United States
Department of
Agriculture

Forest Service

Volume 45, No. 2
1984

Fire Management Notes

After 40 YEARS

. . . still the same message!

Fire Management Notes

An international quarterly periodical devoted to forest fire management

United States Department of Agriculture

Forest Service

Volume 45, No. 2
1984

Contents

Cover: Smokey Bear reminds us he's still on the job. Story on p. 6.

Fire Management Notes is published by the Forest Service of the United States Department of Agriculture, Washington, D.C. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through September 30, 1984.

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

NOTE—The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement of any product or service by the U.S. Department of Agriculture.

Disclaimer: Individual authors are responsible for the technical accuracy of the material presented in Fire Management Notes.

Send suggestions and articles to Chief, Forest Service (Attn: Fire Management Notes), P.O. Box 2417, U.S. Department of Agriculture, Washington, DC 20013.

In-Ear Transceivers Improve Communication In High-Noise Environments

David L. Bunnell

Forester, USDA Forest Service, Lolo National Forest, Missoula, Mont.

A new communicating device that substantially increases user ability to communicate in high-noise environments is being used on the Lolo National Forest in Missoula, Mont. Use of the transceiver supplements existing radio equipment. It attaches directly to portable radios with external microphone capability, or through interface connections on radios without external microphone capability (fig. 1).

The solid state transceivers transmit or receive signals, and have been modified by the producer to be compatible with Forest Service uses. The transceivers substitute for the microphone and speaker in the radio system to which they are attached. A push-to-talk (PTT) switch is located on the control module. This module can be mounted on belt (fig. 2) or shirt for field use. The PTT switch is available as a hand switch, foot switch, underarm pressure switch, or steering wheel switch. The addition of this equipment does not alter the technical performance characteristics of the radio.

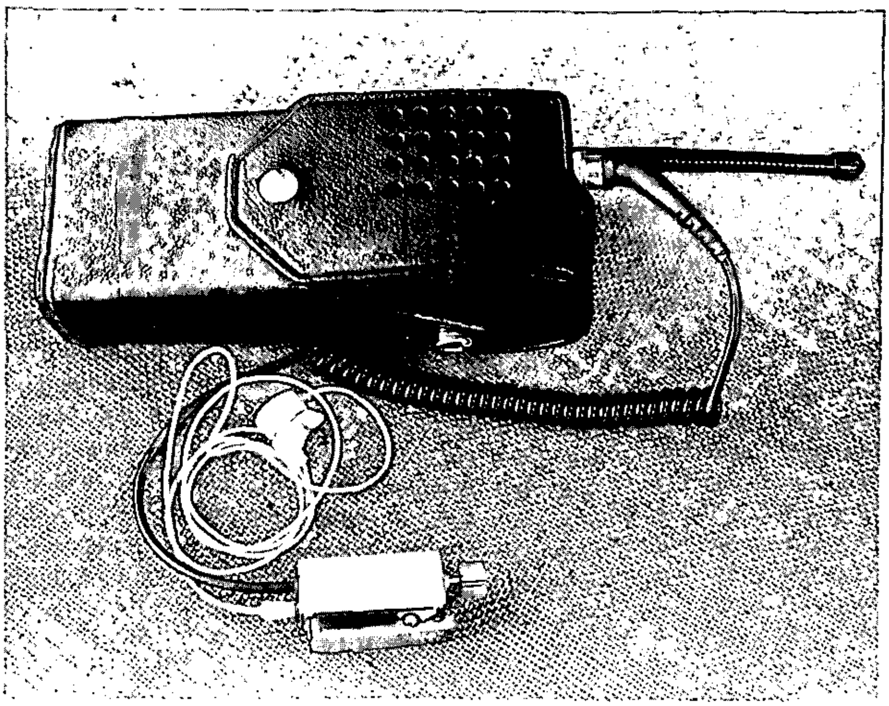
Figure 1—*In-ear transceiver with portable radio.*

Construction

The components of the transceiver are: an earpiece, a control unit, and interface cables. The earpiece is available in standard left or right ear and in small, medium, or large sizes. The standard sizes comfortably fit about 90 percent of the Lolo employees who use them. Custom-fitted earpieces are also available. A wax impression of the ear opening and configuration is made as a model for the earpiece construction.

The control unit amplifies and conditions voice signals detected by the earpiece microphone. The gain of the control module amplifier is preadjusted to provide stabilized gain settings for the radio. Power for the system is pulled from the radio set at the same output as the transmitter and receiver in the radio.

The earpiece assembly consists of an ultraminiature transducer that functions as a microphone on transmit and a speaker on receive. The transducer detects voice energy through the ear-throat canal and the control unit amplifies, filters, and conditions these voice signals, passing the processed signals to the associated transceiver system for transmission. Received audio signals are input from the transceiver to the control unit. The signal is then transmitted to the earpiece for audio signal reception.

The transceiver device allows the user to understand and be understood precisely without an external headset or a mouth microphone. It allows the user to hear and respond in high-noise situations, and it al-

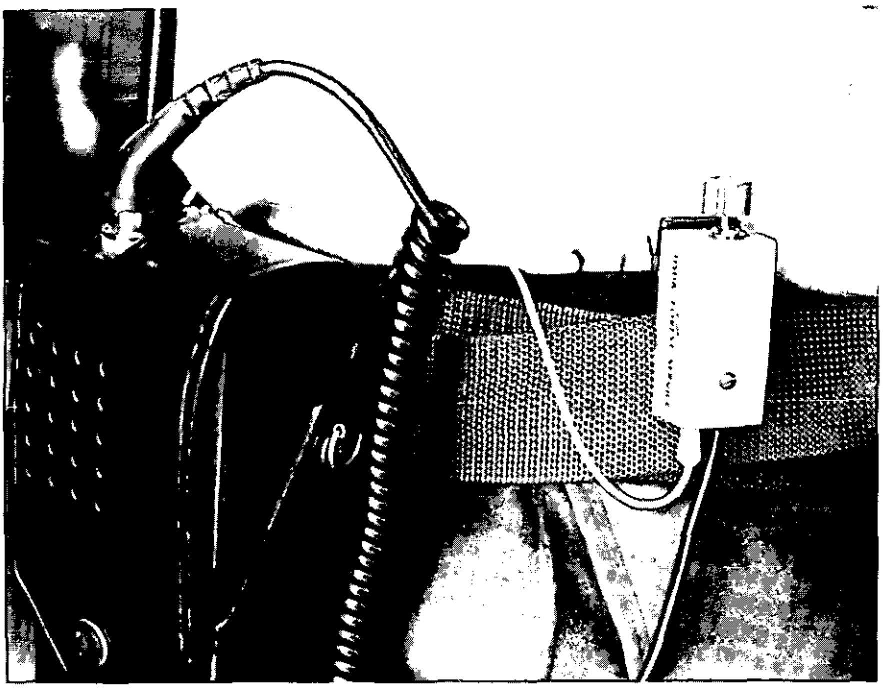

Figure 2—*In-ear transceiver and command portable radio worn on belt.*

lows discrete communications between users, as transmissions are audible only to the wearer. With the earpiece in place, no squelch break or transmission is audible to anyone standing nearby.

The earpiece is connected to the control module by a thin cable. The cable should be passed under the shirt and out the collar to the ear. When worn this way, only 4 to 6 inches of cable are exposed and the possibility of snagging the cable on equipment or brush is reduced. The belt control module has worked best for users on the Lolo National Forest, with the PTT switch located directly on top. Voice transmissions are extremely clear and have all the modulation, resonance, and inflection of normal voice communications. Worn in the manner described, the system allows for complete freedom of movement and very limited opportunity for snagging or equipment damage.

Safety

Precise communication is essential to safety and success in the field. Especially in fire management operations, there is a need for precise communications. For instance, ignition personnel in prescribed burn units are often operating in high-noise and poor-visibility situations. Individuals are often at risk from rolling stumps and logs. Noise of the fire, brush cracking underfoot, and nearly incessant radio transmissions often make radio communications inaudible. It is critical that these individuals hear instructions and warnings precisely. Using traditional radio equipment, radio transmission of "Jones, go left, log coming" might only cause Jones to stop, remove his radio from his belt holster, place the radio in front of his face, and respond "Jones to station calling?" Jones' response may not be understood, may be inaudible, or may be disregarded as unimportant radio traffic. A transmission of "Jones, go left, log coming" transmitted directly into Jones' ear would undoubtedly be met with an immediate reaction.

Uses

During tests and in actual field use on the Lolo National Forest, users have found that in-ear transceivers significantly improve communications during the following activities:

- Prescribed fire ignition
- Wildfire line construction by tractors
- Wildfire line construction by saw crews
- Tanker operations

- Portable pump operations
- Helitorch ignition
- Heliport operations
- Helicopter sling load operations

Transceiver might also be used when operators need to have their hands free for:

- Discreet surveillance by law enforcement authorities
- Heavy equipment operation
- Use of surveying equipment
- Smokejumper training
- Logging operations, like long-line skidding.

The unit has been demonstrated to city and rural firefighters. They feel that this device has significant application to fighting structural fires, especially when communication is impaired because of gas and smoke masks.

Advantages

The in-ear transceiver performed flawlessly during experiments and field uses in 1983. Twenty-four transceivers are being used on the Lolo National Forest to supplement existing radio systems. Some users report that voice clarity is better than speaking directly into a conventional radio microphone. In some instances, transmission clarity is improved if hardhats with attached ear muffs are used.

The present cost of each unit varies from $200 to $250. Cost is the same for all UHF, VHF, and compatible HF radios.

Other new, advanced communicative devices are available from many manufacturers. The in-ear transceivers are only one step in updating our present equipment.

There are seven reasons users of the in-ear transceiver on the Lolo National Forest recommend its use: It is simple to use, maintenance free, and durable; it does not change the technical capacity of radio equipment that it is attached to; it is economically feasible, adaptable to forest uses, and it works. ■

Celebrating Smokey's 40th Birthday

Gladys Daines

Program Manager, USDA Forest Service, Washington, D.C.

The 1984 Smokey Bear Campaign featuring Smokey's 40th birthday was launched at a public meeting on March 12, 1984, in Washington, D.C. Public Service Advertising (PSA) spots for radio and television and advertisements for magazines and newspapers were displayed, along with the new posters and other materials.

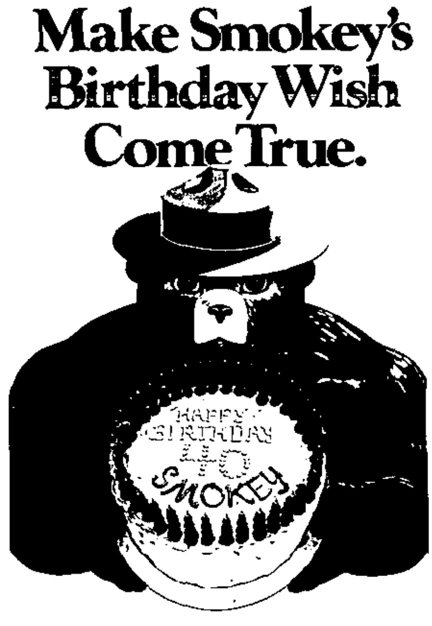

Figure 1—*1984 campaign decal.*

The 40th birthday poster shows Smokey with his birthday cake and candles. The copy says "Make Smokey's Wish Come True." Smokey's birthday cake is featured on television PSA's with a sound track of children singing "Happy Birthday." The radio PSA has recorded animals, birds, and insects that chirp and sing to the "Happy Birthday" tune.

John B. Crowell, Jr., Assistant Secretary of the U.S. Department of Agriculture, told the audience at the public meeting of the $20 billion savings that has accumulated since 1942 for American taxpayers through the reduction of burned acreage. Crowell also said the Department of Agriculture was dedicated to continuing the Smokey Bear program.

In August 1984, the National Zoological Park in Washington, D.C., unveiled a feeder tree to celebrate Smokey's 40th birthday. The feeder tree was constructed of concrete and wire, molded in the shape of a dead beech tree. The apparatus inside the tree will randomly deliver honey, chocolate chip cookies, live beetles, and other choice morsels to the living symbol of Smokey Bear at the zoo. Smokey will get some exercise using the feeder tree, and visitors to the zoo will have more opportunities to view the bear outside his den.

"Smokey may be getting older, but he is also getting better," said Max Peterson, Chief, USDA Forest Service. "He is still one of the most successful of all advertising symbols in the United States. And he is still one of the most popular and beloved animal characters."

Happy Birthday, Smokey Bear. May your wish come true! ■

Predicting Fire Behavior in Big Sagebrush

Big sagebrush *(Artemesia tridentata)* occupies extensive areas of the western United States and Canada and poses problems for resource managers in both controlling wildfires and knowing how to prescribe fires for various purposes. An ability to predict fire behavior accurately is an important aspect of both jobs. Using a system developed at the Intermountain Forest and Range Experiment Station, forest and range managers can now estimate and predict the amount of sagebrush fuel in a given area and can predict fire behavior.

The system, a set of graphs, is based on computer models and is presented in Research Paper INT–290, "Fuel and Fire Behavior Prediction in Big Sagebrush." The user must input data on height and cover of sagebrush and weight of accompanying grasses and forbs. Using the system the manager can then predict the rate of fire spread and the intensity of fire in sagebrush ranging in height from 8 to 47 inches (20 to 120 cm) and from 10 to 40 percent ground cover. Other information—quantity of foliage and stemwood by size class, plant bulk density, and fraction of dead stemwood—is also produced as it must be computed to determine fire spread and intensity.

The system, based on 10 to 15 years of research at the Intermountain Station, demonstrates the current state of knowledge in modeling fuels and fire behavior in sagebrush. Range and fire managers are the primary beneficiaries, but researchers and those interested in plant ecology and biomass may also find the work useful.

Copies of *Fuel and Fire Behavior Prediction in Big Sagebrush,* Research Paper INT–290, are available from the Intermountain Forest and Range Experiment Station, 507 25th St., Ogden, UT 84401. ■

Agency Cooperation Through NIIMS[1]

Jim Whitson and Marvin Newell

Forester, Florida Division of Forestry, Tallahassee, Fla., assigned to the FIRETIP Project; Project Leader, FIRETIP Project. Both are stationed at the USDA Forest Service Boise Interagency Fire Center, Boise, Idaho.

Money is tight—not just for private citizens but for government agencies as well. Even emergency service agencies are facing continuing reductions in budgets, staff, and equipment that are needed to meet routine situations. Those who administer such agencies are rapidly coming to realize that we can no longer manage many types of emergencies alone. It is becoming increasingly clear that we must depend upon immediate and coordinated response from other agencies at all levels of government. The emergency management load must be shared by local, regional, and national agencies—not only in the interests of economy but in the interest of effectiveness.

One response to this budget crunch has been the development and implementation by some of the Nation's wildland fire protection agencies of the National Interagency Incident Management System (NIIMS). Designed to improve coordination and cooperation among all levels of wildland firefighting organizations, NIIMS is easily adaptable to all types of emergencies.

Major disasters occur throughout the country every year. Each region has its own disasters, such as hurricanes, tornados, earthquakes, blizzards, fires, or floods. All such major incidents require multijurisdictional and multiagency assistance.

Fire, police, medical, city, county, State, and Federal agencies have their own individual responsibilities and authority for a part of an emergency situation. In many parts of the country, however, a lack of clearcut lines of responsibility and authority makes it difficult for public safety agencies to work effectively together. Historically, they have operated as separate entities, guarding their own turf, and operating separate—but not necessarily equal—communications systems, processes, and emergency organizations. They have each had different procedures, terminology, training, and maps. With such built-in incompatibilities, it is not surprising that emergency agencies are often not as well coordinated or effective in responding to an incident as they could be in order to maximize savings in both lives and property.

It is not easy to initiate a cooperative program that will pull all affected agencies together into an integrated and unified incident management system. One requirement for such a system is that it serve both for day-to-day incidents as well as for major incidents that necessitate expansion of resources to accomplish control. NIIMS is designed to meet this requirement and is currently being implemented at several locations in California, Colorado, Florida, and Nevada. Other communities around the country have expressed interest in NIIMS as a means to improve their multiagency, emergency-coordinating problems.

How NIIMS Works

NIIMs is made up of five major subsystems that collectively provide an approach to incident management. These subsystems are:

- An on-scene management structure called the Incident Command System (ICS). This subsystem includes the operating requirements and interactive management concepts for organizing and operating the system.
- Standard training that supports the effective operation of NIIMS.
- A qualifications and certification system that provides personnel meeting standard training, experience, and physical fitness requirements necessary to fill specific positions in the ICS.
- A publications-management subsystem that provides for the development, publication, and distribution of NIIMS material.
- A supporting-technologies subsystem, including specialities such as communications and orthophoto mapping.

The ICS of NIIMS is designed to respond to all types of emergencies, large or small, local, regional, or national. It does not matter whether the system is being used by a local

[1]Reprinted with permission from *American Fire Journal* 35(11) 1983.

fire department, the Sheriff's office, a Federal agency, or a combination of all three. The system is adaptable to any kind of emergency situation and any grouping of agencies involved in it. It provides common standards of organization, procedure, and terminology, while retaining flexibility to meet local, regional, and national needs.

The ICS works well on small emergencies occurring entirely within a single agency's jurisdiction. If an emergency becomes too large for that agency to handle, the organization can expand in a logical progression through an extended response from several local or regional agencies, to a full-scale, national emergency, requiring complex operational interrelationships among several jurisdictions and many agencies. ICS accommodates this without interfering with the autonomous jurisdictional responsibility of each agency—regardless of that agency's size.

The other side of the ICS coin is total mobility. So long as all emergency agencies are cooperating under this system, it is possible to move the nearest trained emergency personnel without worrying about jurisdictional boundaries and agency affiliation. Mutual aid agreements, and shared communications, training, standards, and terminology all make this possible.

Since resource needs vary widely according to the kind of incident involved, NIIMS allows for maximum use of previously developed qualifications, standards, and certification of personnel. The system identifies the training and resources needed for dealing with a particular emergency, and identifies the individuals and organizations having those qualifications. At the same time, the improved communications between agencies provided for under NIIMS advances the spread of useful new technology.

NIIMS does not impose extensive, expensive, national training standards on cooperating agencies; it is simple and logical enough to ensure low training, operation, and maintenance costs. It also provides for local and regional development of a qualifications and certifications system to meet local and regional needs.

When different emergency agencies begin to train together and to communicate, when they begin to share common problems and find common solutions, a bond of trust develops, leading to more efficient use of diminishing resources. NIIMS is a practical, workable method of effectively utilizing interagency resources for handling any kind of emergency quickly and efficiently. As public budgets get smaller and smaller, NIIMS is looking better every day. ■

New Fire Camp Shower

David L. Levesque

Fire Cache Worker Leader, Aerial Fire Depot, Missoula, Mont.

A new shower unit has been developed at the Forest Service Region 1 Fire Cache in Missoula, Mont.[1] It replaces an antiquated, military-type unit that was difficult to operate and expensive to maintain. Many of the items needed to set up the new shower unit are already used by the Forest Service for other purposes. The only additional purchase required is a water heater module with thermostat. The heater is oil-fueled, 700,000 Btu, 115 V, 60 cycle, Model 9400, purchased for $1,308.

Antiquated wall tents, previously used for showers on fire camps, are being replaced with collapsible, lightweight walls. The walls are easy to assemble and dismantle, and require less setup time than the tents. The sections are made of reinforced, plastic, tent-fly materials and are easily cleaned. The fabric is stretched over conduit frames. Adjustable legs permit the frames to be installed in level sections on uneven terrain. The use of conduit frames also allows the use of separate shower cubicles that can be placed up to 2 feet apart to increase privacy. A manifold-type shower head apparatus straddles the 2-foot area to supply water to both shower cubicles. Each cubicle has four shower heads (fig. 1).

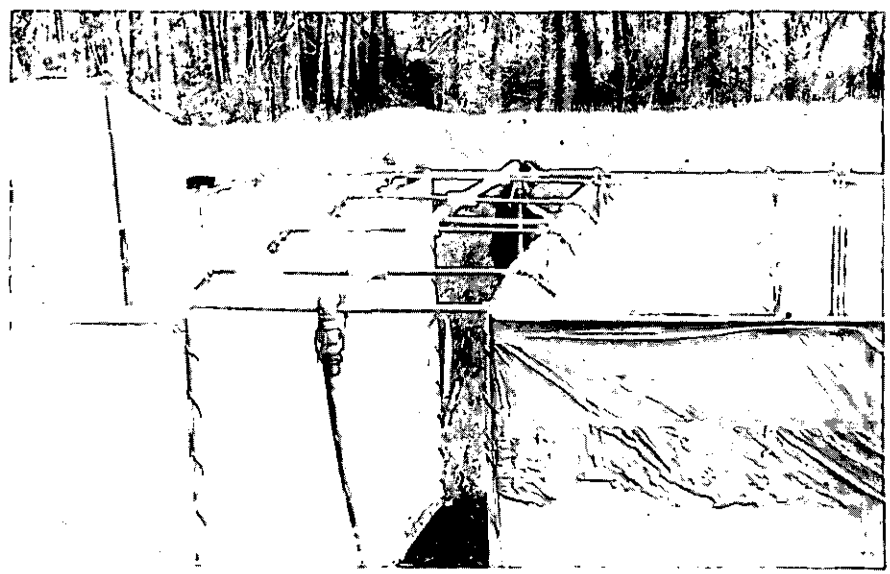

Figure 1—*View of Region 1 fire camp shower.*

The new shower stalls have duckboard platforms. A large dressing area has also been added, and indoor/outdoor carpeting covers the floor of the large area adjacent to the shower stalls.

The shower unit can be transported to fire camp in a one-ton truck (fig. 2). The heater, pump, and generator remain on the truck. Then it is a simple matter of connecting hoses. Hose connections

[1]Levesque received an employee suggestion award for this development from the USDA Forest Service.

Smoke Chasing—1925

Samuel T. Billings

District Ranger, retired, USDA Forest Service, Bitterroot National Forest, Mont.

How many oldtimers still remember the first fire they smokechased?

In the summer of 1925, I was headquarters smokechaser at Sylvanite Ranger Station, Troy, Mont., in the Kootenai National Forest. A. E. Beckwith was district ranger. Garth Kenelty was alternate ranger. There was a packer and a three-person trail telephone maintenance crew out in the woods. That was the district force.

In those days the firepack consisted of a 2½-pound double-bit axe, a Koch tool (grub hoe and shovel combination), and three emergency rations. Each ration was composed of two packages of hardtack (Civil War type), a package of raisins, a can of sliced bacon (usually rancid), ground coffee, and a kit of condiments—salt, pepper, and sugar. A ration was supposed to last a day.

The equipment and rations were all in an enormous packsack with no packboard. The Koch tool was in three pieces: the massive wide-blade grub hoe, the full-size steel shovel, and a heavy hardwood handle, about 3½ feet long, flared out at one end to hold the grub hoe and fitted with a pointed steel rig on the other to fit into the shovel. It was quite a tool.

We tried to protect our backs from the metal parts by placing the emergency ration between the tools and our backs. We carried the Koch tool handle as a cane. We could have done a good job of defending ourselves from a grizzly with it. In the other hand, we carried the axe. This was a year before the ranger district received the Pulaski tool and the Clack backframe.

There was a headset-type flashlight in the packsack for use at night. The flashlight had an elastic band or strip to hold it on. An extension cord ran from the flashlight to the battery box, at the belt, or in a side coat pocket. There was an extra set of batteries in the packsack.

Lightning set a fire up in Fourth of July Creek. It smoked up pretty good, and Beckwith, Kenelty, and I went to it. When we reached it about 5:00 p.m., it was about 3 acres, burning in light fuels on a south slope—just creeping along.

We had a fireline around the fire by midnight. Beckwith and Kenelty left for the ranger station, leaving me to put out the 3-acre fire. They left all the rations from their packs for me.

The humidity was high that night and the fire was under control, so I looked for a place to lie down and sleep. A fire was under control in those days as soon as a fireline was trenched around it. The most likely spot seemed to be out in the burn, beside a windfall that was burning but not too briskly. After scraping off the ashes and smoothing out the rough spots with the grub hoe, I lay down and slept until dawn. Before an emergency-ration breakfast in the morning, I circled the fireline and put out two or three little smoldering slopovers.

The next 6 days I spent in mop-up. A fire in those days was either "under control and under mop-up" or it was "out of control." There was no such thing as a fire being "contained." Mop-up consisted of starting in from the fireline and putting everything dead out, foot by foot. Any underground smudges were dug out and mixed with dirt. Smudges were detected by sighting smokeflies in a tight group in the ascending heat, a few inches or so above a fire that was giving off neither smoke nor flame.

Burning chunks were squared around so they wouldn't roll. Fire was scraped away from standing snags. Burning snags were felled. Burning stumps were dug out, chopped up, and the pieces spread apart. No water was used. There wasn't any within an eighth of a mile, anyway.

Much of the mop-up was done on hands and knees; possible hot spots were felt out with bare hands.

On the evening of the third day, Gene Guish, who lived, and still does, at the mouth of Fourth of July Creek, came in with a packsack of emergency rations. Not even a fresh loaf of bread. Hardtack isn't too bad if fried in bacon grease in the shovel over hot coals. But after 3 days?

After 6 days, having thoroughly gone over the perimeter on hands and knees, feeling for hot spots with my bare hands, I declared the fire out, and shouldered my packsack, now empty of any rations to protect my back from the tools.

Walking back up to the Yaak Road to the Sylvanite Ranger Station, I must have been quite a sight to a passing Model T of people: a week's beard, shirt and pants in tatters, filthy and carrying an axe, and a strange looking walking stick. That was my first fire. ■

Fire—A Natural Component

Wildfire plays a major role in forest succession throughout the northern Rocky Mountains, including those forests east of the Continental Divide in Montana. Lodgepole pine *(Pinus contorta)*, for example, owes its present widespread occurrence to past fire. Without fire, Douglas-Fir *(Pseudotsuga menziesii)* would occupy areas where ponderosa pine now occurs but is not climax.

The Intermountain Station has published a report summarizing fire ecology and management information that applies to forest habitat types east of the Continental Divide in Montana. The authors are William C. Fischer, research forester at the Station's Northern Forest Fire Laboratory, Missoula, Mont., and Bruce D. Clayton, of Mariposa, Calif., employed by the Northern Region to work on the cooperative Region/Station study.

In the report, Fischer and Clayton group forest habitat types of Montana into 12 fire groups based on the response of nine major tree species to fire and the roles of these species during successional stages. For each fire group, the researchers present the relationship of the tree species to fire, fire effects on undergrowth, forest fuels, the natural role of fire, fire and forest succession, and fire management considerations. In the latter group, the authors suggest how the information can be used to develop plans that support land and resource management objectives.

Copies of *Fire Ecology of Montana Forest Habitat Types East of the Continental Divide*, Gen. Tech. Rep. INT–141, are available from the Intermountain Forest and Range Experiment Station, 507 25th St., Ogden, UT 84401. ■

A Procedure for Estimating Duff Depth

Donald F. Potts, Kevin C. Ryan, and Robert S. Loveless, Jr.

Assistant Professor, University of Montana, School of Forestry, Missoula, Mont.; Research Forester, Northern Forest Fire Laboratory, Missoula, Mont.; and Graduate Research Associate, University of Washington, Seattle, Wash.

Managing forest fuels often calls for measurements of duff depth. Such measurements are required for estimating quantities of fuels *(2)*, for estimating the amount of duff that will be removed by prescribed burning *(1, 3)*, and for comparing the amount of duff present before and after a site has been prepared for reforestation.

Forest managers faced with the task of measuring duff depth are often unsure about how to go about it. Common questions include: How does one collect samples? How many samples are necessary? and How accurate are the data? This article describes a reliable, uniform method for measuring depth of duff and provides sample calculations for typical management situations.

In a current study of duff moisture and structure, the variation in duff depth across a homogeneous stand proved to be constant. Therefore, one can estimate average duff depth by sampling a small portion of the area, which simplifies the logistics of data collection.

Procedures

If stand density, species composition, and age distribution of the area in question are uniform, treat the area as one sampling unit. If differences exist, delineate the approximate boundaries and repeat the procedures for each sub-area identified. Avoid disturbances such as roads, skid trails, or landings.

First, locate a plot 20 to 30 feet in diameter. Then, take 20 random samples of duff depth in the plot. Measure to the nearest one-tenth of an inch.

If a calculator is available, the following steps may be computed in the field. Calculations can be done in the office, but managers must either accept the achieved accuracy or return to the field for more samples. Thus, field calculations insure estimates of desired accuracy. Calculate the average duff depth. Then, calculate the standard deviation of the sample.

To calculate the coefficient of variation use the following equation:

$$\text{Coefficient of variation} = \frac{\text{standard deviation}}{\text{average duff depth}}$$

Figure 1 is based on equations from Stauffer *(4)*. On figure 1 locate the calculated coefficient of variation, then find the corresponding sample size required to estimate the true mean duff depth with a 20 percent allowable error and either a 95 percent, 90 percent, 80 percent, or 70 percent confidence level. The 90 percent confidence level implies that the estimated duff depth will be within 20 percent of the true mean 90 percent of the time. Managers may select the desired confidence level.

If more than 20 samples are required, take the additional samples and recalculate the average duff depth or accept the accompanying confidence level, even if it is less than originally specified.

Sample Calculation

Broadcast burning has been scheduled in a 5-acre clearcut block to achieve prescribed duff reduction. Preharvest inventory and survey of the block reveals that the original stand was homogeneous with respect to density, species composition, and age distribution.

After locating a sample plot that avoids major duff disturbance, 20 random duff depth measurements are taken in the plot, carefully measured to the nearest one-tenth of an inch, and recorded:

1.0, 2.0, 6.5, 1.0, 1.2, 1.7, 1.4, 0.0, 1.1, 0.0, 4.0, 0.0, 1.7, 1.0, 2.8, 1.0, 1.6, 1.9, 1.3, 2.1

The average depth of the 20 samples measured is 1.67 inches. The calculated standard deviation of the sample is 1.47 inches. Thus, the coefficient of variation (CV) expressed as a percentage is

$$CV = \frac{\text{standard deviation}}{\text{average depth}} \times 100$$

$$= \frac{1.47}{1.67} \times 100 = 88\%$$

From figure 1, for the 90 percent confidence level, this corresponds to a required sample size of 56. Thus, either 36 additional samples must be collected and the average duff depth recalculated or a confidence level of approximately 65 percent must be accepted.

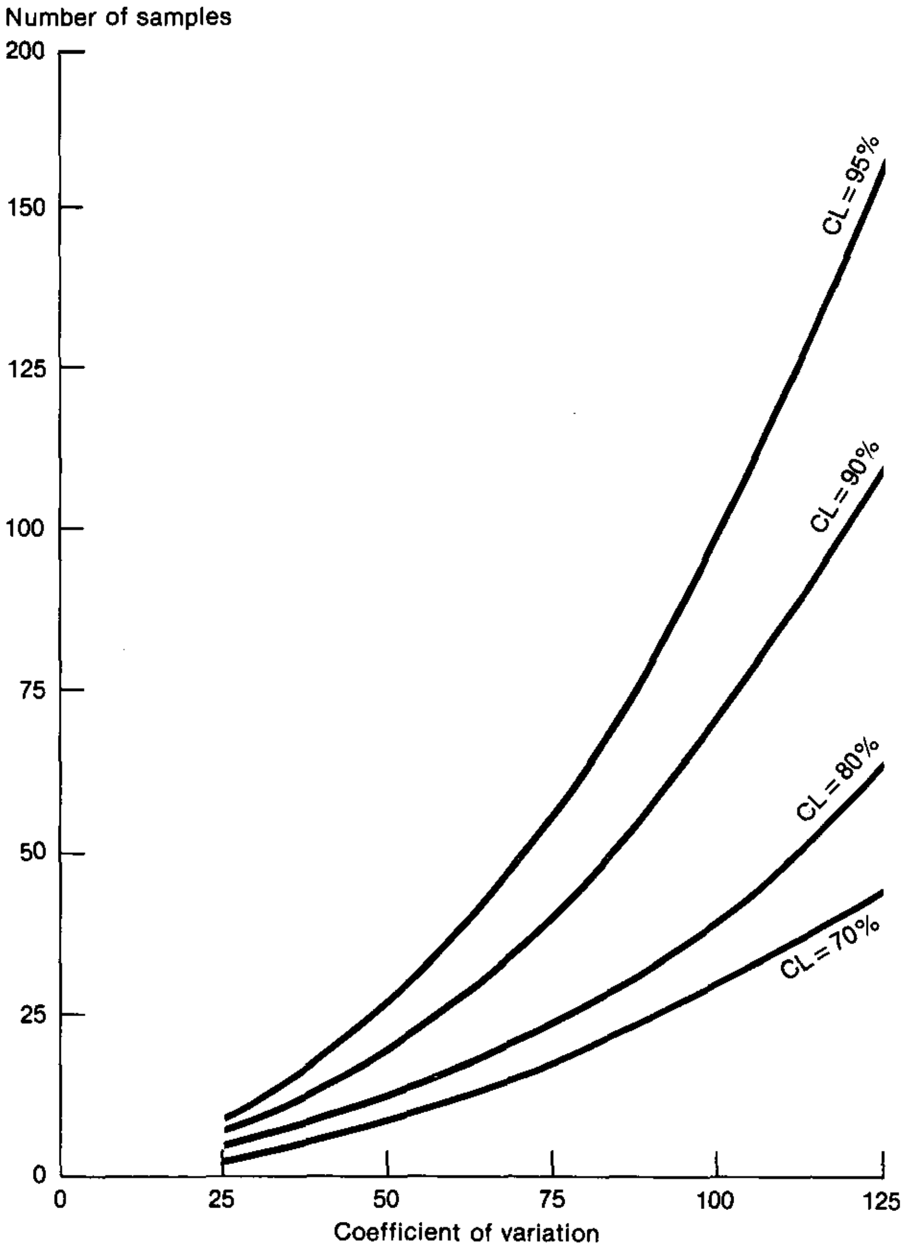

Figure 1—*Sample size from a calculated coefficient of variation for four confidence levels with a 20 percent allowable error.*

If a calculator with preprogrammed statistical operations is not available, the standard deviation must be calculated.

The formula for standard deviation is

$$\text{Standard deviation} = \sqrt{\frac{\Sigma\chi^2 - (\Sigma\chi^2)/n}{n-1}}$$

A sample calculation of standard deviation is as follows:

Data:

χ	χ^2	χ	χ^2
1.0	1.00	4.0	16.00
2.0	4.00	0.0	0.00
6.5	42.25	1.7	2.89
1.0	1.00	1.0	1.00
1.2	1.44	2.8	7.84
1.7	2.89	1.0	1.00
1.4	1.96	1.6	2.56
0.0	0.00	1.9	3.61
1.1	1.21	1.3	1.69
0.0	0.00	2.1	4.41

Calculations:

$\Sigma\chi = 33.3$

$\Sigma\chi^2 = 96.75$

$$\text{Standard deviation} = \sqrt{\frac{96.75 - (33.3)^2/20}{19}}$$

$$= 1.47$$

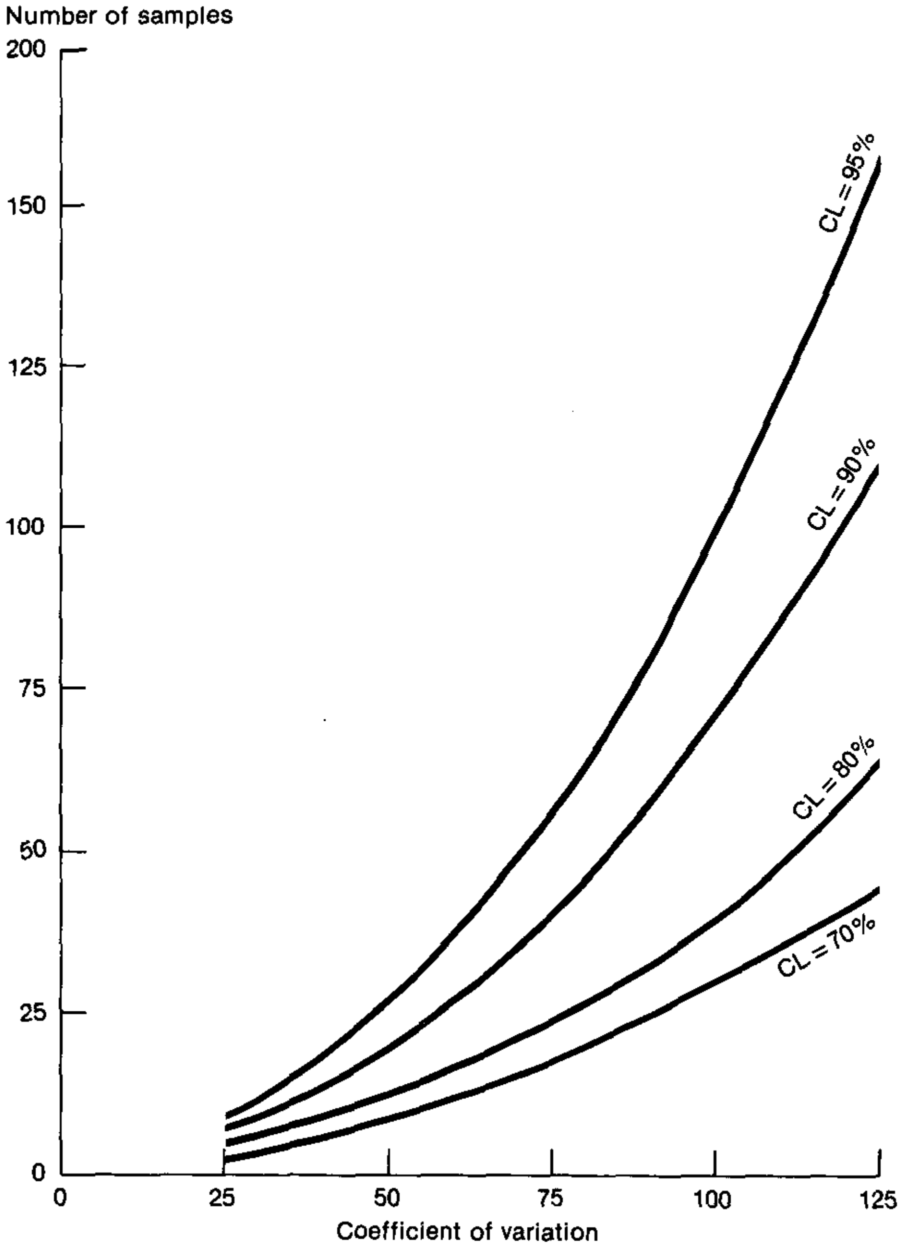

Figure 1—*Sample size from a calculated coefficient of variation for four confidence levels with a 20 percent allowable error.*

If a calculator with preprogrammed statistical operations is not available, the standard deviation must be calculated.

The formula for standard deviation is

$$\text{Standard deviation} = \sqrt{\frac{\Sigma\chi^2 - (\Sigma\chi^2)/n}{n - 1}}$$

A sample calculation of standard deviation is as follows:

Data:

χ	χ^2	χ	χ^2
1.0	1.00	4.0	16.00
2.0	4.00	0.0	0.00
6.5	42.25	1.7	2.89
1.0	1.00	1.0	1.00
1.2	1.44	2.8	7.84
1.7	2.89	1.0	1.00
1.4	1.96	1.6	2.56
0.0	0.00	1.9	3.61
1.1	1.21	1.3	1.69
0.0	0.00	2.1	4.41

Calculations:

$\Sigma\chi = 33.3$

$\Sigma\chi^2 = 96.75$

$$\text{Standard deviation} = \sqrt{\frac{96.75 - (33.3)^2/20}{19}}$$

$$= 1.47$$

References

1. Brown, James K.; Marsden, Michael A.; Ryan, Kevin C.; Reinhardt, Elizabeth D. Duff and woody fuel consumption by broadcast burning in the Northern Rocky Mountains. Res. Pap. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. In preparation.
2. Brown, James K.; Oberheu, Rick D.; Johnston, Cameron M. Handbook for inventorying surface fuels and biomass in the Interior West. Gen. Tech. Rep. INT-129. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1982. 48 p.
3. Sandberg, David. 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; 1980. 18 p.
4. Stauffer, Howard B. A sample size table for forest sampling. For. Sci. 28(4):777–784; 1982. ■

References

1. Brown, James K.; Marsden, Michael A.; Ryan, Kevin C.; Reinhardt, Elizabeth D. Duff and woody fuel consumption by broadcast burning in the Northern Rocky Mountains. Res. Pap. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. In preparation.
2. Brown, James K.; Oberheu, Rick D.; Johnston, Cameron M. Handbook for inventorying surface fuels and biomass in the Interior West. Gen. Tech. Rep. INT-129. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1982. 48 p.
3. Sandberg, David. 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; 1980. 18 p.
4. Stauffer, Howard B. A sample size table for forest sampling. For. Sci. 28(4):777–784; 1982. ■

More Women in Fire Management on the Black Hills National Forest

Al Braddock, Jim Mathers, and Ann Melle

Fire Management Officer and Forest Supervisor, Black Hills National Forest, Custer, S. Dak.; Federal Women's Program Coordinator, USDA Forest Service, Region 2, Denver, Colo.

The Black Hills National Forest has a significant fire suppression and prescribed burning workload. The demand for crews for fire suppression and prescribed burning comes intermittently. Large numbers of people must be available when needed during these periods. Many female employees who fill clerical positions on the forest have never participated directly in firefighting activities. They were recognized as an "untapped resource."

A forestwide survey was made a year ago to determine if more female employees were interested in fire assignments. The women who responded were given the step test, and once they passed, began accelerated basic and intermediate firefighting training. The program continued to grow until 23 new women were on the forest's firefighting team.

The Black Hills had three project fires in 1983; all were fast moving, high intensity fires in steep, rugged terrain. The female firefighters and several experienced women firefighters from ranger districts were a part of the initial attack force on all three fires. They spent three night shifts and two day shifts on fire suppression and served on mop-up operations on two of the fires.

Four experienced women firefighters filled positions on the project fires as sector boss, crew boss, time officer, and supply officer. Another experienced woman firefighter is a contracting officer, and a member of the Regional Class I Overhead Team.

Figure 1—*Newly trained women firefighters on the Black Hills National Forest.*

The forest will continue to provide the training and experience necessary for all firefighters to participate equally in fire control and have opportunities for overhead positions in the command, line, plans, finance, and service organizations. As more women are trained, they will be qualified to fill positions on the Regional Fire Overhead Team. ■

Underburning on White Fir Sites to Induce Natural Regeneration and Sanitation

Gary J. Petersen and Francis R. Mohr

Silviculturist, La Grande Ranger District, and Fuels Management Specialist, Wallowa-Whitman National Forest, Baker, Oreg.

The Blue Mountains of eastern Oregon and southern Washington contain a wide range of vegetation types—from nonforested meadows and grassland plateaus to heavily forested steep mountain slopes. Approximately 24 percent of the 278,000 acres on the La Grande Ranger District of the Wallowa-Whitman National Forest, La Grande, Oreg., is conifer stands of white fir *(Abies concolor)*, grand fir *(Abies grandis)*, or white fir–grand fir hybrids *(Abies grandis* x *concolor)*, generally referred to as "white fir sites" or "white fir stands." Past timber harvest activity on these sites frequently involved a silvicultural system of selectively cutting trees that had a high risk of mortality before the next scheduled harvest.

This high-risk management practice and the resulting postharvest site conditions caused increasing concern on the district. Following harvest, stands contained many trees heavily damaged with basal wounds, root or heart rot,[1] and high levels of suppressed growing stock. Advanced regeneration in some cases was so suppressed that growth release had not yet released 12 to 15 years later. Problems due to soil compaction and fuel buildup were also identified.

Prescribed underburning in shelterwoods was eventually chosen to manage white fir stands. Twenty-four units totaling 903 acres were underburned during the spring, summer, and fall months in 1980–83. The units, on slopes from 0 to 45 percent, varied in size from 13 to 185 acres and contained fuel loading estimates of up to 23 tons per acre in the 0 to 3 inches in diameter size class. Total fuel loading ran as high as 45 tons per acre.

Site Description

A typical white fir underburn unit contained 14 large overstory shelterwood trees per acre, primarily Douglas-fir *(Pseudotsuga menziesii)*, western larch *(Larix occidentalis)*, and white fir at least 15 inches diameter at breast height (dbh). The trees were evenly spaced, full crowned, and free from defect. Often the understory trees numbered 3,000 to 4,000 stems per acre.

Preburn Preparation

Before burning, all understory trees less than 7½ inches dbh (many of which were disease damaged or suppressed) were felled. This preburn activity contributed to the success of the underburn because it eliminated fuel ladder continuity and created a more uniform, horizontal fuel bed close to the ground. The resulting homogeneous fuel bed permitted more control of the fire behavior—a more evenly sustained fire versus erratic fire output. This fuel bed in turn widened the "burning window" (number of burning days available) in which it was possible to conduct the burn.

Burn Objectives

The objectives for this burning program were to:

- Consume at least 70 percent of the 0- to ¼-inch-diameter fuels.
- Consume at least 60 percent of the ¼- to 1-inch-diameter fuels.
- Consume at least 50 percent of the 1- to 3-inch-diameter fuels.
- Consume at least 10 percent of the 3- and 3-plus-inch-diameter fuels.
- Expose mineral soil on at least 30 percent of the unit.

Burn Constraints

The constraints for this burn were to:

- Retain 50 percent of existing duff layer.
- Kill no more than 50 percent of the trees over 20 inches dbh.

Burning Prescription and Implementation

The burning prescription established that a flame length not exceeding 5 feet during 80 percent of the time of the burn was desirable. Because a wide range of temperatures and relative humidities could

[1] Laminated root rot *(Phellinus weirii)* or Indian paint fungus *(Echinodontium tinctorium)*.

exist, careful monitoring of the ignition pattern and sequence would be necessary to manage the heat intensity. There were times when additional ignitions had to cease while heat from larger fuel material and concentrations dissipated.

Duff moisture and fine fuel moisture content were the critical environmental prescription elements for this prescribed burn. The prescription called for a duff moisture content range of 60 to 75 percent and a fine fuel moisture content of less than 10 percent. Duff in contact with larger size fuels or concentrations would be consumed, exposing the mineral soil necessary for seedling establishment. Duff on areas with lighter fuel loadings would not be totally consumed and thus would meet the desired soil covering constraint. The low fine fuel moisture content was necessary to achieve fuel consumption objectives and ensure sustained fire spread in the lighter fuel volume areas. In essence, the prescribed burn was intended to achieve the goal of matching a natural surface fire.

Critical duff and fine fuel moisture content for the project area were often not met until mid-August. However, daytime temperature, relative humidity, and wind conditions were at limits that exceeded heat intensities of 4- to 5-foot flame lengths. Therefore, units were frequently burned during the night.

Results

Preburn and postburn fuel data for a recently burned unit (Minefield #28) are shown in table 1.

Underburning can be successful under white fir. By comparing the objectives with the results, the prescribed burn met or came close to meeting all the objectives set forth in the burning plan.

Postburn examination of the unit (table 1) revealed 27 percent consumption of total fuel loading. However, the consumption of smaller sized fuels is most important in reducing fire hazard and providing adequate seedling establishment sites for natural regeneration. The postburn fuel bed arrangement of partially consumed larger size fuels is a significant contribution as shade for the seedlings and meeting other resource objectives for the site. Mortality to the shelterwood leave trees was within the 5 percent constraint without rearranging fuels near these trees prior to burning. The moderately thick bark of mature white fir and high branching habit that develops when grown in a fully stocked stand, lessens the trees' susceptibility to fire damage.

Natural regeneration has been achieved on these prescribed burn units with a high degree of success. After one growing season, portions of units contain as many as 80,000 seedlings per acre. Height growth of western larch has been as much as 5 inches in the first growing season (fig. 1). Underburning may be the most practical way to achieve consistent success with natural regeneration of western larch and at considerable savings. The species composition varies depending on the overstory, but it includes all major species common to the area. This varied regeneration composition gives the land manager many op-

Table 1—*Ground fuel characteristics before and after burn*

Fuel item	Preburn	Postburn	Consumed/ reduced
	Tons per acre		*Percent*
Loading			
Total fuel loading	23.3	17.1	27
By size class			
0–¼ inch	0.6	0.2	67
¼–1 inch	2.3	0.9	61
1–3 inch	2.9	1.8	38
3+ inch, sound	17.5	14.2	19
3+ inch, rotten	0	0	0
	Inches		
Fuel depth	12.9	2.9	77
Duff depth	0.2	0.08	60

diversity. Soil compaction and adverse soil effects were minimized.

Treatment cost for weeding, cleaning, and burning each acre averages $99. Artificial regeneration is currently $289 per acre. Each acre burned and naturally regenerated results in a $190 savings in the reforestation program.

Outlook

The Wallowa-Whitman National Forest anticipates the prescribed burning of 1,400 to 1,600 acres of white fir stands annually during the next 3 years, primarily to favor natural regeneration and sanitize the sites. If accomplished this will result in a projected reforestation savings of $260,000 to $285,000 annually. Fire and fuel managers on the forest are reevaluating how these prescribed burns might be done within the desired constraints and at reduced cost. Such considerations as night burning with fewer igniters, shape and size of harvesting units, staggered work schedules, and use of specialized fire suppression crews are some alternatives that will be evaluated during the coming season. ■

The Northern Forest Fire Laboratory

Delpha M. Noble

Public Affairs Specialist (retired), USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah.

> "The lab was not yet a year old and there was a feeling that surely it was going to contribute . . . things were going to happen. There was a sense of being overwhelmed, by all the unknowns of wildfire behavior and also by how to use this brand new facility. There were at least two schools of thought in regard to the wind tunnels—bring in boxcar loads of fuel from all over the country to burn in them, or weld the doors shut until a logical plan for their use could be developed."
>
> Richard C. Rothermel
> Project Leader
> Fire Behavior Research,
> NFFL

The scientists at the Northern Forest Fire Laboratory (NFFL) in Missoula, Mont., did not weld the doors of the wind tunnels closed or ship in fuel by the boxcar to burn in them. In fact, since the lab opened in 1960, they have been at the forefront of fire management research. The facility is one of three U.S. Department of Agriculture, Forest Service, fire research laboratories in the United States.

The professional staff of nearly 60 research foresters, mathematicians, physicists, meteorologists, mechanical engineers, biological scientists, chemists, ecologists, and computer specialists conduct fundamental and applied research to meet the immediate and long-range needs of fire managers for fire-related information, including control and use of fire. They study fire in the laboratory and in the field, in created situations and during actual forest and range fires. They concentrate on special problems of fire in the Intermountain West and Alaska, as well as problems found nationwide.

Fire Management as a Concept

Researchers at the NFFL have developed the concept of fire management and how fire considerations are integrated into multiple-use planning and resource management. They are committed to the idea that fire as a management tool can be a cost-effective method to dispose of unwanted wildland fuels and plant growth, to prepare seedbeds for regeneration, to improve wildlife habitat and livestock forage, and to control insects and disease.

Other concepts and products developed at the NFFL include:

- The infrared aerial scanner that detects and photographs wildfires at night or through heavy smoke cover.
- The National Fire Danger Rating System that measures and quantifies daily fire danger.
- Chemical fire retardants and specialized delivery systems that are used by many natural resource agencies.
- A fire behavior prediction system that forecasts fire activity on a daily or short-time basis.
- Fuel inventory and appraisal methods that are used routinely by land management organizations.
- Prescribed burning guidelines that are aimed at a wide variety of habitat and fuel conditions in the United States and Canada.
- Advances in lightning and fire weather meteorology research that aid in detecting and understanding weather phenomena.

Current Research

Scientists at the NFFL are pursuing intensive research programs in fire behavior, control, and effects and use. The work on fire behavior involves an effort to interpret fuel information to predict fire behavior in its simplest form—steady state fire in surface fuels. The scientists are developing methods to extend this knowledge to spotting, crown fires, surface fires in a variety of fuels, and ground or duff fires. Their research also provides the capability to deal with nonsteady state conditions. Richard C. Rothermel, project leader, says his researchers are striving to meet the information needs of land managers for planning, fire control, fuel appraisal, and prescribed burning.

Researchers involved with fire control technology keep fire control organizations informed about the capabilities and limits of all suppression methods. Researchers field-test the effectiveness of large and small equipment, from the hose lay and water in mopping up a fire, to a helicopter carrying retardant that is released from a pressurized delivery system. Such tests have enabled them to develop airtanker performance guides for all aircraft that are part of an airtanker fleet. Other research activities have yielded information with practical applications for fire managers.

A special fire effects and use research and development program at the NFFL is designed to predict the effects of prescribed fire and wildfire in the Rocky Mountain West, particularly in the Northern and Intermountain Regions of the Forest Service and on Bureau of Land Management lands. The program involves researchers, fire managers, wildlife biologists, silviculturists, and other specialists.

Program Manager Jim Lotan says that many resource managers want to use fire to accomplish a variety of tasks. Their ability to use fire effectively depends, in large part, on their ability to write fire prescriptions that will accomplish management objectives without adverse side effects. The program emphasized integration, extension, and application fire research results.

Two research work units make up the special program—fire effects and use and synthesizing fire management techniques. James Brown, project leader of the fire effects unit, says that properly prescribed fire can be used to help manage the various land resources once managers learn to measure, predict, and interpret ecological responses to prescribed fire and wildfire.

To that end, Brown and his associates determine the characteristics of fire needed to predict fire effects and relate these to conditions that exist before burning. Describing the effects of fire on herbs, shrubs, and trees, and how this vegetation recovers after fire are other important efforts. The effects of fire on wildlife habitat, and how that habitat can be managed with fire are also being studied.

Bruce Kilgore is project leader of the work unit that synthesizes the results of fire research in effects, behavior, economics, and weather into systems or guidelines for specific management applications. Kilgore described initial work of this project as pulling together practical predictions, prescriptions from the literature, and on-the-ground practitioner expertise. He promised that guidelines will be presented on how to use differing kinds of fire to achieve objectives decided upon by managers of such forest types as interior ponderosa pine/western larch/Douglas-fir. Managers will then develop procedures for monitoring and evaluating whether the prescriptions achieve the predicted effects. Kilgore and his staff are working closely with personnel of the Jefferson District, Deerlodge National Forest; Glacier National Park; and several Bureau of Land Management districts in Idaho, Nevada, and Oregon to carry out test burns using the guidelines.

Fire: A Tool

Researchers at the NFFL are committed to finding ways to improve the use of fire so that it is one of the most efficient tools used by land managers. ■

NIIMS Training

Jim Whitson, Marvin Newell, and Jerry Monesmith

Forester, Florida Division of Forestry, assigned to the FIRETIP Project, and Project Leader, FIRETIP Project, at USDA Forest Service, Boise Interagency Fire Center, Boise, Idaho; Safety and Training Specialist, Aviation and Fire Management Staff, Washington, D.C.

Training is a necessary prerequisite for every aspect of the National Interagency Incident Management System (NIIMS). Proper training is necessary to plan and organize the successful implementation of NIIMS. The training sequence necessary to implement the system follows.

Organizational Training

Organizational Cadre Training. A one-day session designed to provide selected interagency personnel with the understanding of how to successfully implement NIIMS within their unit, region, or local area. Two visual aid productions are recommended for use in this presentation: "NIIMS In Action," a 13-minute video tape depicting NIIMS implementation at the local level, and "NIIMS Executive Slide/Tape Program," a 19-minute synchronized slide/tape presenting a basic introduction to NIIMS.

NIIMS Seminar for Managers. This seminar is designed to increase agency managers' awareness of NIIMS. The five subsystems are described and the Incident Command System (ICS) is discussed in detail. The role of the manager in implementing NIIMS is also discussed. "NIIMS Executive Slide/Tape Program" is recommended for use with the seminar.

Transition Training

Transition training permits the movement of individuals currently qualified in the large fire organization or agency-specific fire organization to a comparable position in ICS.

Transition training packages are currently available for the operations, planning, and logistics sections of ICS. There is no transition for the Finance Section since those positions remain essentially unchanged and are largely agency specific.

The command and general staff may be expected to participate in a team exercise such as one extracted from the interagency I–420 "Command and General Staff Exercise." Basic ICS (I–220) is a prerequisite to any transition training.

System Courses

Training materials are being designed and developed in two areas: skill positions and ICS management positions.

Skill Positions. Skill positions in the ICS demand specific skills of firefighters. NIIMS training for the following skills are available or agency specific training may be used instead:

- S–130 Firefighter
- S–190 Introduction to Fire Behavior
- S–211 Portable Pumps and Water Use
- S–212 Power Saws
- S–213 Tractors
- S–214 Ground Engine Use
- S–215 Firing Methods and Equipment
- S–230 Crew Boss
- S–260 Fire Business Management Principles
- S–270 Basic Air Operations
- S–353 Mixmaster
- S–370 Intermediate Air Operations
- S–390 Fire Behavior
- S–590 Fire Behavior Analyst

Some skill positions may require a basic understanding of the NIIMS–ICS Management System; others may require an understanding of supervisory relationships. In many instances skill positions are the prerequisite leading to ICS managerial positions.

For most positions in the skill area, the only ICS training necessary would be the "General Familiarization to the Incident Command System" slide/tape program. This 38-minute, 212-slide/tape program is recommended for orientation of firefighters and other personnel who are not in ICS management positions.

ICS Management Positions: Basic ICS (I–220). All personnel expecting to fill a managerial position within the ICS will be required to complete Basic ICS (I–220). It is designed to familiarize students with design, components, and organization of NIIMS. Skill positions such as crew boss and fire behavior analyst in Basic ICS would also benefit from the course.

In addition to Basic ICS (I–200), approximately 39 developmental courses are being developed for personnel new in ICS management positions, or personnel already in the system. The materials for all the courses are developed by groups of interagency personnel for review by the National Wildfire Coordinating Group and for approval and use of the Federal and State agencies. Training materials will be stocked at the Boise Interagency Fire Center and supplied through the NIIMS Publications Management System. ■

Water Handling Equipment Guide

Most people associated with wildland fire management agencies are familiar with the old Forest Service Water Handling Equipment Guide. It has been around for many years and has served as a basic source of information about water handling equipment for combating wildfires. The guide was updated in June 1983 by the Fire Equipment Working Team of the National Wildfire Coordinating Group.

Federal and State wildland fire management agencies were surveyed to identify their needs. The new guide is designed to promote standardization among the various cooperating agencies, which will result in reduced equipment costs and increased efficiency and safety. Many different kinds of water handling equipment are used in the wildfire community. The guide concentrates on two types: (1) equipment that is commercially available or easily reproducible, and (2) equipment that is interagency in scope or application.

Members of the wildfire community are encouraged to purchase needed copies from the Fire Cache, Boise Interagency Fire Center, 3905 Vista Avenue, Boise, ID 83705. The cost of the guide is $1.36 and the stock number is NFES 1275. It can be ordered on Fire Order Form SF–259A or by calling the BIFC Dispatch Office, FTS number 554-9400, or commercial (208) 334-9400. ■

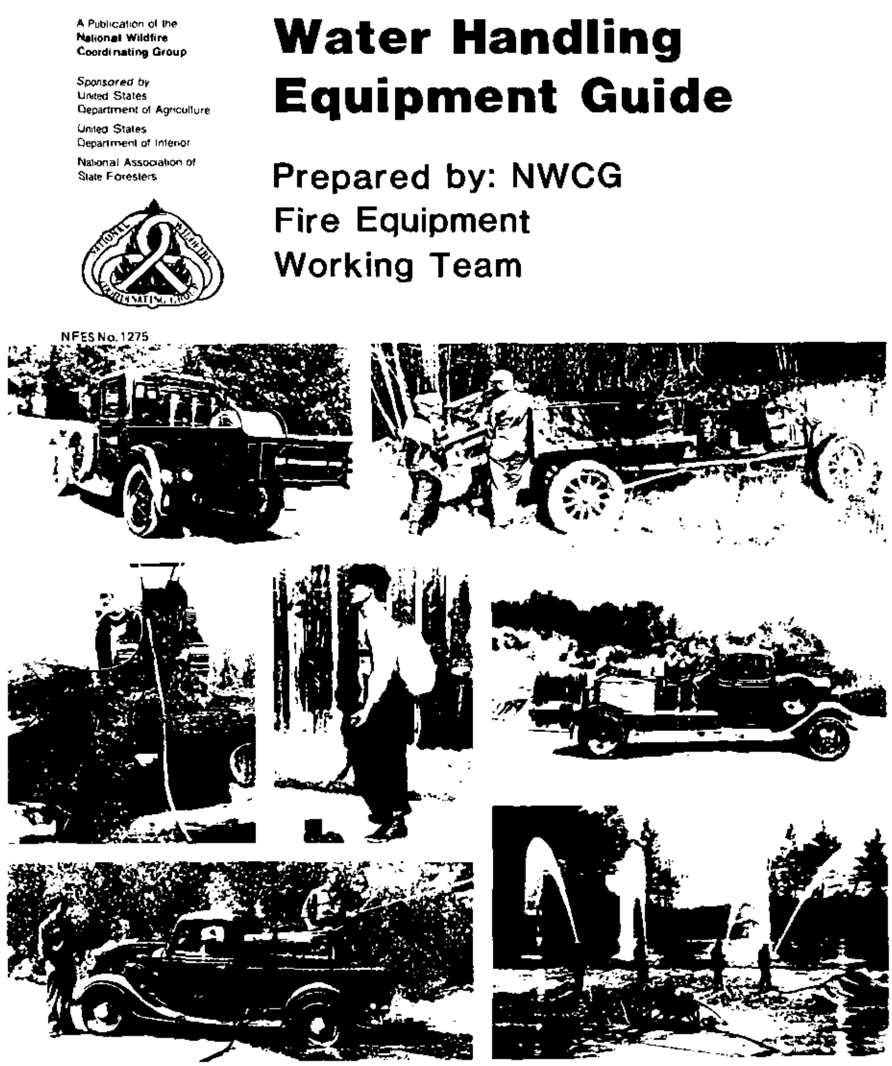

Figure 1—*Cover of new water handling equipment guide.*

Recent Fire Publications

Anderson, Hal E. Equation tools for fire managers. Res. Pap. INT–305. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1983. 21 p.

Bevins, C. D.; Fischer, W. C. Computer system for testing fire management prescriptions. Part 1. User's Manual. Gen. Tech. Rep. INT–155. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1983. 47 p.

Bevins, C.D.; Fischer, W. C. Computer system for testing fire management prescriptions. Part 2. Computer Terminal Operator's Manual. Gen. Tech. Rep. INT–156. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Ranger Experiment Station; 1983. 25 p.

Bratten, F. W. Probability model for analyzing fire management alternatives: theory and structure. Gen. Tech. Rep. PSW–66. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1983. 17 p.

Crane, M. F.; Habeck, James R.; Fischer, William C. Early postfire revegetation in a western Montana Douglas-fir forest. Res. Pap. INT–139. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1983. 32 p.

Gabriel, H.W.; Tande, G.F. A regional approach to fire history in Alaska. BLM/AK/Tech. Rep. 9. Anchorage, AK: U.S. Department of the Interior, Bureau of Land Management; 1983. 34 p.

Gonzalez-Caban, A. Economic cost of initial attack and large-fire suppression. Gen. Tech. Rep. PSW–68. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1983. 12 p.

Gorte, Ross; Baumgartner, David. Fire effects appraisal system for Wisconsin. Gen. Tech. Rep. NC–90. Saint Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest and Range Experiment Station; 1983. 12 p.

Knapman, L. Fireline reclamation on two fire sites in interior Alaska. BLM/AK/Res. Mgmt. Note 1. Anchorage, AK: U.S. Department of the Interior, Bureau of Land Management; 1982. 23 p.

Lynch, Christine M.; and Horton, L. J. Photo series for quantifying forest residues. In: Loblolly Pine, Easterly White Pine, Pitch Pine and Virginia Pine. NA–FR–25. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area; 1983. 69 p.

Martin, S. Clark. Responses of semidesert grasses and shrubs to fall burning. J. Rnge. Mgmt. 36(6):604–610; 1983.

Mcleod, R. G.; Martin, T. Z.; Warren, J. Feasibility study: forest fire advanced system technology (FFAST). JPL–PUB–83–57. Pasadena, CA: Jet Propulsion Laboratory; 1983. 70 p.

Mills, T. J.; Bratten, F. W. FEES: Design of a fire economics evaluation system. Gen Tech. Rep. PSW–66. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1983. 33 p.

Norum, Rodney A. Wind adjustment factors for predicting fire behavior in three fuel types in Alaska. Res. Pap. PNW–309. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1983. 5 p.

Seaver, David A.; Roussopoulos, Peter J.; Freeling, Anthony N. S. An escaped fire . . . what now? Res. Pap. RM–244. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1983. 18 p.

Senft, Dennis. Fire freshens rangeland. Agric. Res. 32(3):10–11; 1983.

Simard, Albert J.; Haines, Donald A.; Blank, Richard W.; Frost, John S. The Mack Lake Fire. Gen. Tech. Rep. NC–83. East

Lansing, MI: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, 1983. 28 p.

Taylor, D.; Mallotte, F.; Erskine, D. Cooperative fire planning for large areas: a Federal, private, State of Alaska example. In: Proceedings of wilderness fire symposium. Missoula, MT: University of Montana; 1983. 9 p.

Westover, Don. Rural fire program—what it means to Nebraskans. Farm, Ranch and Home Quarterly 30(2):20–22; 1983.

■

U.S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. 20250

OFFICIAL BUSINESS

POSTAGE & FEES PAID
U.S. DEPT. OF AGRICULTURE
AGR 101

U.S. MAIL

ORDER FORM To: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

Enclosed is $ ________ ☐ check,
☐ money order, or charge to my
Deposit Account No.
☐☐☐☐☐☐☐–☐

Order No. ____________

VISA

MasterCard

Credit Card Orders Only

Total charges $________ Fill in the boxes below.

Credit Card No. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Expiration Date Month/Year ☐☐☐☐

Please enter my subscription to Fire Management Notes at $13.00 domestic, $16.25 foreign.
(Prices are subject to change without notice.)
Make checks payable to Superintendent of Documents.

Company or personal name

Additional address/attention line

Street address

City State ZIP Code

(or Country)

PLEASE PRINT OR TYPE

For Office Use Only.

	Quantity	Charges
Enclosed		
To be mailed		
Subscriptions		
Postage		
Foreign handling		
MMOB		
OPNR		
UPNS		
Discount		
Refund		