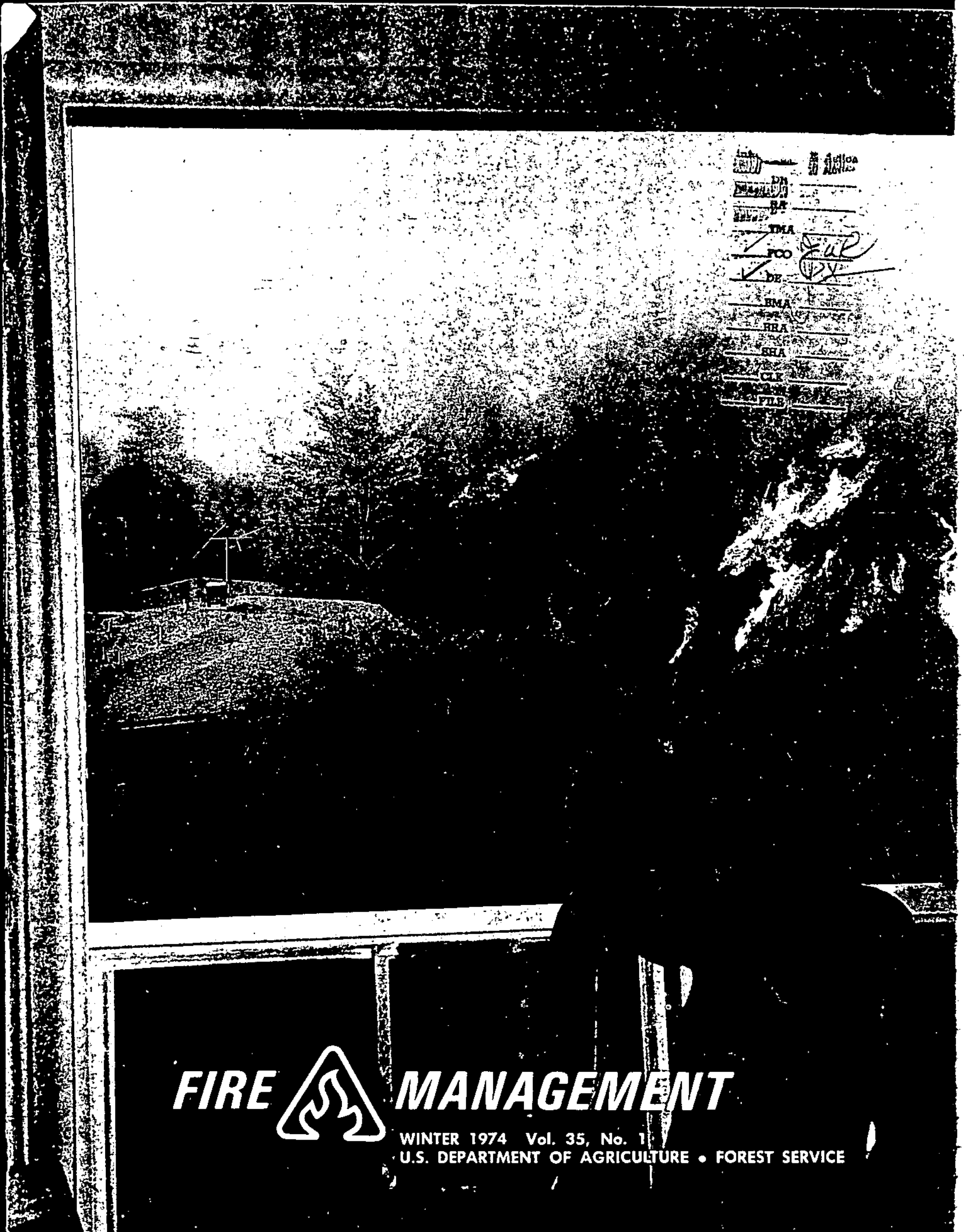

FIRE MANAGEMENT

WINTER 1974 Vol. 35, No. 1

U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE

FIRE MANAGEMENT

An international quarterly periodical devoted to forest fire management

Chaparral is a fire hazard in some residential areas of the West. A new control strategy has been developed for this brush. See story, next page.

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New Fire Control Strategy Developed for Chaparral

C. W. Philpot

How can we predict future fire behavior in chaparral, especially for the highly flammable chamise, and develop an effective fire suppression strategy? In this article C. W. Philpot uses two prediction techniques to develop three alternative fire suppression strategies.

One prediction technique is to couple a dynamic fuel model with a fire behavior model and use simulation. A dynamic fuel model accounts for changes with time. The other technique is to test the hypothesis against fire history on chaparral lands.

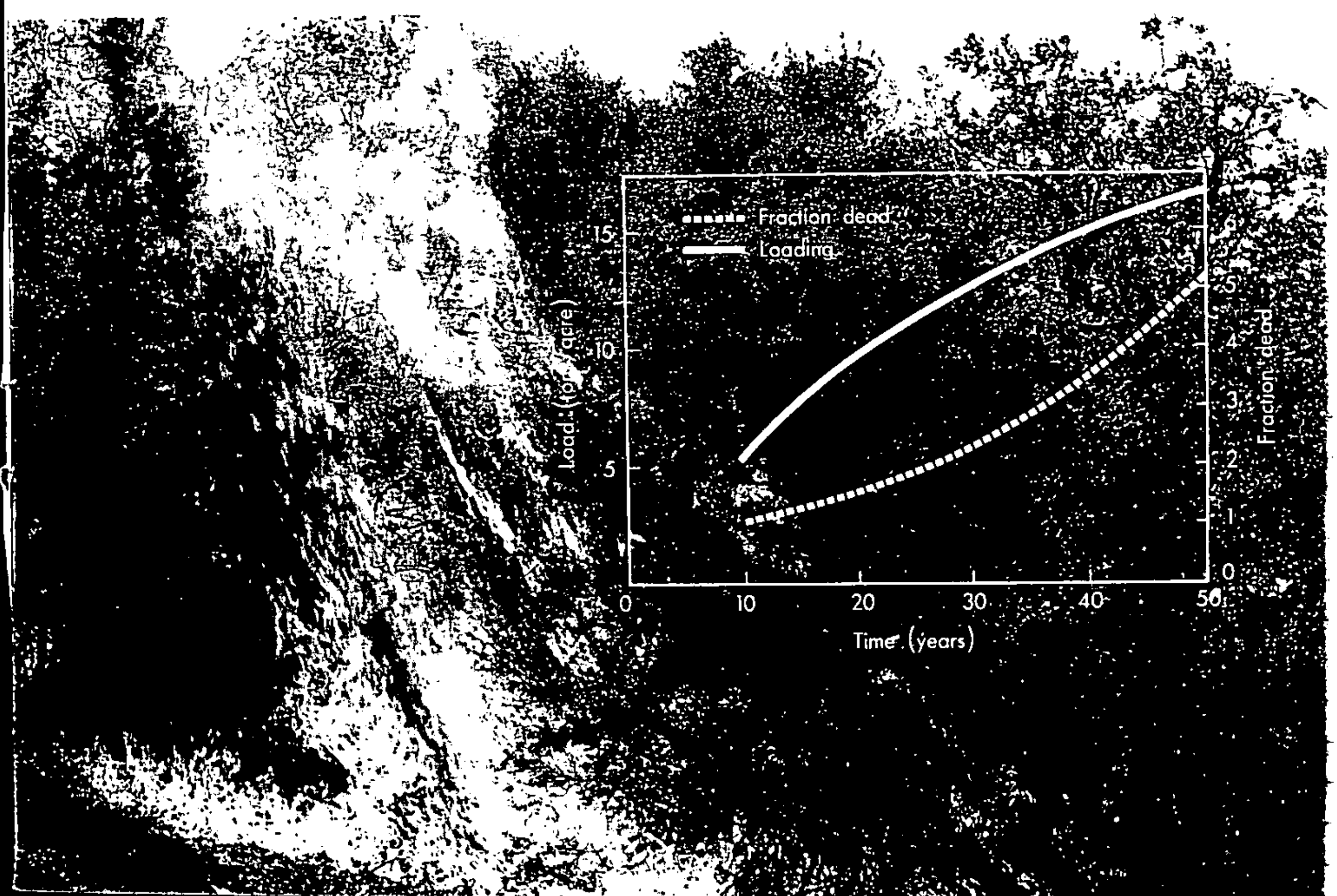
C. W. Philpot is Staff Specialist, Fire Science FF&ASR, Washington Office, USDA Forest Service.

Six Hypotheses Tested

In using this research approach, six hypotheses were developed concerning fire on chaparral. They were:

- Fire Suppression is more effective in younger age classes of chaparral because of slower spread and lower intensity.
- The probability of large fires is highest in older age classes. Fire size should be related to stand age for large fires burning under severe conditions.
- The probability of large fires in the future is related to past fire history.
- Fire suppression is most effective at age class boundaries.
- As fire suppression becomes more effective, the number of large fires decreases, but their size increases. →

Figure 1. Curves showing the load and mortality for chamise used in the dynamic fuel model.



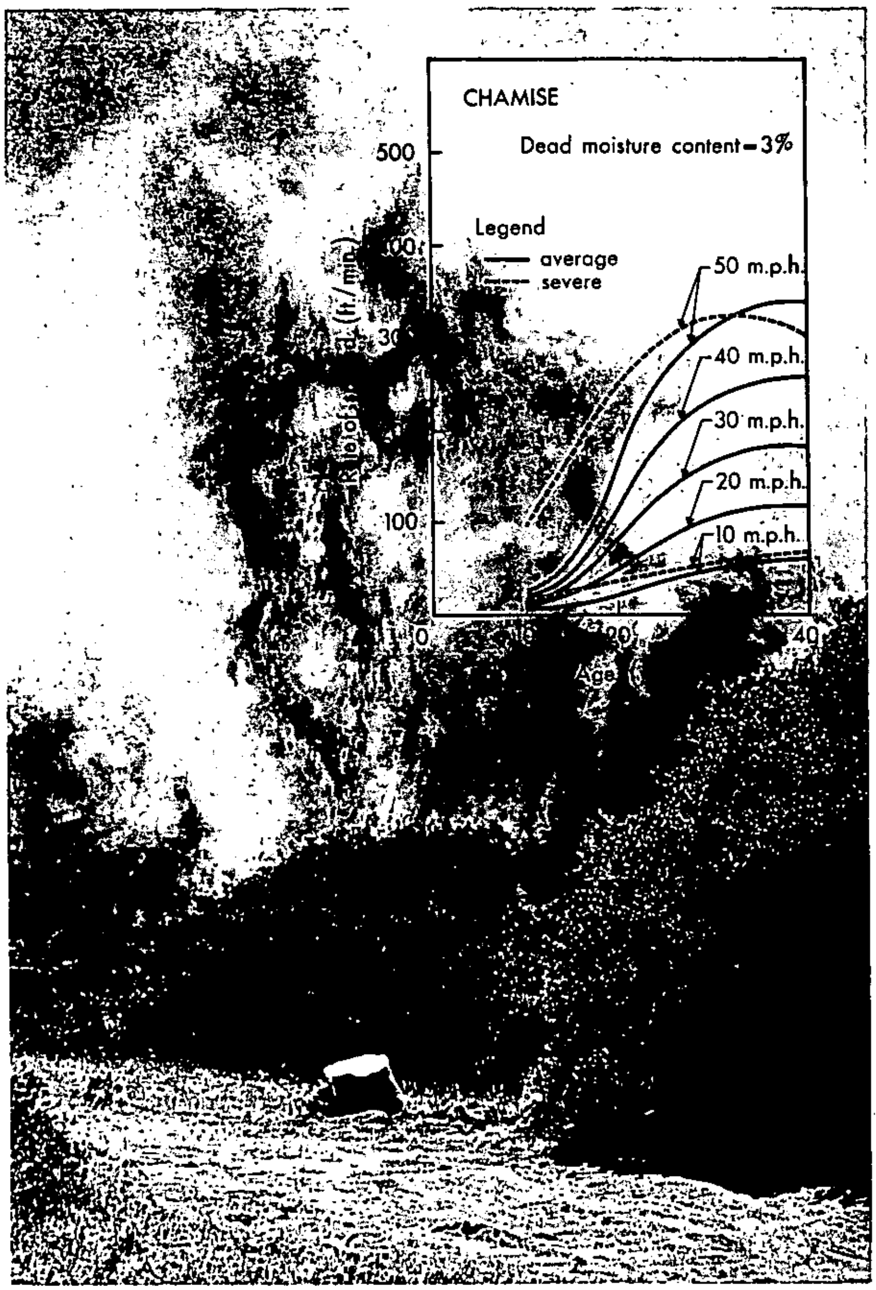
• Fire effects and intensity are a function of age class and therefore a function of fire suppression success.

Characteristics of Chamise

Many chaparral species exhibit adaptations to fire, especially in reproductive mechanisms triggered by heat. Chamise (*Adenostoma fasciculatum*) is highly flammable [1] and can be found in nearly pure stands over large areas.

Chamise sprouts from a root crown after the stems and foliage have been killed or removed by fire. Some new chamise plants develop from germination of heat-treated seeds. Several species of fire annuals also germinate following the fire [2]. They occupy the site for about 5 to 7 years until allelopathogens produced by chamise suppress them.

Figure 2. The predicted rate of speed in chamise at various wind speed and ages. "Severe" represents a higher mortality rate than "average."



Pure Stand After 10 Years

Approximately 10 years after the fire the stand is nearly pure chamise again. As the stand matures the fuel load and depth increases and some stems die, but they remain upright within the plant. This provides a fuel which is a mixture of dead and live material where the proportion of dead fuel increases with age. This scenario describes other chaparral species with minor modification.[3]

Fuel Model Accounts For Age

The dynamic fuel model was developed to account for changes in the fuel complex due to age. Therefore, using the model, we can show how fire behavior changes over time by holding weather and time of year constant. [4]

Information upon which to base the model was gathered from stands of different ages or time since the last fire. [5]

Figure 1 shows an example of load and mortality functions of chamise under average conditions. Figure 2 shows the predicted change in rate of spread in chamise for various wind speeds, average and severe mortality, and seasonal variables such as dead fuel moisture set for September 1. Environmental variables such as dead fuel moisture are held at 3 percent and slope is 50 percent.

These predictions are for sustained, steady-state rate of spread and obviously do not represent real time fire behavior and all of its variability. What they do show, however, is the non-linear change in rate of spread due to changes in fuel characteristics over time under constant environmental parameters. Similar changes in fire intensity are also predicted.

Fire Size Change Nonlinear

The values for rate of spread can be converted to fire size to show how it changes with age of the fuel.

Figure 3 shows fire size based upon an eliptical fire shape which is a conservative estimator for chaparral fires under severe conditions. The conditions for this curve are 12 hours of uncontrolled burning, 30 miles per hour sustained wind, and chamise fuel with average mortality. A fire size of 3,000 acres was assumed for the 10-year old fuel. This curve shows that the change in potential fire size in chamise due to age, under constant environmental conditions, is nonlinear. Watershed damage and downstream effects have been shown to be nonlinear related to fire size.[6]

Hypotheses Tested By History

The model supports the hypotheses, but we can attempt to test them further by looking at fire history on chaparral lands. The fire history from 1940 to 1970 on the San Bernardino National Forests (excluding the San Jacinto District) and from 1920 to 1970 on the Angeles National Forests was used for analysis. All fires over 100 acres were plotted by 10-year periods. Non-chaparral lands exist on both forests, and are generally denoted by the absence of large fires.

Figure 4 shows the large fires of the 1950's and 1960's on the San Bernardino National Forest. Notice that the fires of the 1950's are on different areas than those of the 1960's and that many fires are delineated by age class boundaries. Overlap, when it occurs, is 15 years or more. Figure 5 shows the composite of all large fires from 1940 to 1969 with the two large fires of 1970, the largest during the whole period, overlayed. Both 1970 fires occurred in large expanses of fuel, most of which had not burned since 1940.

This technique was used to plot the large fires of the 1950's and 1960's on the Angeles National Forest. *Many fires were suppressed at age class boundaries and the fires of one decade occurred on different areas than the other decade.*

The fires of 1970 were also overlayed on a 1940-69 composite. Here again the largest fire occurred in old fuel.

Generally, the hypothese derived from the predictive fire models are supported by the fire history. *Since 1950 the numbers of large fires have decreased and large fire size has increased.* Large-fire location does reflect the age of the fuel. Keep in mind that fire starts on these forests do not reflect the age and structure of fuel. These forests have several hundred fires during a decade, but only 15–20 reach large enough size to appear on the fire history maps. This is an indication of the efficiency of fire control forces in limiting the number of escaped fires.

Three Alternatives For Management

Three major alternatives could be followed in dealing with fire on chaparral lands. Regardless of which alternative is followed two assumptions apply.

One is that *ignition sources will remain numerous even with better prevention programs*, and secondly, *severe fire weather and droughts will continue to occur at periodic intervals.* For any alternative to be successful, it must be complemented with regional planning, land use zoning, and effective building codes. The possibility of initiating, funding, and providing authority for Fuel Control Districts, similar to those used for other environmental problems such as floods and air pollution, needs to be investigated.

The three major policy alternatives for dealing with fires in chaparral are:

1. Attempted Fire Exclusion — Maintain current suppression policies, develop new fire control capabilities, and continue the use of fuel breaks.

Prescriptions

- Attack and suppress all fires by 10 a.m. the next morning.

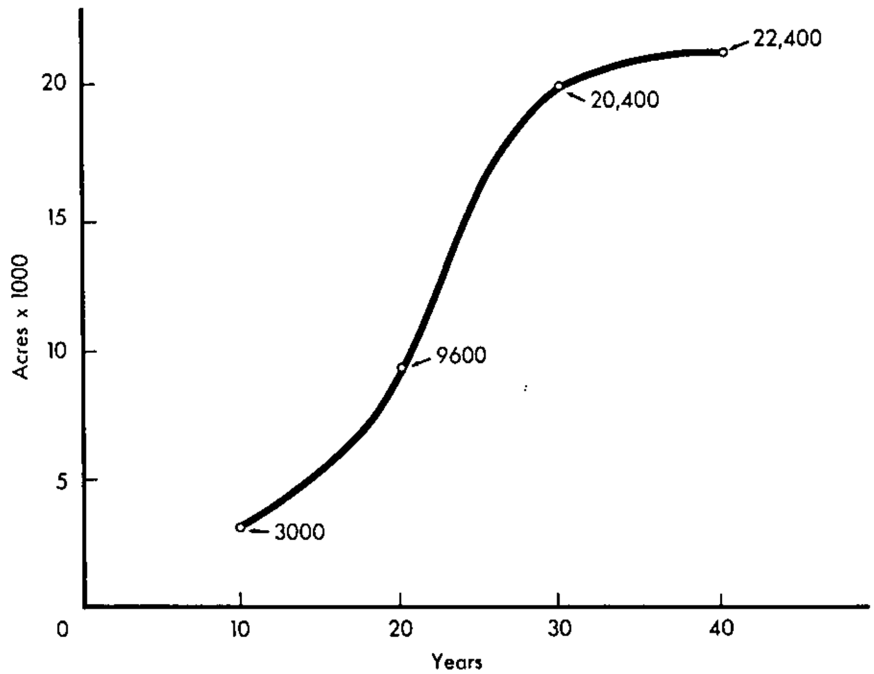


Figure 3. The relationship between fire size and age of fuel for a 12-hour uncontrolled burning period with sustained 30-mile-per-hour winds.

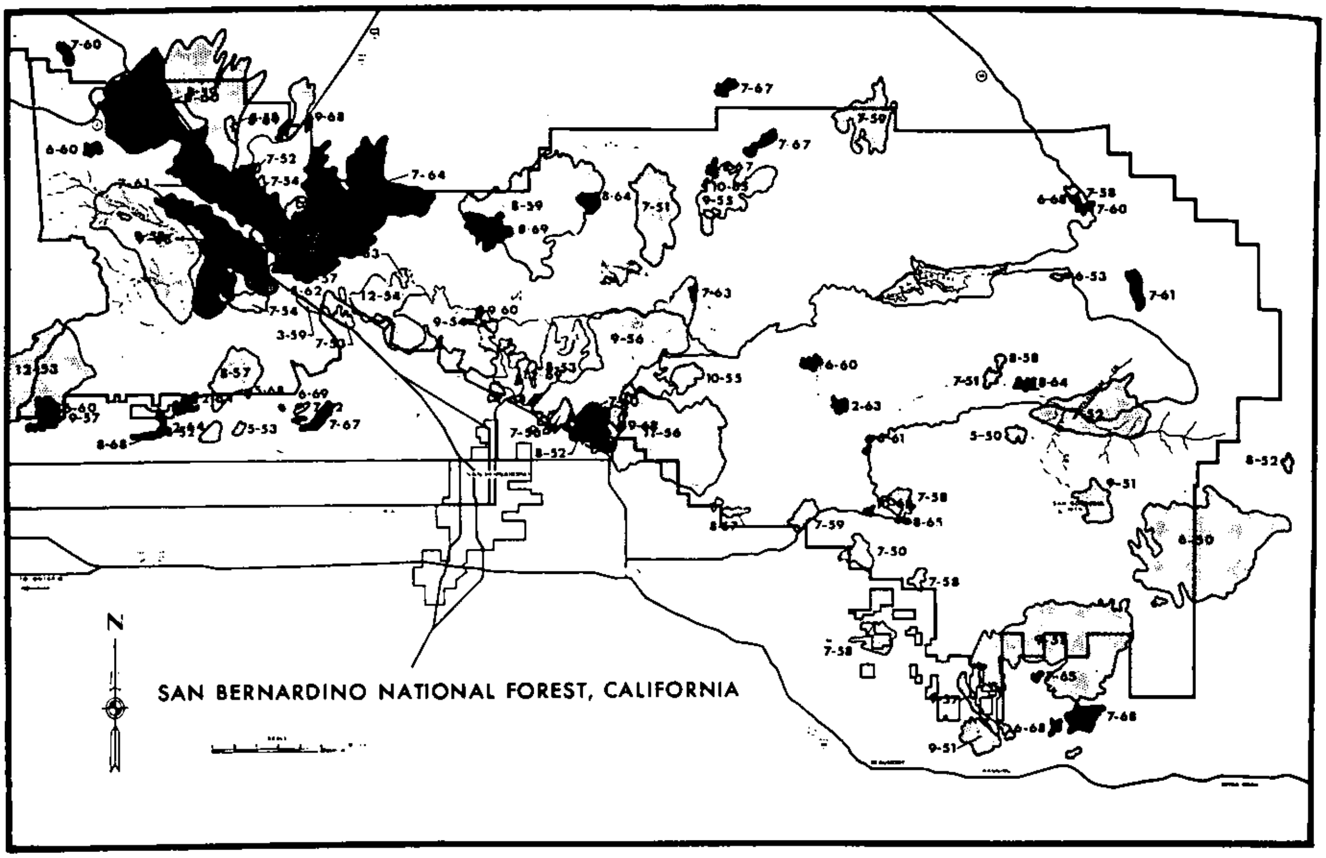


Figure 4. Fires of 100 acres or more for the decades of 1950's and 1960's on the San Bernardino N.F. The numbers refer to month and year of individual fires.

- Build fuelbreaks for better initial attack access as an aid in fire suppression.
- Maintain a strong fire prevention program.
- Use the most advanced suppression technology available.

Effects

- Reduction in the number of fires which "get away."
- Maintains recent and predicted fire history.
- Fewer, but larger fires of high intensity can be expected as larger areas of older fuel occupy the land.
- Watershed and downstream damage will increase because fires get larger.

2. Let all Fires Go — Let all fires go and buy up damaged structures and lands adjoining chaparral.

Prescriptions

- Eliminate all but the essential wildland fire control organization needed to protect structures included in the chaparral lands, such as ranger stations.
- Handle urban problem with buffer zone.
- Protect lives.

Effects

- There would be many large fires in young as well as old age classes for many years to come.
- Equilibrium of age class mosaics similar to the natural condition would not be achieved due to high frequency of unnatural ignitions.
- Erosion potential would be extreme during early stages of policy, but might decrease with time.
- The chaparral ecosystem would be greatly modified because it is not adapted to continuous fire, only periodic fire.
- The social, legal, and political restraints would probably make this alternative impossible.

3. Fire and Fuel Management — Initiate a program of fire management in conjunction with multiple-use planning, and define an acceptable and realistic level of fire occurrence and fire size based upon ecological, economic, and social considerations.

Prescriptions

- Develop a fuel management system which uses age class mosaics as the basic goal, with type conversion, fuel breaks, and other fuel treatment where appropriate.
- Use large prescribed fires, with loosely defined but predictable boundaries.

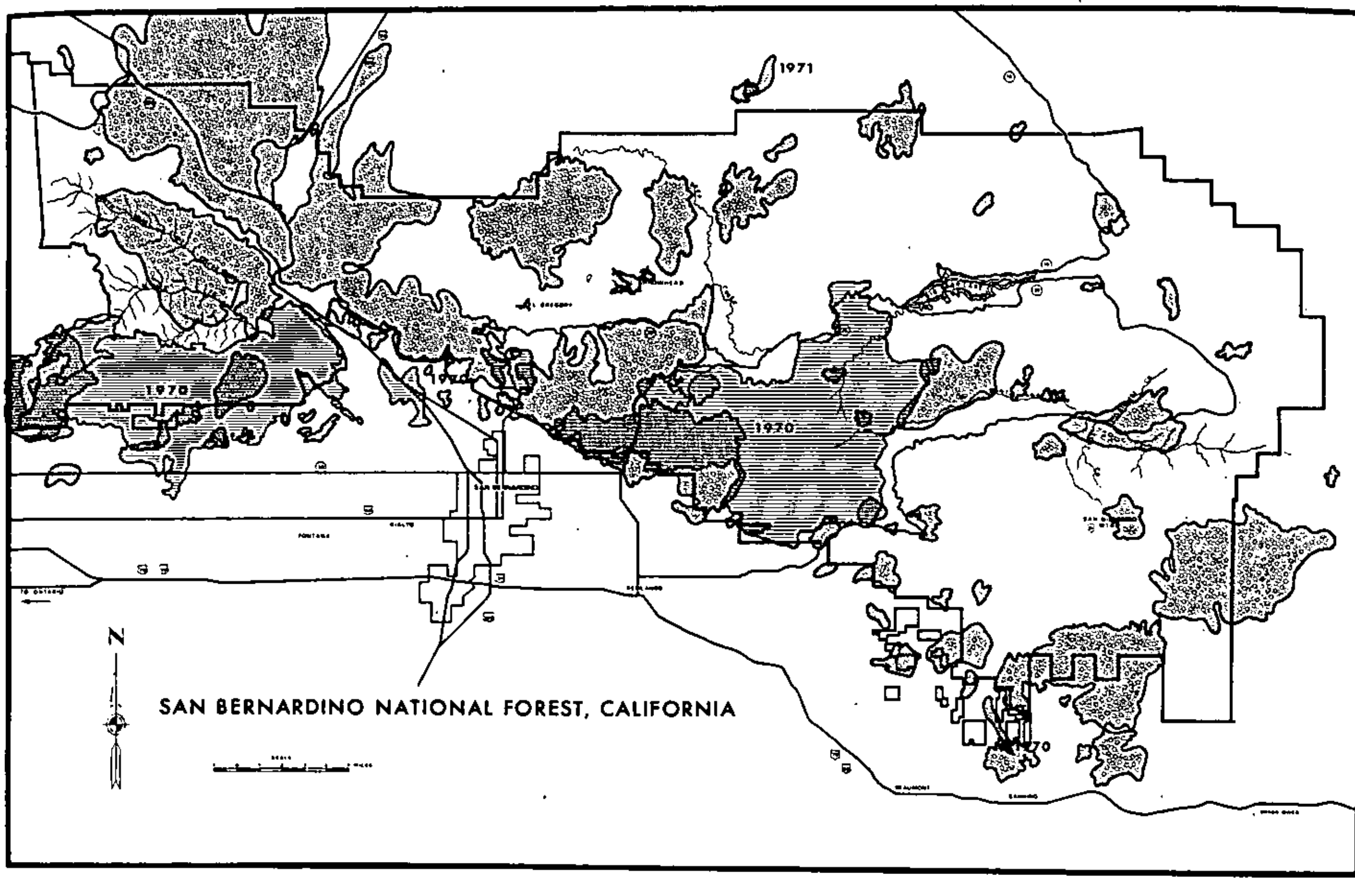


Figure 5. Composite of all fires of over 100 acres on the San Bernardino N.F. from 1940-1969, with the large fires of 1970 overlayed.

- Use modified or limited suppression on fires which meet the goals of the fire management plans.
- Continue to improve prevention and suppression capabilities to meet fire management prescriptions.

Effects

- More fires over 100 acres would occur.
- There would be few if any large fires over 10,000 acres, after a period of adjustment while fire management plan is being implemented.
- Maintenance of the chaparral ecosystem over much of its range.
- It would minimize, but not eliminate watershed damage and flood potential.

The third alternative is technologically and economically feasible today. Similar planning and fire management systems are being developed for other ecosystems in the United States. Obviously, a concerted, multifunctional effort would be needed to accomplish this alternative in a reasonable time. However, the potential payoffs in fire control and other aspects of chaparral management would well justify the effort.

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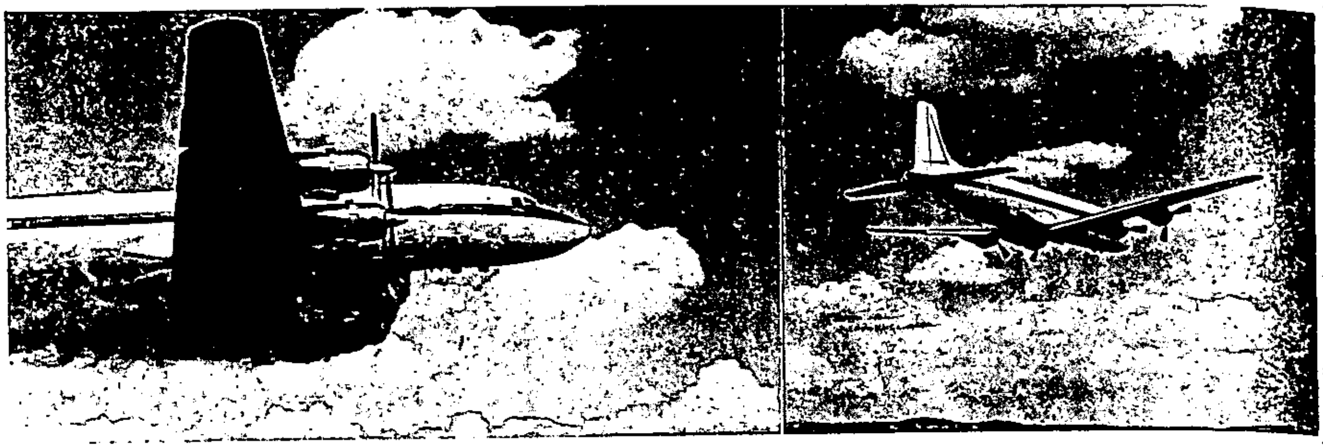
This paper is a condensation of a talk given at the Symposium on Living with the Chaparral, March 29, 1973, University of California, Riverside, California.

The work was done at the Norther. Forest Fire Lab in the Fire Fundamentals Project (Missoula, Montana).



Converted DC-6B Airliner serves as retardant aircraft.

Airliner Turns Bomber

Roy M. Percival, and Richard J. Barney

The Bureau of Land Management used a converted DC-6B airliner as a retardant aircraft during the 1971 and 1972 fire seasons. This ship is a significant step toward solving the cost, distance, delivery time, and payload problems encountered in Alaska. Fire control personnel in Alaska generally agree that the DC-6B is a definite advancement in terms of total retardant capabilities and a welcome addition to the aircraft fleet.

Introduction

Fire retardants and retardant aircraft have been used in Alaska since 1959 and the introduction of borate. Since then, the Alaskan fire control effort has become more sophisticated, as have operations throughout the United States, and retardants and retardant aircraft have become important tools.

One problem that consistently plagues fire control in Alaska is distance. It is not unusual for fire retardant aircraft to be sent on sorties over 200 miles from their base of operations. With the traditional converted World War II aircraft, flight times are often long and payloads small.

During the 1971 season, the Bureau of Land Management (BLM) used a converted airliner as a retardant aircraft.

Basic Equipment

The plane used by the BLM is a DC-6B airliner that the contract aircraft operator modified to deliver retardant. Strato Engineering designed the tanks for the aircraft, and Kamplain was the design engineer. The aircraft has built-in tanks large enough to carry 4,000 gallons. In addition to retardant, the aircraft is also certified to carry personnel and, with the current configuration, will haul 40 people. The tanks are also designed for hauling diesel fuel, making this a multipurpose aircraft.

The entire tank is divided into eight individual tanks, with individual gates and a programable gate trigger system. This trigger system is the same as that available on most multiple-gate retardant aircraft today. A ram air system is provided, offering rapid evacuation of the tanks. Drop speeds normally range

Airliner, next page

Table 1.—Retardant aircraft comparison

Aircraft type	Capacity: gal. retardant	Cruise speed: knots	Aircraft cost per hour[1]	Haul cost per mile per thousand gallons retardant[2]
DC-6B	[3]3,000	250	$850	$1.13
PB-4Y2	2,400	180	700	1.62
C-119	2,400	180	700	1.62
B-17	2000	150	600	2.00
B-25	1000	170	400	2.35
B-26	1,200	180	550	2.54
PBY	1,800	180	500	1.54

1 Based on 1972 BLM figures. BLM furnishes fuel.
2 Does not include actual cost of retardant and mixing.
3 Although tanked to carry 4,000 gallons, current contract specifications call for hauling only 3,000 gallons.

Roy M. Percival, Chief, Div. of Fire Control, Fairbanks District, BLM, Fairbanks, Alaska.
Richard J. Barney, Principal Fire Scientist, Institute of Northern Forestry, Pacific Northwest Forest & Range Experiment Station, FS, Fairbanks, Alaska.

Understanding . . .

The National Fire Danger Rating System

Bill Sullivan

During the fire season we wish to know how easily fuels will ignite when exposed to a firebrand. The ignition component of the NFDRS represents the ease with which fine fuels are ignited.

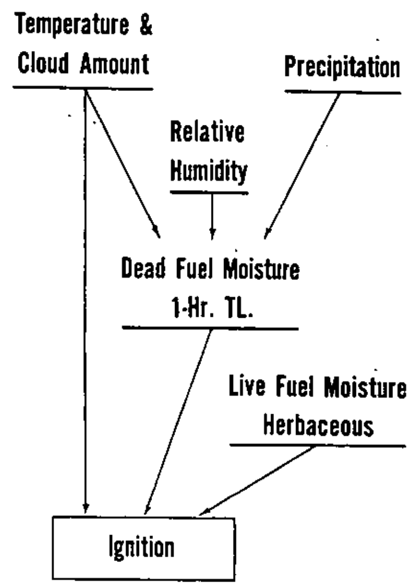
Ignition normally takes place in the dead component of fine fuels. The moisture content and temperature of fine fuels determine if a fire will start when exposed to a firebrand.

The temperature of the fuel is determined by measuring air temperature in an instrument shelter and applying a correction for radiation. If the day is cloudy the fuels do not receive direct radiation from the sun so the air and fuel temperature is assumed the same. If the day is sunny, fuels receive direct radiation from the sun and the fuel temperature is higher than the air temperature, thus requiring a correction.

The moisture content of the fine fuels is determined by the temperature, relative humidity, and their herbaceous vegetative condition (percent green). These relationships are expressed on a scale from 0-100 as the Ignition Component — a measure of how easily fine fuels will ignite if exposed to a firebrand.

Bill Sullivan, Fire Weather Unit, NOAA, National Weather Service, Los Angeles.

IGNITION COMPONENT OF NATIONAL FIRE DANGER RATING SYSTEM



Airliner . . .

from 100-130 knots. The ship is provided with two bottom-loading camlock valves, one front and one rear. The aircraft can be loaded from either end or both. At the present time, using one loading intake, the DC-6B can be fully loaded in 7 minutes. With the existing tank set-up and a full load, this DC-6B has a range of approximately 1,500 miles with 5 hours of fuel on board. This aircraft cruises at 300 miles per hour compared with 175 for the PB-4Y2.

Aircraft Use and Evaluation

The aircraft was used extensively in both 1971 and 1972 fire seasons in Alaska. In 1971, the DC-6B was flown 164 hours and dropped 36,000 gallons of retardant. The following winter, a ram air system was added, and a second aircraft was outfitted. During the 1972 fire season in Alaska, these two aircraft flew a total of 172 hours, hauling 477,000 gallons of retardant.

With 1972 contract prices, daily minimum prices, daily minimum and hourly rates, the DC-6B cost per retardant mile or gallon has a definite cost advantage over other retardant aircraft now in use (table 1). This is attributable to its significantly faster flight speed, as well as greater payload. The general opinion of fire control personnel in Alaska is that the DC-6B aircraft is definitely an advancement in terms of total retardant capabilities and cost. The DC-6B is not the total answer. There is still a use for the smaller capacity aircraft, such as the B-26 and B-25, as well as the PB-4Y2 and related category of aircraft. However, on long-distance hauls and where long trail drops are desired, the DC-6B has proven itself quite successful in Alaska.

Ear Plugs Needed

Ear protection is needed to safeguard against hearing loss while operating portable forestry fire pumps.

The high noise levels emitted by two-cycle engined centrifugal pumps operating at 3,500-6,300 r/min present a risk of permanent hearing loss. All pump operators should wear approved ear protection. Ear protection can be part of the checklist of equipment found in pump tool boxes.

For further information write for "Noise and the Portable Forestry Fire Pumps," Ransey, Townsend, and Bland, July 1973, Research Institute, Ottawa, Ontario I. R. FF-X-37.

Franklin Log Skidder modified for fire control applications

Franklin Log Skidder Adapted For Fireline Use in Alaska

Robert W. Webber and Richard J. Barney

Many examples of severe soil degradation exist in interior Alaska due to firelines being constructed in years past with "cats" on permafrost. There has been increasing pressure in Alaska to reduce the use of crawler tractors for fireline construction. When the insulating moss and duff layers are removed from permafrost soils, the subsoil thaws, and an immediate degradation begins. The cat line turns from a bare mineral soil fireline to a soupy, soggy, running mess.

Robert W. Webber is fire control officer, initial attack, Fairbanks District, Bureau of Land Management, and Richard J. Barney was principal fire control scientist, Institute of Northern Forestry, Pacific Northwest Forest and Range Experiment Station, USDA Forest Service, Fairbanks, Alaska. He is now stationed at the Northern Forest Fire Laboratory, Missoula, Montana.

In order to reduce the impact of fire control activities, the Bureau of Land Management's fire control staff has been trying to develop an alternative to cat-built fire lines in Alaska. New guidelines were developed in an attempt to minimize undiscriminating use of "cats" on fragile soils. The goal of the program is to increase the rate of fireline construction and to minimize or eliminate fireline rehabilitation problems and related costs.

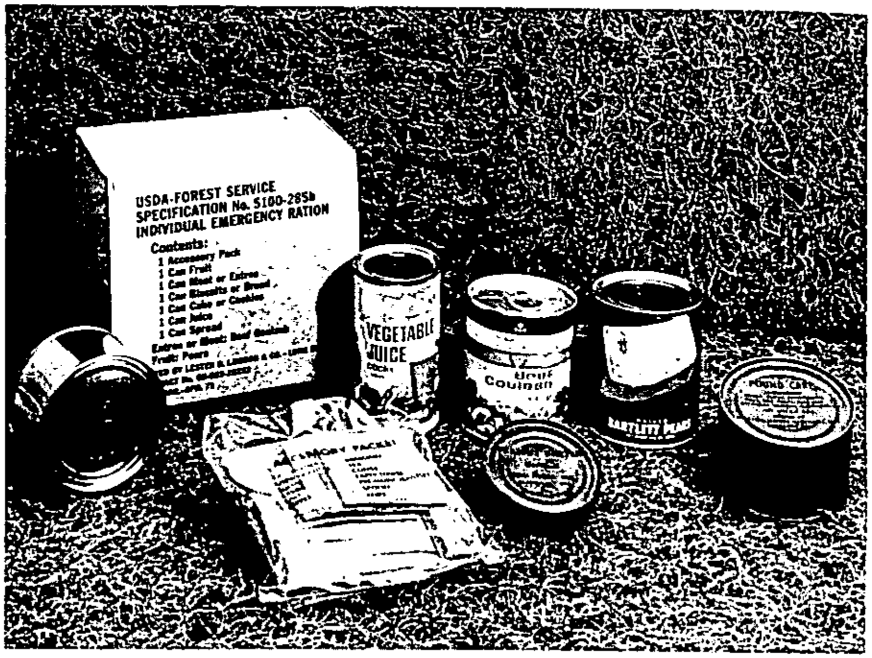
Basis Equipment

As a result of some imaginative thinking by Bureau personnel, a Franklin articulated all-terrain log skidder has been adapted for fireline construction.

The basic machine weighs 10 tons, has four 30.5 x 32 tires, and is driven by a 165 hp GMC diesel engine. It will road at approximately 20mi/h and work in rough terrain without difficulty at 4-7 mi/h. The articulated characteristics improve the all-terrain capabilities of the machine. It is equipped with a large, front-mounted winch with 200 feet of cable. Also included is a winter cab with roll bar protection and a modified standard log decking blade. The decking blade used primarily to move windfalls and small trees and to provide a convenient platform for additional equipment. The blade is used for digging fireline only in rare situations where absolutely necessary.

The basic machine was equipped with a 2,000 gallon split-and-baffled tank with a separate 400-gallon compartment. A double backup pump →

Emergency Rations Improved



Each emergency ration package contains six food items and accessories — can opener, spoon and knife, condiments, bouillon, tea, coffe, chewing gum, paper towels, and pre-moistened towelette. All are packed in a weather-resistant carton.

These days firefighters are enjoying more nutritious meals from their emergency rations. The menus include fruit, meat or other entree, bread or crackers, a spread such as peanut butter, cake or cookies, and juice. Each meal is nutritionally balanced and averages 1,400 calories, 200 more than the Military Inflight and C ration used by the Army.

About a half million dollars a year are spent for emergency rations by the Forest Service and its cooperators. Because the rations affect the health and production rates of workers, the specifications are reviewed every 3 years. Common complaints about the rations have been that they lacked sufficient food energy and that many of the canned foods spoiled during storage. Foods especially susceptible to spoilage are red or dark fruits such as cherries, figs, and purple plums, as well as highly spiced meats.

Food experts at U.S. Army Matick Laboratories, under contract to the Missoula Equipment Development Center, analyzed the rations in 1971. Based on the lab report, purchase specifications were revised and the rations improved.

The new rations have a longer storage life and provide more nutrition. Labeling of contents has been changed to improve inventory control. Individual meal boxes are stronger, and meals are packaged with 12 different entrees per case in weather-resistant cartons. By eliminating foods that spoil easily and by storing rations in a cool (70°F.) place, storage life of the emergency rations has been greatly increased.

The new rations are available from GSA. If supplies of the new rations are depleted during a heavy fire season, Military Inflight and C rations may be substituted by GSA.

Skidder . . .

system was installed, using, for primary pressure, a Cedco 450-psi pump and a Mark III 300-psi pump as backup. The tank with its dual compartments was designed to use liquid concentrate retardant with a blending system. Five Forester 3-gpm nozzle tips with 60-degree sprays were mounted on a spreader bar (distribution manifold) immediately attached behind the front of the decking blade. With these nozzles, a "wet-line" of retardant or water can be laid down as the skidder moves through a given fuel type.

A propane weed burner was mounted on each side of the decking blade, in order that burning can be done as the spreader bar applies a retardant line.

Each burner has a pilot light and is capable of igniting in 40 mi/h winds. It is estimated that a 100-gallon propane tank will supply fuel continuously for 72 hours. Both the weed burners and the spreader bar are controlled in the cab. In addition, there are two "live reels" with 200 feet of ¾-inch hose mounted on each side of the tank. A pipe applicator, 48 inches long and a 45-degree angle tip with a 3-gpm nozzle, was used under high pressure to force retardant or water down into the fuel. The most versatile nozzle tested for hot spotting and retardant laying capabilities is the turbojet nozzle. Because of its size and configuration, the machine may be loaded with or without a ramp onto a lowboy in approximately 4 minutes.

Performance and Use

Over 79 machine days and 1,250 actual-use hours, with *no* down time, were compiled in 1971. The outstanding point of this machine is that there has been no down time in all its use. It can go places that the crawler-type tractor cannot. Another important item is that it travels through the tundra-type terrain and is less damaging (7-psi →

One of the three organized Forest Fire Crews at the Baptist Bible College, Clarks Summit, Pennsylvania. The crews are trained and equipped by the Pennsylvania Bureau of Forestry.

Skidder . . .

pressure). It does not disturb the surface vegetation to the extent of crawler tractors. In addition to relatively light ground pressure, the machine's ability to turn like a car results in less disturbance to the ground cover than the pivoting action used to turn cats.

The skidder has been used not only for direct control activities but also logistical support. As equipped, the machine has been used to lay wet-line with the boom-mounted nozzle system on the skidder blades, and then to ignite burnout with the weed burners attached to the blade.

In addition, mop-up activities have been carried on, using the two live reels and mop-up nozzles. A mist blower has also been used in an attempt to blow retardant into the adjacent fuels and construct fireline, avoiding any kind of mechanical disturbance to the fuel complex and fragile permafrost. Initial problems indicate that the mist blower is too small. The current program is to obtain a larger blower and use this, mounted along with the other equipment, on the skidder.

Ideally, the machine is handled by a two-man crew. The contractor provides the driver, and fire control puts a well-trained and experienced fire foreman on the machine. He directs the ground operation using radio communication with the line boss and fire boss. This combination works well. It has been estimated that in a going fire situation this machine can replace as many as 300 crewmen in constructing line.

Future plans cover various innovations, including the development and attachment of a large funnel on the top which will allow filling the water tank using helicopter buckets. This machine is meeting the twofold objective of:

(a) Protecting the fragile tundra environment and

(b) Constructing more fireline at a reduced cost.

Fire control personnel in Alaska feel that this type of machine is well worth considering in other areas of the country as an additional tool in the arsenal of fire control.

Bible Students Answer Bells For Fire Fighting

Jeff Hannon

Four bells echo through the empty halls, and suddenly the once quiet and peaceful campus of Baptist Bible College, Clarks Summit, Pennsylvania becomes a beehive of activity. Men from all over the campus converge upon the information desk to find out the details.

"FIRE! On West Mountain.. 20 men needed.. we leave in 15 minutes." The instructions come from one of the appointed crew leaders. The truck is loaded with tanks, rakes, axes and other equipment and they are on their way. Thus, another call for the crew of B. B. C.

Forest fires have become a part of life for some 30 or 40 students in the past 4 years. It was in the Spring of 1969 that 20 men offered their services to Fire Inspector John Wargo, District #11, Pennslyvania Bureau of Forestry, who wisely seeing the potential, trained them that same season. Since that time training sessions have been given in November of every year.

In the past years, fire fighting has become a normal event at B. B. C. Under the leadership of Wardens Leonard Vanderveld, a teacher at the college, and Carl Smith, head of ground maintenance, the crew fights as many as 20 fires a season. Crew leaders are chosen by experience and leadership ability and have direct charge of the crews.

The training and experience Inspector Wargo has given the men of B. B. C. has proven to be a classroom in the field. The students are studying to be pastors, missionaries,

→

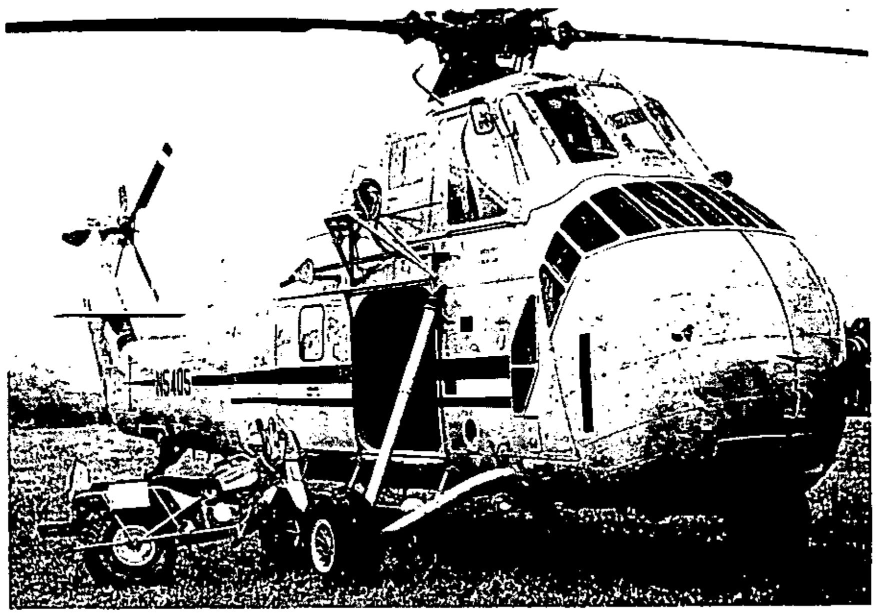
Jeff Hannon is the Crew Leader, Baptist Bible College, Clarks Summit, Pennsylvania.

Copter and Cycle Team-up For Mountain Hotshot Attack

Marshall Newman

An obstacle to helitack operations in Appalachian hardwood areas is the lack of suitable landing sites.

To offset this, during the 1973 spring fire season, a North Carolina Forest Service helicopter hauled a cycle to provide initial attack and support to a three-county area. This "Peachtree Zone," is removed and isolated from the main attack forces. The zone headquarters was equipped with dispatcher, five-man helitack crew, tractor and plow, a 250-gallon sling dip bucket, helicopter, and trail bike.



North Carolina's Skyorsky UH-34D Helicopter and ROKON Trail Breaker used for initial attack on fires in Peachtree Zone.

Customized Trail Breaker

The ROKON Trail Breaker was equipped with the automatic torque converter plus the large wheel sprockets designed for high torque hill operations. Other options included the two-seats, alternator plus headlight, tow bar, and tool box. It also had a chain saw mount, two canteen mounts, and two fire rake mounts. One canteen was found to be sufficient, and two saddle-mounted tool boxes of sufficient size to carry normal tools, fire rake heads, backfire fuses, first aid kits, portable radio, etc. were added. Riders were equipped with protective wear including laceup shoes, helmet with visor, and leather gloves.

Surplus Sykorsky UH-34D

A Sykorsky UH-34D helicopter equipped with pelican cargo hook and a hydraulic-electric winch was used to transport men and cycle. We were fortunate in having an ex-military helicopter pilot trained and experienced in operating and servicing the UH-34D.

The UH-34D frame provided a spacious interior which is sufficient for personnel and cargo. Due to the bulk of the rigid fiberglass, 250-gallon sling bucket, we were unable to carry (internally) the bucket plus the bike and our 5-man crew without exposing the crew to an unsafe seating arrangement. The bucket was left behind, available for support action if necessary.

Bike Designed For Inexperienced

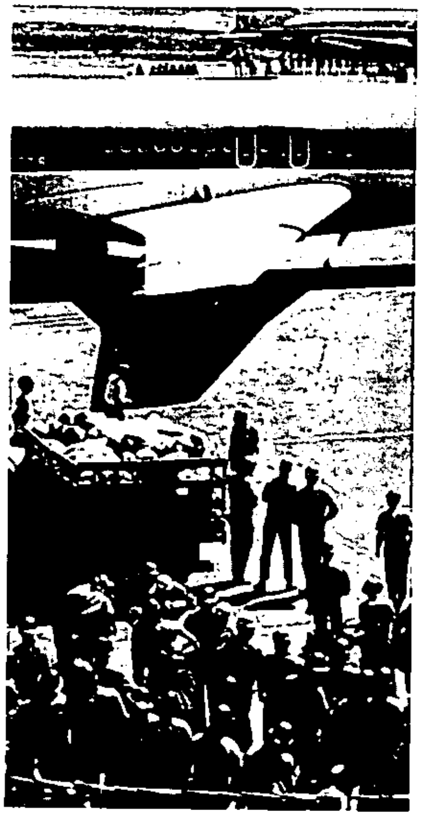
The impressive feature of the Train Breaker Mark IV is its ruggedness, stability, and simplicity of operation. Its sturdy stance, large tires, and two-wheel pulling ability readily separates it from the lightweight recreational trail bike. Operation and control of the Trail Breaker by an inexperienced cyclist posed little problem. (Obviously the operator should be of good physical condition and stamina.)

→

Marshall Newman is Chief Pilot in North Carolina Forest Service.

Students . . .

and teachers in Christian schools throughout the world. Through their training and experience, they have learned important aspects of leadership and what is more important, the ability to detect, understand, and extinguish forest fires. Crew members will take this experience with them to many distant countries, and the training they receive at B. B. C. will undoubtedly prove to be valuable wherever they may be assigned.



Total mobility will help reduce damage from fire.

Fire Management . . .

Toward an Expanded Dimension

R. L. Bjornsen

Looking at the future role of fire organizations in land use planning, resource managers must consider a broader dimension. The fire manager's role must be broader than the traditional protection role. The need for the expanded role is reinforced by three essential concepts:

1. Fire is a basic element in forest ecsosystems;
2. Lowering flammability of forest land is an objective in land use planning;
3. Total mobility will reduce damage from fire.

In addition, coordination and cooperation are required today and will need to be increased in the future to further reduce fire losses, to take advantage of skills and resources at hand, and to make effective use of fire as a resource protection and management tool.

R. L. Bjornsen is Assistant Director, Fire Management, Forest Service, USDA.

Fire as a Basic Element

Fire as a factor, force, and element in the forest environment is in evidence throughout our Nation. Witness the even aged forest mozaics in the western forests, the fire dependent species of the south, and the horrible destructive wildfires that occur from Main to Minnesota and Florida to the Puget Sound.

Wildfire is destructive to forest resources, property and human life, and fire has built a good case history of destruction. With the spread and growth of urban population into the forest, there is an ever increasing threat to life and property. Native vegetation which is attractive to suburban homeowners can prove to be a highly volatile fuel capable of reducing suburban tracts to ashes.

While fire has its destructive aspects, it can also be beneficial. The term used by professionals, "pre- →

Copter-Cycle . . .

We operated the bike for approximately 40 hours of operational testing. In evaluating the bike we subjected it to over 100 spills, spinouts, rolls, and tumbles. There was no significant damage to the bike nor injury to the driver. This was attributed to the bike's stability and low speed.

The Trail Breaker carried a three-man crew up and down any trail suitable for logging operations. It transported a heavy two-man crew through axle deep mud. The deeper the mud the more stable the machine became. A quick aerial scouting of the fire area from the copter before crew drop-off enables the bike master to select trail approaches to the fire site. During the 40-hour operational test the Trail Breaker required only minor servicing and maintenance.

The useful payload of the UH-34D, with approximately 1½ hours fuel load aboard, is 3,500 lbs. at sea level with 80° temperature. The useful payload value diminishes rapidly with a gain in altitude and/or temperature. We devised a load limit chart for elevation and temperature. At a density altitude of 3,000 ft., the useful load limit is approximately 1,600 lbs. The 1,600-lbs. payload was sufficient to accommodate our expected load, a six-man crew plus bike and fire tools.

The direct operating cost of a surplus helicopter depends upon the availability of surplus parts and replacement items. With access to military 115/145 av-gas, the UH-34D can be operated at approximately $25 per hour direct cost for gas and oil. With acess to surplus parts, the direct maintenance cost may run approximately $5 per hour.

Manpower Saved, Fewer Acres Burned

Results of the Peachtree Zone Project have convinced us that the copter and cycle concept is a workable and effective means of solving our fire suppression problems in western North Carolina. The copter allows the delivery, support and pickup of a hotshot helitack crew to several fires over a normal day's burning time. The savings is in unburned acreage and manpower — manpower which simply is not available. The cycle saves minutes and hours in →

scribed fire" is familiar to many. Prescribed fire yields beneficial results through reduction of hazardous fuels, as a silvicultural tool, and in insect and disease work. Understanding of the much more complex ecological role of fire in land use is expanding and developing rapidly.

Lowering Flammability of Forest Lands

Fire's role as a destructive force causes us to seek to lower flammability of the forest. Achieving this goal is paramount in achieving other goals and objectives. Attaining the goal of lower flammability demands a dynamic fire management thrust. Part of this thrust is to dispose or treat man-made and natural fuels.

Treatment of logging residue with fire is a well-accepted practice by land managers. Disposal or treatment of natural fuels with fire is not so well-accepted.

It is evident that a half century or more of protection has caused an untenable build-up of natural fuels in many places. This build-up, and the need for staying on top of man-created fuel disposal, prompts us to meet the challenge to develop a dynamic fuels management program.

Copter-Cycle . . .

transporting fire crews from the copter drop point to the fire site. The bike is also used to scout the fire, coordinate the attack, and mop-up.

A Major Question Remains

One major question remains in the future. Can we provide helicopter maintenance service to an expanded fleet of surplus UH-34D type copters, or is it more efficient to contract the service from private operators? Modern turbine helicopter types are more capable and perhaps more reliable for mountainous operations. Future availability of surplus turbine craft and parts may well be the key to answering the question of our own fleet versus a contract fleet.

Reducing flammable fuels such as dead insect killed lodgepole pine in the Northern Rockies must be an objective in land-use planning.

Much can be accomplished in man-created fuel disposal by commercial utilization of logging residues, by better harvesting techniques, and through research and development of marketable products from residues. Today research foresters are working on opportunities to provide this improved utilization.

Seeking to lower the flammability of the forest and commercial utilization of residues are not the complete answer to coping with increased flammability of forest lands. There must be created a new dimension in fire prevention. Such prevention efforts must be supported by research and development of new methods and application.

The traditional reduction of fire ignitions from man-caused sources must be vigorously pursued. Reduction of lightning fire starts must continue. But besides preventing ignitions, we must also:

- "Prevent" fires from escaping initial attack;
- "Prevent" creating increased fire problems through sound land use planning;
- "Prevent" build-up of potentially disasterous fuel accumulations.

Total Mobility

Our expanded dimension in fire management must be supported by a capability for total mobility of manpower, equipment, and supplies to fight wildfire. Our experience in the fire busts of 1967, 1970, and particularly 1973 have demonstrated that total mobility will reduce damage from fire, and that this can be achieved essentially by three means:

1. Establishing preparedness levels of manning based on probabilities;
2. Prepositioning of suppression forces;
3. Maximizing efficient movement of firefighting resources, i.e., namely by air through computer supported dispatching.

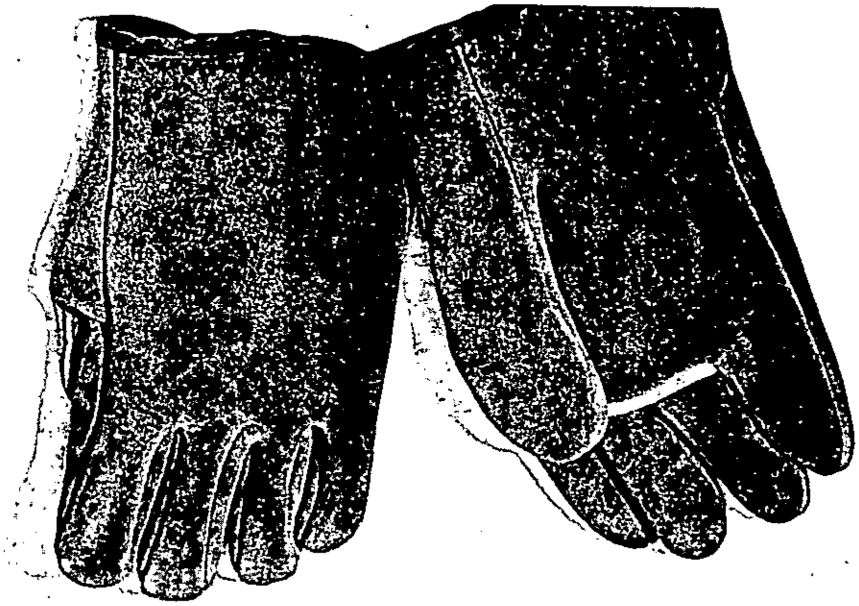
The payoff to total mobility was exemplified in mid-August of 1973 when 11,000 men were mobilized to combat over 70 major fires stretching from Eastern Montana to the Canadian Border in Idaho, down through Eastern Washington and Oregon to the Central Sierras in California and Nevada. The payoff was there, even though the Northwest was experiencing its worst drought in 39 years.

→

Firefighter's Gloves Can Be Ordered As GSA Item

Crews that wear gloves and are trapped by fire escape with fewer and less serious burns. To take advantage of this safety fact, special gloves have been designed for firefighters and are now available from the General Services Administration (GSA).

In addition to firefighting, these gloves are suitable for general forestry work. They were developed by the Missoula Equipment Development Center in cooperation with the glove industry. Some 120 glove manufacturers were contacted, and 36 different samples of gloves meeting general requirements were evaluated.



These gloves, which meet Forest Service Health and Safety Code requirements, are leather (split cowhide) and specially treated to resist heat and flame. They are similar to those used by welders and foundry workers.

Need Shown in '71 Study

Development of these gloves was aimed at meeting the need reported in 1971 in the Forest Service study "Zero in On Safety." The study showed that hand injuries were more numerous than any other category. Although burns comprise only 2 percent of hand injuries, they are extremely painful and often require extensive treatment or surgery.

OSHA-Act of 1970

With the passage of the Occupational Safety and Health Act of 1970 and recent rulings of the Comptroller General, these gloves can be purchased by the Forest Service with appropriated funds.

These gloves meet requirements of the Forest Service Health and Safety Code which states that gloves must be worn for these tasks: firefighting, timber felling, thinning, girdling trees, pruning, tree planting, tree climbing, fencing, blasting, welding, tool sharpening, brush cutting, and grinding.

Dimension . . .

State and Federal agencies kept losses to less than 200,000 acres. This was a remarkable feat considering the 2,500 fires which occurred during the period.

Coordination and Cooperation

The new dimension of fire management demand greater coordination and cooperation. *Coordination* means more than just scheduling, it means standardization of qualifications, training, contracting, communications, nomenclature, reporting, and a myriad of other elements. Coordination also means integrating development of new techniques and equipment to maximize the effectiveness of fire management programs.

It means coordination intra- and inter-governmental agency-wide in matters of building codes, zoning, and land use policies.

Cooperation means sharing across unit, agency, and international boundaries. Cooperation calls for sharing of knowledge, pooling resources, and committing to common goals. Coordination and cooperation are not easily attained because there is an element of threat and sharing present. Both imply giving something up. To proud fire managers this can be construed as not being able to handle their problems.

Fortunately, most managers recognize they can no longer afford to "roll their own." The smart ones know the long term payoff of sharing knowledge, pooling resources, and committing to common goals are good ways to enhance their programs.

The challenge facing resource managers is to recognize the expanded dimension for fire management in land use planning.

Computer Graphs Fire Reports In Three-dimensional Form

Romain M. Mees

As decision-makers, fire managers and reseachers need data expressed in clear, understandable form.

Three-dimensional pictures offer a more effective, graphic way of displaying complex data. A computer program can quickly generate three-dimensional histograms. Pictures are produced by a computer and an incremental plotter. The main program reads Fire Report data from disk files and prepares it for use of a subroutine which, in turn, generates all data required by the plotter. The subroutine can be incorporated in other programs and modified to suit the user.

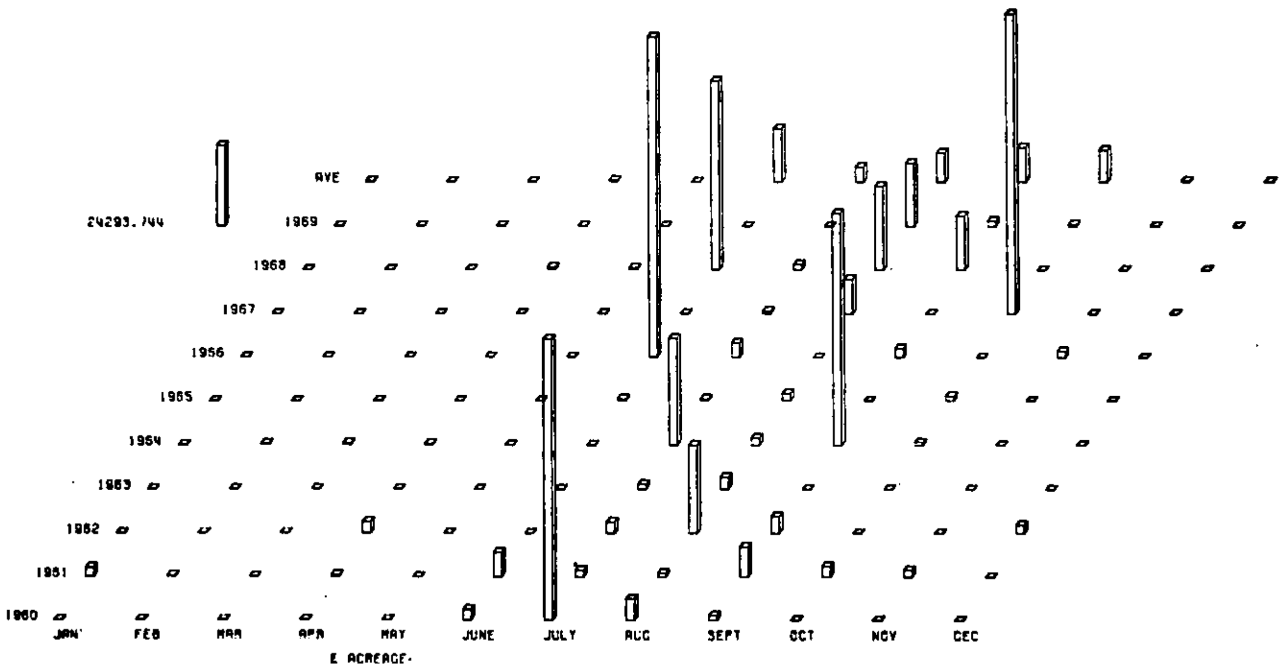
To illustrate how the technique is used, data were drawn from 10 years of Individual Fire Reports (Form 5100-29) of four National Forests in California. The data are stored in permanent disk files so that any variable can be plotted with minimum effort.

The example illustrates frequency of fire acreage burned, but the computer program can handle any three-dimensional data. Column heights in the histogram can, for example, be board feet of timber cut or visitor-days of recreation use. Units can be expressed in any desired dimension. The width, depth, and orientation of the columns can be varied from plot to plot. In the example, one-tenth inch was used for width and depth and 60-degree orientation for all plots.

The computer program and more detailed information are available upon request to: Director, Pacific Southwest Forest and Range Experiment Station, P. O. Box 245, Berkeley, Calif. 94701, Attention: Computer Services Librarian.

Romain M. Mees is a Computer Analyst, Pacific Southwest Forest and Range Experiment Station Forest Service, U.S. Department of Agriculture, Berkeley, Calif.; stationed at Riverside, Calif.

Total acreage of Class E fires (300+ acres) for the years 1960-1969, on the Angeles, Cleveland, Los Padres, and San Bernardino National Forest, California. The uppermost row represents the 10-year average for each of the 12 months. The single vertical column in the upper left-hand corner of the plot shows the scale.



Toward a Common Language For Aerial Delivery Mechanics

Marshall Newman

When describing aerial delivery systems, airmen and fire control and fire research specialists often use various terms such as "drops," "gallons per square feet," and "application rates," etc. This article is an effort to get us to speak a common language.

Aerial delivery mechanics is defined here as the interworking variables involved in effectively treating a fire situation with the proper amount of fire retardant. To effectively treat a given fire situation efficiently, a retardant line of certain length, width and depth is required; in other words, each situation requires that the retardant pattern be "tailor-made" to suit the situation. Tailoring the pattern is a standard practice with the larger air tankers equipped with multiple or variable tank-door systems. There is a need for a common understanding of how to determine the most effective pattern to treat each fire.

Mechanical Approach

The approach taken here is to define "effective" treatment by empirically setting measurable and immeasurable factors for an average drop and then determine the volume of retardant pattern as a function of fuel weight and fire intensity (or flame length). An effective aerial delivery treatment on a fire front is defined here as a retardant pattern which will "stop and hold" a fire front along the given pattern length for a period of approximately 15-20 minutes.

The following variables in aerial delivery mechanics were set as average values:

(1) Effective Pattern Width: The inner 60 percent of the drop pattern (which contains approximately 90 percent of the total volume) will be constructed to equal at least 1½ times the average flame length.

(2) Retardant Type: Long term.

(3) Retardant Distribution Patten: Overlap drops to obtain even concentration.

(4) Retardant Tank-Door: Capable of varying application rates through the range of 1 gallon per linear foot to 20 gallons per linear foot.

(5) Winds: 10-15 mi/h winds.

(6) Type of Attack: On the outer edge of the flame front.

(7) Type of Aircraft: Good maneuverability and visibility with drop speed range from 110 mi/h to 150 mi/h.

(8) Terrain: Rolling hill type.

(9) Target Identification: Target is defined and understood, and is visible on approach.

(10) Drop Accuracy: 80 percent (even the best miss a few!).

Now that conditions and variables have been set, while others have been completely ignored, the job of planning an effective retardant pattern along a fireline can be expressed in gallons per linear foot along the fireline as a function of fuel weights and flame lengths.

Most experienced lead plane pilots or air tanker pilots can use the table as a guide if they can recognize the fuels, estimate the intensity, and can assume the conditions are averages.

Application

The Application Rate Chart provides a guide instrument for the novice lead plane pilot, or air tanker pilot, to tailor a retardant pattern to a particular fire. The relationship can help the fire boss or line boss on the

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Marshall Newman is Chief Pilot of the North Carolina Forest Service.

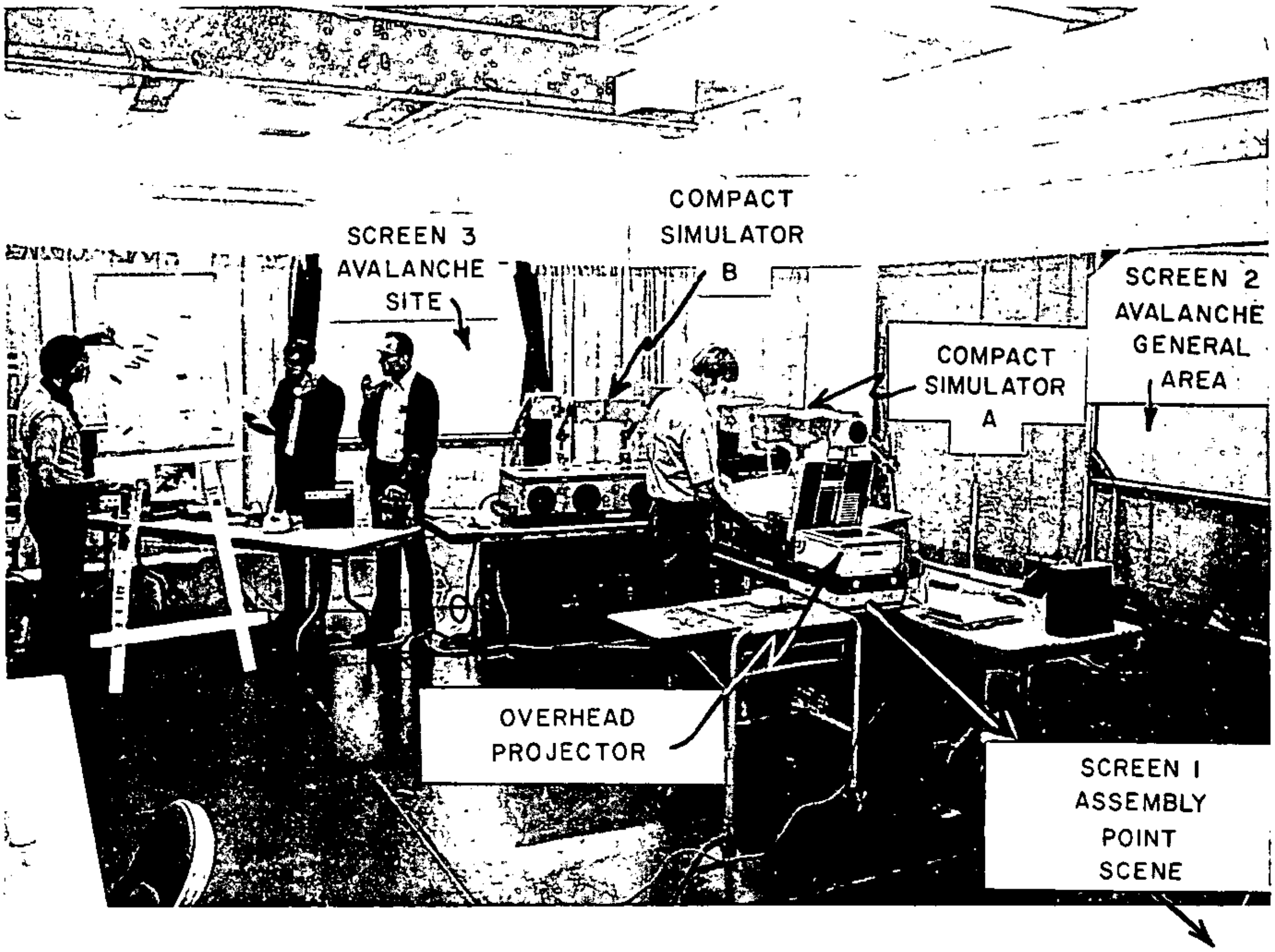
AVERAGE, EFFECTIVE RETARDANT APPLICATION RATES (Gallons/Linear Foot)

Flame Length - Height in Feet

Tons of Fuel ∠1"Dia./Acre	10	20	30	40
4-6	1	2	3	4
10-12	2	4	8	16
18-20	3	9	27	Fire Too Hot For Retardant
30 ±	4	16		
Fire Intensity=10h² in BTU/sec./ft.	1000	4000	9000	16000

Gal./Lin. Ft.

This chart shows average application rate requirements used under the variable conditions. The table values were derived from a combination of experience and rounding off the values as a linear function of fuel weights and fire intensity (approximately ten times flame length squared). EXAMPLE: 500 ft. effective line on 20 ft. flame in 10T/A fuel requires 4 gallons/linear ft, OR: 500 x 4 gal/ft = 2,000 gals.



Role players, two Compact Fire Training Simulators, one overhead projector, and audio equipment provide a complete system for demonstrating a unique avalanche problem.

Common language . . .

ground understand the capabilities and limitations of aerial delivery, allow him a means of projecting *time* requirements for aerial delivery assignments (rate values for an indirect line construction type of attack should not be much higher than those shown in the chart), and give him the understanding necessary to coordinate the air attack with the ground attack.

Another important application of the guide is to assist the fire control planner in devising a *balanced* air-ground fire suppression force. Air tankers merely extend the effective radius of coverage.

Avalanche School Uses Fire Simulator

The National Avalanche School used the Compact Fire Training Simulator to realistically produce avalanches in testing performance of some 250 National Ski Patrolmen, Forest Service Snow Rangers, and Ski Area Safety Leaders in directing avalanche rescue operations.

The simulator dramatically portrays an avalanche in a classroom environment, where many trainees can easily participate. Trainee Al Turner said of the simulation. "This is very real!" Turner should know, as he was one of three men directing an actual avalanche rescue at Whistler Mountain last winter.

In addition to fire training, the Compact Fire Training Simulator has now proven ideally suited for avalanche training. It has also been reported that Elgin Air Force Base uses the simulator in their aircraft fire training. Now that some 75 Compact Fire Training Simulators are in the United States and Canada, they are readily available to meet most needs. Scott Engineering Sciences, 1400 S. W. 8th Street, Pompano Beach, Fla. 33060, the original contractor for the Forest Service production run, now has a GSA contract for this avalanche simulator.

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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.

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Availability Code

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NFFL . . . . . Northern Forest Fire Lab., Drawer G, Missoula, Montana 59801.

IBP . . . . . Fire Ecology Project, US/IBP Coniferous Biome Science Comples 444, University of Montana, Missoula, Montana 59801.

UM . . . . . University of Montana, School of Forestry, Missoula, Montana 59801.

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PNW . . . . . . Pacific Northwest Forest & Range Experiment Station, 809 NE 6th Ave., P. O. Box 3141, Portland, Oregon 97208.

JF . . . . . Journal of Forestry . .