FIRE MANAGEMENT

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FIRE MANAGEMENT

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Towards The Future . . . .

Land, People, and Fire

William R. Moore

On a hot July afternoon over 40 years ago a fire broke out in the Bitterroot Mountains a half mile from the cabin where my lumberjack Dad and I were cutting cordwood for a living. Armed with a No. 2 shovel and my doublebitted axe, I legged it up the valley and made first attack. Driven by strong winds, the fire crowned up the mountain through the pines and firs and I was soon joined by Ranger Earl Tennant who led a crew of husky, well-equipped firefighters.

We stopped the fire some time during the night and began mopup immediately. I learned to dig out stumps, mix cool dirt and hot coals, fell burning snags and feel for hot-spots in the ashes with my bare hands. My work must have been acceptable, because Ranger Tennant asked me to join him to help chain the perimeter of the fire and calculate its size which I recall to be about 80 acres.

Fighting that fire was my first paid duty in the Forest Service. The wages were 35c per hour; big money for me at the time. Now, some 40 years later, the pay remains good and gets better every time the Congress meets. Nonetheless, at a time when I feel most proficient in fire and land management, I'm leaving the service. Let me tell you why.

Direction Towards Quality

I like the direction towards quality land management that now prevails throughout the Forest Service. If I didn't, I would stay and help you design a more promising future. The fire and related land management concepts that I believe in have good momentum. If they didn't I would stay and help you make them work. Every land manager should have heard Ben Lyon and Tony Dorrell present fire in multiple use management at this meeting. And heard Dick Worthington vow that reforestation and timber stand improvement funds would not be invested where fuel treatment and past fire losses were unacceptable. Certainly, those and similar penetrating presentations dispel any doubt that professional fire management is well on the way.

Beyond that, I am possessed with overwhelming conviction that the time has come when I can do more lasting good for this country from outside the Forest Service than from inside. And I want to leave while I'm strong. I feel strong. The Forest Service and fire and air management are in good hands. So it is time to go.

Now, in leaving, I'm tempted to tell you what I think you ought to do. But that would be presumptuous and contrary to my beliefs that reasonable men and women reasoning together can make better decisions than any one of us can do by himself. Nonetheless, from among the many great opportunities available to you, I shall mention four toward which I would direct most of my personal energy if I were to stay in the service with you.

Replace Growth Ethic

The first is to help replace the growth ethic with a true land and people ethic throughout America. To do this, you have to rise above the commercial product preoccupation that dominates the industrial age in our country. You must take a step beyond Gifford Pinchot.

As a prerequisite, you should again read, "Breaking New Ground." Then ask yourselves two questions:

- How adequate would Gifford's philosophies be in today's competitive world?
- How far has forest management advanced beyond Gifford's early day concepts?

This probe will tell you that more than ever before we have to learn to share and conserve all products from the earth. Most encouraging is our land use planning which helps chart the way towards a stronger land and people ethic. Tie fire solidly into that planning. And as you progress, don't forget that the National Forests can be catalysts for cultural change throughout America.

Towards The Future, p. 4

William R. Moore is Chief of Fire Management (retired), of the Northern Region, USDA Forest Service, Missoula, Montana. This article is taken from his remarks at the 1974 National Fire Chiefs, Washington, D.C.

"I want to leave while I'm strong. I feel strong. The Forest Service is in good hands. So the time has come."

Towards The Future, from p. 3

To involve young people like these firefighters in worthy conservation activities helps protect the Nation's resources and meets an important social need in America as well.

Develop People

The second opportunity is that of developing people fully capable of implementing quality land management. Fire management is a part of this opportunity. Our direction is sound, our plans comprehensive and our concepts are visionary. That is as it should be because there can be little progress without visions and goals.

But future results will be as good as our people's capability to do the jobs; and today, especially in fire management, our concepts are beyond our personnel's ability to implement. Much of fire management's future, then, centers on strong professional and technical personnel development.

Improve Quality, Reduce Costs

The third opportunity is to improve quality with reduced costs. The people of this country will not long tolerate huge expenditures like fire suppression without demanding full accountability, nor should they. For fire programs can be improved in many ways to achieve better quality at far less cost to the taxpayer.

Cost-wise, we have lots of belt-tightening to do in fire. And I regret that I won't be here to help train and hold our personnel accountable for costs as well as results.

Maximize Involvement

And fourthly, we can maximize people involvement in all National Forest activities. It is ironic that in these times when the youth of our country want to take part in worthwhile causes, we in the Forest Service—and in all industrial operations for that matter—seek to reduce the number of people involved in our activities.

The solution to this dilemma is perhaps the greatest challenge facing the nation in the years ahead. The National Forests should be leaders in meeting this vital social challenge. Rather than seeking only to hold personnel ceilings at a minimum, plans for each enterprise should respond to the question: "Have I involved all possible people meaningfully in this operation?"

Deeper Feelings

The above are logical goals to pursue. But logic is one thing, feelings quite another.

So in leaving, I want to share more deeply with you what this Forest Service means to me:

Lightning over the Bitterroots and the smell of smoke on hot August afternoons. . . .

Elk tracks in new fallen snow and frozen bed rolls in mountain cabins. . . .

The rattle of pack train hooves on mountain trails and the resinous smell of lumber on the green chain. . . .

The clank and clang of traffic at Washington National Airport and stillness of night in the Bob Marshall Wilderness. . . .

The bawl of beagles on the Cumberland and a pert girl named Jan who docks float planes on Prince of Wales Island. . . .

Canoe paddles and spray splashes on the Shenandoah and burned chamise in Southern California. . . .

Grizzlies digging marmots in the Beartooths and old Dora Eaton who spent 96 years in the same Appalachian mountain hollow. . . .

Loons yelling in the Boundary Waters and lunch with the Secretary of Agriculture in the Washington cafeteria. . . .

Dirt and heat on the fireline and delightful secretaries in monotonous government buildings. . . .

The tragedy of lives lost to fire and the delight of new research discoveries. . . .

Camping on 15 feet of snow in the Crags Mountains and flowers that open their petals only at night in Utah's deserts. . . .

Ski tips floating on deep powder in the Wasatch Mountains and empty bourbon bottles in New York's Hotel Astoria. . . .

People shouting; "Guard our land!", and the roar of bulldozers digging at the countryside. . . .

The Forest Service is comradeship, campfire rendezvous, training sessions, staff meetings; all this and many, many more.

But to me, most of all the Forest Service is the eager uncertainty of young men and women as they confront an old pro at their first job in the woods. With that thought, I want to tell you why I began work for and stuck with the Forest Service for over 40 years.

God's Country

First of all I loved the land. To me the National Forests were God's country. And they still are.

And the Forest Rangers were the best woodsmen, best packers, best rifle shots, and the best fighters. Since I was only 15, I wasn't concerned about the best lovers. When I signed on I thought I was joining the finest people in the country. Now, in leaving, I still feel that way about you all.

In reflecting on the past it is obvious that critical events have much to do with the course of life for each of us. Sometimes it seems we are born losers. Fortunately, some events make each of us winners, too.

My big break in the Forest Service came when a Ranger named Casey quit his job out in the Clearwater River country of Idaho. When Casey left, Forest Supervisor Myrick asked me to go out there and do the best I could to run the District. Thanks to some fine coaching by top woodsmen, I was ready and Casey's resignation became my opportunity to bury myself in a lifetime of professional care for the land.

High Quality People-Site

In many ways people are like trees. When you take an old tree out of good quality site, a vigorous sapling sprouts to take its place. The Forest Service is high-quality people site. And in my leaving I don't want you to merely gain another permanent full time ceiling toward some reduced goal. Instead, I want the domino effect to cut loose one, maybe even two, eager young saplings for full careers in service to our land.

So with full conviction that the Forest Service is in good hands, my wife Janet and I look forward to an exciting future. You can be sure that our eyes, our voices, our energies, and our pens will focus on the National Forests. That's because, you see, we are convinced that America needs a stronger land and people ethic and the best opportunity to lead the way lies with you who manage these priceless public lands.

Fire, with all its ecological complexities, is an inevitable force to be dealt with during our quest for quality management on the National Forests.

National Policy Change...
Natural Prescribed Fire

Louis L. Gunzel

When the National Park Service changed its fire policy from complete control to management of naturally-occurring fires, it presented a challenge to fire managers to find the most effective means of re-introducing fire into the natural areas of the National Park Service and into the newly established wilderness areas.

We at Saguaro National Monument have chosen to elaborate on prescribed fire, and to institute what we call "natural prescribed fire."

Prescribed fire has proven successful in a great variety of forest management situations for many years. As most people associated with fire management know, prescribed fire is fire ignited by man for a specific purpose, contained within a predetermined area, and allowed to burn only when certain favorable conditions exist. "Natural prescribed fire" is fire which occurs naturally and which is allowed to burn under prescribed conditions.

Although our choice of natural prescribed fire is only one of several alternatives, our experience at Saguaro National is an example of how change in policy at the national level allows managers to seek ways to put fire back into ecosystems.

Louis L. Gunzel is Chief Ranger, Saguaro National Monument, USDI National Park Service, Tucson, Arizona.

Fire Excluded

Saguaro National Monument is located in Southern Arizona near the city of Tucson. Approximately 400,000 people can look out their living room windows and see the Tanque Verde and Rincon Mountains which comprise a major portion of the Monument. The elevation starts at 2,700 feet and goes to 8,660 feet. Ecosystems range from Sonoran Desert to Montane, with grassland, pinyon, oak, juniper and chaparral sandwiched in. Fire had been excluded for the entire period of USFS-NPS stewardship (1906 to 1971).

In March of 1963, the Secretary of Interior released the report, "Wildlife Management In The National Parks," by a special blue ribbon, five man committee, headed by Dr. A. Starker Leopold of Berkeley, California. The report stressed that exclusion of forest and range fire had seriously affected the ecosystems of many areas and that in future management plans, fire should be used as a tool to preserve or restore the natural biotic scene of natural areas.

Policy Change

In response to this report, as well as findings of numerous studies dealing with all disciplines within ecosystems, the National Park Service changed its fire policy from complete control to the following:

"The presence or absence of natural fire within a given habitat is recognized as one of the ecological factors contributing to the perpetuation of plants and animals to that habitat.

"Fires in vegetation resulting from natural causes are recognized as natural phenomena and may be allowed to run their course when such burning can be contained within predetermined fire management units and when such burning will contribute to the accomplishment of approved vegetation and/or wildlife management units.

"Prescribed burning to achieve approved vegetation and/or wildlife management objectives may be employed as a substitute for natural fire.

"Any fire threatening cultural or physical facilities of a natural area and posing a threat to any resources of physical facilities outside that area will be controlled and extinguished."

Saguaro's Response

In response to this change in policy at the national level, we at Saguaro, where the staff is well qualified, decided to go for a new type of prescribed fire: natural prescribed fire, in which natural lightning-ignited fires (or wildfires) are allowed to burn under certain prescribed conditions.

It was recognized that the summer monsoonal rain produced the greatest number of lightning fires. However, most large and intense fires occurred just prior to the main rainy season. Analysis of past fire history, lightning occurrence, climatology, fire danger, buildup index, and other fire related factors indicated that from about mid-July to mid-September fires occurring would be of low to moderate intensity. It was also noted that an accumulation of 2 inches of rain at Manning Camp (8,000 ft. elevation) seemed to coincide with the establishment of the monsoonal rain period.

Accordingly, the following Fire Management Plan was developed and approved to begin during the summer of 1971.

Basic Fire Management Plan

A. All man-caused fires will be controlled and extinguished as soon as possible.

B. Control and extinguish all fires that threaten cultural resources and physical facilities within the area, or those fires that pose a threat to any resource or physical facility outside the area.

C. Control and extinguish all fires that occur in or threaten that portion of the saguaro cactus forest excluded from grazing in 1958.

D. Because most of the Monument is roadless, motorized fire fighting vehicles will not be used without the specific approval of the Superintendent—and then only when deemed necessary to the protection of human life, significant culture features, or property outside the Monument.

E. All natural fires will be controlled and extinguished except those occurring when *all* of the following prescribed conditions prevail:

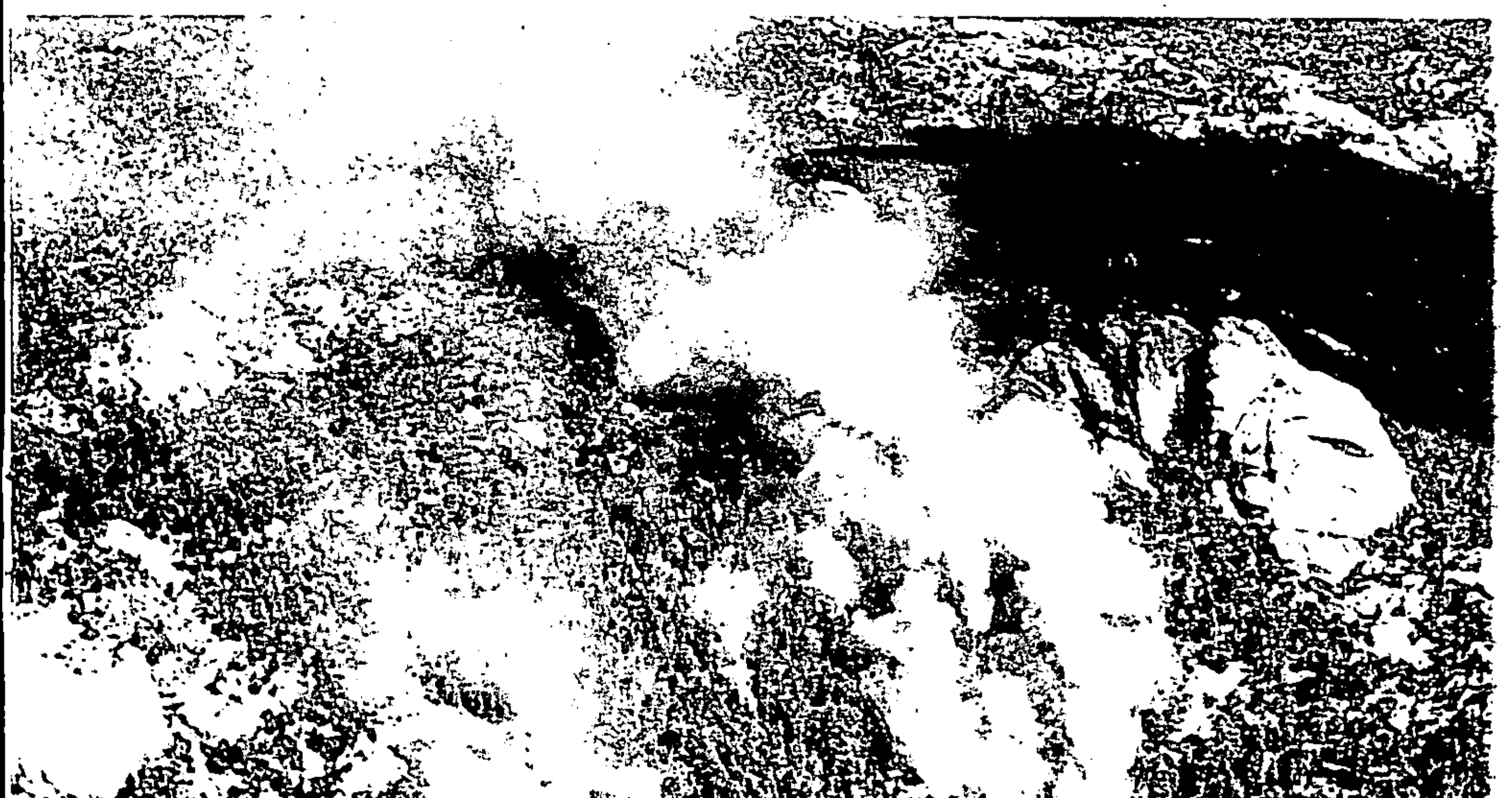
   a. The fire occurs between July 1 and September 15.

   b. The total accumulated rainfall in the period beginning June 15 exceeds 2″ or more at Manning Camp.

   c. The summer monsoon rain pattern is fully established. (In

Natural Prescribed Fire, p. 8

Aerial view of the Helen's Dome Fire. Fire is burning quietly on the ground. Only rarely did the fire burn into the tree tops.



Natural Prescribed Fire, from p. 7

Low intensity fire left small ponderosa seedlings intact. Note the new growth on the bunch grass two weeks after fire.

addition to rainfall, check with the Weather Bureau for any unusual shift or change in weather pattern.)

d. The Buildup Index (National Fire Danger Rating System) does not exceed 40 at Manning Camp.

e. The Spread Index (Timber, National Fire Danger Rating System) does not exceed 30 at Manning Camp.

You will note, there were no limits set with regard to acreage the fire could burn. It was anticipated that all fires burning during the above prescribed conditions would be of low to moderate intensity and have little undesirable effects.

Results of Plan

The plan has been in operation for 3 full years and has produced the following results:

- A total of 24 of 46 fires have been allowed to burn without control.
- More than 900 acres have burned with low to moderate intensity fire.
- Large quantities of dead and down fuel have been removed from burned areas.
- The overstory has remained intact with little damage by fire.
- Reproduction was thinned, leaving adequate numbers of small trees for future open-park like stands characteristic of ponderosa pine stands of southern Arizona.
- Burned areas have been cleared of dead snags and ground fuels making them more resistant to the disastrous high intensity fire.
- There has been no soil movement or soil loss.

Future Goal

The goal for the future is to eliminate unnatural fuel concentrations caused by past fire suppression activities and allow all natural fire to burn uncontrolled, producing a fully natural area for future generations. It may well be that in the future the streams will again flow year-round in the Rincon Mountains of Saguaro National Monument.

There is much to learn in changing from complete fire control to fire management. We are learning by the natural prescribed fire method in Saguaro. With any method, however, there are several major problems to overcome. The first of these is fuel accumulation caused by many years of complete protection. Other significant problems are human prejudice against fire of any magnitude, air pollution and governmental agency policies.

These barriers can be overcome. Fire management can be applied in many areas. When this is done, management practices will vary from no control in certain areas to complete fire exclusion in other areas.

Regardless of the method you use in your area, though, you will need research, logic, intestinal fortitude and a certain amount of luck to obtain the ultimate for your management area.

Foam Ear Protectors Prevent Hearing Loss

If things get so noisy on the fireline or in fire camp that you must raise your voice to be heard at a distance of 3 feet—*you should be wearing ear plugs.* If you don't you are running a risk of permanent hearing loss.

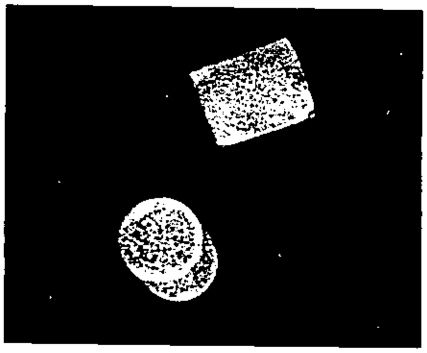
Complete details on recommended ear plugs and ear muffs can be found in 2 recent EQUIP TIPS based on findings of San Dimas Equipment Development Center's study of noise hazard problems.

The EQUIP TIPS, available from USDA Forest Service, Washington, D.C. 20250, are:

- "Hearing Protection for Off-road Vehicle Operators," March 1974
- "Protect Your Hearing!", July 1974.

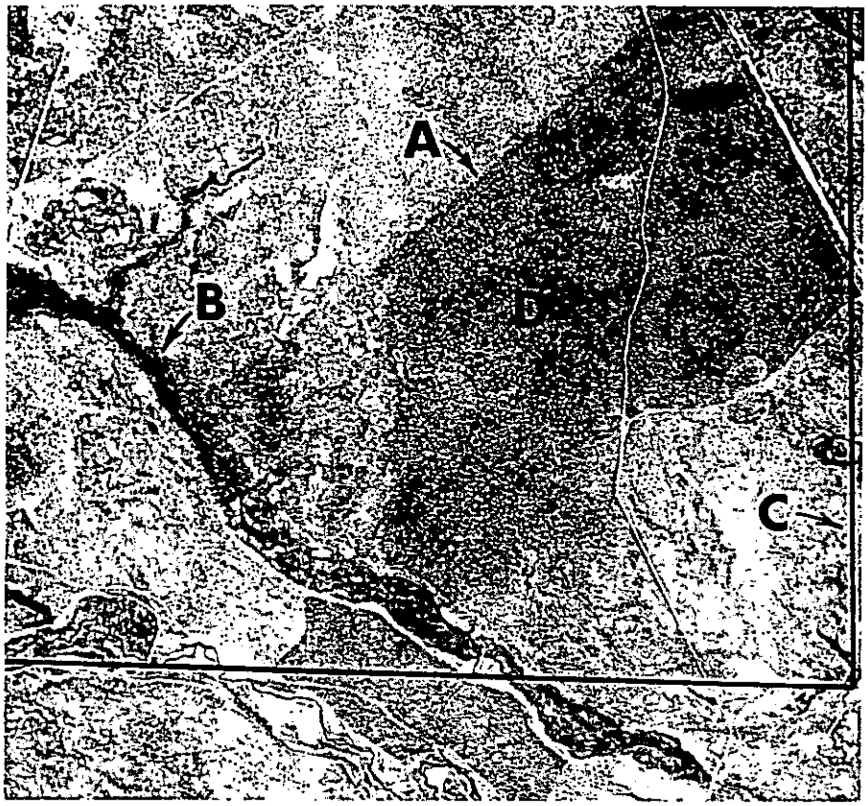
The expandable foam plug has proven outstanding for firefighters in terms of comfort, cost, availability, and effectiveness. It is recommended for use by firefighting personnel whenever they are in a noisy environment.

The foam ear protectors cost 17c a pair and are available from GSA-FSN 4240-08R-4681. They come with instructions for using and are contained in a self-sealing plastic storage bag.



Foam Ear Protectors

Fuel Type Mapping in New Jersey Pine Barrens



Standard 1:20,000, panchromatic ASCS photography. A—edge of destructive 1954 fire. B—Atlantic white-cedar. C—Study area boundary. D—Oak-pine stand.

A study on the use of aerial photographs to map fuel types in the New Jersey Pine Barrens[1] showed that color or black and white film and scales of photography at least as small as 1:18,000 are suitable for fuel type identification.

The study also showed that fuel types, as identified, can be mapped with acceptable precision and at reasonable cost.

The study failed to show that all important fuel types can be identified accurately and consistently on aerial photos. However, this failure appears to be due mainly to too great an effort to make identification purely objective and to the use of too many fuel types.

Questions Asked

The stated aim of the study was to answer the following questions:

- Can Pine Barren fuel types be identified reliably on some common kinds of aerial photography?
- If so, what kind of photography yields the best results?
- Is it technically and economically feasible to map fuel types from aerial photos?

The study area comprised a rectangular area approximately 2 x 2½ miles in size on the Wharton State Forest, Burlington County, New Jersey.

The 26 fuel types originally established for southern New Jersey were reduced to 15 for this study through elimination of some distinctions due to vegetational differences that did not affect fire behavior or control. Only 9 types occupied enough of the study area to be mapped, yet reaching agreement on the identity of some of them was difficult in the field, let alone on aerial photographs.

Consolidation Necessary

The study made it clear that further consolidation of fuel types was necessary. Therefore, the 15 fuel types used on the study were consolidated into 8.

Qualified personnel can now map the fuel types of the New Jersey Pine Barrens or similar areas with acceptable accuracy and at reasonable cost. Qualifications include mainly stereo vision, a little experience in using aerial photographs, and some familiarity with the vegetation types.

Fuel-type identification cannot be made completely objective, but a little training should suffice to qualify even a quite inexperienced person for the work. The fuel-type mapper, no matter how high his apparent qualifications, will have use for an interpretive aid, such as the Key, to maintain consistency. He will also need to field-check type identifications and boundaries occasionally.

Before Decision

Before protection personnel make a decision to map fuel types by using aerial photographs they should first determine:

- Are maps needed?
- Can important types be recognized on aerial photographs?
- Will maps require frequent updating?
- Is suitable photography available?

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[1]Complete report on file in the Library NEFES, Upper Darby, Pa. Pahnestock, G.R., H.G. Lund, III, W.B. Phoenix, W.M. Stiteler, Jr. 1972. Mapping New Jersey Pine Barren Fuel Types with Aerial Photographs. 46 pp.

A Clarification . . . Wildfire Suppression Terminology*

John E. Deeming and
Dale D. Wade

The movement of organized fire crews and overhead teams, as well as individuals, during the periods of high fire potential or frequency has become commonplace. Both State and federal firefighters have been moved across the country during fire emergencies. If men from various agencies and sections of the country are to effectively work together, a universal terminology becomes mandatory.

The field of fire management has generated a terminology to express the role of fire in wildfire suppression. This terminology has, however, developed region by region and agency by agency. Efforts to achieve a uniform nationwide terminology in fire control, have, in general, been successful (SAF Terminology of Forest Science, Technology, Practice and Products, 1971); but in the particular area of fire use for wildfire control, several terms still have the same meaning—or worse yet—one term may have several contradictory meanings.

John E. Deeming is Research Forester at Rocky Mountain Forest and Range Experiment Station, USDA Forest Service, Fort Collins, Colo., stationed at Interagency Fire Center, Boise, Idaho. Dale D. Wade is Research Forester at Southeast Forest Experiment Station, USDA Forest Service, Macon, Ga.

This article presents a concise terminology that describes the use of fire in wildfire suppression.

The Suppression Operation

"Suppression burning" is the intentional application of fire to speed up or strengthen control action on wildfires. This is a general term, comparable in scope to the term "prescribed burning." Together, they encompass all uses of fire for forest management purposes. The uses of fire in the suppression operation can be divided into four major task groupings according to the stage of control of a wildfire and the difficulty of applying the suppression fire. Ranked in descending order of difficulty, they are:

- To reduce intensity of, slow, or steer a wildfire
- To remove potentially dangerous fuel concentrations
- To widen and strengthen control lines
- To expedite mopup

Selection of a terminology based on the above task breakdown was based not only on considerations of their descriptiveness but also on past usage. The major exception is the term "backfire."

"Backfire" should have only one definition—a fire burning against the wind. This usage is analogous to the terms "head fire," which designates a fire burning with the wind, and "flank fire," which designates a fire burning across the wind.

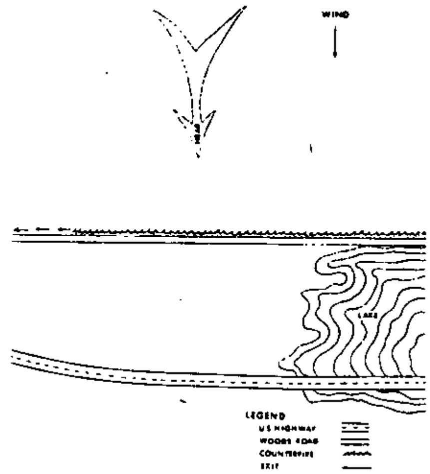


Figure 1.—Use of a backfire in counter firing to temporarily decrease the wildfire intensity and rate of spread.

Such a restriction will facilitate the description of firing techniques and patterns and ensure their independence from specific fire suppression objectives. The above firing technique definitions are the same whether used in suppression burning or prescribed burning and can be found in any prescribed burning manual.

Proposed Terminology

The following is an outline of the suppression fire terminology we propose and a discussion and example of the tactical terms.

I. Strategical Term
   A. Suppression Burning
II. Tactical Term
   A. Counter Firing—Emergency firing to stop, delay, split the flame front, or steer the fire.
   B. Burning Out—The use of fire to widen control lines during line construction.
   C. Mopup Burning—The use of fire to eliminate unburned fuel inside the control lines after containment.
III. Firing Technique
   A. Head Fire
   B. Flank Fire
   C. Backfire
   D. etc.

Counter Firing

Counter firing is emergency firing with or without a control line in or near the projected path of an intense wildfire for the purpose of extinguishing, delaying, or splitting the flame front or steering the fire in a desired direction. Distinction is made here between the fire whose direction and rate of spread are reasonably predictable and the erratic, high-intensity fire which is exhibiting violent convection. Under the latter conditions there is little man can do; counter firing is not recommended because of the unpredictable results and potential hazard to personnel.

The use of a counter fire to stop wildfire may be indirect. The immediate aim may be to reduce the fire's intensity or to steer the fire into an area where more advantageous firefighting methods can be employed. Another characteristic which distinguishes the counter fire from the other categories of suppression fire is the absence of the requirement that firing be accomplished from established control lines. Thus, the counter fire may, in turn, require suppression. A common example is where an existing break, that you know in advance won't hold, is fired. The intensity of the wildfire will be reduced and rate of spread slowed until the slopovers unite and again build up momentum (fig. 1).

Burning Out

Burning out is the use of fire to widen control lines. This procedure is an active part of line building. Tasks included range in difficulty from simply using a fire to consume the fuel between 2 established control lines to strip head firing along a control line ahead of the wildfire in order to clear a wide break in as short a time as possible. Removal of the fuel from an area between the fingers of a fire which have just been connected by a control line is another example.

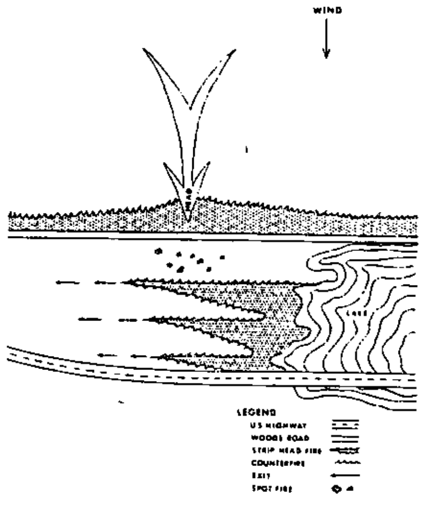


Figure 2.—Use of multiple head fires in burning out to quickly produce a wide firebreak.

To illustrate burning out, let's consider the same wildfire we used in figure 1. The counter fire has been completed and the control forces know it will not stop the wildfire. The burning out operation is then started at the primary control line. Strip head fires are set parallel to the highway (fig. 2). The time gained by using the counter fire will allow a larger area to burn out between the highway and the woods road before arrival of the wildfire.

Mopup Burning

Mopup burning is the use of suppression burning techniques after the fire has been contained. The purpose of fuel removal in the mopup stage is to prevent any remaining areas of fire from gaining enough momentum to carry across the completed control lines.

Mopup burning is the least difficult form of suppression burning to use because there is more latitude in the choice of techniques and in the timing of the actual operation—time and weather are usually more on the side of suppression organization.

Reasons for mopup burning include:

- Removal of islands of dangerously heavy fuel within the control lines before more severe weather conditions arrive.
- Transfer of the fire edge to the control lines when cold trailing is impractical or it is evident that the fire will not reach the completed control lines before burning conditions worsen.

Conclusions

Suppression burning is a valuable fire control tool. It may offer the only chance to stop a fast moving wildfire. It is also a very dangerous tool in the hands of the inexperienced or careless, and is no panacea even in the hands of an expert. However, it is the most economical, fastest, and least damaging means of widening control lines when properly utilized.

Adoption of the terminology proposed in this paper would eliminate the need for such terms as clean burning, line firing, and firing out, while at the same time establishing a single definition for each of the terms that are used.

A complete understanding of suppression burning terms is a prerequisite for fire control personnel contemplating its use. The redefinition of terms while under the pressures of the fireline is a loss of valuable time at best. A universal terminology will facilitate the exchange of ideas and increase the probability of correctly carrying out orders pertaining to suppression burning.

*Editor's note: We welcome your comments to the authors' proposal to standardize fire terminology.

Fire Suppression With The Tractor-Plow Unit

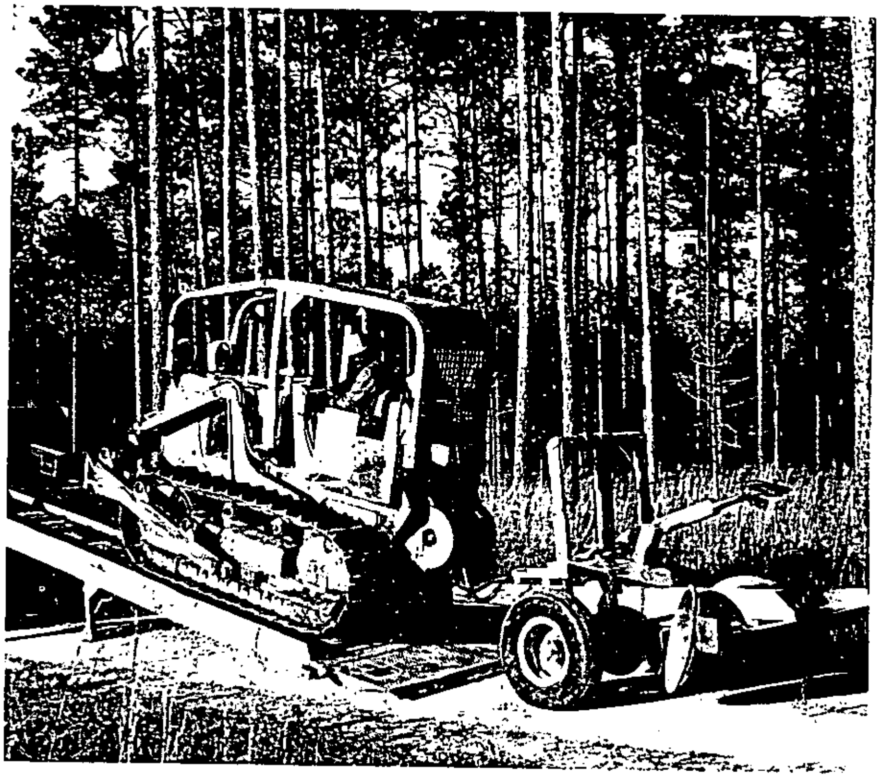
David D. Devet

The tractor-plow-transport combination has been utilized as the primary first line suppression unit in the Francis Marion National Forest in South Carolina since the early 1940's.

The Francis Marion National Forest is located in the low flat coastal plain of South Carolina and consists of extensive pine covered ridges interspersed with hardwood bays, swamps, creek bottoms and mixed pine hardwood river terraces.

Fuel on the ridges consists of pine needles mixed with hardwood leaves. Some brushy understory species contain leaves that exude volatile oils when heated. Swamps and bays have a heavy accumulation of fuel consisting of hardwood and brush leaves plus accumulation of organic material sometimes exceeding 30-40 tons of available fuel per acre.

Except in sandy areas a heavy dense root mat makes rapid mineral soil line construction by hand tools extremely difficult and slow.



Bed rolled back and tractor is being unloaded. Yoke for blade has been raised.

Five Units in Use

Five tractor-plow units are now used to protect 250,000 net National Forest acres in a gross area of 414,700 acres. These units construct firelines needed to suppress 65 to 100 wildfires annually and to conduct a 40,000 acre annual prescribed burning program.

The bulk of the wildfires are concentrated during March and April, with an occasional flurry in the late fall. About 67 percent of the fires are of incendiary origin. These have a tendency to occur in clusters, and as multiple sets. As many as 9 fires have started on a single day.

An excellent road system covers most of the Fire Control Unit but extremely mobile units capable of rapid line construction are a necessity for the fire management workload.

Currently the Forest has 3 International TD-9 and 2 Caterpillar D-4 tractors. Each tractor pulls a 2-disc Mathis wheeled plow. Three droop tail transports (37,000 gross vehicle weight) and 2 rollback and tilt bed transports (45,000 gross vehicle weight) haul the tractor-plows. Four of the tractors have yokes for mounting a bulldozer blade.

All tractors and transports are equipped with mobile radios. Each unit is capable of constructing and holding 80-150 chains of line per hour, depending on the support received, basal area, terrain, fuel and weather conditions.

Suppression Tactics

Usually a crew boss caliber fireman precedes the tractor-plow crew to a fire and has a suppression strategy planned by the time the mechanized unit arrives. The typical tractor-plow crew consists of the tractor-operator and 2 firemen. Once the unit is unloaded and committed, the suppression tactics are carried out by the tractor-plow operator and his 2 firemen. Communications are maintained by radio.

Strategy and tactics usually consist of:

David D. Devet is Fire Staff Officer, Francis Marion National Forest, South Carolina.

• Predicting the rates of spread and direction of movement of the head fires in relationship to the capabilities of line construction under existing conditions

• Deciding where and how to anchor the line

• Deciding at what angle to approach the head of the fire

• Deciding when, how and where to start burning out along the constructed fireline

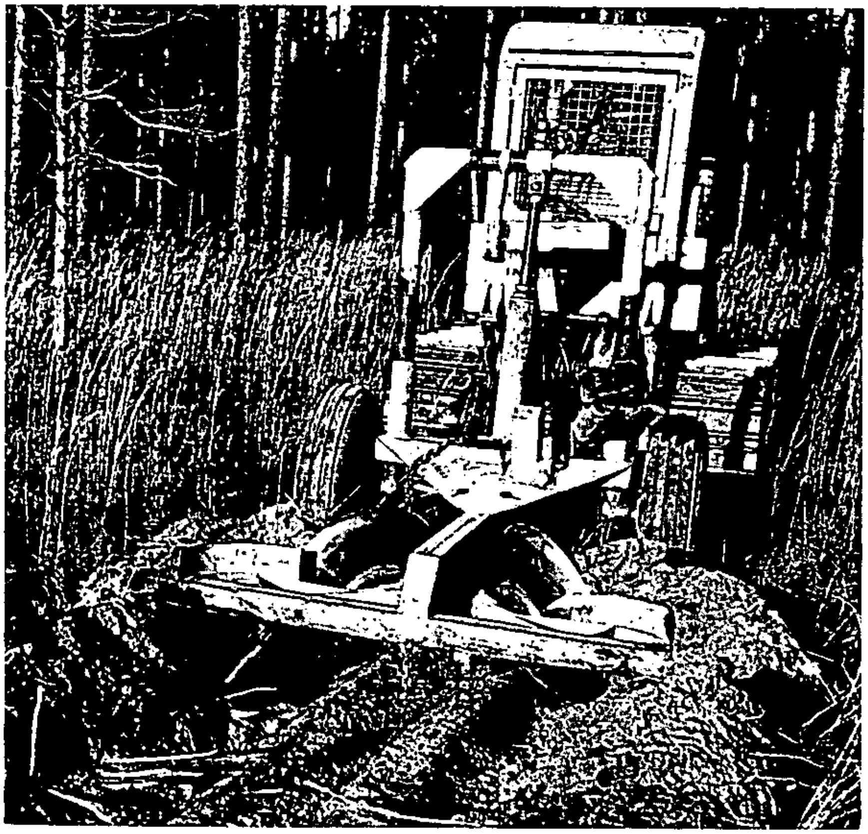
The principle behind all tractor-plow tactics is to first control the fast moving heads of fires. Most of the time this is done by burning out the fuel in front of the headfires. The 7-foot-wide line constructed by the plow acts primarily as a base for burning out operations. Many times the plowed line itself will not stop the head of a fire. However, once the head is stopped the flanks are easily handled with a minimum of burning out.

Movement Factors

The movement of the head of the fire depends primarily upon velocity of the wind, relative humidity, ignition component and the burning index.

During low or moderate fire danger days, the tractor may be able to plow immediately adjacent to the fire edge. As the fire danger increases, the plow works at a greater distance from the main fire edge.

The tractor operator selects the specific tractor route as he plows. A lead man cannot move fast enough through the vegetation to remain ahead of the unit. From his elevated perch on the tractor, the operator can see the terrain better than anyone from the ground level. Changes in vegetation types provide clues about the type of terrain ahead. This enables the operator to alter his line location.



The 7-foot wide line made by TD-9 tractor-plow unit.

Tandem Plowing

Frequently during periods of very high and extreme fire danger, 2 tractor-plow units are dispatched to a single fire. These units may plow in tandem. The line prepared by the lead unit is burned out while the second unit prepares a safety line, parallel to the control line. The second unit also catches and plows a line around any breakovers that may occur. The two units assist each other in the event of any mechanical problems. Both units have rear mounted winches. The distance between parallel lines depends upon burning conditions, but is usually less than 1 chain.

Most burning out operations are conducted simultaneously with line construction. The tractor-plow operator varies his rate of line construction with the ability of the supporting forces to burn out and hold the line. An experienced operator will double back and double plow lines that may need reinforcement.

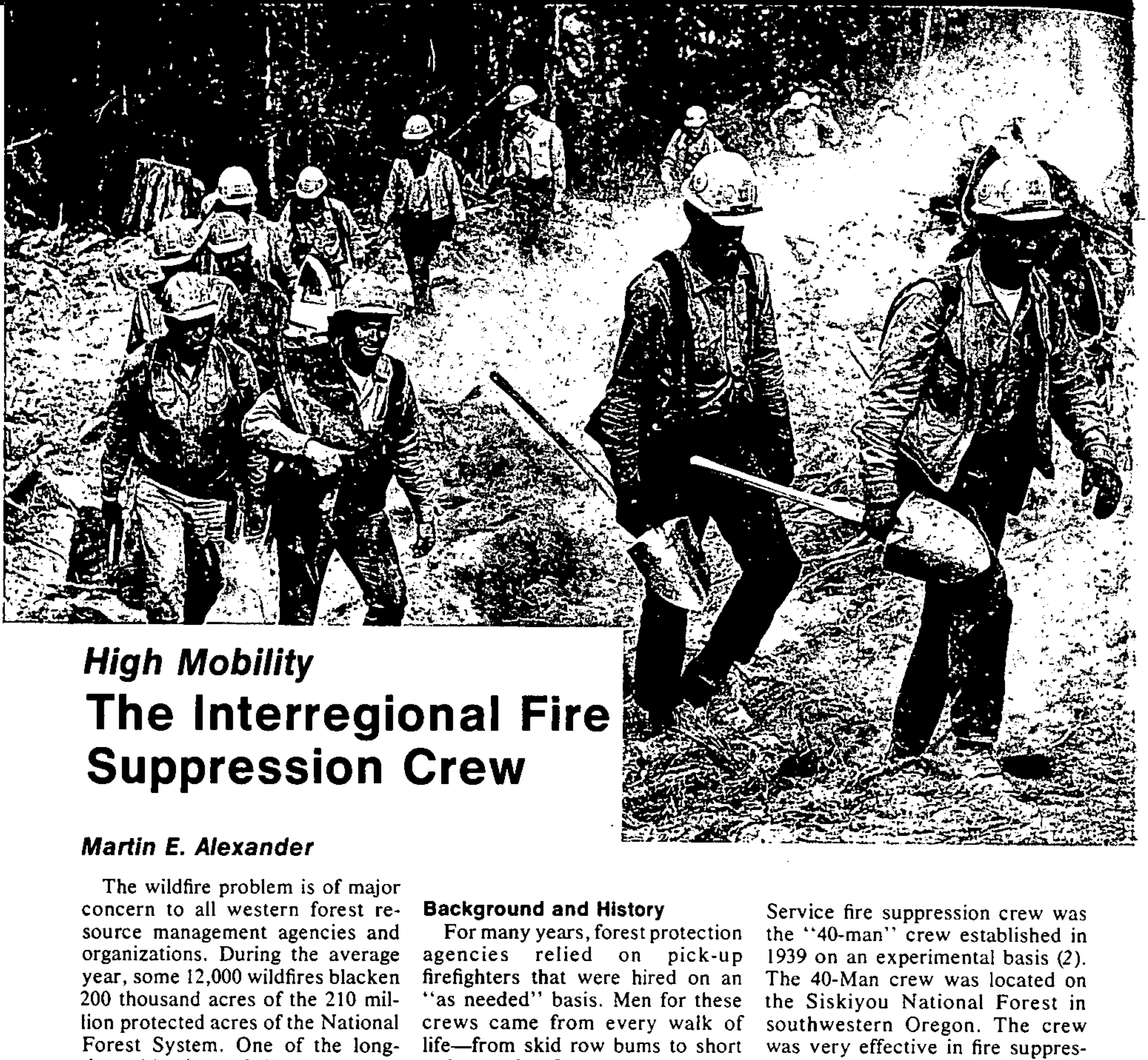
Sometimes when breakovers are anticipated the tractor-plow unit plows a series of parallel lines by looping back and forth in front of the head of the fire. The ends of the loops tie into the adjacent plowed lines.

"Potato Patching"

Whenever short distance spotting is anticipated, 2 or 3 tractor-plow units will "potato patch" an area where spot fires may occur. This tactic consists of creating many parallel lines as close as possible resulting in a maximum exposure of mineral soil and resembling a plowed field.

Another tactic is for 2 plows to attack the head of a fire in tandem and then separate and proceed to plow each flank.

All tractor-plow units are equipped with two radiant heat shelters, CO_2 fire extinguisher, rake, shovel, axe, first aid and snake bite kits, drip torch, safety goggles and some miscellaneous small tools. Crew members are highly trained and form a skilled team.



High Mobility

The Interregional Fire Suppression Crew

Martin E. Alexander

The wildfire problem is of major concern to all western forest resource management agencies and organizations. During the average year, some 12,000 wildfires blacken 200 thousand acres of the 210 million protected acres of the National Forest System. One of the longtime objectives of the U.S Forest Service has been to provide highly trained, well conditioned, versatile fire suppression crews to critical fire situations. A fire suppression crew with high mobility that can reach a large project fire on short notice and do an effective job during the first burning period, has always been the dream of fire control managers. The interregional Fire Suppression Crews developed by the U.S. Forest Service serve this purpose.

Background and History

For many years, forest protection agencies relied on pick-up firefighters that were hired on an "as needed" basis. Men for these crews came from every walk of life—from skid row bums to short order cooks. In most cases these men had very little fire suppression training or experience. It was not until the advent of the Civilian Conservation Corps (CCC) in the 1930's and early 40's that any semblance of organized fire suppression crews was achieved (*1*). The CCC crews were used primarily for conservation projects such as trail and campground construction, but doubled as a firefighting force.

The first organized U.S Forest Service fire suppression crew was the "40-man" crew established in 1939 on an experimental basis (*2*). The 40-Man crew was located on the Siskiyou National Forest in southwestern Oregon. The crew was very effective in fire suppression in the Region 6 National Forests. The Oregon "Red Hats," co-sponsored by the School of Forestry at Oregon State College and various State agencies in 1940, was organized along the same lines as the 40-Man crew (*4*). During the war years programs like these were largely discontinued. However, some of the principles of training, organization, and use were to be later adopted by other U.S. Forest Service fire suppression crews.

In 1947, Region 5 of the U.S. Forest Service began to organize "Hot Shot" crews for use in California (*5*). They were well-trained, fast and hard hitting hand-line crews. Such crews as the El Cariso (Cleveland National Forest) and Del Rosa (San Bernardino National Forest) Hot Shots proved themselves more than once under difficult conditions in the brush-fields of southern California.

During the 1950's most of the western U.S. Forest Service regions maintained large brush crews to do slash disposal and other timber sale work. There were also several hundred blister rust control crewmen organized into 25-man fire suppression crews in regions with blister rust infested stands. These crews provided trained manpower for use on large project fires. "The Redmond Raiders," a TSI crew stationed on the Deschutes National Forest, was a good example. Because of transportation problems in dispatching these crews to other areas of the West, their most common use was local. With the termination of the blister rust program and the transition to bulldozer slash piling, such project crews were no longer available.

In the late 50's, fire control personnel in Washington, D.C. felt fire suppression crews could be used more efficiently if men were stationed near an airport. It was felt that a large airplane immediately available to transport men was necessary to carry out the concept of quick mobilization and dispatching. Such a plan became a reality when 5 IRFS crews were organized for the 1961 fire season (*3*). The first IRFS crews were located in the far West and Northwest. By 1963, the number of IRFS crews increased to 9. Through the years their value in fire suppression became quite apparent and allowed for an expansion of the IRFS crew program. In 1970, 15 IRFS crews were available for summer fire season. At present there are 19 IRFS crews stationed in the western U.S. during the summer fire season (table 1).

Recruitment and Organization

Men for IRFS crews are recruited predominantly from the western U.S. Most often they are college students majoring in some phase of forestry. The Forest assigned an IRFS crew is responsible for screening, recruiting, and hiring crewmen and overhead. Crew members must be at least 18 and preferably not over 45, with the average age being 21. They must pass a yearly physical examination, be willing to fly, and be away from home base for extended periods of time. Employment is from about mid-June to early September. Some IRFS crews, specifically the Region 5 crews, terminate in November. Most IRFS crews have experienced fire fighters—65 to 95 percent are former crew members.

The crew headquarters have been strategically placed. Ideally they are located near large airports, which permits rapid transport by aircraft to going wildfires and high fire-danger areas. Crew members are housed in some sort of barracks, varying from reconditioned garages to elaborate college-type dormitories.

An IRFS crew is normally composed of 25 men, consisting of a foreman, assistant crew foreman (who may or may not be one of the squad bosses), 3 squad bosses, and 20 to 21 crew members. Overhead positions on IRFS crews are usually based on past fire experience, training, and crew seniority. The IRFS crew foreman is responsible for supervision of the crew, both on fire assignments and at home base. Crew size and structure vary among the regions, depending upon the objectives and the needs of the home region.

Movement and use of these crews within their own regions is coordinated by the regional fire dispatchers. Requests for IRFS crews from other regions are coordinated through the Boise Interagency Fire Center (BIFC) at Boise, Idaho. BIFC arranges for air transportation and maintains a national listing of available IRFS crews (*6*). BIFC provides logistic support rather than serving as a command center. This permits a central office, which has fire suppression crew requests coming from all over the West, to analyze and estimate potential situations and assign priorities when the demand for IRFS crews is greater than the supply.

Training

Crew members usually receive 2 weeks of both formal classroom instruction and field training. Training is given in various facets of the fire suppression job. Training is intensive because without it crewmen would be no better than pick-up firefighters.

Classroom training consists of films, lectures, and programmed instruction texts in Forest Service organization. This includes fire and crew organization, fire behavior and weather, the 10 Standard Firefighting Orders, safety, first aid, retardant and aircraft management, radio communications, fire suppression principles for both small and large fires, fire control attack methods, woodsmanship, and thinking and reasoning during emergency stress conditions. Field demonstrations are given in various fireline construction methods (progressive, one-lick, etc.), care and use of hand tools, and specialized equipment such as chain saws, portable and slip-on pumps, and drip torches.

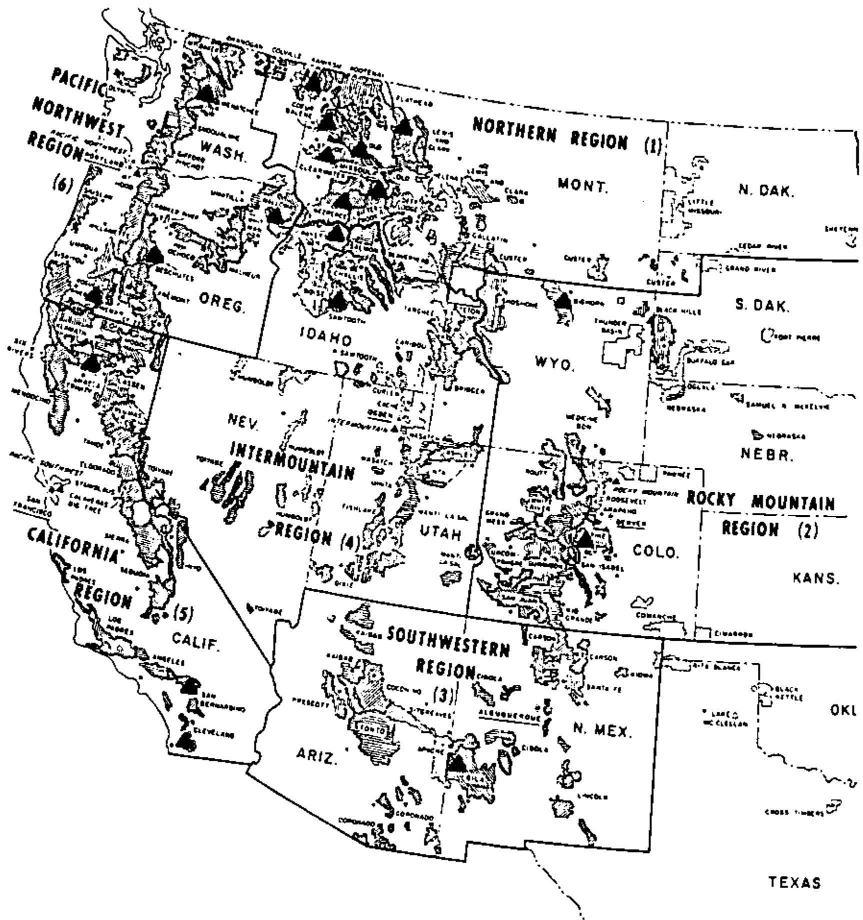
Physical conditioning is stressed during the 2-week training period. It consists of calisthenics, hikes, obstacle courses, and outdoor sports.

Interregional Crew, next page

Martin E. Alexander is a forestry technician, Moose Creek Ranger, Nezperce National Forest, Grangeville, Idaho. He served as a crew member of the Bighorn National Forest IRFS Crew during the 1972 and 1973 summer fire seasons.

The Interregional Crew, from p. 15

Figure 1. National Forests in Western United States.



▲ Location of U. S. Forest Service Interregional Fire Suppression Crews

Refresher training and conditioning are continued as needed.

IRFS crews are often faced with long working hours, little food, high air temperatures, and low humidities, all of which take their toll on crew members. Another fatigue factor is the required traveling from one fire to another. It's not uncommon to find IRFS crews that have been away from home base for 2 or 3 weeks during a busy fire season. But despite the hazards and hardships, the safety record among IRFS crews is extremely good.

When not actively engaged in training or suppression, the crew performs district project work such as hazard reduction, maintenance and construction jobs, fire proofing heavy use areas, slash disposal, timber stand improvement, trail building, and reconditioning firefighting tools and equipment. These activities keep crew members in shape and provide a ready work force for priority district work. The IRFS crews are on a 24-hour alert, 7 days a week. A sign-out roster system is utilized by most crews to determine where individual crew members may be reached at any particular time during off-duty hours.

Philosophy and Crew Morale

The effectiveness of any fire management organization is no greater than the morale of its personnel. Recognition of this has fostered a high degree of *esprit de corps* among IRFS crews which consider themselves the "best." It is customary to assign the IRFS crews control of the most difficult sectors of project fires. Crew morale appears to soar the hotter the fireline gets.

IRFS crew members develop nicknames as the result of incidents, individual characteristics, or backgrounds. Good natured kidding among fellow crew members prevails constantly. Several IRFS crews have developed shoulder patches exemplifying their crew name or locality.

Crew morale is a necessary component of an IRFS crew. Only through a sense of personal satisfaction and pride can the individuals obtain the desire required for successful action in difficult fire situations.

Mobilization

The primary purpose of IRFS crews is to provide highly trained and well equipped reinforcement crews for large fire suppression. All 19 IRFS crews are air mobile and can be moved to any location in the western U.S. in 6 to 8 hours after being dispatched. Thus, approximately 420 highly trained men can be mobilized very quickly for any large project fire or lightning bust.

In one instance, 12 of the 15 IRFS crews were used in the 4,000 acre Pumpkin Creek fire on the Bighorn National Forest in 1970. IRFS crews are used in different types of wildland fuels, burning conditions and terrain—from mopup in heavy West Coast fuels to punching line in southern California's Class 14 brush type.

IRFS crews are used for both day and night duty. They are sometimes used as an initial attack force on their home forest and by nearby cooperating agencies and organizations. In such cases they will travel to a fire utilizing their own crew ve-

Table 1.—National Forests assigned IRFS crews by U.S. Forest Service regions with year of crew organization and crew name.

U.S.F.S. Region	National Forest Assigned IRFS Crew(s)	Year of Crew Organization	Crew Name
Region 1	Bitterroot	1963	Bitterroot I.R.
	Flathead	1966	Flathead I.R.
	Idaho Panhandle[1]		
	at Wallace	1967	Coeur D'Alene Hotshots
	at Priest Lake	1967	Kaniksu Hotshots
	at St. Maries	1967	St. Joe Hotshots
	Lolo	1961	Lolo I.R.
	Nezperce	1962	Slate Creek Hotshots
Region 2	Bighorn	1967	Gibhorn I.R.
	Pike[2]	1962	Pike I.R.
Region 3	Gila	1970	Gila I.R.
Region 4	Payette	1961	Payette I.R.
	Sawtooth	1967	Sawtooth I.R.
Region 5	Cleveland	1961	El Cariso Hotshots
	San Bernardino	1961	Del Rosa Hotshots
	Shasta-Trinity	1961	Redding Hotshots
Region 6	Deschutes	1962	Deschutes I.R.
	Rouge River	1963	Rouge River Roughriders
	Wallow-Whitman	1967	Wallow-Whitman I.R.
	Wenatchee	1966	Wenatchee Bushmen

[1]In 1974, the IRFS crews stationed on the Coeur D'Alene, Kaniksu, and St. Joe National Forests were reorganized into the Idaho Panhandle National Forest (personal written communication from William R. Moore, R-1, Div. of Fire Mgmt.).

[2]Originally the crew was assigned to the Roosevelt National Forest but was reassigned in 1969 to the Pike National Forest (personal communication with Glen C. Scott, former Pike IRFS Crew Foreman).

hicles. At certain times and because of individual experience, the crew may be split up and used as smokechasers during a large lightning bust. Individual crew members can also be utilized as "straw" bosses for pick-up and district crews. Besides serving as handline crew, they also fill in on fire control specialty jobs such as helitack crewmen and managers, retardant mixmasters, and tank truck operators.

Although IRFS crews are used primarily by the U.S. Forest Service in all of the western regions, 2 unusual fire assignments for IRFS crews were the Russian River fire and the Chaldron fire. The first occurred in 1969 when 4 IRFS crews from Region 1 were used on the Russian River fire on the Chugach National Forest in Alaska upon personal written communication from Philip W. Gum, R-10, Div. of Fire Mgmt. and Air Operations. The second occurred during the 1973 fire season when three Region 1 crews and one Region 2 crew were used on the Chadron fire on the Nebraska National Forest.

The eastern and southern U.S. Forest Service regions have never used IRFS crews, nor do they anticipate using them because of readily available manpower, generally small and short duration fires, and because their fire season does not coincide with IRFS crew employment periods (personal written communications from Wayne E. Ruziska, R-8, Div. of Fire Mgmt. and Monroe E. Kimsey, R-9, Div. of Fire and Air Mgmt.). Therefore, although IRFS crews are available to the eastern and southern states, it would require extreme fire danger over a large area for an extended period of time to warrant dispatch.

The IRFS crews are also used by other federal agencies such as the Bureau of Land Management, National Park Service, and the Bureau of Indian Affairs. They are also called upon for fire suppression by western state forest resource management agencies, private forest industry, and timber protection associations.

When the regular fire season is finished in the crew's headquarters area, a crew may be moved to some other part of the West if needed. This type of arrangement usually consists of a 30- or 45-day detail. The Bighorn IRFS crew was used in this manner during the 1972 fire season in California (*1*). The Lolo and Pike IRFS crews were also assigned to the Lassen and Los Padres National Forests, respectively. Such an arrangement not only provides the Forest with an extra fire suppression force, but allows crew members to gain more varied experience and see different parts of the country. Similar arrangements include stand-by duty at fire coordination centers during periods of extreme fire danger.

An extremely valuable asset of IRFS crews is that they arrive at a fire as a complete "package" outfit—they have their own overhead, chain saws, crew radio communication system, and hand tools (if ordered with crew). Crew members carry their own fire pack which includes a sleeping bag, personal gear, and fire suppression clothing and equipment. The requesting fire control agency has only to provide food and water.

Continued on p. 19

Sensitivity to Potential Damage . . .

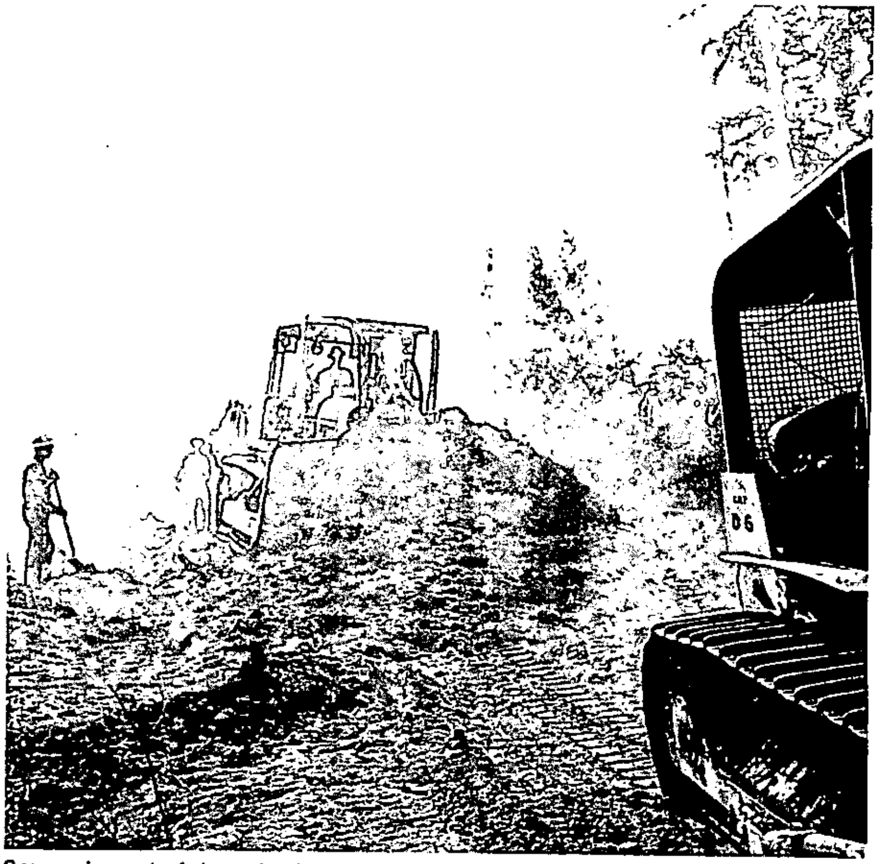
The Role of the Resource Advisor

Ernest V. Andersen

"Put the fire out" is the motto of all fire bosses. Fire management specialists must also be sensitive to damage resulting from their own activities in suppressing a fire.

It, therefore, falls to the Resource Advisor to have complete knowledge of all multiple use and function plans relating to the area in which the fire is burning. He must be able to predict potential effects of fire—beneficial, detrimental, or negligible—on these plans. He advises the fire boss on the type of control activities compatible with resource management objectives. Prevention of soil damage, water damage, resource damage or enhancement from fire will be his primary areas of concern.

The Resource Advisor should be accountable for his recommendations to the same line officer that the fire boss reports to. In addition, he should be at the base of operations on a nearly continuous basis. He must have no other duties than those as Resource Advisor. The Resource Advisor should not provide liaison with other landowners, utility companies or other agencies. In the past, this practice resulted in such a dilution of the Resource Advisor's time that he was unable to successfully complete his duties.



Severe impact of dozer is shown here. Dozer fireline location can be located and constructed to limit effects of erosion and serve future resource objectives.

Qualifications

As minimum qualifications, a Resource Advisor should:

- Be intimately familiar with the fire suppression organization
- Know the environmental impacts of a wildfire burning through the various vegetative unions occurring in the area
- Know fire behavior including weather factors for the area
- Know the environmental consequences of firelines, roads and other improvements
- Know the habitat needs of animal and fish populations and the long-range potential for both for the area
- Have past local Unit Planning and/or work experience within or adjacent to the fire

Responsibilities

The Resource Advisor's duties are:

- To provide fire overhead team with information on Forest resource values
- To identify for the fire boss, plans chief and finance chief those areas where fire will enhance land productivity, where it will damage critical resources and where fire effects will be negligible
- During the strategy development, to integrate his knowledge of the fire effects with other plans and line, and to help seek the strategy to control the fire at least cost, with minimum damage and maximum benefits from fire.
- To provide the fire boss with information on private land boundaries, properties and values
- To advise the fire boss on environmental protection work needed in conjunction with control activities
- To advise the Service Chief about service and logistic problems peculiar to the area

Actions to Avoid

The following are some of the specific actions with which the Resource Advisor should *avoid* becoming involved:

- Tactics and/or strategy except in an advisory capacity
- Functional problems; to the degree it reduces his capability to fulfill his responsibilities
- I&E aspects of the suppression effort

The District Ranger, a primary District Assistant, or Resource Staff member from Forest Headquarters should serve as a Resource Advisor. Well-informed, qualified Resource Advisors will help keep fire suppression-related environmental damage to a minimum consistent with the land values being protected.

The case of suppression action damage exceeding the wildfire damage can be avoided. The intelligence gathered during the fire can easily be applied in development or refinement of preattack plans. Rehabilitation efforts can be undertaken with confidence that all needs have been considered.

Ernest V. Andersen is District Ranger, Nezperce National Forest, USDA, Idaho.

Hand constructed fire line may be the only option open and recommended by Resource Advisor.

Continued from p. 17

IRFS Experience Important

Experience and training on IRFS crews is sometimes used as criteria for selection of smokejumpers. Because of the wide variety of fire management experience gained on these crews, crew members should be well qualified to pursue careers as fire control technicians or professional wildland fire managers, depending upon their education. Many fire control personnel have worked their way up through the ranks from seasonal fire control jobs such as lookouts, fire guards, fire prevention patrolmen or as IRFS crewmen. The experience gained on an IRFS crew not only allows young men to gain district fire control fundamentals but also allows them to experience all phases of large fire suppression. This experience is necessary to all persons pursuing a career in wildland fire management.

The development of the Interregional Fire Suppression Crews by the U.S. Forest Service marks a major milestone in wildland fire suppression. Philip V. Cloward, fire staff officer on the Sawtooth National Forest, once said that "what the smokejumper is to small fires, the IRFS crew is to large fires." Performance to date indicates that the IRFS crews are meeting their objectives and giving fire management agencies a new dimension in wildland fire suppression not previously available.

Literature Cited

(*1*). Anderson, Rolfe E., Boyd L. Rasmussen, and Verne V. Church.
1941. Adapting advanced principles of organization and fire-line construction to CCC suppression crews. Fire Contr. Notes 5(3): 123-218.

(*2*). Cliff, Edward P., and Rolfe E. Anderson.
1940. The 40-Man crew—A report on the activities of the experimental 4-Man fire suppression crew. Fire Contr. Notes 4(2): 47-62.

(*3*). Division of Fire Control. U.S. Forest Service
1963. The interregional suppression crew. Fire Contr. Notes 24(4): 93.

(*4*). Schroeder, George H.
1941. Oregon's "Red Hats." Fire Contr. Notes 5(3): 129-130.

(*5*). Stevenson, Stanley.
1951. "Hot Shot" crews. Fire Contr. Notes 12(2): 29-31.

(*6*). U.S. Dept. of Agriculture. Forest Service.
1971. Interregional Crews. USDA For. Serv. Handb. FSH.5131.41a.

Guidelines For Protecting Fish and Aquatic Organisms When Using Chemical Fire Retardants

Robert L. Borovicka

A series of widely scattered fish kills in several states prompted resource managers to study the effects of various fire retardants on aquatic environments. As a result of these studies, preliminary guidelines for protection of aquatic life when using chemical fire retardants have been established.

The use of chemical fire retardants to help control forest fires has become a wide-spread practice with some 15 to 20 million gallons used annually in the United States.

A team of scientists and natural resource managers met in Portland, Oregon, in December 1970 to discuss and analyze the problem. This was a multi-agency team with national and international resource management goals. Committee members were from the Bureau of Land Management, U.S. Forest Service, and the Bureau of Sport Fisheries and Wildlife. The committee solved problems and developed procedures and guidelines based on laboratory and field research.

National Marine Fisheries Service Environmental Field Station located on the lower Columbia River, Oregon, where bioassay of fire retardants using salmon and trout was conducted.

Robert L. Borovicka, BLM, Portland, Oregon, is chairman of an interagency committee studying the effects of fire retardants on the environment. Other members of the committee are: Jack F. Wilson, BLM, Boise Interagency Fire Center, Boise, Idaho; Mike Bowman, BLM, Washington, D.C.; Logan Norris, USFS, Missoula, Montana; Clifford Bosley, BSF&W, Portland, Oregon.

Basic Research: A Critical Need

During the initial meeting it was decided to form an interagency group that would explore existing and needed research concerning the impact of fire retardants on the environment. A program was proposed that included study into the effects of retardants on aquatic organisms, water quality, soil and vegetation, wildlife, livestock, and public health.

Initial research was to be aimed at determining toxicity of retardants to fish and other aquatic organisms. The studies were to be of standard design to determine toxicity of the most widely used retardants to a variety of aquatic animals by bioassay procedures. The basic composition of retardants indicated high levels of ammonia and this factor provided a clue to the relative toxicity to aquatic animals.

Major manufacturers of retardants were contacted and they agreed to cooperate by providing several formulations and technical information to researchers. The manufacturers have been extremely helpful throughout the bioassay study.

Agencies' Help Enlisted

Preliminary testing of retardants was provided by the Fish Toxicology Laboratory of the Environmental Protection Agency at Corvallis, Oregon. The Bureau of Land Management negotiated a contract in 1971 with the National Marine Fisheries Service, an agency of the National Oceanic and Atmospheric Administration. The Northwest Fisheries Center of NMFS selected the Environmental Field Station located on the Columbia River at Prescott, Oregon, to conduct a detailed bioassay of retardant effects on Coho salmon and rainbow trout.

The Director of the Fish Pesticide Laboratory at Columbia, Missouri (Bureau of Sport Fisheries and Wildlife), agreed to conduct static and "flow-through" bioassay with other aquatic forms such as plankton, larger crustaceans, eggs, and sac fry of fish and warm water fish such as bluegills.

The U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, is studying the movement of retardants into stream systems and their impact on streambottom organisms in Oregon, Idaho, and California.

Tanks used to conduct bioassay of fire retardants with trout and salmon at National Marine Fisheries Service Environmental Field Station on the lower Columbia River, Oregon.

Retardants Can Be Toxic

The final bioassay laboratory reports are now complete and as a result certain guidelines for using retardants near aquatic habitats have been sent to the field. The information received from the laboratories indicates that chemical fire retardants can be toxic to fish and other organisms when present in heavy concentrations in their aquatic environment.

Ammonia is the component of retardants causing the problem. All retardants contain ammonia and are therefore potential toxic agents.

The U.S. Forest Service study on field application will not be complete until 1975. In the interim, however, the following guidelines and precautions should be followed to minimize the entry of chemicals into streams when using fire retardants in or near areas which include important living aquatic resources.

Guidelines

1. Inform field personnel (fire personnel, lead plane pilots, airtanker pilots, etc.) of the potential problem of fire retardants in streams or lakes.
2. Locate retardant mixing and loading points where natural water contact is minimal.
3. Exercise care in prevention of accidental or careless spills at mixing, loading, and assembly areas, especially near live streams.
4. Exercise particular caution when using retardants in watersheds where fish hatcheries are located.
5. Avoid direct drops of retardants into rivers, streams, lakes or along lakeshores. Use alternative methods of fire line building (ground crews, helitankers, ground tankers, dozers).
6. Notify proper authorities promptly if a fish kill is observed in retardant use areas.
7. Include these precautionary measures in training fire personnel.

Automation of Fire Weather Observations

Floyd Maxwell,

Morris McCutchan and

Charles F. Roberts

The possibility of automatically obtaining a fire weather observation from any arbitrarily selected location on a District or Rating Zone has always held great appeal for those who have been engaged in fire danger rating and fire protection planning. Managers have long envisioned being able to obtain a reasonably complete weather observation from a remote location whenever it is needed without sending someone there to get the data or stationing someone there to make the measurements.

Automation of weather observations has been attempted in the past by many groups, including the Forest Service; however, none have achieved total success.

Since there really is no great technological problem in automating the sensing and transmission of weather data, problems encountered thus far can be judged economic rather than technical. The economic problems consist of high initial investment costs (in excess of $10,000 for a sophisticated system) and high continuing service and maintenance costs.

The economic justification for automation hinges largely on manpower savings, but for sophisticated systems one can actually experience increases in manpower costs by having to replace a clerical person who previously took weather readings with a skilled, highly trained electronics technician whose salary exceeds that of the clerk. In these cases, the justification for automation must rest on the capability of obtaining data that would not otherwise be available.

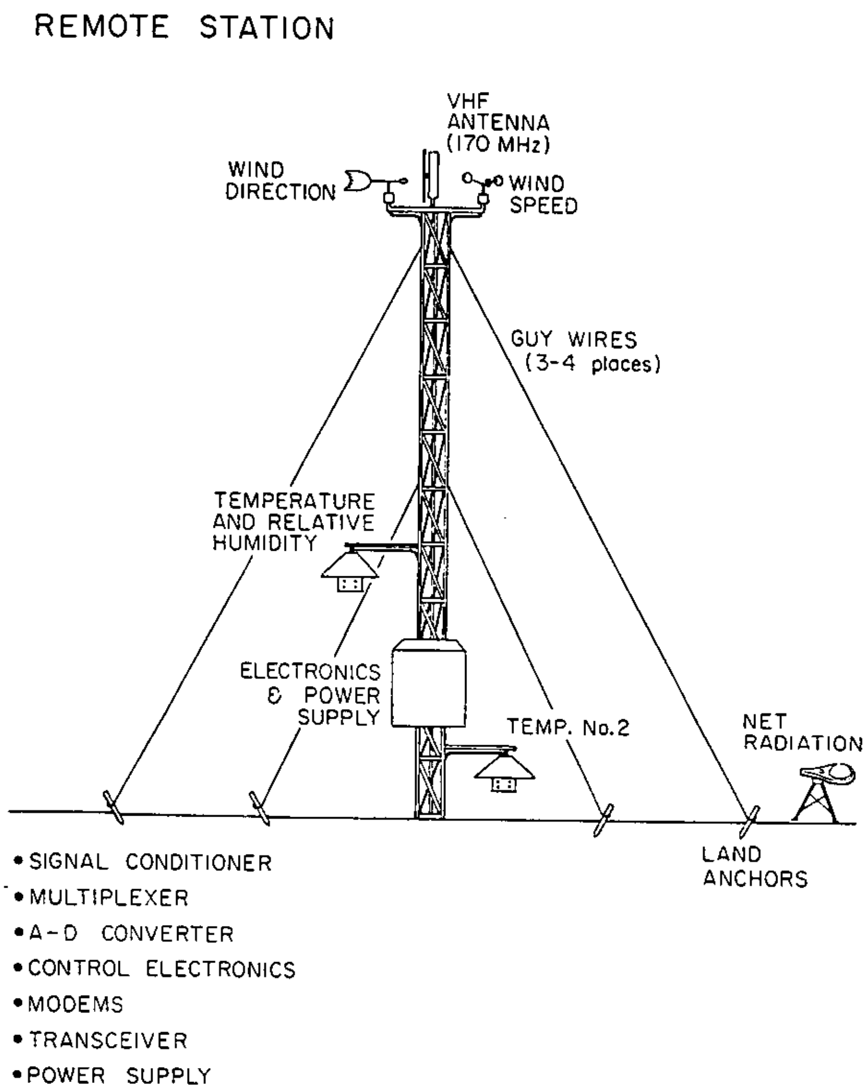


Figure 2. Sketch of a remote station of the meteorological research telemetry network.

Economic Problem Solving

The Forest Fire and Atmospheric Sciences Research program has recently initiated development work aimed directly at the solution of the economic problems involved in automating a fire weather observation for danger rating.

The Pacific Southwest Station has been assigned the responsibility

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Floyd Maxwell, Research Electronic Engineer, and Morris McCutchan, Research Meteorologist, located Forest Fire Laboratory, Riverside, Cal. Charles F. Roberts, Principal Research Meteorologist, Forest Fire and Atmospheric Sciences Research, Washington, D.C.

for developing a set of automatic fire weather measurement stations suited to at least 3 levels of cost constraints.

The principal effort involves the development of an inexpensive, reliable, semi-automatic fire weather station. A second effort involves a contract with Honeywell to perform the necessary modifications to adapt the U.S. Air Force droppable weather station to fire weather needs. The third consists of the installing of a sophisticated automatic meteorological research telemetry network in the San Bernardino Mountains of southern California to provide research data to support the PSW FIRESCOPE program.

The inexpensive, reliable, semi-automatic fire weather station will be capable of being remoted over distances of up to 25 miles. It will be semi-automatic in that a person located at a central facility will have to participate in the observation to the extent of querying the station, orienting the antenna, receiving and perhaps decoding the information, and monitoring the operation.

Price Goal

The price goal for such a system is "under $2,000" for each remote station. The price objective for the central or base facility, capable of handling up to 10 remotes, is "around $3,500." The validity of these cost objectives, which are approximations, will depend on the number purchased. The price goals stated are for a total production run of more than 100 units. Requests for proposals have been issued and if satisfactory responses are received, a contract should have been

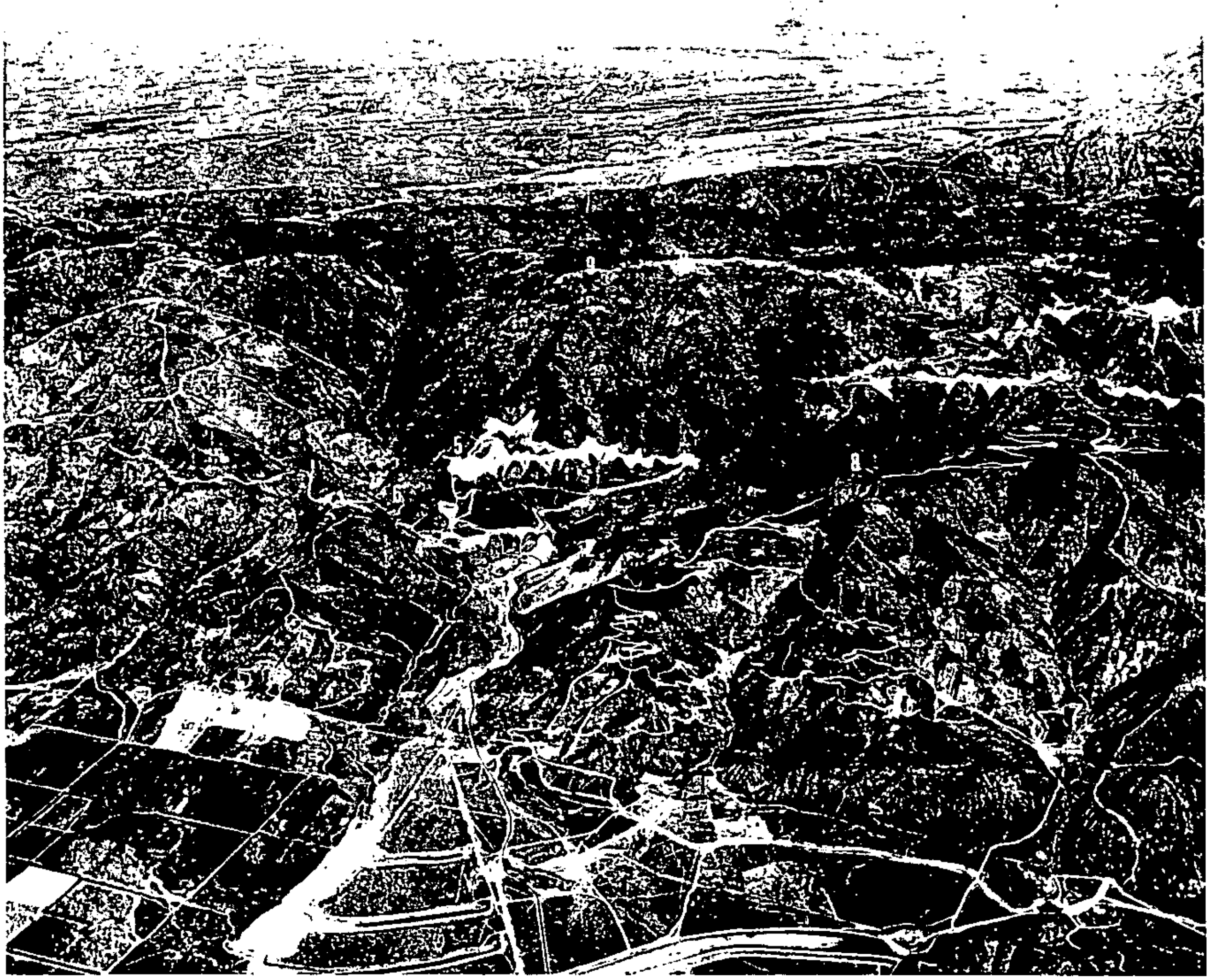
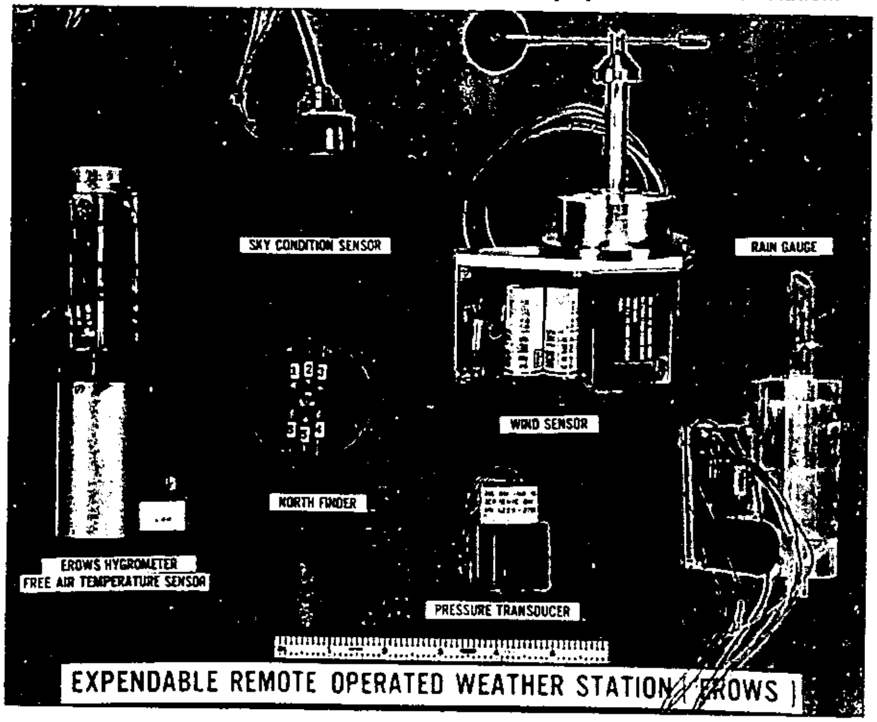


Figure 1. Oblique photograph of Devil Canyon in the San Bernardino Mountains. Remote station locations are numbered. R is the location of the repeater on Palvika Peak.

Continued on p. 24

Automation, from p. 23

Figure 3. Components of the air droppable, remotely operated weather station.



PARAMETER	RANGE	ACCURACY (2δ)	THRESHOLD	RESOLUTION
Air temperature	20°F-130°F	±2°F	—	1°F
Relative humidity	0-100%		—	
	@5-20%	±2% RH	—	1%
	@>20%	±3% RH	—	2%
Wind speed	2-99 MPH	±1 MPH [2-10]	<2 MPH	1 MPH
		±10% [11-99]		
Wind direction	0-359°	±15°	<2 MPH	Correct sector
Precipitation (dumped prior to each readout)	0-6 in	±.01 in [0-1]	.01 in	.01 in
		±10% [1-6]		10%

negotiated by the time you read this article.

The simple fire danger weather station will be equipped to supply measurements of air temperature, relative humidity, wind speed, wind direction, and precipitation accumulation. The contract will include an option for up to 3 additional sensors (probably fuel moisture analogues) without increased costs other than those involved in sensor purchase and any necessary signal conditioning circuitry.

The following are accuracy-resolution objectives for the different measurements to be provided by the system:

Second Approach

A second approach to automating the fire weather observation is also being undertaken by the PSW FIRESCOPE Program.This work grows out of the recognition that there are needs for fire weather data that cannot be satisfied by the simple economical station. An example is the need for fire weather data to serve as input for fire weather forecasting and fire behavior prediction. These applications involve atmospheric variables other than those included in the fire danger observation program.

To provide a system which meets this need an agreement has been negotiated with the U.S. Air Force Systems Command providing for the transfer to the Forest Service of automatic weather measuring equipment developed as a portable unit for use by the Air Force in combat situations. The Air Force deployment concept envisioned air dropping a sufficient number of these stations over a combat zone to define adequately the meteorological situation. The stations were designed for a stand-alone operation in the remote areas, and they were to be expendable. A layout of the Air Force equipment is shown in Figure 1.

The costs of a system capable of performing as an air droppable unit and which would also supply high quality meteorological measurements were too high to permit its being expended routinely. Hence, the Air Force program was cancelled, and the equipment transferred to the Forest Service.

While the Forest Service is not interested in employing the Air Force System as an air droppable, expendable unit, the miniaturized sensing and telemetering package using up-to-date high technology has great appeal for fire weather observations, especially in campaign fire situations. A contract has been negotiated with Honeywell, the original suppliers of the Air Force system, to perform those modifications necessary to adapt the Air Force equipment to fire weather needs.

Followup work on the communications aspect of the telemetering system will involve an attempt to utilize satellite communications to relay data in topographic situations which preclude line-of-sight transmissions.

Research Network

A third automation effort is underway in order to develop a proper research data base to answer many questions about weather effects on fires.

Questions relating to the placement of fire weather stations (How many? What separation distances are optimum? etc.) can also be addressed. For this purpose the Pacific Southwest Station is installing a sophisticated automatic meteorological research network consisting of 10 stations to be located in the San Bernardino Mountains north of the city of San Bernardino, California, at elevations ranging from 1,800 feet to 5,300 feet. Locations will include canyons, with sites on the floors, walls, and ridges. The general configuration of the stations' instrumentation is shown in Figure 2.

Devil Canyon Selected

Devil Canyon has been selected as the first site for intense meteorological measurements in this program because of its north-south orientation and its great vertical extent. This area is subject to a wide variety of local weather regimes, including sea breeze, Santa Ana, and canyon winds. The terrain for the location of the meteorological research network is depicted in Figure 3.

Each of the stations will measure wind, air temperature, relative humidity, precipitation, net radiation, and ground level temperature. All sensors will be advanced state-of-the-art with matched accuracies and response times.

The system will provide its own radio coverage of the measurement area with a computer-controlled master station to command and sequence remote station reporting. The master station consists of a General Nova 1200 mini-computer, with 24K memory, real time clock and power failure option, ASR 33 teletype, a Wangco 9-track tape transport and General Electric Model 549-AISI remote control console for voice transmission to remote stations.

The network is projected for installation, check out, and initiation of data gathering operations during the summer of 1974.

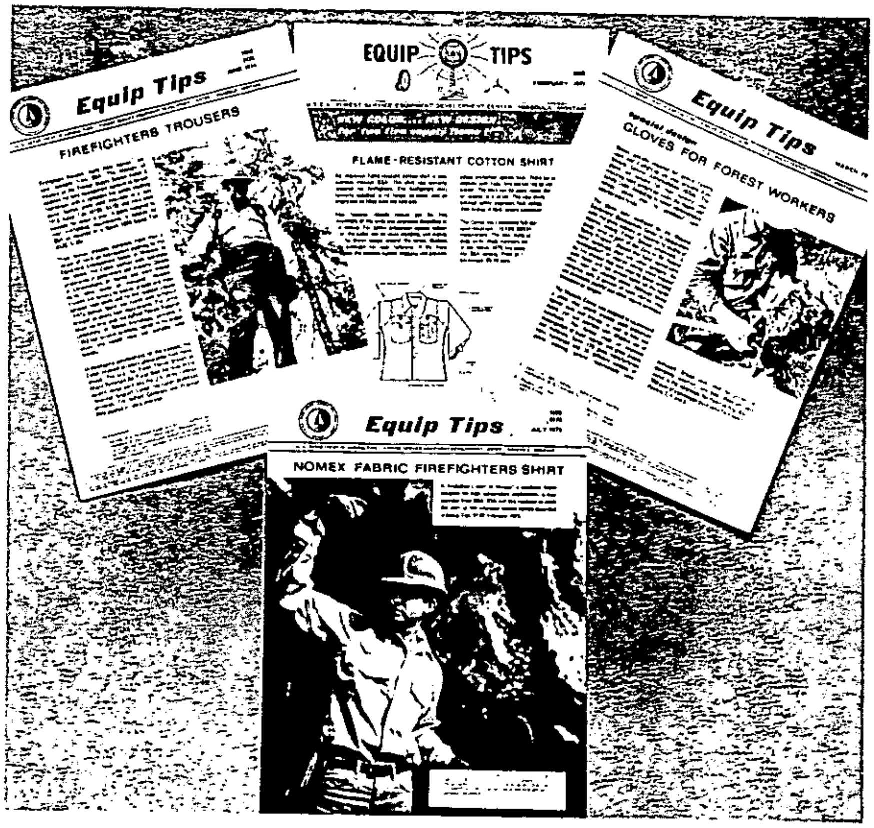
Fire Management Safety Equipment Development

Arthur H. Jukkala and Richard L. Marsalis

When the National Fire Safety Review Team met in 1967 it made a number of specific recommendations about fire safety clothing and equipment. The team and the Washington Office wanted development completed on fire-resistant trousers and face heat shields. The team also wanted work initiated on firefighters' gloves and recommended studying coveralls and other types of loose fitting fire-resistant garments worn over work clothing. It also recommended continued development of fire shelters to improve protection, reduce weights, and lower cost.

Fire Protective Equipment

The Equipment Development Center at Missoula has acted on these recommendations. Work was recently completed on Nomex trousers. The fire retardant-treated (FRT) cotton workshirt was improved and a specification written for a Nomex workshirt. Both shirts are being used in the field. Special leather gloves offering thermal and flame protection are available. The General Services Administration now stocks these items, and it is possible for land management agencies to furnish firefighters with a complete safety clothing outfit.



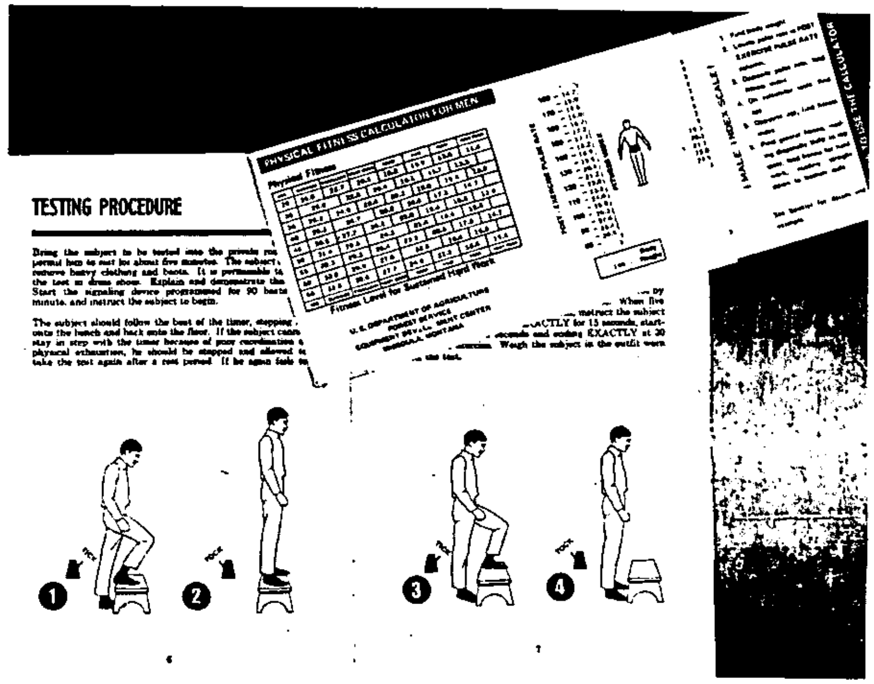
Safety clothing developments

Continued next page

Fire Management Safety, from p.25

After the fire safety review team recommended that coveralls be studied, a number of field units also expressed interest in them. We discourage the use of coveralls for these reasons: (1) They are usually worn over other garments, and this double layer of clothing restricts body cooling which results in higher worker heart rates and increased physiological stress. (2) Coveralls are made from a single-weight fabric and do not take into account the different clothing requirements of the upper and lower parts of the body. Garments made from heavy trouser-weight fabrics chafe if worn directly over underwear. Whereas garments made from shirt-weight fabrics and sometimes called jumpsuits do not provide adequate leg protection. (3) A one-piece garment seldom fits properly because the distance between crotch and shoulders is fixed. In a work situation this causes chafing and discomfort. (4) One-piece garments made from fire-resistant fabrics are expensive. Unlike a shirt and trouser outfit, if part of the coverall, top or bottom, becomes unserviceable, the entire garment must be replaced.

The Center has reviewed face heat shields and concluded that they have two basic uses: (1) As a comfort item so firefighters can work closer to the flames for short periods. (2) As an escape item that protects firefighters during a dash to safety to avoid entrapment. We uncovered little evidence to support the need for further development of comfort-type face shields. In fact, this type of protective device may be more harmful than beneficial because it enables a firefighter to work longer in an extremely hot environment, diminishing his work capacity and increasing the risk of heat exhaustion, heat cramps, and heat stroke. We recommend that work on comfort-type face shields be deferred until a need for them can be justified and that development concentrate on face shields for escape use.



Forest Service physical fitness test

A Forest Service physical fitness test has been developed and is being used voluntarily in all Regions. Last year the California Region required that "red card" holders exceed a minimum test score. This practice will soon be adopted nationally. Currently the calculator is being simplified so that fitness levels can be determined more easily.

The Center tested and reported on a full-head heat shield and smoke hood developed by the Federal Aviation Administration. The Washington Office chose not to adopt this item for Forest Service use because it has a short air supply (about 30 seconds when the wearer is running). No further work on face protective devices is planned at this time.

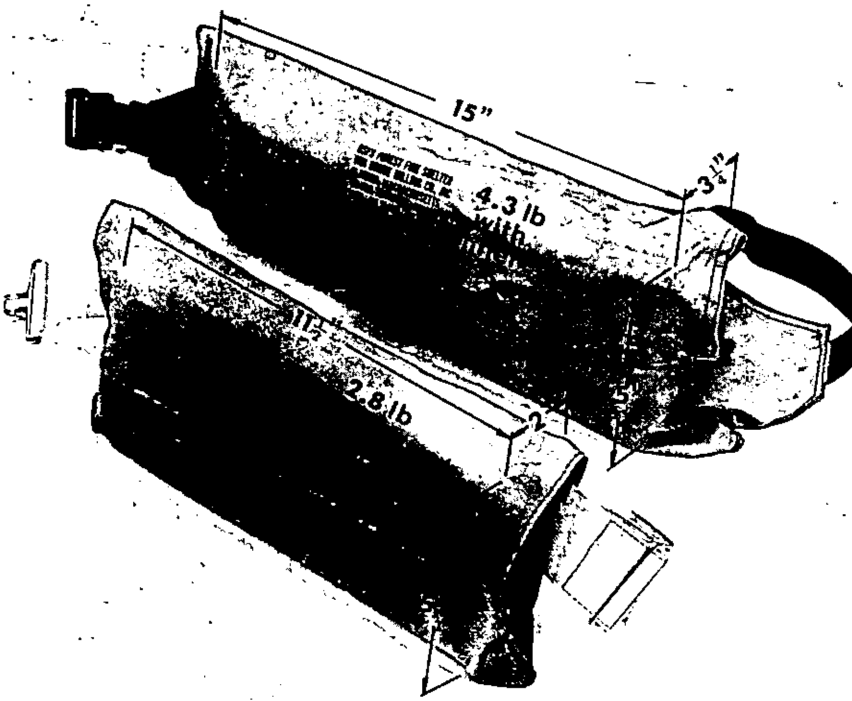
Arthur H. Jukkala and Richard L. Marsalis are equipment development specialists at USDA Forest Service, Missoula, Montana, Equipment Development Center.

The fire safety team recommended continuing efforts to improve fire shelters including reducing their weight. More recently the California Region stressed the need for reducing the shelter weight. Center engineers concluded that the best way to lighten the shelter without compromising protection was to remove the inner liner. This was done and the procurement specification rewritten. The revised shelter weighs 1-1/2 pounds less than the old shelter. It is also more compact, and the belt case has been redesigned to improve carrying comfort. The lighter shelter will be in GSA stock prior to the 1975 fire season.

Other Safety Developments

Since the Fire Safety Review Team met, the Center has worked on other safety items. Protective chaps have been designed for chain saw operators and are now stocked by GSA.

A large field first aid station to serve 300-man crews and larger has been developed.



Shelters with and without liner

References

Brouha, Lucien
1960. Physiology in industry. Permagon Press Ltd.

Jukkala, Arthur H.
1973. Kapton fire escape hood. USDA For. Serv. Missoula Equip. Develop. Center, proj. record (unpub.), ED&T 829, Jan.

Jukkala, Arthur H. and R. Lynn Marsalis
1970. Face heat shields. USDA For. Serv., Missoula Equip. Develop. Center, proj. record (unpub.), ED&T 829, Jan.

Marsalis, Richard L. and Ray G. Beasley
1971. Field first aid station. USDA For. Serv. Fire Control Notes, Summer 1971, Vol. 32, No. 3.

Missoula Equipment Development Center
1960. Protective clothing and equipment for firefighters. USDA For. Serv. Tech. Equip. Rpt. No. ACF-7, March.

———
1971. Field first aid station. USDA For. Serv. Equip Tips, 6170, Oct.

———
1971. Flame-resistant cotton shirt. USDA For. Serv. Equip Tips, 5100, Feb.

———
1972. Protective chaps for chain saw operators. USDA For. Serv. Equip Tips, 6170, Feb.

———
1973. Firefighters trousers. USDA For. Serv. Equip Tips, 5100/6170, June.

———
1973. Gloves for forest workers. USDA For. Serv. Equip Tips, 6170/5100, March.

———
1973. Nomex fabric firefighters shirt. USDA For. Serv. Equip Tips, 5100/6170, July.

Ramberg, R. G.
1974. Firefighters physiological study. USDA For. Serv., Missoula Equip. Develop. Center, proj. record (unpub.), ED&T 2003, May.

USDA Forest Service
1967. Report of the Fire Safety Review Team, March.

Chain saw chaps and field first aid station.

New Fire Research Publications

These publications are available from various offices of the Forest Service and private organizations. If you would like to obtain a copy, write to the office indicated in parentheses at the end of the citation, e.g. (INT), Intermountain Forest and Range Experiment Station.

Behan, Mark J., Ronald N. Kickert, and Alan R. Taylor.
1973. The toll of fire in western coniferous forests: a problem analysis. Progress Report Fire Ecology Project Coniferous Forest Biome. IBP, Univ. of Mont. 9 p. (IBP,UM)

Bernardi, Gene C.
1973. Fire prevention film spots for television . . . narrator influence on knowledge and attitude change. USDA Forest Serv. Res. Paper PSW-94. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif., 14 p. (PSW)

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Bernardi, Gene C.
1974. Fires caused by equipment use during critical fire weather in California, 1962-1971. USDA Forest Serv. Res. Note PSW-289, 6 p. (PSW)

Cooper, Robert W.
1974. Pollutants emitted by prescribed burning and wildfires on the forest. Presented at Program in Air Pollution Effects to Plant Life, VPI and State Univ., Blackburg, VA., Mar. 4-6, 9 p.

Cooper, Robert W., and Hugh E. Mobley
1974. The smoke management research and development program at the Southern Forest Fire Laboratory. Presented at Third Natl. Conf. on Fire and For. Met., AMS/SAF, Lake Tahoe, California-Nevada, April 2-4, 10 p.

Deeming, John E., and William G. Sullivan.
1974. Automation of the National Fire Danger Rating System-impacts on the fire weather forecaster. Bull. Am. Meteorol. Soc. 55:68 (Abstr.) National Weather Forecast Offices in Arizona and California participated in the field trials of AFFIRMS (Automatic Forest Fire Information Management and Retrieval System). Communication of fire weather observations from the field to the forecaster and from the forecaster to the users was greatly simplified.

Donoghue, Linda R.
1973. Prescribed burning the the Lake States—1971, USDA Forest Serv. Res. Note NC-156 2 p. (NC)

Folkman, William S.
1973. Roadside fire prevention signs . . . a restudy of their effectiveness. USDA Forest Serv. Res. Note PSW-282 Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif., 6 p. illus (PSW)

———
1973. Public involvement in the decision-making process of natural resource management agencies: with special reference to the Pacific Northwest Institute of Governmental Research, Public Affairs Paper 3. 29 p. University of Washington, Seattle, Washington. (PSW)

Furman, R. William, and Robert S. Helfman.
1973. Computer time-sharing used with NFDRS, Fire Manage. 34(2) 14-16 (RM)

1973. A computer program for processing historic fire weather data for the National Fire-Danger Rating System. USDA Forest Serv. Res. Note RM-234 11 p. illus. (RM)

Finklin, Arnold I.
1973. Meteorological factors in the Sundance Fire Run USDA Forest Serv. Gen, Tech, Rep. Int-6, 46 p. (INT)

Mobley, Hugh E.
1974. Air pollution regulations and their effect on forest management. Presented at Speciality Conf. on Control Tech. for Agr. Air Pollutants, APCA, Mar. 18-19, Memphis, TN.

Pharo, James A.
1974. Prescribed fire's environmental impact—an assessment. Presented at Third Joint Natl. Conference on Fire and Forest Meteorology, AMS/SAF, Lake Tahoe, California-Nevada, April 2-4.

Ryan, Paul W.
1974. Quantity and quality of smoke produced by southern fuels in prescribed burning operations. Presented at Third Joint Natl. Conf. on Fire and Forest Meteoro., AMS/SAF, Lake Tahoe, California-Nevada, April 2-4.