression costs ($)
L/50	4.8	11.6	64	1.77	3/ 3			7.1	$ 254.00
L/90	7.8	18.9	76	5.17	3/ 3			1.8	771.16
M/50	10.5	25.4	69	7.41	9/13			1.9	6,125.49
M/90	14.4	34.9	90	21.35	12/13			0.5	15,293.08
H/50	17.1	41.4	101	36.58	15/15			3.7	22,849.45
H/90	22.0	53.3	Escape @ 95	47.69	15/15	24.3	86.0	0.9	Unknown

[PgDn], [PgUp]—Next, Previous screen; (F2)—Edit Data; (F1)—Help.

Figure 3—*Data output screen for analysis zone (CFES–IAM = California Fire Economics Simulator—Initial Attack Module; L = low; M = medium; H = high.)*

will be grouped and relative levels of protection will be examined. High levels of protection, or "peaks," and low levels of protection, or "valleys," will be identified. These peaks and valleys can then be studied in greater detail.

The CFES–IAM will likely receive greater use as a policy analysis tool at the local level than elsewhere. Such policies as initial attack dispatch strength, move up and cover, engine staffing patterns, drawdown levels, and many others can be evaluated. For example, an analysis of a local-level policy covering airtanker dispatch resulted in a revision of the old policy, saving thousands of dollars in unnecessary airtanker dispatches.

CFES-IAM Output Screen No. 112.

Expected annual acreage burned in contained fires for all representative fire locations

Fire dispatch level	0-0.25	0.25-10.0	10.0-25	25-50	50-100	Average fire size	Total acres
L	0.00	38.21	0.00	0.00	0.00	1.12	38.21
M	0.00	27.44	10.21	0.00	0.00	4.09	37.66
H	0.00	72.28	47.65	134.67	0.00	14.38	254.59
Total	0.00	137.93	57.86	134.67	0.00	5.41	330.46

Expected annual number of fires by size class

Fire dispatch level	0-0.25	0.25-10.0	10.0-25	25-50	50-100	Escapes	Total fires
L	0.00	34.20	0.00	0.00	0.00	0.00	34.20
M	0.00	8.72	0.48	0.00	0.00	0.00	9.20
H	0.00	10.48	2.62	3.68	0.00	0.92	17.70
Total	0.00	53.40	3.10	3.68	0.00	0.92	61.18

[PgDn], [PgUp]—Next, previous screen; (F2)—Edit Data; (F1)—Help.

Figure 4—*Data output screen for analysis zone. (CFES–IAM = California Fire Economics Simulator—Initial Attack Module; L = low; M = medium; H = high.)*

Spin-off Products

Development of the CFES has been a time-consuming, oftentimes overwhelming, task. In addition to the actual analysis process, many other products have been spun off from the development of the CFES. These products have great utility for many CDF management tasks.

For the first time, the CDF has an automated fire-reporting system. From 5 to 11 years of fire activity is now instantly available for analysis. This is already being worked into a Department-wide fire prevention planning process. Central processing of these data will continue through 1988. By 1989, an automated reporting system will be extended to the station level.

To model fire behavior of some 50,000 historical fires, the FIRDAT program was selected from FIRE-FAMILY and was adapted to run on microcomputers (*8*). FIRDAT calculates National Fire Danger Rating System (NFDRS) indexes and components from historical weather data. All of the historical weather data for California was obtained from the National Fire Weather Data Library at the Fort Collins Computer Center (*6*). With this data and FIRDAT, many other planning projects can be undertaken from prescribed fire management to suppression planning.

The design of the CFES software lends itself to a planning process at the ranger level. This process has provided for better involvement of local-level fire managers in the Statewide planning program by providing a direct feedback mechanism. The design also provides for better involvement with CDF's cooperators, the Forest Service of the U.S. Department of Agriculture, the Bureau of Land Management of the U.S. Department of the Interior, and the six contract counties. These software design factors are very important in gaining local-level support for CDF's fire plan.

The Future of the CFES–IAM

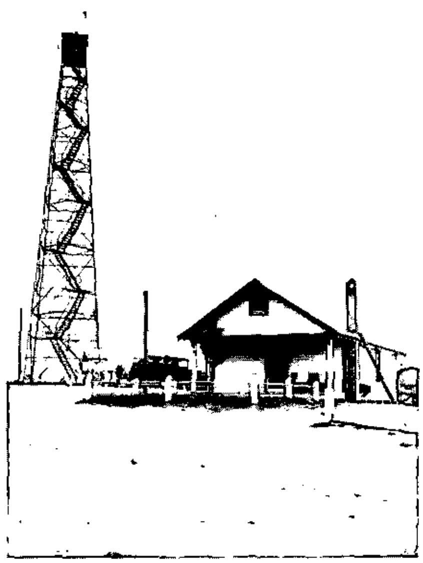
From our work with the University of California, Berkeley, it seems as if a Pandora's box of research issues has been opened. Work on the CFES–IAM, version 2, is focusing on a "stochastic" simulator to better reflect real world variability in wildfire occurrence, behavior, and initial attack control efforts (*5*).

A stochastic simulator provides for variable inputs in the form of frequency distributions. Many input factors such as the time to move equipment, fire spread rate, fireline construction rate, and fire occurrence can better be accounted for by using their distributions. With this simulator, the outputs will be in the form of expected values and confidence intervals for annual acres burned and control costs.

To obtain these frequency distributions, research is continuing on fireline construction rates, peak-period and diurnal fire behavior patterns, distributions of fire occurrence, and frequency and severity of multiple fire days. Coordination efforts are also ongoing through the airtanker effectiveness research project of the USDA Forest Service Operational Retardant Effectiveness (ORE) study (7). Version 2 of the CFES–IAM will enhance CDF's ability to look at questions relating to nighttime fire, depth of resources, and probability associated with alternative resource allocation. ■

Literature Cited

1. Bratten, Frederick W.; Davis, James B.; Flatman, George T.; Keith, Jerold W.; Rapp, Stanley R.; Storey, Theodore G. 1981. FOCUS: a fire management planning system—final report. Gen. Tech. Rep. PSW–49. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 34 p.
2. California Department of Forestry and Fire Protection. 1988. *Fire protection plan procedures handbook*, ch. 7100.
3. Cal. Pub. Res. Code §4130 (West 1965).
4. Fried, Jeremy S.; Gilless, J. Keith. 1988. The California Fire Economics Simulator—Initial Attack Module (CFES–IAM): Version 1.11 User's Guide (MS-DOS). Bulletin 1925. Berkeley, CA: Division of Agriculture and Natural Resources. University of California. 83 p.
5. Fried, Jeremy S.; Gilless, J. Keith. 1988. Modification of an initial attack simulation model to include stochastic components. In: Proceedings on the 1988 Symposium on Systems Analysis in Forest Resources; 1988 March 29–April 1; Pacific Grove, CA. Gen. Tech. Rep. RM–161. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 235–240.
6. Furman, R. William; Brink, Glen E. 1975. The National Fire Weather Data Library: what it is and how to use it. Gen. Tech. Rep. RM–19. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.
7. George, Charles W. 1985. An operational retardant effectiveness study. Fire Management Notes. 46(2):18–23.
8. Main, William A.; Straub, Robert J.; Paananen, Donna M. 1982. FIREFAMILY: fire planning with historic weather data. Gen. Tech. Rep. NC–73. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 31 p.



Metts Tower and lookout dwelling built by the CCC on the Choctawhatchee National Forest in Florida (transferred to the War Department in 1940) (B.W. Muir, 1937). 352873

Olive-Drab Federal Property

The Federal Property and Administrative Services Act of 1949, as amended, authorizes the USDA Forest Service to lend Federal Excess Personal Property to State forestry agencies for rural fire protection. Since most of this equipment (80 percent) comes from the military, it usually is U.S. Army olive-drab or some other military color such as U.S. Navy gray, Air Force blue, or Marine camouflage (that's the stuff you can't see). When put in service, these military colors should be painted over by the State in the Fire District or Department color scheme.

The State Forester or Fire District may have former military equipment that was acquired from programs other than the USDA Forest Service. Some of the other channels for olive-drab and other military equipment are the State Surplus Property Agency, General Services Administration surplus property sales, and other Federal excess property programs. Some States are still using military-type equipment given to them under the Defense Civil Preparedness Agency program when it was in operation and the U.S. Fish and Wildlife excess property program.

The point is this: Not all equipment painted military colors was lent to the State Forester by the USDA. That is one reason why the USDA Forest Service requires that our lent property be marked with decals or other forms of identification. Forest Service-lent property is identified by aluminum tags or yellow vinyl labels. If it is not, it *should* be. ■

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

The 1988 Greater Yellowstone Area Fires: A Slide-Tape Story

Robert Swinford

National fire prevention officer, USDA Forest Service, Fire and Aviation Management, Washington, DC

The 1988 Greater Yellowstone Area fires slide program was initially presented at the Western States Forestry Legislative Task Force meeting in Vancouver, BC, in November 1988. The program, later enhanced with an audiotape, focuses on four important questions: How did the fires happen? What was done about them? Why did they burn 1.5 million acres (607,050 ha)? What is happening in the aftermath? It describes the geographic area, the administrative organization and its goals, recent weather history, the area ecosystem, the spread of the Yellowstone fires, and suppression strategy and action.

The program is available for loan through the Fire and Aviation Management Washington Office. Contact Robert Swinford, Fire and Aviation Management, P.O. Box 96090, U.S. Department of Agriculture, Washington, DC 20090-6090; telephone number (703) 235-8666; DG address: R. Swinford:W01A.

Slides	Script
1. Fire scene	• The year of 1988 will be remembered as one of the worst wildfire years in history. Over 73,000 fires burned more than 5 million acres (2,023,500 ha) in the United States.
2. U.S. map of fires	• Three hundred major fires burned in 22 States; 2.2 million acres (890,340 ha) burned in Alaska alone.
3. Yellowstone sign	• However, it was the fires that burned in and around Yellowstone, the "Crown Jewel" of America's national parks, that were the focus of national and international attention and controversy.
4. Fire scene	• How did these fires happen?
5. Fire scene	• What was done about them?
6. Fire scene	• Why did they eventually burn over 1.5 million acres (607,050 ha)?
7. Burned area	• What is happening in the aftermath?
8. Title slide	• This program on the Greater Yellowstone Area fires of 1988 will attempt to answer these questions and others about the fires that will probably be chronicled as the major wildfire event of the 20th century.
9. Greater Yellowstone Area map	• The Greater Yellowstone Area is made up of parts of six national forests (the Beaverhead, Bridger-Teton, Custer, Gallatin, Shoshone, and Targee National Forests) and two national parks (the Yellowstone and Grand Teton National Parks).
10. Vicinity map	• It is located primarily in northwest Wyoming and encompasses roughly 11.7 million acres (4,734,990 ha).
11. General scenery	• The area is world renowned for its scenery, wildlife, wilderness, rivers, hunting, fishing, outdoor recreation opportunities, and geologic and thermal features.
12. General recreation	• National park and national forest managers have met informally over the last 3 decades to ensure coordination of management and public service.
13. Greater Yellowstone Coordination Committee plan	• This management coordination committee was formalized in 1986 and in 1987 released "The Greater Yellowstone Area—an Aggregation of National Parks and National Forests Management Plans for the Greater Yellowstone Area."
14. Timber sale	• The report describes the condition and extent of natural resources in the area—
15. Elk	• And the management programs for those resources.
16. Fire scene	• The interagency fire management objectives are also described in the report. They are:

17.	Fire suppression	• Ensure that suppression strategies are compatible with management objectives of adjacent units.
18.	Fire suppression	• Ensure fire suppression strategies do not present undue risk to the resources of other units.
19.	Smoke column	• Manage prescribed fire and fire suppression so that smoke is at an acceptable level and meets State air quality standards.
20.	Fire suppression	• Each national forest and national park has a plan that delineates certain areas where all fires will be suppressed and—
21.	Prescribed fire	• Other areas where prescribed fires may be used within specified conditions.
22.	June drought maps for four preceding years	• Critical contributing factors to the extent of the Greater Yellowstone Area fires in 1988 were the weather and fuel conditions. It was the fourth year of drought for many parts of the country. A review of drought conditions in late spring and early summer over the past 4 years reveals numerous areas of drought severity, especially in 1987 and 1988.
23.	August drought maps for four preceding years	• By August 1988, the cumulative effect of 4 years of below normal moisture resulted in extreme drought severity throughout a significant area of the United States.
24.	Severity map—July 9 to August 5	• Fire potential based on drought and other factors was either "high" (shown in yellow) or "extreme" (shown in red) for the entire Northern Rocky Mountain Area, including Yellowstone, by early July 1988.
		During the summer of 1988, a high pressure area over the central Rockies, with a low pressure area off the Pacific Coast dominating the weather pattern, resulted in above normal temperatures for much of the Nation including the Greater Yellowstone Area.
25.	Severity map	• More important for the Greater Yellowstone Area, west to southwesterly flow (winds associated with a well-entrenched high pressure system) over northwest Wyoming during July and August prevented precipitation from moving into the area as in normal summers. The thunderstorms that did occur produced lightning that started numerous fires but brought little rainfall.
26.	Clouds	• The prevailing westerly flow in the upper atmosphere brought a series of dry cold fronts with very high winds throughout the summer.
27.	Lodgepole pine stand	• The forest areas involved in the Greater Yellowstone Area fires developed after earlier fires and are essentially maintained in an unmanaged condition.
28.	Lodgepole pine	• The majority of the stands are lodgepole pine in early-to-late stages of succession.
29.	Insect damage	• Large areas have been infested by the mountain pine beetle.
30.	Dead and downed lodgepole pine	• Trees killed by the beetle usually fall after 5 years, then become part of the heavy fuel buildup.
31.	Fuelbed—snags and dead and	• Combined with the heavy fuels of both standing and fallen

downed	lodgepole snags, highly flammable subalpine fir and Engelmann spruce create potential for high-intensity fires.
32. Fine fuels	• Measured light fuel moistures in late August were as low as 2 percent. A normal range for the summer period would be 8 to 12 percent.
33. Heavy fuels	• In many cases, the larger fuels were as dry as the small fuels. The moisture content of these larger fuels ranged between 5 to 7 percent. As a comparison, moisture content of kiln-dried lumber is about 12 percent.
34. Dark	• With these current and cumulative weather and fuel conditions, the stage was set.
35. Fire scene	• The first of what became known as the Greater Yellowstone Area fires was—
36. Storm Creek Fire on map	• Storm Creek Fire on the Custer National Forest. Started by lightning on June 14, it was managed initially as a prescribed fire. It exceeded the prescription on July 3 and was declared a wildfire at 125 acres (51 ha).
37. Fan Fire on map	• On June 25, the Fan Fire was started by lightning in Yellowstone National Park. It was also managed as a prescribed fire until July 25 when it was declared a wildfire at 3,500 acres (1,417 ha).
38. Mink Fire on map	• The Mink Fire in the Teton Wilderness of the Bridger-Teton National Forest started on July 11 and was managed as a prescribed fire until it reached 24,000 acres (9,713 ha) on July 14.
39. Snake River Complex Fires on	• The Snake River Complex in Yellowstone National Park was
map	designated on July 21 to manage three prescribed natural fires burning south of Yellowstone Lake when the decision was made by National Park Service officials to take suppression action. The Snake River Complex eventually managed a total of seven fires as new lightning fires started in the area.
40. North Fork Fire on map	• The North Fork Fire started on July 22, in a wood-cutting area on the Targee National Forest. It escaped initial attack and spread rapidly into Yellowstone National Park.
41. Clover-Mist Fire on map	• The Clover-Mist Complex was designated on July 23 to manage seven separate lightning fires in northeastern Yellowstone National Park.
42. Emerald Fire on map	• The Emerald Fire started by lightning near Emerald Lake on the Bridger-Teton National Forest on August 16. It was classified a wildfire immedi-ately, but escaped initial attack.
43. Huck Fire on map	• On August 20, wind blew a tree across a powerline in Grand Teton National Park starting the Huck Fire. Classified as a wildfire, it made an immediate run that threatened evacuation of a ranch and caused evacuation of a campground. Although spotted immediately by a helicopter that made a series of water drops, conditions were such that the fire escaped.
44. Hunter Fire on map	• On August 20, the same windstorm blew a green aspen over a powerline near Aspen Ranch in Grand Teton National Park, starting the Hunter Fire.
45. Fire suppression	• This wildfire, the Hunter

Fire, escaped initial attack and spread rapidly into the Bridger-Teton National Forest.

46. Fayette Fire on map
• The Fayette Fire was started by lightning on August 21, near Fayette Lake on the Bridger-Teton National Forest.

47. Smokejumper
• Initial attack was made by six smokejumpers—but steep terrain, dense timber, extremely dry fuels, and severe spotting made control difficult, and the fire escaped initial attack.

48. Wolf Lake Fire on map
• On August 25, the North Fork Fire was divided into two incident commands, due to its large size. The fire was about 40 miles (64 km) long and 104,000 acres (42,088 ha) at this time.

49. Hellroaring Fire on map
• The Hellroaring Fire started near an outfitter's camp in Beaver Creek on the Gallatin National Forest on August 25.

50. Suppression
• Immediate suppression action was initiated. The fire escaped initial attack and was 120 acres (49 ha) by the end of the first day.

51. Fire scene
• The last of the Greater Yellowstone Area fires was the Corral Creek Fire on the Beaverhead National Forest. Caused by an escaped campfire, it burned 2,860 acres (1,157 ha) and was controlled on September 6. Although it was by comparison a small fire, it was significant in that resources were pulled off other large fires in the Greater Yellowstone Area to suppress it and protect structures.

52. Severe burning
• In 1988, the fire behavior in the Greater Yellowstone Area rewrote the record book. It was a year when new charts and procedures had to be developed so fire behavior analysts could accurately predict the spread and intensity of the fires. For example—

53. Severe burning
• A 15,000 acre (6,071 ha) blowup on the North Fork Fire was simply called a "slopover."

54. Fire scene
• The flanks and rear areas of fires became fire fronts as dry cold fronts crossed the Greater Yellowstone Area.

55. Fire scene
• Rates of spread of 2 miles (3.2 km) per hour in forested fuels were common.

56. Fire scene
• Five- and ten-mile (8- to 16-km) advances in a single day were predicted and observed.

57. Spotting
• Spotting was frequent with new fires starting ½ to 1½ miles (.08 to 1.69 km) beyond fire fronts.

58. Convections with Caps
• Convection cloudcaps were commonplace—17 were counted in one afternoon. Convection columns often reached altitudes of 20,000 to 30,000 feet (6,096 to 9,144 m).

59. Nighttime burning
• Fires often burned at night with as much severity or more than during daylight hours.

60. Severe burning
• The Mink Creek Fire released an estimated 3.5 trillion BTU's per hour—enough to heat 4,400 homes for a year.

61. Wind-driven fire
• Of all the weather factors influencing fire behavior in the Greater Yellowstone Area, wind had the most direct impact, often causing spectacular fire behavior.

62. Severe burning
• The 1-day, 14-mile (22.5 km) run down Jones Creek on the Clover-Mist Fire was wind driven.

63. Old Faithful Complex	• The September 7, North Fork Fire run on Old Faithful was the combined result of wind-driven fire following topographic boundaries.
64. Greater Yellowstone Area map (July 15)	• By mid-July, the fires in the Greater Yellowstone Area totalled approximately 8,500 acres (3,440 ha).
65. Greater Yellowstone Area map (July 31)	• During the next several weeks, a total of six dry cold fronts crossed the Greater Yellowstone Area. Each producing strong southwest to west wind gusts between 40 to 60 miles (64 to 97 km) per hour. These are the times the fires made their major runs with significant increases in acreages.
66. Greater Yellowstone Area map (August 12)	• By August 12, the acreage had grown to 234,267 acres (94,808 ha).
67. Greater Yellowstone Area map (August 29)	• Of these fronts, the August 20 system was the most significant wind event with fires growing dramatically. With sustained winds of 20 to 49 miles (32 to 79 km) per hour and gusts of 60 to 70 miles (97 to 113 km) per hour—
68. Fire scene	• The Clover-Mist Fire alone gained 46,500 acres (18,819 ha), the Hellroaring 25,000 acres (10,118 ha), the Storm Creek 18,500 acres (7,487 ha), and the North Fork 14,900 acres (6,030 ha). This was the day the Huck and Hunter Fires started with the Huck Fire racing 4 miles (6.4 km) in 45 minutes. In total, the Greater Yellowstone Area fires increased in acreage by 160,000 acres (64,752 ha) in one day.
69. Greater Yellowstone Area map (September 8)	• By the end of August, the Greater Yellowstone Area fires had grown to over 1 million acres (404,700 ha).
70. Final Greater Yellowstone Area map	• Two more dry cold fronts moved through the area in early September, one on the 6th and the other on the 10th. The last cold front, on the 10th, brought winds again but also brought light rain and snow with cool damp weather continuing through September 20, permitting firefighters to finally start containing the fires at a total acreage of 1.6 million acres (647,520 ha).
71. Graphic of data	• The final statistics are awesome.
72. Steep terrain	• The topography of the Greater Yellowstone Area is a mixture of deeply glaciated, high-elevation mountains that—
73. Plateau	• Give way to relatively flat plateaus and broad valleys.
74. Handcrew working	• Topography not only influenced fire behavior, but hampered firefighters' efforts to contain the fires. Anchor points for firelines were scarce.
75. Severe burning	• Major river drainages such as the Yellowstone, Firehole, and Madison created their own micro-weather patterns. Even small creek channels became conduits that carried the fires along like water in a pipe. The Continental Divide crosses the southern end of the Greater Yellowstone Area. Often, winds blow in opposite directions at the same time on either side of the Divide.
76. Greater Yellowstone Area Command	• Due to the numerous fires and complexity of the situation, a unified area command was established on July 23. The

	unified area command was staffed by fire command officers from both the National Park Service and USDA Forest Service.
77. Greater Yellowstone Area Command	• They set priorities on allocation of forces and equipment to the ongoing fires as well as coordinating with members of the Greater Yellowstone Coordinating Committee.
78. Objectives graphic	• Park Superintendents and Forest Supervisors set the following objectives for the area commanders: Make safety the first priority; protect life and property; protect cultural values; and keep the local public, visitors, media, and cooperators informed.
79. Fire team	• Each individual fire or fire complex was managed by an incident management team that decided on the combination of strategies and tactics for each fire.
80. Suppression	• Suppression actions on the Greater Yellowstone Area fires were initially the traditional perimeter control strategies, using both direct and indirect attack. This is the most aggressive suppression option and involves the completion of a control line around the fire.
81. Burnout	• It may also include burning out on the fire side of the control line and cooling all hot spots that are an immediate threat to the line.
82. Severe burning	• As the fires developed and conditions made it unsafe and unproductive for firefighters to continue with the perimeter control efforts, a combination of containment and confinement strategies were utilized.
83. Line building	• A containment strategy uses a combination of constructed containment lines tied into existing humanmade or natural barriers.
84. Fire with natural barrier	• Confining a fire restricts the fire's spread to boundaries established either before or during the fire.
85. Structural protection	• The protection of life and property was the top priority, and full control efforts were utilized around structures with confinement and containment strategies employed on the fire perimeters.
86. Fire scene	• The great majority of the Greater Yellowstone Area fires burned in National Park and National Forest wilderness lands. Many of the agency fire management plans provide specific policy and guidelines to minimize the extent and impact of traditional fire suppression practices. Use of powersaws, dozers, and other motorized equipment must be approved.
87. Dozer	• These approvals were obtained, and dozers and other mechanized equipment were used in Yellowstone Park and National Forest wilderness areas where necessary.
88. Scratch fireline	• Many of the fire management plans also provide guidelines for "light-hand-on-the-land" suppression tactics. Light-hand guidelines include suggestions to minimize impact of fire camps and spike camps, selection of helispots to minimize construction, location of control lines to take advantage of

natural barriers and light fuels, and other measures to minimize lasting impacts on the land.

89. Severe burning
• Torching, crowning, and spotting produced fire behavior that was extremely difficult to contain under prevailing conditions regardless of strategies and tactics utilized. At one point, 400 miles (644 km) of fireline had been constructed and only 20 miles (32 ha) held.

90. Tree faller
• Concern for personnel safety was an integral part of all strategy and tactical decisions. There were no fatalities or critical injuries on the Greater Yellowstone Area fires before October. In early October, there was one fatality and one critical injury resulting from falling snags. This is a remarkable record considering the conditions and suppression activities that continued for more than 3 months.

91. Helicopter and bucket
• A helicopter crashed while filling a bucket on the Clover-Mist Fire, but the pilot was not seriously injured.

92. Handcrew
• Crews were overrun or threatened on several fires. Fire shelters were used on three occasions and several spike camps were burned out with the loss of some equipment.

93. Grizzly bear
• Safety in grizzly country was also of primary concern. Bear warnings and information were distributed and incorporated into shift plans. Helicopters were used to head off grizzly bears following crews on the North Fork Fire.

94. Fire camp with snow
• Respiratory problems such as flu, bronchitis, and strep throat became commonplace as crews were exposed to dense smoke, dust, and cold nighttime temperatures for extended periods.

95. Graphic listing resource data
• Personnel and equipment came from throughout the United States.

96. Graphic detailing Canadian support
• During the Greater Yellowstone Area fires, we also enjoyed considerable assistance from Canada. While most of the Canadian assistance was utilized on other western fires, it was invaluable and permitted us to concentrate existing resources on the Greater Yellowstone Area fires.

97. Graphic listing suppression costs
• The cost of fighting the Greater Yellowstone Area fires is estimated at $120 million.

98. Graphic listing structure loss
• There was minimal loss of structures due to the outstanding efforts of firefighters.

99. Burned area
• Natural processes create the diversity of vegetation, wildlife, and landscape patterns that characterizes healthy ecosystems.

100. Wildlife in burn
• In the Greater Yellowstone Area, fire is one of the processes that has a major role in shaping the environment. While no responsible land manager would advocate burning 1.6 million acres (647,520 ha) in an ecosystem in 1 year, the fires did have a beneficial as well as a negative impact.

101. Regrowth in burn
• Studies of the 1988 fires will provide an important addition to existing knowledge of fire effects on a variety of vegetative types, wildlife habitats, soils, and water resources.

102. Burned area
• A Greater Yellowstone Area Fire Recovery Research Consortium has been organized to coordinate the numerous postfire research efforts that are underway. Members of the consortium are the universities in the Rocky Mountain area and the research branches of the USDA Forest Service and USDI National Park Service.

103. Media
• Media and public interest in the Greater Yellowstone Area fires has been tremendous at the local, regional, and international level. At the peak of the media interest, staff at the fire information office, established at the Park headquarters, totalled 34 persons and the office was handling 200 media inquiries a day. During the entire summer, the office handled over 2,000 media contacts and over 5,000 public inquiries.

104. Burned area
• Emergency burn rehabilitation assessments were initiated on the over 500,000 acres (202,350 ha) of national forest lands involved in the Greater Yellowstone Area fires before the fires were contained.

105. Fuelbreak
• Suppression-related impact was rehabilitated as part of the firefighting effort.

106. Aerial seeding
• Emergency rehabilitation of watersheds including seeding, channel clearance, contouring, and other measures were started as soon as possible in the attempt to provide some measure of vegetative cover before the first rains.

107. Trail stabilization
• Emergency rehabilitation of burned over national forest land in the Greater Yellowstone Area included seeding of 27,070 acres (10,955 ha), log terraces constructed on 350 acres (142 ha), 121 miles (195 km) of erosion control on trails, 100 miles (161 km) of stabilization on road clearance and stabilization of stream channels.

108. Lodge or store
• Damage and loss of private property and the impact on local economies due to reductions in park visitation is another negative impact of the Greater Yellowstone Area fires.

109. Damaged structures
• The U.S. Department of Agriculture organized the USDA Fire Recovery Task Force which with the Small Business Administration held a total of seven public meetings in the Greater Yellowstone Area as well as other areas affected by the 1988 summer's fires. The purpose of the meetings was to explain USDA assistance programs, listen to problems, offer advice on other sources of Government help, and otherwise try to alleviate problems in fire-impacted communities.

110. Recreation use
• Efforts were also initiated, nationally and internationally, by the Forest Service, National Park Service, and local community organizations to promote future visitation to the Greater Yellowstone Area.

111. Smoke and fire
• The fire management policies of both the National Park Service and the Forest Service were criticized during the fires. The so-called "let burn" policy was blamed for the fires getting so large.

112. Fire suppression
• The Forest Service policy is to take appropriate suppression

action on all wildfires. Naturally occurring fires in wilderness areas are permitted to burn under specified conditions and in specific areas with a preapproved plan. National Park Service policies are similar.

113. Large smoke plume

• Several of the fires in the Greater Yellowstone Area started out as prescribed fires in the park or surrounding national forest wilderness areas. They eventually burned out of prescription and suppression action was taken. As previously mentioned, conditions thwarted suppression efforts on these fires as well as new fires that were attacked immediately.

114. Fire scene

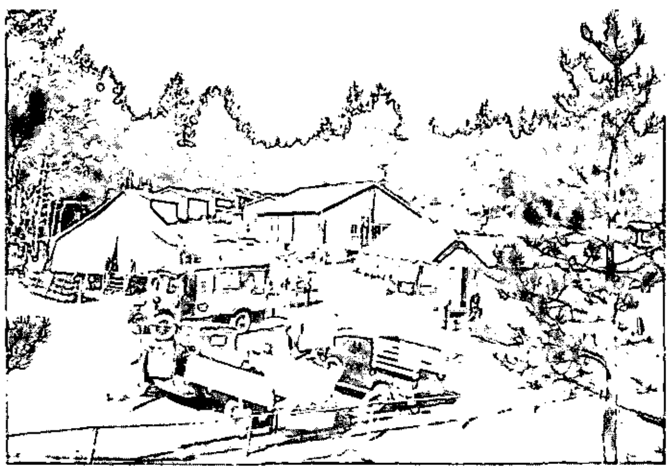
• The Greater Yellowstone Area fires and the fire policies of the National Park Service and USDA Forest Service were reviewed after the 1988 fire season. This was accomplished through the normal administrative fire review process and the fire policy review team appointed by the Secretaries of Agriculture and the Interior.

The recommendations from the reviews include strengthening fire management policies governing wilderness and parks. The agencies reject as impractical and unprofessional the practice that fires can be allowed to burn free of prescriptions or appropriate suppression action.

The review team also called for both the USDI and USDA to review existing fire management plans for parks and wilderness areas to be sure they are in compliance with current policy, direction, and the additional requirements recommended by the review.

Revisions in the fire management policies of the agencies were in place prior to the 1989 fire season.

115–118. Credits ■



Company street with mess hall in right foreground of Rochford Camp F-5 on Black Hills (then Harney) National Forest (Fred R. Johnson, 1933). 283157

Enrollees relaxing through sport at Circleville, WV, Camp on the Monongahela National Forest (E.S. Shipp, 1933). 280523

Mobile Food Service in Remote Areas

Jeannette Wright

Firefighter, Weston County, WY

When a wildfire starts to burn, much hard work is required from the firefighters and the people behind the lines. Feeding the firefighters three times a day, for several days in a remote area can be a big challenge. Aside from sleep, firefighters need a high calorie diet and much liquid while on duty. Mobile food service has an important job to see that they get the proper diet. Weston County has its own mobile fire kitchen that was used several times during the past fire season. The question always arises: Is there a use for a mobile fire kitchen such as the Weston County Mobile Fire Kitchen in a fire situation? Is it efficient enough to feed the firefighters or should this job be left to the professional caterer?

The year 1988 has gone down as one of the worst years for fire in Wyoming. Numerous fires throughout the State and the large fire in Yellowstone National Park blackened thousands of acres during the year.

The main job of the mobile food service is to provide well-balanced and tasty hot meals and nutritious sack lunches. The remote locations and the distance from town create additional problems in doing this.

Equipment

The Weston County Mobile Fire Kitchen Unit is built in a Federal excess personal property step-van that has one large grill and oven, a smaller grill and oven, a refrigerator, and a sink with running hot and cold water. Along with the fire kitchen is a truck that has a 500-gallon (1,892 l) water tank, a tank of liquid propane, and a generator to supply electricity, water, and the gas for the kitchen. There are special lights on the truck to light the dining area, when needed. There is also a place for firefighters to wash up. Disposable towels are provided.

The Crew

To run this kitchen usually takes five people. Two members of the food service crew work outside the kitchen, seeing that the garbage is taken care of, making sure that the generator is kept running, and running errands for the food preparers and servers in the kitchen who are responsible for all phases of food preparation and serving. (I was one of the food preparation-serving crew that worked in the kitchen.) The crew can feed 30 to 150 people per meal.

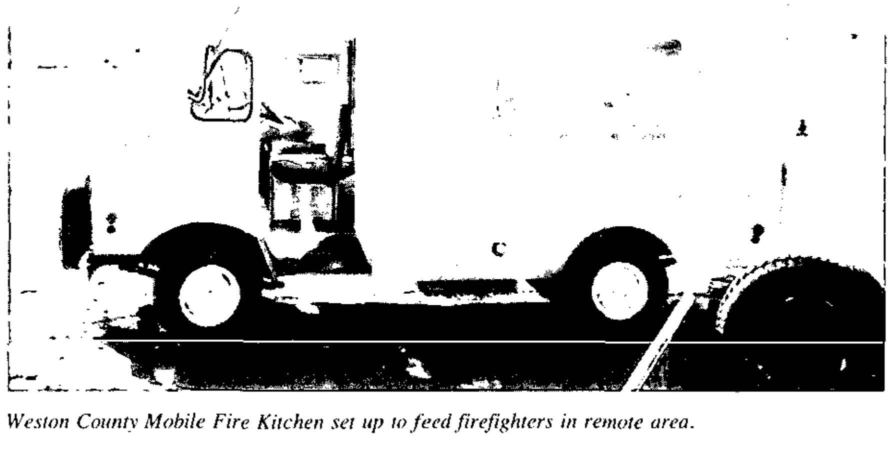
While the job is not life threatening, many times we put in more hours than the firefighters themselves. There were times when we were up at 4:00 a.m. to prepare breakfast and to bed as late as 2:30 a.m. after feeding everyone the evening meal and cleaning up the kitchen.

During the last year, the kitchen was called upon to feed firefighters in Weston, Campbell, and Crook Counties.

The Usual Day

Usually, we start serving breakfast about 5:30 to 6:00 a.m. It usually takes about 1 hour to serve. Immediately after breakfast, we start packing sack lunches. Many times we start packing lunches with the

The question always arises: Is there a use for a mobile fire kitchen such as the Weston County Mobile Fire Kitchen in a fire situation?



Weston County Mobile Fire Kitchen set up to feed firefighters in remote area.

nonperishable items after supper the night before, leaving the sandwiches to be put in lunch sacks the following morning. The sack lunches are kept in coolers or the refrigerator until they are brought out to the field.

After breakfast and lunches are done, we obtain a count on the number of people to plan on for the next three meals. Much thought is put into the meals. Once the menu is set, we shop in the nearest town for groceries, ice, and supplies. (A trip to town sometimes takes over 3 hours.) Then we rush back to camp to start preparing supper. Supper always takes the longest to prepare and to serve, because it is the largest meal of the day and the crews eat in shifts. The last shift may come in to eat as late as 12:00 a.m. We still keep supper hot for them even at that hour.

The kitchen uses the regulations of the professional caterer as a guideline to determine the amount of meat or cheese, vegetables, bread, milk, and fruit needed at each meal.

Besides the meals, the kitchen has Gatorade, coffee, and water available 24 hours a day.

Joni Brown (left) and Jeannette Wright in the Weston County Mobile Fire Kitchen.

Keeping up Morale

One of the "fun" parts of the job is keeping up the morale of the firefighters. After a long day's work, we feel that a smile is needed while serving. So no matter how tired we are, we keep on smiling and joking around.

Caterer and Fire Kitchen Costs and Capabilities—a Comparison

There are many professional caterers located throughout the western United States that are hired under contract with the USDA Forest Service at Boise Interagency Fire Center. When their services are needed, an

Sample Menus from the Weston County Mobile Fire Kitchen*

Breakfast	Lunch	Supper
Pancakes Link sausage Melon and grapes Butter Syrup Coffee Milk	Ham and cheese sandwich Roast beef sandwich Potato chips Apple Chocolate chip cookies Gum Hard candy Fruit juice Miracle Whip and mustard	Lasagna Garlic bread Tossed salad with dressing Cheesecake
French toast Bacon Hash brown potatoes Orange juice Coffee Butter Syrup	Turkey sandwich Peanut butter and jelly sandwich Orange Oreo cookies Gum Granola bar Fruit juice Miracle Whip and mustard	Pork chops with rice Green beans Rolls and butter Cherry or blueberry cobbler
Scrambled eggs Fried ham Biscuits Grape juice Coffee Butter	Beef sandwich Turkey sandwich Potato chips Pear Peanut butter cookies Gum Fruit juice Hard candy Miracle Whip and mustard	Hamburger and bun Baked beans Potato salad Pickles Catsup and mustard Chocolate cake

*See menu requirements in Request for Proposal (REF 49-89-04).

order is placed through the Logistic Support Office, Boise, ID. Contract requirements in the April 1987 "Interagency Mobile Food Services and Shower Facilities" (NFES No. 1276) state: "Orders will be placed with firms whose service is most advantageous to the Government considering the earliest time services could commence to meet needs, ability to meet incident needs, and price."

Professional caterers have a lot of the same problems and responsibilities as the mobile kitchen. They have to organize shifts and cook meals. One shift is responsible for breakfast; one, for sack lunches; and one, for supper. Each shift consists of seven to nine people. They may also have to prepare a buffet dinner. Their operation is very impressive. Joni Brown, a firefighter working on the Weston County Mobile Fire Kitchen unit crew, observed: "Because the caterers cook for such large numbers of people, sometimes as many as 4,000, they do great with quantity. But I feel our quality is better because the maximum number of people we serve is 150."

Firefighters gathered around Weston County Mobile Fire Kitchen at mealtime.

While the caterers deal in large numbers, they too can be very friendly, but have little time to give the personal touch that the smaller kitchen crew can. We have the chance to get to know some of the people and their likes and dislikes in food.

The caterers have trucks that deliver the groceries and supplies to the location. This saves them time. They do not need to run to the nearest town each day.

Weston County charges $250 per day for the use of the kitchen and $75 per day for the use of the truck. These charges include the water and fuel. The workers are paid an hourly wage. With these expenses and the price of the food and supplies, the cost for feeding one person averages out to be $14 per day.

The professional caterers charge a setup and takedown fee of $300 and an average of $6.23 per mile. To feed more than 100 people, they charge an average of $27.75 per person per day. To feed fewer than 100, they charge $30.56 per person per day. The workers are also paid an hourly wage.

The Government may supply the caterers with such things as water, garbage cans and liners, lights for eating areas, and insulated cans. They may be asked to put the meals in the cans.

The Government is responsible for garbage removal, gray water, dust control, refrigeration, and extra personnel to help keep the area clean for the caterers.

The caterers must have tents and tables for the dining area. The fire kitchen does not have any specified dining area. The people sit on the ground or stand up.

The caterers must be able to feed a minimum of 350 people per hour on a 1,000-person incident. The fire kitchen just feeds them as fast as possible.

The professional caterers are better equipped to handle large numbers of firefighters with great ease, but the mobile fire kitchens, like those in Weston and Fremont Counties, do a good job at feeding smaller groups of firefighters. The State would be well-served by adding one or two more mobile fire kitchens. ■

References

Brown, Joni. 1988. Personal interview. November 12.

National Interagency Incident Management System, Incident Command System. 1984. Food unit leader I–357 student workbook. NFES Catalog No. 1926. Boise, ID: Boise Interagency Fire Center, November.

Soper, Walt. 1988. Personal interview. November 10.

U.S. Department of Agriculture, Forest Service, and the Boise Interagency Fire Center. 1987. Interagency-mobile food service and shower facilities. NFES Catalog No. 1276. Boise, ID: Boise Interagency Fire Center, April.

With hydraulic skillets and enormous toasters, OK's caterers feed the fight against forest fires. 1987. People. September 21: 47–48.

Smokey and the American Cowboy

Gene Dowdy

Assistant fire management officer, USDA Forest Service, Pacific Southwest Region, Mendocino National Forest, Willows, CA

In June 1988, the Mendocino National Forest created a program associating Smokey Bear with the American Cowboy to spread Smokey's fire prevention message at the professional rodeo. Both Smokey Bear and the American cowboy are important symbols in our national heritage. The program was designed as a pilot to use this theme in fire prevention for a 1-year trial period as an interagency effort of the USDA Forest Service, the California Department of Forestry and Fire Protection, and the California Bureau of Land Management.

The Message and the Medium

The message focused on American heritage—the land, livestock, and people—and was tailored to appeal to a large number of people who live in or near the national forests. The goal was to market the fire prevention message by combining these two symbols, creating a Smokey and the American cowboy theme, to reach a large group of forest users not targeted by other prevention programs.

The rodeo was selected because it is one of America's oldest athletic activities, with deep roots and acceptance in almost all States. It is family entertainment and appeals to age groups from 6 years on up. As designed, the pilot included personal appearances by Smokey Bear at rodeo events, media coverage of these events, posters and handouts of Smokey Bear with public service messages, and for event coordinators a Smokey and the American cowboy user's guide—all coordinated to promote fire prevention information and education.

Smokey's Rodeo Activities

Major activities commenced at the annual Professional Rodeo Cowboys Association (PRCA) convention in Las Vegas, December 1 to 3, 1988. A fire prevention display booth was set up and furnished information about the program to rodeo committee members and other attendees. A presentation was made at one of the PRCA seminars. A banner with the words "Partners in Fire Prevention" and the emblems for the PRCA and the Smokey and the American cowboy program hung in the arena. A plaque was presented to the PRCA Commissioner at the close of the activities as recognition of his personal support of the project. Smokey also told his fire prevention story to the National Finals Rodeo and the Exceptional Rodeo held in Las Vegas, NV.

An outgrowth of our partnership with the PRCA was the decision of Chrysler Corporation to contribute the use of a truck and trailer for the program. Through their national merchandising manager, Chrysler agreed to donate the vehicle for Smokey's use for 1 year.

The effect of Smokey and the American cowboy program has been encouraging.... spreading the fire prevention message and developing partnerships with nontraditional publics.

Program Success

Smokey appeared at more than 40 rodeos in California during the pilot year and was seen in person by 500,000 people. In addition, through the print media and television, approximately 86 million people saw Smokey or heard his message through the pilot program.

Smokey, with a little help from his friends: Gene Dowdy, Director of Smokey and the American Cowboy Program; Ken Lawrence, National Marketing Director of the Dodge Division, Chrysler Corporation; and Lewis Cryer, Commissioner of the Professional Rodeo Cowboy Association.

The effect of the Smokey and the American cowboy program has been encouraging. It is spreading the fire prevention message and developing partnerships with nontraditional publics. We have completed the activities of the first year of this pilot program and look forward to continue Smokey and the American cowboy as a regular program in the coming year. ■

Smokey, the traveling bear, ready to move on to the next rodeo.

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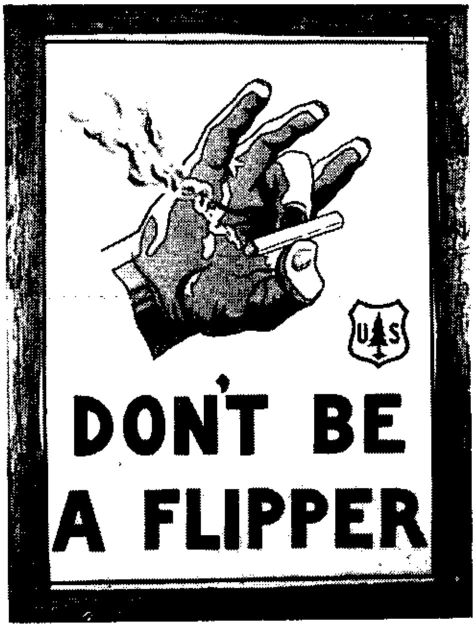

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