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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

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Volume 5 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

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The value of this publication will be determined by what Forest Service officers, State forestry workers, and private operators contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire-fighting methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

Address DIVISION OF FIRE CONTROL
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A PLANNING BASIS FOR ADEQUATE FIRE CONTROL ON THE SOUTHERN CALIFORNIA NATIONAL FORESTS

By S. B. Show, C. A. Abell, R. L. Deering, and P. D. Hanson of Region 5 and the California Forest and Range Experiment Station, United States Forest Service

Introduction

This paper represents a method of approach to the fire problem on an area where severity of fires and resulting damage make its solution of paramount importance. The authors define the problem, analyze its elements, and present specifications for reduction of losses to an endurable rate, both on individual watersheds and on the area as a whole. They provide a basis for future program planning in southern California.

As is indicated, the more advanced appreciation of the need for fire control in southern California has led to an intensive system of fire-prevention measures. Similar measures will steadily become appropriate in other regions. The dwindling supply of water and the increasing need for it in southern California suggest what may be expected in many other localities as human use rises to exceed the readily available supply. Experiences related show how forest fires affect the management of water supplies under such conditions.

Believers in the practicability of sustained fire control, particularly the managers of the more recently established national forests, will note the long continued downward trend of area lost despite the rapid accumulation of inflammable material and an increase in number of fires as human use on some of the oldest national forests has become more intense.

The system used in this article for classification of land into "significant fire control zones" is in sharp conflict with the system of classification by fuel types used in most other regions. Understanding of the problem of classifying areas for fire-control purposes may be increased by consideration of the method employed.

As values at stake and intensity of fire-control increase on other forested areas of the United States, more detailed methods of analyzing occurrence and size of fires will steadily become appropriate. Guides of general applicability may be found in the methods used in this instance. The analysis of relationships between size, control time, and percent of total area burned is particularly suggestive for the development of methodology in such studies.

Recognition and handling of bad fire days is a problem with which fire-control managers and analysts have struggled everywhere—without too much success. The methods of analysis used by the authors to get at the significant facts regarding bad fire days may be applied in all other fire-control units.

With the advantage of the new coded statistical reports for the Nation's forest fires, it will be relatively easy on all national forests to bring out the highly important and highly significant facts about trends in speed and strength of attack by the methods of analysis developed by the authors. This is true also, with respect to trends in development of roads and other improvements.

It happens that the use of mechanical equipment, particularly tankers, tractor-trailbuilders and specialized backfiring equipment, has advanced more rapidly in California than elsewhere. This is not because such mechanical aids are important only in California. The discussion and analyses of this subject should promote the recognition of the practical value of such aids under a wide range of conditions.

Failure to make a serious attempt "to determine a rational and demonstrable objective" in fire control is by no means confined to southern California. The methods used by the authors represent a serious attempt and should provide a new level of development on which to base further advances in thought on this point in all other regions as well as in California.

The analysis of the effect of high wind velocities is pertinent evidence bearing on the problem of moisture-wind ratios now under special consideration in all regions.

The analysis of the risk problem, leading to mportant conclusions about fires from miscellaneous causes is significant generally. As other national forests attain the success reached in the control of the more common causes in some portions of southern California, the same exasperating problem of miscellaneous fires will arise. Analysis and experience in southern California should prepare other regions for more effective treatment of these elusive causes as they rise to relative importance.

Development of Need for Fire Protection

The southern California coastal plain, in 1890, had a population of 217,424 compared to an estimated 3,687,000 in 1940. Irrigation agriculture, the present key industry, was practiced on 153,823 acres, compared to 741,421 acres today. The annual value of agricultural crops was $24,360,070, now $217,608,770. Irrigation was done by direct diversion from streams, by tapping the centuries old subterranean accumulation of water by artesian or other shallow wells. Not even a beginning had been made in the present capital investment of $226,091,128 in major structures for water conservation and flood control. The capital investment in pumping equipment which has multiplied as water tables were lowered had barely begun.

The entire community, with its total assessed valuation of $319,617,081 compared to $3,437,310,351 today, went along on local supplies of water. The importation of water from distant sources, now representing a capital investment of $252,500,000, was unthought of.

But in this relatively simple, self-contained community, the difficult task of protecting the mountain cover quickly came to the fore. Fires were commonplace, severe, and large. Use of the mountains for range and for recreation, use of fire for land clearing, and occasional lightning storms all contributed to the total. Disastrous floods were recognized by the more farseeing leaders as originating from the mountain lands denuded by the frequent fires. The low summer stages of streams, at the very time when water was most needed for irrigation, could, it was believed, be measurably raised by improving the density of cover on the mountains, that is, by protecting it against fire and against the uncontrolled uses that caused fires. The leaders saw, in protection of the mountains, at least a partial solution of the water conservation and flood-control problems of the day. And while perhaps no one anticipated the spectacular increase in population, irrigation agriculture, and intensified need for water, it was recognized that growth was inevitable.

So, as early as 1899 the leaders banded together to further a program of management and protection of the mountains, as an essential step in protection and development of the growing coastal plain community. This movement affiliated itself with other groups scattered over the Nation seeking to curb the reckless wastage of timber on the public domain. Both groups sought the solution in Federal reservation and management. The southern California group was primarily responsible for inclusion, in basic legislation leading to establishment of the present national forest system, of the phrases "insuring favorable conditions of water flows" as a purpose coordinate with "preservation of timber for the use and necessities of citizens of the United States."

Action by the President was prompt on both declared purposes, for almost simultaneously the Yellowstone Timber Reserve and the San Gabriel Forest Reserve were set aside by Executive order. The initial battle had been won. Further reservations were progressively made: San Bernardino Reserve and Trabuco Canyon Reserve, 1893; San Jacinto 1897; Pine Mountain and Zuca Lake Reserve, 1898, and Santa Ynez 1899,, are now part of the four national forests of Southern California.

But the reservation, it was quickly apparent, was not a solution but a mere beginning. Still, there was a change. The thinly spread handful of forest reserve officials, when there was a fire in the mountains, rounded up crews from among mountain men and from the cities and camped on the fires for days or weeks until they were put out—sometimes by the fall rains. Some gradual, but growing progress was made in obtaining care with fire. The mere presence of an effort to curb fire losses, coupled with the missionary zeal of the leaders, led to an increasing interest and participation in the problems by people who had a real, but unrecognized stake in them.

This growing interest found expression in tangible ways. The Tri-Counties Reforestation Committee, the Angeles Forest Protective Association, and the Southern California Conservation Association were formed and not only preached and fought for better protection, but contributed men and money to strengthen the pitifully weak Federal efforts. Mutual water companies contributed to the job. The local courts began to impose fines for causing fires. The Federal Government, for its part, began through the Bureau of Forestry, efforts to reclothe the mountains with timber. Forest nurseries sprang up at hopefully optimistic spots.

By 1905 when the Forest Service took over management of the national forests, progress was well under way. But several factors speeded it up: More aggressive Federal officers; constantly and rapidly expanding growth of the community, and consequent increased need for use of water and protection against floods; expanding public interest and participation; enthusiastic recognition that the southern California area was destined for great things, and that water was the key to growth; local supplies of water were limited, and it was expensive to import.

So more and more water user groups contributed to the job of protection. Counties came in on cooperation with the Forest Service. Led by Los Angeles County, several county forestry organizations were formed to protect watershed lands outside the national forests. Additional public domain areas were set aside. A trail system was built. Firebreaks were constructed, and the spectacular increase in use of the mountains for recreation got under way

Up until 1916 the venture had received no severe test, but in that year heavy, protracted rains in January resulted in severe floods and high damage. Evidently, protection of mountain cover, which had been rather successful, was not a complete answer to the flood problem The Los Angeles County Flood Control District was formed and built an extensive series of flood-control reservoirs. Their vulnerability to silting in and the similar situation of water conservation reservoirs led to an increased interest in and demand for better mountain cover protection.

Perhaps the relative success in protecting mountain cover from 1905–18 was due to the fact that it was recovering from earlier burns, and was thin enough so that fires were relatively easy to control. Whatever the reason, two disastrous fires in 1919 exploded any existing complacent belief that fire organization had caught up with the problem. The San Gabriel and Ravenna fires, totaling 151,000 acres, burned on some of the most valuable watersheds.

In rapid succession there followed other major fires: Kelly Canyon (106,300 acres, 1922, Los Padres); Arrowhead Springs (20,000 acres, 1922, San Bernardino); Oso (68,300 acres, 1923, Los Padres), etc. The culminatmg blow was the San Gabriel (49,200 acres, 1924, Angeles). Keen dissatisfaction with the whole fire-control program focused in an insistent demand for a far more active and aggressive program.

The special Board of Fire Review of 1924, particpated in by local leaders, led to local sponsorship of the southern California improvement bill, setting up a program of fire-control improvements, financed half by local contributions and half by Federal funds. Its prompt enactment was due to the energy with which its sponsors insisted on a program more nearly adequate to do the fire job. For by this date, heavy public investment in water importation; in flood control and water conservation projects; the tremendous population growth rate; the obvious need to conserve and use every drop of water; the many newly built urban and residential areas subject to flood damage; all combined to make the imperative need for better protection of the mountains a project of major public interest.

With the new improvement program under way, and with prompt cure of some evident weaknesses brought to light by the 1924 disaster, public opinion quickly gravitated toward a renewed feeling of assurance and safety. A short respite—for in 1928 major fires on each of the four national forests burned a total of 158,000 acres inside the boundaries. To be sure, the largest individual loss of 29,540 acres within the protection boundary, was far smaller than the major burns of former years, and was only a little over half the size of the San Gabriel of 4 years earlier. But the total loss was too great to endure, and renewed demand for intensified effort developed. Additional Federal funds became available, county participation increased, the trained suppression crew was developed, tank trucks became a powerful element in suppression, the slow building up of road and trail systems began to show effect in more rapid, heavier, and diversified attack. Again came a major surge ahead.

The Matilija fire (218,000 acres, 1932, Los Padres) the largest fire in the long record of southern California fire control, served to emphasize that the program of fire road construction was sound. For the history of this fire was that of almost complete inaccessibility, and consequent inability to move men and supplies rapidly and in quantity, to attack when and where needed, and lack of already existing backfiring lines, from which quick attack could be safely done. Opinion, both professional and civilian, generally held that rapid expansion of transport systems—breaking down the barrier of inaccessibility—held the key to eventual solving of the fire problem. There was no decrease in the belief and faith that it could be conquered.

The advent of the C. C. C. gave a quickly grasped opportunity to place 54 camps on southern California fire-control improvements in Federal, State, and county areas, and to expand greatly the system of organized crew attack. The tempo of progress speeded up.

During the years since organized efforts at fire control began, there had been no sharp, major demonstration of the vital need for the highest possible level of protection. The La Crescenta flood of January 1934, originating on the Pickens Canyon burn (September 1933, 4,831 acres) resulted in "more than 40 dead" and damage to property of 5 to 5½ million dollars. It became clear that destructible downstream values had grown so great that the occasional coincidence of a burn of even a few thousand acres and heavy protracted rain would lead to major disasters.

Public effort promptly moved to develop a comprehensive downstream flood-control program, in the hands of the Army engineers. Temporarily, this tended to divert emphasis from mountain fire protection, and this trend was accentuated by the major flood of February–March 1938, which set a new high in flood losses.

But as it became evident that the cost of the major works in the downstream program would be enormous, that only part of the whole area would likely be treated, that water conservation in the long run perhaps transcended flood control in importance, opinion in the community shortly came back to emphasis on the fire-control program.

The reawakened interest took two principal directions. First, insistence in the paramount place of fire protection in the upstream flood-control program, established by act of Congress in 1936, and second the development and sponsoring of a new program for what is now regarded as adequate fire control, covering all watershed lands in southern California and taking account of all that has been learned of effective means to prevent and control fires.

It is evident that public opinion now holds:

1. Protection of natural cover alone cannot wholly solve water conservation and flood-control problems, but remains vital.

2. Both upsteam and downstream flood-control programs are needed.

3. Fullest conservation of local water supplies has not diminished in importance, despite large-scale importation of water.

4. Disastrous results of heavy rain on burns of even a few thousand acres show need for higher, rather than lower, standards for mountain protection.

5. The southern California community of 1940, like that of 1890, finds irrigation agriculture a principal base for its economy.

6. This economy rests on full use of local water supplies, which must be protected.

Development of Fire Control

INITIAL STEPS

Prior to 1905, fire-control effort developed slowly. A thinly spread net of fire wardens and rangers, few trails to give access, slow attack, small crews, generally large fires, and long suppression campaigns were usual.

From 1905 on, a rather steady if slow, building up went on. More and better trained men, more trails, and some roads, larger crews, and autos and trucks were used to strengthen and speed up both initial attack and control.

PERIOD OF STUDY

The two major fires of 1919 were the signal for the end of the period of slow development. In the same year, major fires in other national forest regions compelled a fresh and Nation-wide look at forest-fire control on the national forests. The Mather Field Conference in 1921, which undertook this job, resulted, among other things, in recognizing that detailed information on fires was needed, rather than the sketchy outline then followed. So, beginning with 1922, such detailed reports have been made on all national forest fires.

In this study, the principal source of the data is the reports on individual fires. In order to have complete and comparable reports to study, those for 1922–39 were used.

AREA OF STUDY

All of the four national forests in southern California are included in this study, except the Monterey Division of Los Padres National Forest which was omitted, since the unit is geographically isolated, and the fire types and the nature of the fire problems are a mixture of northern and southern California characteristics.

The four forests include an area of 3,716,000 acres of which Los Padres contains 1,655,600, Angeles 690,500, San Bernardino 804,000, and Cleveland 566,000 acres. This area has remained constant during the period of study, except for the not particularly significant elimination of 68,160 acres from the Angeles National Forest in 1925, when the San Bernardino National Forest was established as a separate unit.

Administrative boundaries of all forests have been changed during the period of study, but since the study is concerned principally with the whole area, rather than its several parts, this fact has no bearing of consequence on the methods of study or the conclusions.

METHODS OF STUDY

Card records, abstracted from the reports made by field men throughout the years, giving all available statistics on each individual fire, were used. These covered 3,035 fires, both lightning and man-caused, for the period 1922 through 1939, for which reasonably comparable data were available.

The figures submitted undoubtedly were not mathematically perfect, but in general their completeness and correctness obviously are of a higher quality than those used in the northern California study. This was due not only to greater care in report preparation, but also to the fact that smaller numbers of cases were involved, which permitted more time for each report's preparation. However, absolute accuracy in detail of individual figures is not essential since general trends were being studied, and previous analyses prove that reasonable compensation of errors is to be expected.

Obviously incorrect data were discarded. In many parts of the study the available data were used on all fires reported upon within the national-forest protection boundaries, since action such as initial attack was generally quite uniform. In the consideration of areas burned by fires over 40 acres in size only that area covered within the actual national-forest boundaries was included. This was done primarily because the responsibilities for protection of the outside areas have varied within the period on account of national-forest boundary changes.

The forest reports do not include data on all fires in this outside zone for which more than one protection agency is responsible Hence for burned area studies, the area within national-forest boundaries was chosen as the area upon which complete fire history was known.

The data were assembled in various ways to develop the phases of the study with segregation made by periods and zones of inflammability, since initial tentative analysis showed there were logical differences that justified such an approach.

Each fire used in the present study was classified as to location of origin by reference to large scale inflammability zone maps. In addition, all fires over 40 acres had the burned area broken down according to the zones the fire burned in. One of the first steps in the present study was to verify the existence of real differences between zones from a fire-control standpoint. The integrity of zones was therefore maintained throughout many phases of the present study.

SELECTION OF ELAPSED TIME INTERVAL

Since a primary purpose of this report is to determine the speed with which the attacking force should reach the fire, it appears proper if possible to consider and study only those factors which are of a definite character and related to this subject, if a set of factors with this quality is available with sufficient completeness for the purpose desired.

The factors available for study on this subject are: (1) Time of origin, (2) time of discovery, (3) size on discovery, (4) elapsed time from discovery to arrival of crew, (5) size when reached. Of these, time of discovery, elapsed time from discovery to arrival, and size when reached are the three factors which are definitely measurable and are not weakened to any appreciable extent by the element of estimation which is essential in connection with observations on time of origin and size on discovery.

It should be noted here that the elapsed discovery time in southern California is in general considered relatively shorter than in northern California, because of the more universal use of the limited areas subject to travel in the south, which results in the forest users contributing materially as a primary detection agency. Discovery of the fire is hastened also because of the characteristics of the initial fire in the south, which very quickly makes its presence known by its initial rate of spread and associated smoke column.

Since this study does not pretend to cover the field of detection planning and is interested chiefly in speed of attack, it appears perfectly logical and permissible to limit the study to the three definitely tangible factors mentioned. This study therefore is based on reported elapsed time data concerned with discovery of the fire and arrival of the crew, rather than on the elapsed time from estimated origin to arrival.

PERFORMANCE RECORD BY YEARS

During the period of study the loss in individual years inside national-forest boundaries has ranged (table 1) from 222,208 acres in 1932 (of which 218,000 is represented by the Matilija fire, Los Padres National Forest) to 2,665 acres in 1930. These correspond to 6.0 percent and 0.1 percent, respectively, of the total protected area within the national-forest boundaries. The total loss for the 18-year period was 1,059,591 acres, an average of 58,866 acres a year or nearly 1.6 percent of the above protected area.

Percentage of C, D, and E fires (that is, those 10 acres and over in area), a useful index of performance, has varied from 52 percent in 1923 to 7 percent in 1935. The total number of fires (both man-caused and lightning) has varied from 115 fires in 1924 to 261 in 1938. The tendency to increase from the earlier to the later years of the period is evident.

TABLE 1.—*The fire history of southern California national forests. Number of reportable fires fought by the Forest Service and area burned within the national forest, by years*

Year	Number of fires	Area burned within national forest by C, D, and E fires	Portion of protected area burned	Year	Number of fires	Area burned within national forest by C, D, and E fires	Portion of protected area burned
		Acres	*Percent*			*Acres*	*Percent*
1922	140	177,853	4.8	1931	174	9,829	0.3
1923	160	118,248	3.2	1932	150	222,208	6.0
1924	115	128,765	3.5	1933	172	40,044	1.1
1925	139	35,230	.9	1934	136	11,570	.3
1926	116	26,315	.7	1935	232	9,085	.2
1927	129	22,816	.6	1936	246	8,271	.2
1928	138	158,047	4.3	1937	215	6,744	.2
1929	185	35,237	.9	1938	261	15,535	.4
1930	127	2,665	.1	1939	200	31,129	.8
				Total	3,035	1,059,591	28.5

The most striking features of the record are:

1. The tremendous variation in losses in individual years, particularly in the earlier part of the record.

2. The preponderance of heavy loss years in the earlier part of the record. Undoubtedly, the large burn during the period had some influence on the size of large fires during later years because of the reduction in the amount of inflammable material.

3. The preponderance of light loss years in the latter part of the record.

4. The heaviest loss year in recent years is little greater than the lightest loss in the earlier years.

5. With two exceptions (1930 and 1932) there is very direct relationship between area burned and percentage of C fires.

COMPARATIVE PERFORMANCE ON MAN-CAUSED AND LIGHTNING FIRES

In U. S. D. A. Tech. Bull. 209, "The Determination of Hour Control For Adequate Fire Protection in the Major Cover Types of the California Pine Region," by Show and Kotok, major differences were found between man-caused and lightning fires. Far more rapid spread of the former group was reflected in highly significant differences in size of fire, percentage of C fires, and area burned inside the national-forest boundaries.

In the area of study, lightning fires are not relatively so numerous as in northern California (table 2), though they may make up about one-fourth of all fires (784 out of 3,035). But this 25 percent of the total fires burned only 1.3 percent of the total area burned, and the percentage of lightning C, D, and E fires averaged but 6.5 percent compared to 22 percent for all fires, and 23.6 percent for man-caused fires.

Clearly, then, man-caused fires are for all practical purposes the real fire problem in southern California. Lightning fires are not considered further in this study.

TABLE 2.—*Lightning fires fought by the Forest Service on southern California national forests 1922–39, inclusive*

Total number of lightning fires fought by Forest Service	784 fires.
Portion of lightning fires that became C, D, and E	6.5 percent.
Area burned by lightning fires 10 acres and larger	13,798 acres.
Portion of total burned area due to lightning fires	1.3 percent.

TABLE 3.—*Man-caused fire business and results of control effort on the national forests of southern California. Average annual number of fires, average annual number of C, D, and E fires, and percent of C, D, and E fires by designated periods which have had different levels of accomplishment*

	Average number of fires per year	Average number C, D, and E fires per year	Percent of fires that became C's, D's, or E's
1922–28	100	41	41
1929–31	110	30	27
1932–39	141	17	12

PERFORMANCE LEVELS

As indicated earlier (table 1) there are major differences between the earlier and later years of the record. Without doubt these differences are the result of varying performance levels rather than of accident. The more important major changes in protection effort have been mentioned.

Primarily from the performance record of man-caused fires (table 3) it is clear that there are three quite distinct groups of years—1922 to 1928, 1929 to 1931, and 1932 to 1939. Within each group, there are certain important similarities between years, and, in area burned in individual years (table 1) some sharp contrasts.

The average annual number of man-caused fires has grown from 100 to 141; the number of C, D, and E fires has dropped from 41 to 17; the percentage of such fires has deceased from 41 to 12 (table 3).

So, despite an increase in number of fires, the performance in suppressing them has improved sharply. Detailed consideration of the means by which the results have been obtained is postponed to a later section of the study, since this analysis furnishes the keys to further advances.

The three periods are used through the remainder of the study.

SIGNIFICANT FIRE-CONTROL ZONES AND PROFILES

Botanically, the cover types of the southern California national forests are numerous and complex. From the fire-control standpoint, the botanical types can be grouped into a few zones, broadly characterized as

Zone 1. Flash fuel, grassland, open brush, and open woodland.—Lie at lower elevations. Grassland has grass and other herbs as principal cover. More numerous plants are wild oats (*Avena* spp.), bromegrasses (*Bromus* spp.), fescues (*Festuca* spp.) and alfileria (*Erodium Sicutarium*). Open brush consists of open shrub stands of sages (*Salvia* spp.), sagebrushes (*Artemisia* spp.), buckwheats (*Eriogonum* spp.) and other similar woody vegetation. Shrubs usually are 2 to 4 feet high and frequently intermingled with grassy areas. In some localities Yuccas are an important constituent in the stand from a fire-control standpoint. Open woodland consists of areas of grass and open brush, with scattered individuals and small clumps of woodland trees, such as blue, valley, and Engleman oaks (*Quercus* spp.).

Explosive types of fuel with highest rates of fire spread. Cover is low and open enough for easy movement of suppression forces and the rapid construction of fire lines.

Zone 2. Dense brush.—Usually above zone 1, and characterized by thick, unbroken, almost impenetrable masses of brush from 3 to 15 feet high. The principal genera represented are chamise (*Adenostoma* spp.), manzanitas (*Arctostaphylos* spp.), ceanothus (*Ceanothus* spp.), shrub oaks (*Quercus* spp.), and mountain mahogany (*Cercocarpus* spp.). Litter under the pure chamise stands is usually less than 1 inch deep, but under the other types is deeper, running from 1 to 3 inches, except in older stands of manzanita and shrub oaks, where it is often 4 to 6 inches deep. Yuccas are occasionally found scattered throughout the south slopes. Many narrow stringer canyons of zone 3 are interspersed throughout the dense brush areas.

Fires in this zone spread rapidly, generating a tremendous volume of heat. The movement of suppression forces, except along prepared lines, is slow and dangerous. The construction of fire line requires much labor and proceeds at a slow pace. The dense brush zone contains both the most difficult fire suppression problem and the highest watershed values.

Zone 3. Dense woodland.—Includes the stream bottom type consisting of dense to sparse stands of hardwoods such as sycamore (*Platanus*), alder (*Alnus*), cottonwoods (*Populus* spp.), willows (*Salix* spp.), maple (*Acer*), and oaks (*Quercus* spp.). The latter are more numerous around the fringes as the brush zone is approached. In the stream bottom at higher elevations and on some northerly slopes, stringers and patches of bigcone spruce (*Pseudotsuga macrocarpa*) are found. On higher ridges, and extending varying distance down the slope, depending on exposure, are frequently found dense stands of canyon live oak (*Quercus chrysolepsis*) or coast live oak (*Quercus agrifolia*) averaging from 4 to 12 inches in diameter and 15 to 25 feet high.

General inflammability is low. However, the stream bottom hardwood areas abound with summer homes and recreational areas which generate high risks. For this reason, and because the width of the type is usually not great and fires, therefore, soon spread to open or dense brush, the zone requires fast attack.

Zone 4. Coniferous timber.—Found mainly above the dense brush at elevations of 5,000 to 8,000 feet. Consists of areas of ponderosa pine (*Pinus ponderosa*), Jeffrey, pine (*P. jeffreyi*) Coulter pine (*P. coulteri*), and bigcone spruce, and white fir (*Abies concolor*), usually open in character but occasionally in fairly dense stands. In mnay of the stands there is an understory of brush, usually manzanita and ceanothus.

Rates of spread are usually slow and fire-line construction is relatively easy. Many of the fires are from lightning, but timbered areas have high recreational value and portions are already intensively used, pointing towards an increase in human risks.

Zone 5. Desert brush.—The desert brush zone occupies the lower and middle slopes facing the desert. Contain species similar to those in dense brush, but ordinarily of much less density and shorter, ranging from 4 to 8 feet high. In addition, species of the open brush type, such as sagebrushes and buckwheats and juniper (*Juniperus California*) and pinon (*Pinus* spp.), are also present.

Inflammability is low and line construction easy because of the sparseness of the cover. Fires are few and seldom attain any great size.

Zone 6. Subalpine.—Includes areas of higher elevations, above zone 4, characterized by rocky terrain with shallow soil. The principal trees are lodgepole pine (*Pinus contorta*) and limber pine (*P. flexilis*), usually occurring in scattered groups. The more important kinds of brush are chinquapin (*Castanopsis sempervareus*), ceanothus, and manzanita.

Fires in this zone are few, burn slowly, and do not account for much burned area. The major factor interfering with the suppression of fires that do start is their inaccessibility.

The relative location of cover types by elevations is shown on Figures 1 and 2.

In importance as to area zone 2 is, as might be expected, overwhelmingly first, with 69 percent of the total (table 4), with zones 5 and 6 combined next. Zone 4 and zone 1 follow in order, with zone 3 the smallest, comprising but 0.5 percent.

In fire occurrence, zone 3 leads with 10 percent of all man-caused fires on 0.5 percent of the area (table 4). The heavy recreational use of canyon bottoms is the obvious explanation for the disproportionate incidence of fires. The coniferous timber zone (4) with 20 percent of the fires on 10 percent of the area, is likewise heavily used for recreation. The low elevation flash fuel zone (1) like zone 4, has a two to one ratio between area and number of fires. The brush zone (2) has 47 percent of the fires on 69 percent of the total protected area. The number of fires per 100,000 acres is thus only about one-fifteenth as great as in the canyon bottom types. Lowest rate of fire occurrence is in Zones 5 and 6 combined, with 8 percent of fires on 12 percent of the area.

The distribution of fires over 10 acres in size (C, D, and E) shows 31 percent of the total number originating in the 8 percent of area in the flash fuel of zone 1; 31 percent on the 69 percent of total area in the brush zone; and 14 percent of C, D, and E fires in the 1 percent which is in dense woodland. These three types cover 78 percent of the area, but have 77 percent of the C, D, and E fires.

In percentage of C, D, and E fires, the zones rank: Flash fuels, brush, dense woodland, zones 5 and 6 combined, and timber.

In number of large fires (those 1,000 acres and over), the flash fuels with 33 percent, the brush zone with 56 percent and the canyon bottoms with 6 percent, account for 95 percent of the total for the 18-year period of study.

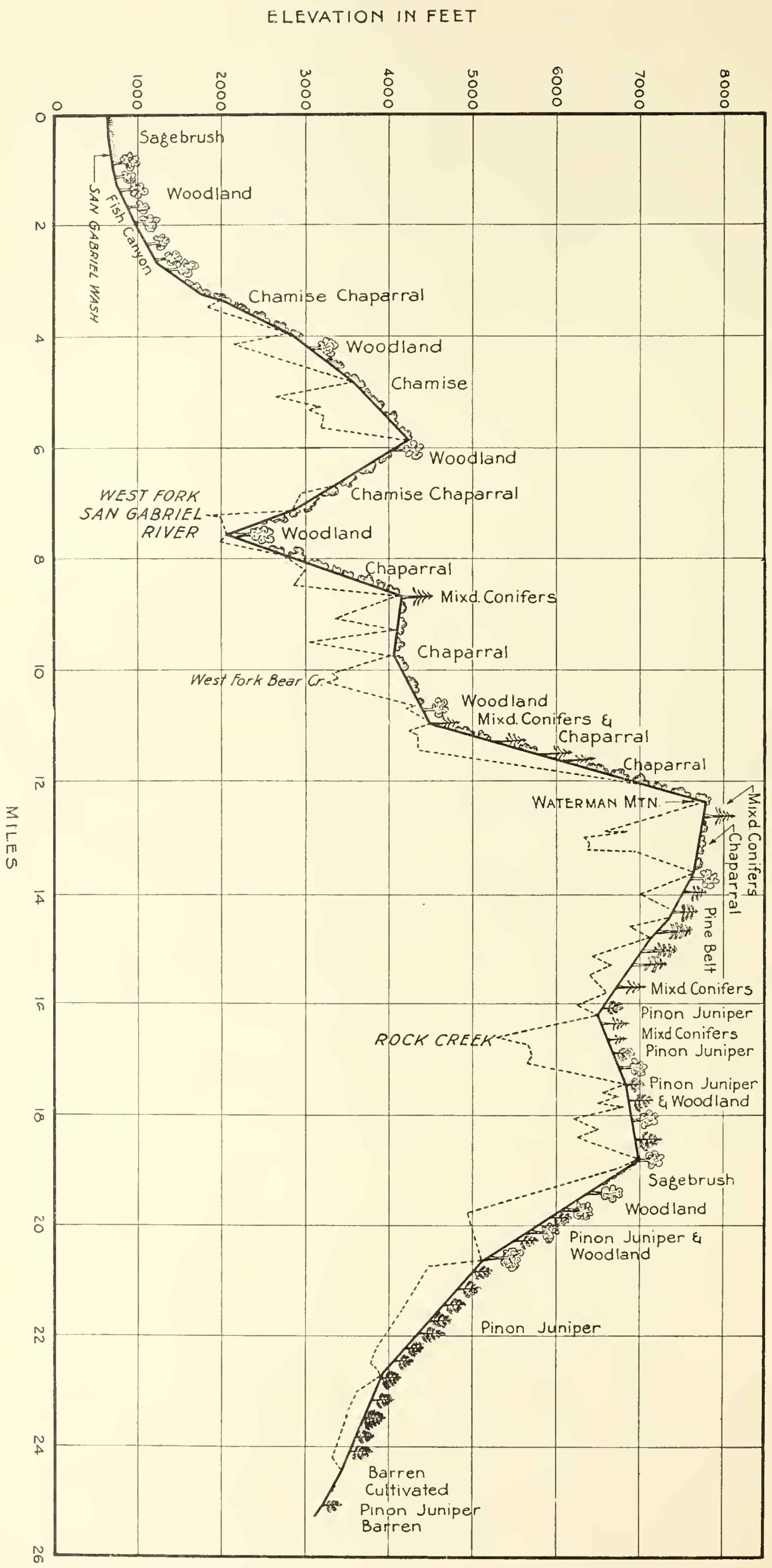

FIGURE 1.—Profile of the Angeles National Forest, showing the approximate life zones and distribution of cover types.

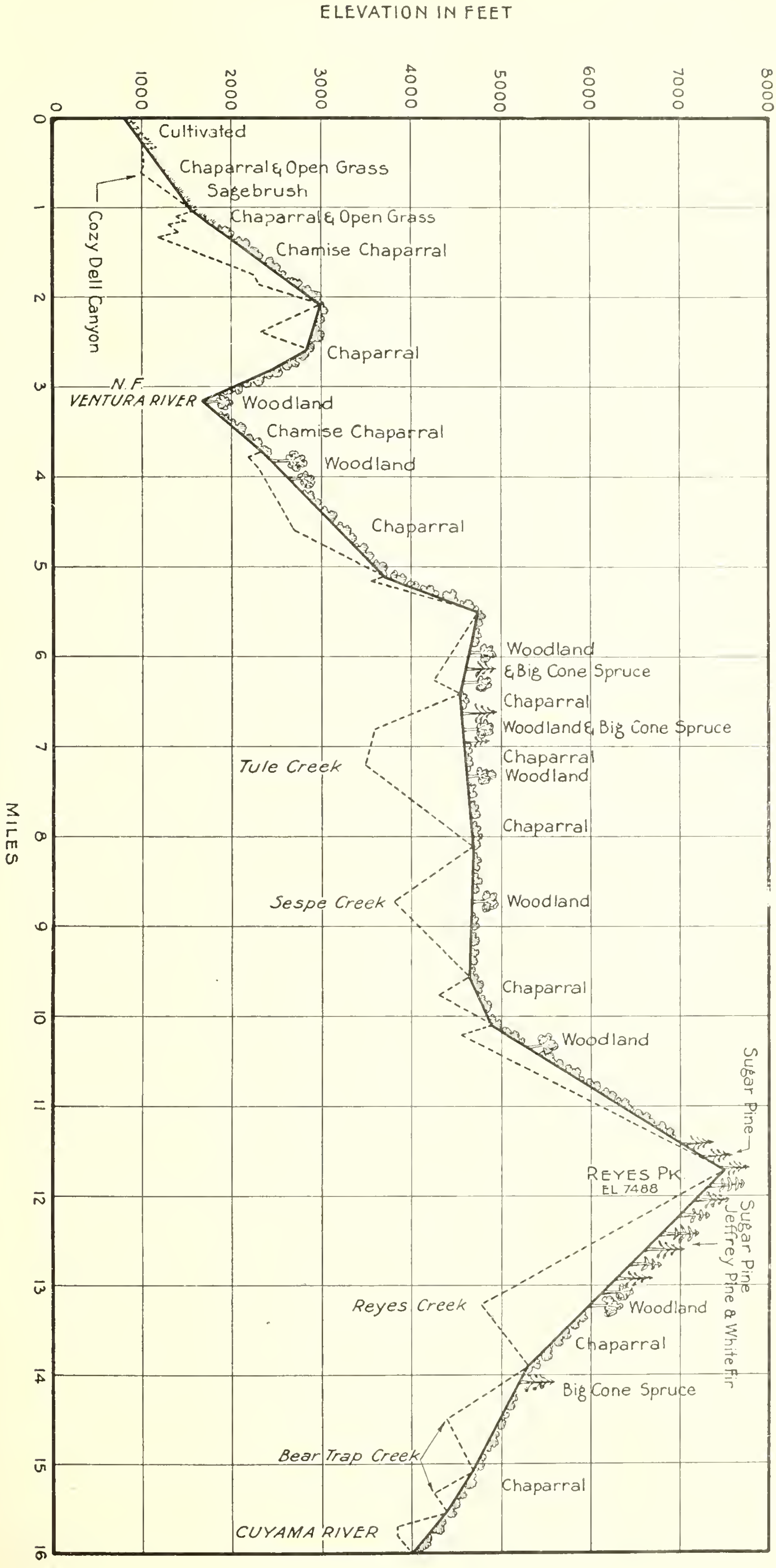

FIGURE 2.—Profile of Los Padres National Forest, showing the approximate life zones and distribution of cover types.

The dominant problem is shown by accumulated experience to lie in the flash fuels and brush zones. The other zones are relatively unimportant.

That these zones are the crux is further indicated by the size of average fires (table 4) which is greatest (911 acres) in the flash fuels, and least (95 acres) in the combined desert brush and subalpine zones.

COMPARATIVE PERFORMANCE IN DIFFERENT ZONES

During the earliest of the three periods of study (1922–28) the average annual rate of loss was 3.25 percent, 3,08 percent, and 3.34 percent (table 5) of the area in the flash fuel, brush, and dense woodland zones, respectively, indicating approximate equality of difficulty under the relatively extensive protection methods then available. The ratio of 0.68 percent and 0.48 percent for the timber and desert-alpine zones show the relative simplicity of the problem in those zones.

Table 4.—*Characterization of the inflammability zones recognized in fire-control planning on the national forests of southern California. Data on fires from individual fire reports for the years 1922–39, inclusive*

	All zones	Inflammability zones				
		I	II	III	IV	Other
Area protected within national forest, acres	3,716,100	317,900	2,570,900	17,800	365,500	440,000
Percent of protected area	100	8.5	69.2	0.5	9.8	12.0
Percent of all man-caused fires originating in zone	100	16	47	10	19	8
Average annual number of man-caused fires originating in zone	120	20	57	11	23	9
Average annual number of man-caused fires per 100,000 acres protected in zone	3.2	6.1	2.2	63.4	6.3	2.1
Average annual number of man-caused C, D, and E fires	28.4	6.3	17.7	1.4	1.8	1.2
Number of fires over 1,000 A, originating in zone, 18 years	130	43	72	8	2	5
Average size of man-caused fire originating in zone		911	665	500	226	95
Average rate of initial spread—chains perimeter per hour		43	30	35	10	15

During the most recent period of years (1932–39) the loss rates have been reduced to 0.30 percent, 1.52 percent, and 0.21 percent, respectively, for flash, brush, and dense woodland zones. That is, the loss rates were one-eleventh, one-half, and one-fifteenth as great as in the earlier period of years, a sharp reduction indicating striking success in the use of additional fire-control resources available. The stubborn persistence of heavy losses in the brush area continues. Even with 207,000 acres of such cover burned in the Matilija fire disregarded, the loss rate in the brush type for the last period of years remains over one-sixth as great as in the early period. That is, losses were reduced less than half as fast as in the two other zones discussed.

However, the brush zone, not only because of its dominant importance in area and its recognized key value in watershed management, but because of its continued high average rate of loss, is the major problem of fire-control planning.

The progressive and rapid reduction in loss rates in all the zones, even the crucial brush zones, as additional protection efforts were applied, gives clear indication that the problem of reducing losses to acceptable proportions is solvable, depending on application of further protection efforts.

Historical perspective of the main mechanics of attack on the fire-control problem is necessary before analyzing the present-day problem and the indicated steps for its eventual solution.

TABLE 5.—*Area burned in the major inflammability zones of southern California national forests, by periods. All man-caused fires; area within national forests only*

Periods	Inflammability zones				Other	Total
	I	II	III	IV		
1922–28						
Average annual burn, acres	10, 319	79, 122	394	2, 480	2, 134	94, 648
Average annual burn, percent of zone	3. 25	3. 08	3. 34	. 68	. 48	2. 55
1929–31						
Average annual burn, acres	1, 662	13, 090	83	123	596	15, 554
Average annual burn, percent of zone	. 52	. 51	. 47	. 03	. 13	. 42
1932–39						
Average annual burn, acres	952	39, 111	37	1, 630	344	42, 075
Average annual burn, percent of zone	. 30	1. 52	. 21	. 45	. 08	1. 13
All years 1922–39						
Average annual burn, acres	4, 713	50, 334	261	1, 709	1, 082	58, 100
Average annual burn, percent of zone	1. 48	1. 96	1. 47	. 47	. 24	1. 56

SIZE CLASS DISTRIBUTION OF CLASS C, D, AND E FIRES

Major changes have taken place from the earlier to the latter period in both the number and the proportion of C, D, and E fires in different size classes (table 6).

For example, in the earlier period 49.1 percent of all such fires were caught in the 10–100-acres size class; from 1932–39 the corresponding figure was 59.1. This, in effect, leaves relatively fewer going fires which may develop into really large burns.

Similarly, comparing first and last period, 63.1 percent and 75.2 percent, respectively, of C, D, and E fires were caught at less than 300 acres; 77.8 percent and 85.4 percent at 1,000 acres or less. For fires of these size classes the increased transportation system and consequent ability to mobilize adequate forces rapidly have undoubtedly been potent factors in increasing the proportion of smaller C, D, and E fires.

Obviously, the major proportion of the total burned area has come from fires of over 1,000 acres. These, with few exceptions are those not caught during the first work period. From 1922–28, 22.2 percent of all C, D, and E fires burned over 1,000 acres each; from 1932–39, 14.6 percent or about two-thirds as many. This means that the key problem of overnight control has not yet been solved, although progress has been made. In each of the size classes above 1,000 acres, there is an improvement between first and last periods, particularly great in the 5,000–10,000- and the 10,000–20,000-acre fires. One way to state the reduction of major fires is that in 1922–28 the average annual number of fires 5,000 acres and over was 4.3; from

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1932–39 the average annual number was 0.5, less than one-ninth as many. But such fires clearly must be eliminated to deliver full protection to the area as a whole, and particularly to deliver protection to individual watersheds.

Least progress has been made in reducing the number of 1,000–5,000-acre fires.

Total number of C, D, and E fires per year has been reduced from 40.7 in first period, to 29.7 in the second, and to 17.1 in the third.

TABLE 6.—*Increase in efficiency in handling large fires, by periods. Classification of C, D, and E fires on southern California national forests according to area burned within forest boundaries. All man-caused fires included*

Period and item	Area burned within national forest boundaries								Total
	C	D	E						
	10–99	100–299	300–999	1,000–4,999	5,000–9,999	10,000–19,999	20,000–49,999	50,000 and up	
1922–28	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	
Number of fires	140	40	42	33	13	10	5	2	285
Number per year	20.0	5.7	6.0	4.7	1.9	1.4	.7	.3	40.7
Portion of total number in each size class, percent	49.1	14.0	14.7	11.6	4.6	3.5	1.8	.7	100
1929–31									
Number of fires	47	18	14	7	3	0	0	0	89
Number per year	15.7	6.0	4.7	2.3	1				29.7
Portion of total number in each size class, percent	52.8	20.2	15.7	7.9	3.4				100
1932–39									
Number of fires	81	22	14	15	1	1	2	1	137
Number per year	10.1	2.8	1.8	1.9	.1	.1	.2	.1	17.1
Portion of total number in each size class, percent	59.1	16.1	10.2	11.0	.7	.7	1.5	.7	100

TREND IN OVERNIGHT CONTROL OF FIRES 1,000 ACRES AND OVER

The fires of 1,000 acres and over in size in zones 1 to 4 (flash fuels, dense brush, dense woodland, and coniferous timber) may be analyzed as to whether they were or were not controlled before burning conditions of the second day (table 7).

The most striking point is that for the entire period 90 percent of the total burned area was accounted for by the 90 fires of over 1,000 acres which went into extra period control. Only 2 percent of the total burned area was accounted for by the 21 fires which were controlled overnight. The percentage by periods is uniformly high.

That increased facilities have been effective in reducing the problem of extra period fires is indicated by the fact that in the first period 86 percent of all fires 1,000 acres and over required extra period control, whereas in the last period the proportion had been reduced to 70 percent. But, equally obviously, the problem is a long way from solution.

A key to the difficulty may lie in the fact that the average size of the 1,000 acre and over fires which were controlled overnight has remained nearly constant at just over 1,000 acres. That is, even today fire organization is unable to effect overnight control on fires of much over 1,000 acres in size.

This stands out as a key problem.

An extra period fire is defined as one which is not controlled by 10 a. m. of the day following discovery.

TABLE 7.—*Importance of overnight control of large fires in successful protection areas burned by extra period fires (those not controlled by 10 a. m. of the day following discovery) and by first period fires on southern California national forests. Includes man-caused fires burning 1,000 acres or more within forest boundaries, inflammability zones 1–4, inclusive, only*

Years	Extra period fires					Nonextra period fires			
	Number of fires	Portion of fires 1,000 acres and up in period	Area burned	Average size of fire	Portion of area burned by fires of all sizes	Number	Acres	Average size	Percent of total
		Percent	*Acres*	*Acres*	*Percent*				
1922–28 percent of total	63	86	598,753	9,504	90.4	10 14	10,480	1,048	1.6
1929–31 percent of total	8	73	29,917	3,740	64.1	3 27	2,660	887	5.7
1932–39 percent of total	19	70	313,632	16,507	93.2	8 30	8,605	1,076	2.6
All periods percent of total	90	81	942,302	10,470	90.1	21 19	21,745	1,035	2.1

LENGTH AND CHARACTER OF THE FIRE SEASON

In the unit of study, fires according to past history, may occur in any month of the year, but with varying degrees of intensity as the season progresses (table 8). The fire business increases gradually from January through May, starts accelerating in June, reaches a maximum in early August, then decreases gradually in number of fires but not in intensity of the individual fire until early November, then drops abruptly in the latter part of that month. A few fires only may be expected in December, with a remote possibility of their developing into fires of damaging proportions.

TABLE 8.—*Distribution of fire occurrence throughout the year on southern California national forests. Percent of all fires and percent of C, D, and E fires by months for the years 1931–39, inclusive*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
All fires	1.2	0.9	1.6	2.9	4.4	*Percent* 9.9	22.6	24.7	17.7	6.1	6.2	1.8	100.0
C, D, and E fires	3.4	------	3.0	2.6	3.0	10.4	21.6	19.0	19.0	7.3	10.3	.4	100.0

Table 9.—*Seasonal distribution of fire business on the national forests of southern California. Cumulative percent of all fires and of class C, D, and E fires from Jan. 1 to June 1 and from Jan. 1 to Nov. 1 for the years 1931–39, inclusive*

Forest	Cumulative percent, whole year			
	As of June 1		As of Nov. 1	
	All fires	C, D, and E fires	All fires	C, D, and E fires
Los Padres	12	12	95	92
Angeles	16	5	91	86
San Bernardino	9	11	95	92
Cleveland	11	21	85	85

In general, burning conditions from January through May are moderate in intensity, chiefly because of precipitation and its lingering effect, which increases fuel moisture and produces green annual vegetation in the more open cover types. That fires—particularly in the pure brush types—can burn during this period and, if not suppressed immediately, may become large is evident from table 9, which shows by June 1 the Angeles had 5 percent of its class C, D and E fires and the Cleveland 21 percent. Evidence of the size of fire that can be expected during this early period is found in two instances which occurred inside the Cleveland forest in 1933 and 1934 and with characteristics as follows:

Time of occurrence	Mar. 5	Apr. 15
Elapsed time, discovery to arrival	35 minutes	1 hour, 10 minutes.
Size on arrival	25 acres	300 acres.
Size attacking force	165 men	50 men.
Final area	3,560 acres	1,380 acres.

Some form of suppression organization seems to be required in the early and late months of the year. Evidently, too, the intensity of organization will vary greatly in different parts of the year.

SEASONAL DISTRIBUTION OF BAD FIRE DAYS

The general level of fire danger in southern California is high, often over periods extending up to 8 months. During this time various numbers of critical fire days may occur.

Since the bulk of burned area results from a relatively few large fires, it is important to know at what seasons and how often the days on which such fires start may be expected.

In the first period (1922–28) fires of 1,000 acres or over started on 63 different dates—an average of 9 days per year (table 10). Individual years ranged from 5 days in 1925 and 1926 to 15 days in 1924, a recognized critical season.

In the second period (1929–31) there was an average of 3.7 days per year, on which such fires started with none in 1930, a recognized easy season.

In the last period (1932–1939) there was an average of 2.9 days per year, with great uniformity in number of days in individual seasons.

The progressive reduction in number of days per season, on which major fires started probably means increased ability to catch fires in smaller size classes, rather than any real difference in seasons or in difficulty of control.

Seasonal distribution of 1,000-acre fire days shows, for the first period, days from March to November, though the bulk were in July, August, and September (fig. 3).

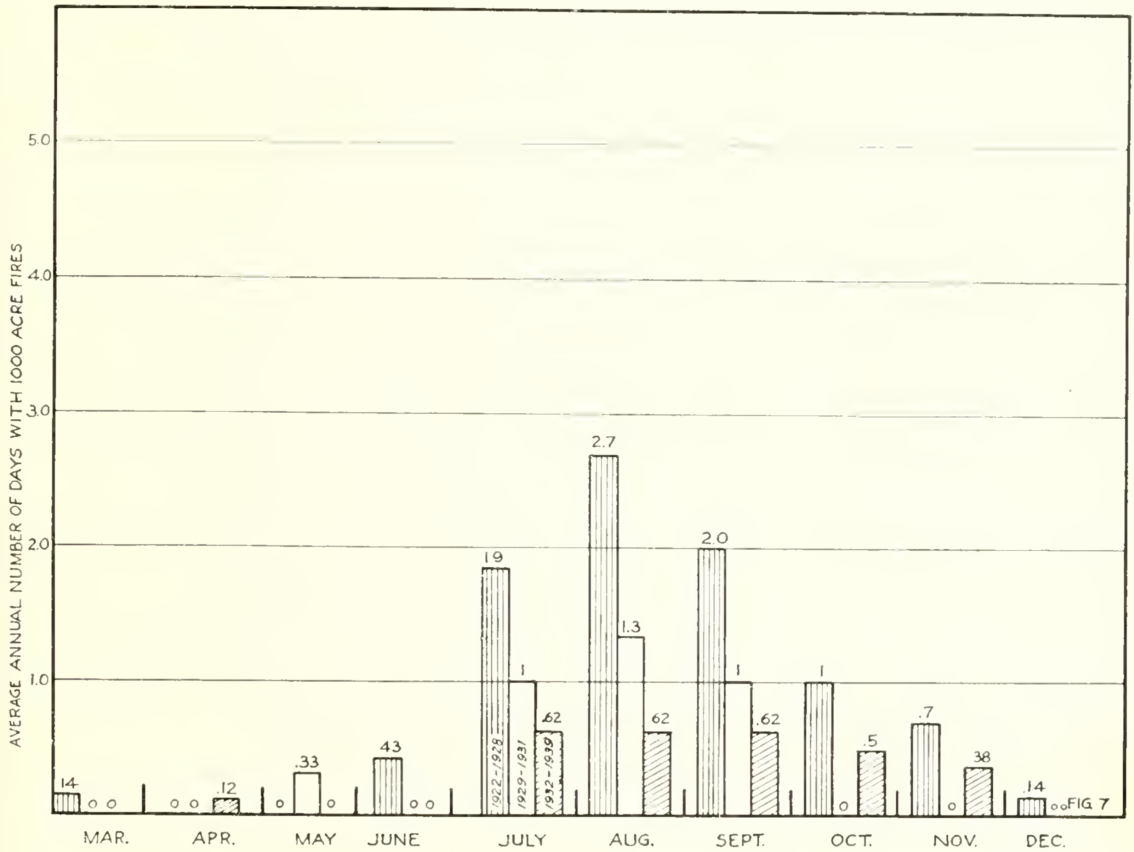

TABLE 10.—*Number of days on which fires started that burned 1,000 acres or more within the national forests of southern California, by months and years. Man-caused fires only*

Year	March	April	May	June	July	August	September	October	November	December	Total
922				1	2	2	4	2			11
923	1				4	4	1	1			11
924				2	5	3	3	1	1		15
925						4			1		5
926						1	1	1	2		5
927					1	2		2		1	6
928					1	3	5		1		10
Total	1			3	13	19	14	7	5	1	63
929					3	2	3				8
930											
931			1			2					3
Total			1		3	4	3				11
932					1		1	1			3
933		1				1		1	1		4
934					2		1				3
935					1			1			2
936							2	1			3
937					1	1					2
938							1		2		3
939						3					3
Total		1			5	5	5	4	3		23

In the last period, with one exception, there were no days in March, April, May, June, or December on which 1,000-acre fires started, thus the problem of major fires is from July to November, inclusive.

The progressive compression of the bad fire days from the earlier to the later period is evident. As facilities for fire control have increased, fewer days each year within fewer months represent a major threat.

A broadly similar historical trend is evident in analyzing the days on which major fires (5,000 acres and over) have started (table 11). In the first period such days were found in each year, with as many as 7 days in 1928. In the last period there is only a single day in any year, and no such day in 3 years out of 8.

The seasonal distribution included all months from June to December in the first period, whereas in the last, only August, September, and November had 5,000-acre fire days.

All this indicates that the attack is catching up with the critical days, but has not wholly done so. The lack of spread in number of bad days per season in the last period, measured either as to 1,000-acre or as to 5,000-acre fires shows that the problem is one of days instead, as in northern California, of whole seasons. This obviously shows an urgent need to identify the characteristics of bad days, and provision for such forecasts of such conditions. It shows urgent need for further progress in methods of attack.

TABLE 11.—*Number of days on which fires started that burned 5,000 acres or more within the national forests of southern California, by months and years. Man-caused fires only*

Year	March	April	May	June	July	August	September	October	November	December	Total
1922				1		1	2	1			5
1923					1	1	1				3
1924					2	2	2				6
1925						3					3
1926								1			1
1927						1				1	2
1928						2	4		1		7
Total				1	3	10	9	2	1	1	27
1929					1	2					3
1930											
1931											
Total					1	2					3
1932							1				1
1933						1					1
1934											
1935											
1936							1				1
1937											
1938									1		1
1939						1					1
Total						2	2		1		5

RECOGNITION AND HANDLING OF BAD FIRE DAYS

That certain days had characteristics resulting in abnormally rapid spread of fire was known from the very beginning of fire-control effort. But in the years up to the early twenties it is far from evident that anything effective was done to offset this well-known fact. Fire suppression was generally with limited sized crews, controlled by the restricted means available for service of supply. The idea of predicting bad days was in its rather formless infancy. Little professional study had been given to defining the characteristics of the bad days.

Perhaps the Arrowhead Springs fire (San Bernardino National Forest, 1922, 20,000 acres) served to focus attention on "Santa Ana" days as the crux of the fire-weather prediction problem. Such days, characterized by high wind velocities from east or northeast, and at times by abnormally low relative humdities at all elevations, are not uncommon in late fall. Strangely, there is evidence that the fire days connected with other and larger fires of the early twenties, which occurred in summer and early fall, were definitely not extreme "Santa Ana" days.

Fire weather forecasting, as a quite incidental phase of general forecasting, began in the early twenties. The results were hardly spectacular. The foresters had not furnished very precise definition of "fire days," and the forecasters in necessarily assuming certain targets, had not yet checked on the fire line the true relations between weather and fire.

This process began in the early thirties, with development of a mobile weather forecast unit and assignment of a qualified forecaster to fire-weather work. Results improved.

But even at the end of the period the diagnostic characteristics of the summer "fire days" were apparently imperfectly known. Common belief of fire fighters remained centered tenaciously on the severe "Santa Ana" days as the critical fire weather phenomenon.

Even before the advent of C. C. C. fire suppression strategy generally depended on scores of men, often more than could be effectively serviced or led. The C. C. C. accentuated this trend. Most effective relation between existing and impending fire weather on the one hand, and strength, intensity, and strategy of attack on the other, was recognized to but a limited degree.

TREND IN SPEED OF ATTACK

When, as in the record heretofore discussed, obvious trends appear in the direction of improved performance on fires, it is necessary to examine the mechanics through which the trends above come into existence.

Speed in reaching fires is one of the well-known means of handling the fire problem. That the increase in effort, which has been frequently mentioned, has increased speed of attack is readily shown (table 12).

For example in the earliest peroid, on the average 24 percent of all man-caused fires in zones 1 to 4 and for the four national forests combined were reached within 15 minutes, and this increased to 30 percent in the period 1929–31, and to 58 percent from 1932–39. The percentage of fires reached within 33 minutes speed increased from 43 percent in the first period to 78 percent in the last. In the early period 13 percent of all fires went over 3 hours before attack and in the last period only 3 percent. The major increase in speed has been obtained in the last period since only a slight increase between the first and second period is evident. Speed of attack is measured from discovery to first attack of fire.

The increase in speed of attack has not been uniform in the four major zones (table 13). For the last period the percentages of fires reached in 15 minutes for zones 1, 2, 3, and 4 are, respectively, 55, 54, 69, and 62 percent. The brush zone (2), which covers the bulk of the area and which all analyses show is the key to the whole problem, has the lowest rate of performance. The dense woodland zone (3), which is smallest in area and is relatively easy to control fires in, shows the highest speed of attack. The same relative position of zone holds true regardless of what period or speed of attack interval is selected as the basis for analysis.

TABLE 12.—*Speed of attack on man-caused fires in southern California national forests. Percentage of fires attacked within specified time following discovery. Major inflammability zones 1 to 4, inclusive*

Period	Elapsed time, discovery to attack—Percent of fires, accumulative								
	3 minutes or less	9 minutes or less	15 minutes or less	21 minutes or less	27 minutes or less	33 minutes or less	1 hour or less	2 hours or less	3 hours or less
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1922–28	5	14	24	31	37	43	57	79	87
1929–31	5	15	30	38	48	54	72	89	94
1932–39	16	42	58	68	74	78	88	95	97
1922–39	10	27	43	51	56	60	74	88	93

TABLE 13.—*Speed of attack on man-caused fires in southern California national forests by inflammability zones by periods. Percentage of fires attacked within specified time following discovery*

Inflammability zone and period	Elapsed time, discovery to arrival—Percent of firse, cumulative			
	3 minutes or less	15 minutes or less	27 minutes or less	1 hour or less
Zone 1	*Percent*	*Percent*	*Percent*	*Percent*
1922–28	6	27	41	58
1929–31	9	22	45	76
1932–39	16	55	74	90
1922–39	11	39	56	75
Zone 2				
1922–28	4	21	31	53
1929–31	4	29	40	65
1932–39	16	54	71	86
1922–39	10	39	52	71
Zone 3				
1922–28	8	42	54	69
1929–31	5	41	59	85
1932–39	18	69	81	95
1922–39	12	56	68	85
Zone 4				
1922–28	2	22	39	61
1929–31	5	31	60	77
1932–39	17	62	76	90
1922–39	11	45	63	79

A strong presumption arises that further speeding up of attack in the overwhelmingly important brush zone is an urgent current problem.

The coniferous timberland zone (4) is, in the area of study, confined to a few high mountain areas—the Lagunas and Palomar Mountain, Cleveland National Forest: the Crest area and parts of the San Jacintos, San Bernardino National Forest: Charleton, Chilao, and Horse Flats, Angeles National Forest: and the Mount Pinos Area, Los Padres National Forest. All these areas are heavily used recreational centers, and most of them have considerable investments in structures, necessitating various types of urban fire-protection organizations.

Fires evidently are not difficult to handle if attacked in any reasonable period, since only five class C fires are recorded out of 230 fires, and two of these were not attacked for over 1 hour after discovery.

The combination of special urban protection organization, recreational management personnel, and overlapping coverage from adjacent brush zones, seems to make unnecessary a detailed analysis of the timber zone speed of attack problem. The type is of very high value, but coverage is not a major problem.

TREND IN REACHING FIRES AT SMALL SIZES

Increased speed in attacking fires should be reflected in reaching them at smaller sizes. The trend has been in this direction (table 14).

When all man-caused fires, zones 1 to 4 inclusive, and all four forests are combined it is found, as an over-all picture, that in the last period of years 73 percent of the fires were reached when they were one-fourth acre or less in size. This is a very great increase from the 40 percent in the first period and 55 percent in the second. Substantially the same increase in attacking fires when small is found in the other size groups.

Particularly significant is the fact that in the first period 26 percent of all fires were already C, D, or E fires (over 10 acres) and that in the last period only 6 percent were already class C, D, or E when first attacked.

There are striking differences in size when reached among the four zones (table 15).

In each type, without exception, a higher proportion of fires were reached at one-fourth acre and subsequent size classes up to 10 acres, from period to period. And conversely a lower percentage of fires were already C, D, or E fires when attacked.

In practically all periods of years and in all size classes up to 10 acres, the flash fuel zone (1) has the lowest percentage, the brush zone (2) ranks second, the dense woodland (3) is third, and coniferous timber zone (4) has the highest percentage.

Inferentially, the rate of spread is highest in zone 1, lowest in zone 4. The contrast is particularly marked, as in the last period of years only 1 percent of zone 4 fires were already class C, D, or E when reached, whereas 13 percent of the fires in the flash fuel zone had gone over this line.

TABLE 14.—*Size of fires when attacked on national forests of southern California. Percentages of fires attacked when of the specified size or smaller by periods. Man-caused fires in inflammability zones 1 to 4, inclusive*

[Cumulative percent, fires in period]

Periods of years	Size upon arrival of initial attacking force				
	0-0.25 acre	0.26-1.0 acre	1.1-4.0 acres	4.1-7.0 acres	7.1-10.0 acres
1922-28	40	52	65	72	74
1929-31	55	66	74	81	83
1932-39	73	85	90	93	94
1922-39 total	59	70	79	84	85

TABLE 15.—*Size of fires when attacked on southern California national forests by inflammability zones. Percentage of man-caused fires attacked when of the specified size or smaller, by periods*

[Cumulative percent, fires in period]

Zone and period	Size upon arrival of initial attacking force				
	0-0.25 acre	0.26-1.0 acre	1.1-4.0 acres	4.1-7.0 acres	7.1-10.0 acres
Zone 1					
1922-28	29	41	57	69	71
1929-31	43	53	62	76	78
1932-39	58	76	84	87	87
1922-39 total	44	59	70	78	79
Zone 2					
1922-28	35	47	60	66	68
1929-31	52	63	71	79	79
1932-39	70	81	88	92	93
1922-39 total	55	66	75	81	82
Zone 3					
1922-28	54	62	78	79	79
1929-31	64	74	82	82	82
1932-39	79	92	93	95	95
1922-39 total	68	79	86	88	88
Zone 4					
1922-28	58	74	86	88	90
1929-31	65	77	86	91	94
1932-39	91	97	99	99	99
1922-39 total	77	87	93	95	96

TREND IN STRENGTH OF INITIAL ATTACK

There is a decided tendency during the last two periods to attack larger percentages of all fires in the high danger zones at greater rates of speed, but with smaller initial attack crews. This is clearly brought out in tables 16 and 17.

The smaller crews arrived on the fires earlier, and while these were in smaller size classes, their efforts in starting the control of such fires were effective in holding many more of them to less than 10 acres in size than was the case in the first period.

The main reasons for more rapid initial attack in the later periods were the better distribution of protection forces, speedier means of transportation, and greatly extended road systems. During the later years of the last period, too, an increased number of speedy light tankers has contributed to the holding of fires to a smaller acreage with reduced numbers of men. The better transportation facilities and ready availability of strong forces of organized labor such as the C. C. C. camps, no doubt, played their part in the prompt backing up of the smaller crew initial attack.

In zones 1 to 4, as the data in table 16 show initial attack crews of from 1 to 3 men started action on 26 percent of all fires in the period 1922–28. In the years 1932–39 similar sized crews began control action on 35 percent of all fires. Similarly, in the first period, in zone 2 (table 17) crews up to 10 men in size arrived and started action to control 28 percent of all fires in the zone while these were one-fourth acre or less in size. In the later period the same sized crews arrived on 55 percent of all fires while they were in the above size class. The same general pattern is evident in studying the rest of the picture of initial attack crew size between the two periods (table 17). Thus in the first period, crews of from 1 to 3 men got to 42 percent of all fires on which control action was started by such sized crews before these fires were one-fourth acre in size, as contrasted with 79 percent in the last period. Corresponding figures on fires that were first attacked when they were from ¼ to 1 acre in size show 57 percent and 89 percent, respectively.

Thus, a very material increased speed of attack supplemented with tanker equipment has made possible reductions in the size of initial attack forces.

Table 16.—*Strength of initial attack on man-caused fires in the national forests of southern California. Percentage of man-caused fires in each period attacked by specified numbers of men. Inflammability zones 1 to 4, inclusive*

Period	Size of crew, initial attack					
	1 to 3 men	4 to 5 men	6 to 10 men	11 to 20 men	Over 20 men	Total
1922–28						
Number of fires	180	127	177	131	84	699
Percent of fires, cumulative	26	44	69	88	100	--------
1929–31						
Number of fires	107	53	55	47	35	297
Percent of fires, cumulative	36	54	72	88	100	--------
1932–39						
Number of fires	360	167	241	135	116	1,019
Percent of fires, cumulative	35	52	75	89	100	--------

TABLE 17.—*Comparative strength of initial attack in 1922–28, inclusive, and 1932–39, inclusive, on southern California national forests. Number of fires of various sizes (when attacked) with attack by specified numbers of men. Percentage of fires attacked by each size crew when of specified sizes, or smaller. Man-caused fires in inflammability zone 2*

Size of initial attacking force	Size upon arrival of initial attacking force: 0–.25 acres	.26–1 acres	1.1–4 acres	4.1–7 acres	7.1–10 acres	10.1–20 acres	20.1–30 acres	Total
	Period 1922–28, inclusive							
1–3 men								
Number of fires	39	13	11	2	4	4	3	92
Percent of fires, cumulative	42	57	68	71	75	79	83	100
4–5 men								
Number of fires	30	7	6	4	1	7	2	63
Percent of fires, cumulative	48	59	68	75	76	87	90	100
6–10 men								
Number of fires	31	4	16	5	0	4	4	84
Percent of fires, cumulative	37	42	61	67	67	71	76	100
1–10 men								
Number of fires	100	24	33	11	5	15	15	239
Percent of fires, cumulative	28	35	44	47	49	53	55	67
	Period 1932–39, inclusive							
1–3 men								
Number of fires	152	18	9	3	1	4	1	192
Percent of fires, cumulative	79	89	93	95	95	97	98	------
4–5 men								
Number of fires	62	8	11	4	1	2	0	89
Percent of fires, cumulative	70	79	91	96	97	99	99	------
6–10 men								
Number of fires	65	8	6	6	1	3	1	94
Percent of fires, cumulative	69	78	84	90	91	95	96	------
1–10 men								
Number of fires	279	34	26	13	3	9	2	375
Percent of fires, cumulative	55	62	67	69	70	72	72	72

TREND IN ROAD AND OTHER PROTECTION IMPROVEMENT DEVELOPMENT

Because of the lack of even a skeleton road system in the period from 1922 to 1928, inclusive, the fires that became large presented serious problems of transportation. This resulted not only in delayed initial attack but also in slow mobilization of adequate control forces, in difficulties of attack through inaccessibility of control lines and lack of mobility of forces on the lines, as well as innumerable handicaps in the service of supply. The operating field of the small number of tank trucks available was limited and no facilities existed for the transport of heavy machinery to fires. Thus, fires such as Kelly Canyon on Los Padres National Forest in 1922 burned 106,300 acres in an area which had absolutely no transportation routes except a poor trail. The Oso fire in 1923 on the same forest burned 68,300 acres and, except that it started fairly near a road, burned in an area in which there were nothing but trails; similar lack of facilities was the case in the 49,200-acre San Gabriel fire on the Angeles in 1924. Naturally, these fires were not only extended campaigns but were suppressed with the greatest of difficulty.

The Matilija fire in 1932 burned in an area in which a major highway was being built, but practically the entire area of 218,000 acres was merely touched by roads on the edge and no appreciable road mileage was inside its perimeter.

The development of a primary road system started in 1925 after the disastrous season of 1924 when a special southern California improvement appropriation of $100,000 was obtained. This money was matched by local interested agencies. The special fund continued in varying amounts for the next several years.

With the advent of C. C. C. in 1933, rapid strides were made in the development of needed improvements with special attention given to roads.

This has meant much in meeting the difficulties in fire control mentioned earlier. Several large areas still lack even a primary network of roads, chiefly on Los Padres National Forest, where several major essential trunk routes exist only in part.

Large mileages of firebreaks were built on which to make stands as fires approached the prepared lines. They were also of value as means of access into hitherto unbroken brush areas.

Rapid progress was made, too, in the construction of other fire control improvements designed to speed up attack as well as to make actual control of large fires more certain and easier to accomplish. More lookout houses, tied in by extensive, high-grade telephone systems, were built to complete the detection program and campgrounds were developed in large numbers to concentrate the campers in prepared and fireproofed grounds.

In recent years extensive radio networks have been built to supplement the telephone system and to facilitate the actual communication on fires in the field. Airplanes have been called into use in scouting and in dropping food to crews on isolated fires.

Thus all of the facilities were developed to provide speed in attack on fires through shortening the period during which fires burned undetected; to permit rapid attack by motorized equipment and full utilization of tank trucks and heavy machinery over a prepared network of roads and to provide modern facilities such as radio and airplanes to use on the suppression jobs themselves. Table 18 shows the work accomplished on the improvement program by periods.

TABLE 18.—*Approximate accomplishments in fire protection improvement development by periods in southern California national forests (Monterey district of Los Padres eliminated)*

	Jan. 1, 1922–Dec. 31, 1928	Jan. 1, 1929–June 30, 1931	July 1, 1931–Dec. 31, 1939
Truck trail construction:			
Total ... miles	73	299	1,899
Per year ... do	10.3	120	223.4
Trail construction:			
Total ... do	407	189	508
Per year ... do	58.1	75.6	59.7
Telephone line:			
Construction, total ... do	348	244	775
Construction, per year ... do	49.7	97.6	91.1
Firebreak construction:			
Total ... do	455	732	1,262
Per year ... do	65	292.8	150
Lookout houses, construction:			
Total	20	7	50
Per year	2.8	2.8	5.8
Campground item, construction:			
Total	174	121	350
Per year	24.8	48.4	41.1

TREND IN MECHANIZATION

Obviously, fire suppression had to remain chiefly in the shovel and ax hand-labor stage until a road system was created, regardless of known deficiencies of unmechanized attack and regardless of known opportunities to strengthen as well as to speed up the attack.

So the use of tank trucks in forest fire suppression did not really start until the period 1929–31, during which time they were used on about 10 percent of the man-caused fires occurring on national forest lands in southern California. With the continuing expansion of the road system, their usefulness from then on increased as shown by their use on 60 percent of all similar fires during the period 1932–39.

The value of this equipment is due primarily to its usefulness in rapidly decreasing the spread of fire through the application of water from a distance. This, in part, overcomes the difficulties and dangers of working men too close to the actual fire edge.

That this equipment can be used on a great majority of the fires is clearly evident from analysis of table 19. This shows how the fire problem is tied in with roadsides, especially on the Angeles, San Bernardino, and Cleveland Forests, which have intensive road systems and where 78 percent of the fires which accounted for 69 percent of the burned area, originated within 265 feet of some road. This distance is readily within the range of tanker equipment.

TABLE 19.—*Occurrence of fires in relation to roads on southern California national forests, number of fires, percent of C, D, and E and burned area according to distance from roads. Man-caused fires, years 1934–38, inclusive.*

Distance from road	All fires		C, D, and E fires		Burned area	
	Number	Cumulative percent	Number	Cumulative percent	Acres	Cumulative percent
	Angeles, San Bernardino, and Cleveland National Forests					
0–265 feet	513	78	51	77	41,271	69
265–800 feet	70	89	2	80	5,875	78
800 feet–¼ mile	34	94	4	86	5,667	88
Over ¼ mile	40	100	9	100	7,334	100
Total	657		66		60,147	
	Los Padres National Forest					
0–265 feet	75	60	12	40	3,746	31
265–800 feet	11	69	2	47	1,204	41
800 feet–¼ mile	5	73		47		41
Over ¼ mile	34	100	16	100	7,037	100
Total	125		30		11,987	

The effectiveness of tank trucks is dependent on reaching the fire while it is small and confined to an area close to the road, since it is difficult to move the hose rapidly in dense brush so characteristic of zone 2 conditions.

Effectiveness is also dependent on a highly trained crew working as a coordinated unit. The effectiveness and use of tankers is expected to increase, especially when units are developed to negotiate more of the steeper brush-covered slopes under their own power while traveling cross country from adjacent roads.

Use of trail builders for line construction is recent, largely in gentler slopes at the lower elevations. The road system was not designed for transport of the heaviest units, which are generally needed in the heavy cover of the brush zone. But more and more opportunities are being found for effective use of the machines, as greater operating experience builds up. Extensive redesigning of key roads remains to be done.

Servicing of suppression forces on fires in the extensive roadless and trailless areas, particularly on the Los Padres National Forest, has always been a bottleneck. The attack has been limited to the size crew which limited numbers of pack stock could service. Development of successful airplane servicing technique has in the past two years removed this barrier. The most effective coordination of airplane and pack string on inaccessible fires remains to be worked out.

Lack of efficient backfiring equipment has always been a major barrier in executing control plans. Commonly, key backfiring jobs have had to be done at night, when burning conditions were poor, and the burning has been patchy and incomplete.

New, portable power backfiring equipment, of the flame-thrower principle, though not yet fully tested under service conditions, is expected to solve many of the technical questions of backfiring. Solution of this problem is expected to reduce the disinclination to backfire, which has been a marked characteristic of fire fighting in the unit of study, and which has, in large part, been due to known difficulties of backfiring.

TREND AND EFFECT OF FIRE-PREVENTION EFFORTS

Attack on the fire problem has included not only the measures designed to speed up and strengthen attack, but the fire-prevention problem as well, for early in the history of the southern California national forests' venture, it became evident that preaching care with fire and imposing fines on apprehended violators of the fire law was far from a complete answer to the problem of fire prevention. The insistent public interest in the problem, and public willingness to accept reasonable restrictions and policing have given an opportunity to devise and test on a large scale many methods aimed at prevention of man-caused fires.

A mere listing of fire-prevention measures gives an idea of the diversification of the attack on prevention of fires.

Summary of specialized fire-prevention measures

Measure	Date started	Purpose	Planned enforcement or execution
Law enforcement	1901 [1] 1918	To build idea of importance of laws.	Fire prevention officers.
Burning permits	1905	To train in safe methods. To put needed burning in safe seasons.	State, county, and forest officers.
Blasting permits	1905	To remove chance for fires to start. To train industrial users in habit of care.	Do.
Campfire permits	1915	Chance for prevention emphasis. To give feeling of individual responsibility. To assist in law enforcement.	Issued largely by forest officers and limited cooperating agencies. Enforced in field by forest officers.
Prepared campgrounds	1915	Same as for closure to use	Rangers and patrolmen.
Requiring camping only in prepared camps.	1915	do	Do.
Prevention patrol	1920	To maintain active realization of dangers.	Field patrolmen.
Building inspection	1920	To decrease fires from structures	Rangers and guards.
Closures to recreational use	1924	Removing chance for fires to start.	Posting in the field and patrol.
No smoking	1924	To train people in recognition of dangers.	Posting, patrolmen, and registrars.
Hunter camps	1924	Specialized care. Same as for all prepared camps.	Patrolmen.
Controlled use of roads	1924	To prevent use in high-hazard areas.	Locked gates.
Registration	1926	Same as for campfire permits	Registrars.
Shovel and ax	1926	To emphasize and train in care with safe methods.	Campfire permit agents, all forest officers.
Fag stations	1930	To train people in recognizing safety. To offset burden of smoking closure.	Patrolmen.
Permit system for recreational use (Gibraltar area).	1934	Same purpose as other measures intensified.	Patrolmen and registrars.
Local ordinances		Facilitate law enforcement	State, county, and forest officers.
Newspaper, radio publicity, public talks, exhibits, etc., signing.		To build up appreciation of problems. To capitalize on educational effect of repetition.	All forest officers.
Road cleanup		To prevent opportunity for fires to start.	Highway organization and forest officers.
Railroad cleanup		Same as road cleanup	By railroad companies.
Power-line clearing		do	By power companies.
Helping users to do needed burning.		To train in safe methods	Forest officers.
Boundary contacts		Same as for campfire permits	Registrars and patrolmen.
Prohibition against open fires.		Same as for prepared closures to use.	Campfire permits patrolmen.
Fire clauses in right-of-way permits.		Same as for blasting permits	Forest supervisor.
Fire clauses in special use of grazing permits.		do	Do.
Change in hunting season		To put use in relatively nonhazardous seasons.	Legislation.

[1] Intensive program.

The list indicates, too, that successive steps were taken as old ones failed to solve the problems at which they were aimed. In total, these measures have succeeded in reducing the number of man-caused fires per 100,000 users (table 20). In the first period the index figure was 2.24, in the second 0.86, and in the third had dropped to 0.82. It is noticeable that the rate of decrease seems to have slackened, and evidently further decrease is likely to be won at considerable effort and expense.

This decrease in number of fires per 100,000 users has not, however, been accompanied by a decrease in absolute number of fires. On the contrary, there has been an increase. So from that standpoint, prevention effort has failed to keep up with the growth of the problem. A large part of the difficulty lies in the great importance of miscellaneous fire causes, many of which are little susceptible to prevention effort, or are stubbornly resistant.

The summary indicates the methods of application or enforcement used for each measure. There is a rather queer mixture of dependence on specialized personnel and on the regular yearlong ranger force and on guards hired primarily for suppression. Reconsideration of methods seems desirable.

TABLE 20.—*Results of organized fire prevention effort on the national forests of southern California. Number of man-caused fires and number per 100,000 user-days, by periods*

Period	Average annual number of man-caused fires	Average number of fires per 100,000 users
1922–1928	100	2.24
1929–31	110	.86
1932–39	141	.82

TREND IN THE CONCEPT OF ALLOWABLE BURN

The almost complete absence of published serious analyses of the distinctive southern California fire problem is perhaps responsible for the lack of a cohesive, reasoned, and widely accepted statement of the basic fire-control objective. At the start, the elimination of the very large burns of preorganization days was accepted as a goal. Later, from time to time major fires—the San Gabriel and Ravenna, 151,000 acres, of 1919; the Kelly Canyon, 106,300 acres, of 1922; Oso, 68,300 acres, of 1923; San Gabriel, 49,200 acres, 1924; Devore, 14,400 acres, 1928; climaxed in the Matilja, 218,000 acres, in 1932; were emphatically recognized at the respective times as too large to tolerate, even occasionally and on widely scattered watersheds.

The disastrous La Crescenta flood resulting from the Pickens Canyon fire, 4,831 acres in 1933, stepped down to below 5,000 acres the general concept of allowable burn in a watershed.

But no serious effort seems to have been made to determine the probable real consequences of burns of different sizes in different watersheds and hence to settle on allowable burn objectives, and to relate the attainment of these to certain levels of protection.

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A general figure of two-tenths of 1 percent annual loss for the entire protected area has been mentioned, and the same figure has been discussed as the objective for single major watersheds, though the two are demonstrably vastly different.

Inauguration of the study phase of the upstream flood control program was at the end of the period of this study, compelling fresh consideration of the objective.

TREND IN FUND EXPENDITURES

Tremendous increases in funds have been granted for development work on the southern forests since the need for such increases was shown after the serious losses of 1924. This money started to come from the special improvement funds passed by Congress for use in southern California, which had to be matched by cooperative funds. In addition to this, very large emergency appropriations were made available, such as C. C. C., C. W. A., and E. R. A. Thus the expenditures that averaged $472,901 in the first period were stepped up to $777,878 per year in the second, and $1,980,694 in the third. It should be kept in mind, too, that the cost and value of the C. C. C. enrollee labor is not included in the figures, and when it is remembered that there were some 10,800 such enrollees on the job in the first period an idea of the magnitude of the contribution can be secured. (See table 21.)

There has been a steady increase in strength of protection forces since 1922. Thus the crew has grown from 76 the first year to 192 in 1939. This has meant a lot, not only in strengthening detection and prevention efforts, but in a better distribution of small crews, more widely scattered over the greatly extended transportation system to give more complete coverage.

Table 21.—*Approximate fund expenditures on the southern California national forests—by periods* [1]

Funds	Jan. 1, 1922–Dec. 31, 1928		Jan. 1, 1929–Dec. 31, 1931		Jan. 1, 1932–Dec. 31, 1939	
	Total	Yearly average	Total	Yearly average	Total	Yearly average
General operating and fire suppression	$1,915,019	$273,574	$851,431	$283,814	$2,778,774	$347,347
Southern California improvement	264,126	37,732	476,137	158,712	104,947	13,118
Cooperative funds deposited	294,356	42,050	269,328	89,773	456,998	57,087
Cooperative funds undeposited	377,004	53,853	372,394	124,131	306,610	38,326
Road funds	459,805	65,687	363,346	121,448	1,232,136	154,017
Emergency funds					10,966,391	1,370,799
Total	3,310,310	472,901	2,333,636	777,878	15,845,856	1,980,694

[1] Exclusive of Monterey division of Los Padres forest.

TREND IN TRAINING OF FIRE-CONTROL PERSONNEL

Clearly, the great advances in speed, strength, and diversity of attack during the period of study impose increasing opportunities for success or failure on fire-control personnel. At the start of the period only the most casual and sporadic attention was given to training of the fire guards and patrolmen who made up the initial attack forces. This nearly exclusive reliance on mere experience resulted in costly failures to control fires at small sizes.

So, beginning in the early twenties, more systematic group training of the seasonal fire-control employees was begun in the southern California area as elsewhere. The program of training has measurably kept in step with the mechanization of fire control, with substitution of organized stand-by crews for pick-up crews, and with the increasing mass of mobilization of labor and material on the larger fires. But this process is never-ending, and there is a quite evident lag in the training of leadership to take fullest advantage of forces and equipment which are now made available. The existing financial set-up provides but a few days a year for training in advance of the fire season. The cost of failure of leadership on a single fire is so great that evident progress in training serves as an indicator of major remaining opportunities.

Present Problems and Means for Solution

FOREWORD

The problem of fire control in southern California has long been recognized as perhaps the most difficult in the Nation because of the very long dry season, the rugged terrain, the exceptionally heavy cover, and the close proximity of enormous destructible values to the forest areas, as well as the value of the watersheds themselves to the local economic interest.

The analysis of trends in the many phases of the fire-control problem in the southern California national forests has indicated varying progress in different fields; persisting uncertainties in such vital matters as the fire-control objective; and some apparent lack of progress, notably in inability to increase the size of fires handled by overnight control. Some indication in general terms of urgency or importance has been given.

In briefest summary form the problems as recognized included:

1. The flash fuel and brush zones, particularly the latter, represent the crux of the problem.
2. Progress in solution of overnight control problem is far from complete.
3. Sure and reliable forecasting of the relatively few bad fire days a season is a prerequisite to better and more flexible fire-control organization.
4. Clear definition of the fire-control objective, that is, the maximum allowable burn, is urgently needed.
5. There is a large field for further progress in fire-prevention to reduce not only relative but absolute numbers of fires.
6. Required speed of attack in brush and flash fuel zones has not been worked out.
7. Most effective strength and type of attacking brush and flash fuel zones need clarification.
8. The program of mechanization lags behind the development of the road system.
9. There are great opportunities for more training of fire-control personnel and capitalization on past training through stabilization of employment of high quality personnel.

The following sections undertake to analyze accumulated experience and to develop reasoned answers to these questions.

SETTING THE OBJECTIVE

It has been customary to state the objective of organized fire-control in terms of holding average annual loss to a stated percentage of the entire protected area. The latter has usually been an entire national forest region, or a group of several national forests, or a major widespread type, or a group of types having similar values and uses. Or the two bases are sometimes combined. Thus the accepted burned area objective for the timberlands of the northern California national forests is not to exceed 0.2 of 1 percent average annual burn. This is based on an average rotation of 100 years, on the fact that fires are customarily very destructive, and that loss of over one-fifth of a working circle would tend to disrupt it.

In the southern California national forests, no serious attempt has been made to determine rational and demonstrable objective. In a general way, there has been some belief that if an average annual rate of loss of not over 0.1 percent to 0.2 percent could be attained, the problem would be solved.

Since the primary purpose of this study is to develop the planning basis for adequate fire-control in the region under study, it is necessary first to have an arithmetical expression of "adequate." The recorded fire history for the period of study affords a basis for investigation.

For the entire protected area of 3,716,000 acres, individual years have had burned areas ranging from 2,665 acres in 1930, or 0.1 percent of the total up to 222,200 acres in 1932, or 6.0 percent of the total. The years have been sorted into groups, or classes, having respectively 0.1–0.2 percent burn, 0.2–0.4 percent, 0.4–0.8 percent, 0.8–1.5 percent, 1.5–3.0 percent and 3.0–6.0 percent, thus covering the whole range of experience (table 22). Then for each class the size of average fire, 10 acres or over, average size of five largest fires in each year, average size of single largest fire in each year, and size of largest single fire have been computed. The minor irregularities in relation between classes have been smoothed out by curving (fig. 4).

In the years when 0.2 percent or less of the total area was lost the average fire was 42 acres, a very comforting figure if it is assumed to mean that each fire was of that size. Of course, that is a fiction.

In the same years the average fire, 10 acres or over, was 334 acres, and if this were a true measure of maximum size of fires, there would be relatively few watersheds on which such a loss would be really serious. But all fires in the C, D, or E class are not of the same size, any more than all fires are of the same size.

Table 22.—*Years grouped according to percentage of protected area burned showing related data for each group on largest fire and average size of fire for specified classes. Man-caused fires on the national forests of southern California*

Percent protected area burned annually	Years	Largest single fire per group of years	Average largest single fire each year in group	Average area 5 largest fires each year in group	Average size fire over 10 acres, all year	Average size fire, all years
		Acres	*Acres*	*Acres*	*Acres*	*Acres*
0–0.2	1930, 1935, 1936, and 1937	5,370	3,045	1,045	334	42
0.3–0.4	1931, 1934, and 1938	11,302	5,484	2,095	573	95
0.5–0.8	1926, 1927, 1929, and 1939	22,720	12,462	4,901	946	265
0.9–1.5	1925 and 1933	30,800	20,458	6,589	1,474	359
3.1–6.0	1922, 1923, 1924, 1928, and 1932	218,000	94,278	27,967	3,873	1,416

In the same years, with an over-all loss of less than 0.2 percent, the five largest fires in each year average 1,045 acres. This is coming close to the point where general judgment might say that single fires of around 1,000 acres can be of serious consequence. But this figure, like average fire, and average fire 10 acres or over, is only a fictional

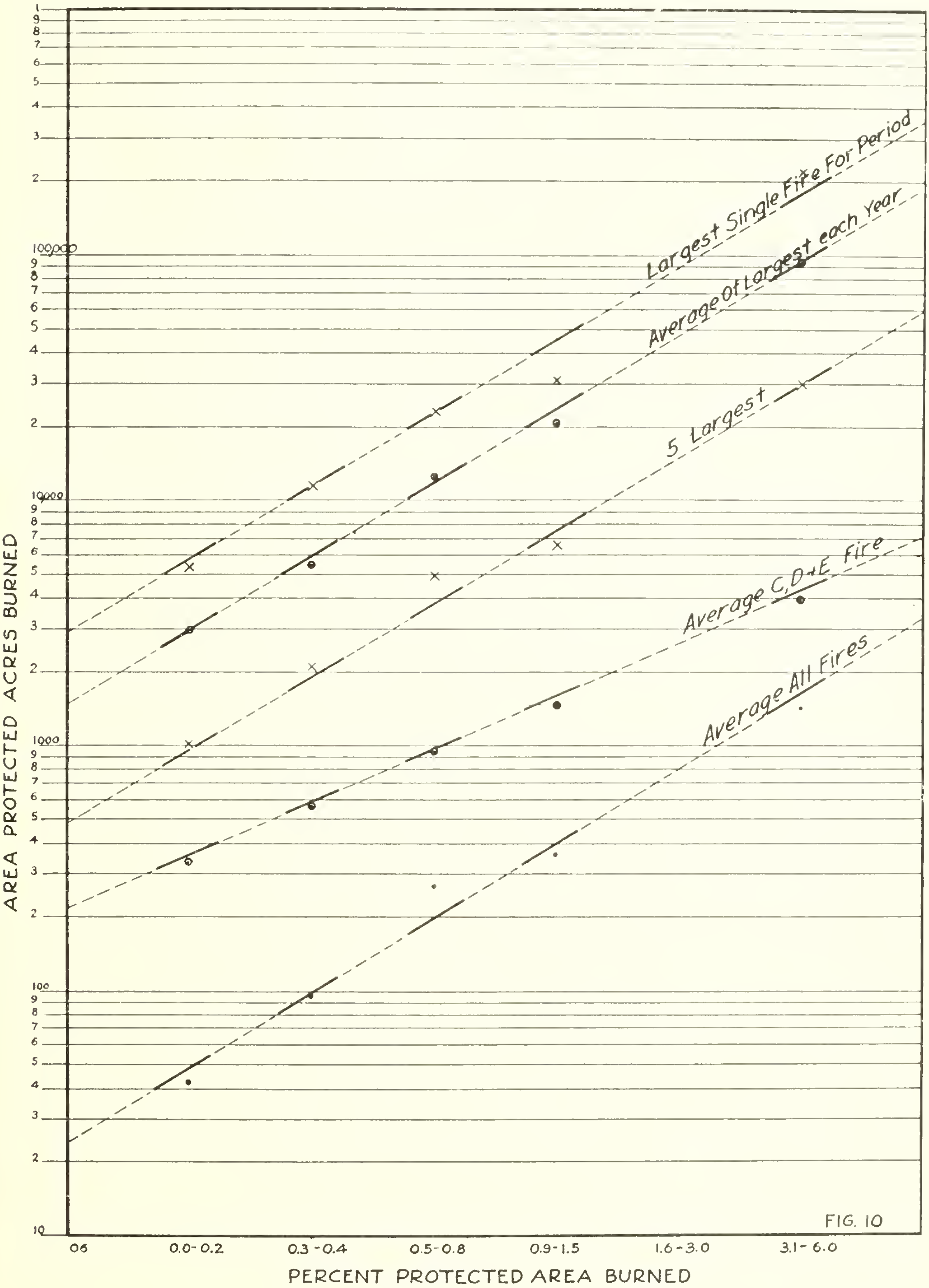

FIGURE 4.

way of expressing the results of a given over-all level of protection. For in the same group of years, the average of the single largest fires in each year is 3,045 acres, and a 3,000-acre fire in some particular watershed is in most cases something to be concerned about.

The final possible criterion is the largest single fire which occurred in any of the 4 years in the group. This fire was 5,370 acres. The well-remembered LaCrescenta flood, originating from the 4,831-acre Pickens Canyon fire, indicates that a fire of this magnitude can lead to a major disaster. The group of years in which burned area was 0.3–0.4 percent have, as comparable figures, an average fire of 95 acres, average fire over 10 acres in size was 573 acres, average of 5 largest fires each year 2,095 acres, average of single largest fire each year 5,484 acres, and largest single fire in any year 11,302 acres.

The curve for each of the above units of measure (fig. 4) is a strong one, and for all measures except average fire, 10 acres or over, the curves are parallel on semilog paper. The fact that average fire, 10 acres or over, and average fire curves converge is due obviously to the fact that with poorer and poorer protection, all fires would finally be C, D, or E fires.

The key to a rational and defensible statement of objectives lies in the fact that the purpose of fire control in the unit of study is to protect each individual watershed. That is, the water users subject to water shortage or the community subject to flood damage, or the investors in reservoirs subject to silting on watershed A, are not in any better shape if a 5,000-acre fire in their unit is the only large fire in the whole of southern California forests, and if the record for the year is below the general objective for the entire unit.

So, in dealing with watershed protection, the realistic way to state the fire-control objective is in terms of the absolute or, at most, average maximum fire to be expected under a level of protection that will deliver a given degree of control for the entire protected area.

In planning protection of a single watershed, it is impossible to ignore protection on other watersheds. The well-known fact that fires can and do migrate from one drainage to another means that substantial equality of protection organization on all units of essentially similar types and value is required to attain the calculated level of protection on any unit.

The question how best to express the objective lies in a choice between average of the five largest fires per year, or average of single largest fire per year, or the absolute largest fire expected occasionally from a given protection level.

Here one enters the field of watershed values, rather than that of fire control. Final decision on the largest endurable fire will finally have to come from flood-control and water-conservation experts. No such documented and supported decision has so far been made.

As a matter of fire-control planning it can be said that known opportunities exist to reduce the size, both absolute and average, of the larger fires by a substantial margin. The expansion of current programs of transport facilities, specialized equipment, machinery, crew organization and leadership, and better forecasting can probably be expected to reduce by about 40 percent the absolute and average maximum size of fires below the present level of protection.

From the data available the conclusion is reached that an absolute maximum fire of not over 2,000 acres should be the goal, that with expected increased efficiency this corresponds to, or will be associated with a general protection level allowing not over 0.15 of 1 percent average annual burn on the entire national forest protected area.

DETERMINING SPEED OF ATTACK

In planning to attain this objective, the mechanism of attack, already examined from the standpoint of historical trends, must be reexamined as to cause and effect between the mechanism and performance level. Of these mechanisms, speed of attack is first.

As previously shown, the speed of attack on fires has increased greatly. That this has been a major factor in the progressive reduction in fire losses is clear. But the discussion of historical trends in attack on the southern California fire problem did not attempt to determine what speed of attack was required to attain a particular level of performance. Either in all or in each of the principal zones, such a determination is, of course, an essential in the setting of a fire-control planning basis.

Required speed depends on a series of steps—relationship between area burned and percentage of fires 10 acres or over, between percentage of fires 10 acres or over and size when reached, and similar factors.

Relation of Area Burned to Percentage of Fires Over 10 Acres.—In earlier work in northern California, this relationship has proved useful and fairly consistent.

For the 18 years in the period of study in this investigation, percentage of C, D, and E fires for the whole has ranged from 9 percent in 1938 to 51 percent in 1923 (table 23 and fig. 5). Two years are highly inconsistent with the whole record—1932 with only 13 percent of C, D, and E fires and the largest area burned (because of the 218,000-acre Matilija fire), and 1930 with 22 percent of C, D, and E fires and the lowest area burned.

The other years, however, establish a strong curve, indicating that with 10 percent C, D, and E fires the average expectancy is for 7,400 acres burned (that is 0.2 of 1 percent of the entire protected area), and that burned area expectancy has slightly more than doubled (to 15,700 acres) or 0.4 of 1 percent with 20 percent C, D, and E fires.

If the suggested objective of 0.15 of 1 percent is accepted (that is 5,574 acres), percentage of C, D, and E fires will have to be reduced below 10 percent.

Since the curve is a weighted average of all zones, it does not serve to set this relation for the two most important zones—the flash fuels and the brush zones (1 and 2).

TABLE 23.—*Characterization of the man-caused fire problem on the national forests of southern California. Numbers of man-caused fires and percentage which became C, D, or E fires, area burned, man-caused fires by years, for the years 1922–39, inclusive*

Year	All man-caused fires	Portion of man-caused fires which became C, D, or E fires	Area burned within national forests by man-caused fires
	Number	*Percent*	*Acres*
1922	108	40	174,588
1923	112	51	118,063
1924	98	50	128,765
1925	81	36	34,680
1926	86	37	25,794
1927	100	34	22,616
1928	113	36	158,027
1929	121	28	35,022
1930	102	22	2,665
1931	107	31	8,975
1932	135	13	222,208
1933	116	16	36,089
1934	100	14	11,570
1935	155	10	9,085
1936	155	12	8,251
1937	172	10	4,744
1938	174	9	15,535
1939	118	16	29,116
Total	2,153	24	1,045,793

For the latter (table 24 and fig. 5) the general relationship between percentage of C, D, and E fires and area burned is well established. With 10 percent of C, D, and E fires the average expected burn is 4,700 acres for the entire protected area (that is a little less than the 5,140 acres which represents 0.2 of 1 percent of the 2,572,000 acres in the brush zone). With 20 percent C, D, and E fires, the expected burned area is 9,100 acres or slightly less than twice the expected loss associated with 10 percent C fires.

TABLE 24.—*Relation between area burned and percentage of class C, D, and E fires on southern California national forests. Man-caused fires for the years 1922–39, inclusive*

Area	10 percent			11–20 percent			21–30 percent		
	Number of years	Average annual burn	Portion of fires that became C's, D's, or E's	Number of years	Average annual burn	Portion of fires that became C's, D's, or E's	Number of years	Average annual burn	Portion of fires that became C's, D's, or E's
		Acres	*Percent*		*Acres*	*Percent*		*Acres*	*Percent*
All zones [1]	3	9,788	10	5	17,847	14	2	18,844	25
Zone 2 [2]	1	4,000	9	6	6,180	16	2	17,435	23

[1] Matilija fire omitted.
[2] Fires originating in zone 2. Matilija fire omitted.

TABLE 24.—*Relation between area burned and percentage of class C, D, and E fires on southern California national forests. Man-caused fires for the years 1922–39, inclusive*—Continued

Area	31–40 percent			41–50 percent			51–60 percent		
	Number of years	Average annual burn	Portion of fires that became C's, D's, or E's	Number of years	Average annual burn	Portion of fires that became C's, D's, or E's	Number of years	Average annual burn	Portion of fires that became C's, D's, or E's
		Acres	*Percent*		*Acres*	*Percent*		*Acres*	*Percent*
All zones [1]	6	70, 780	36	1	128, 765	50	1	118, 063	51
Zone 2 [2]	3	18, 835	36	3	56, 235	44	3	71, 206	57

[1] Matilija fire omitted. [2] Fires originating in zone 2. Matilija fire omitted.

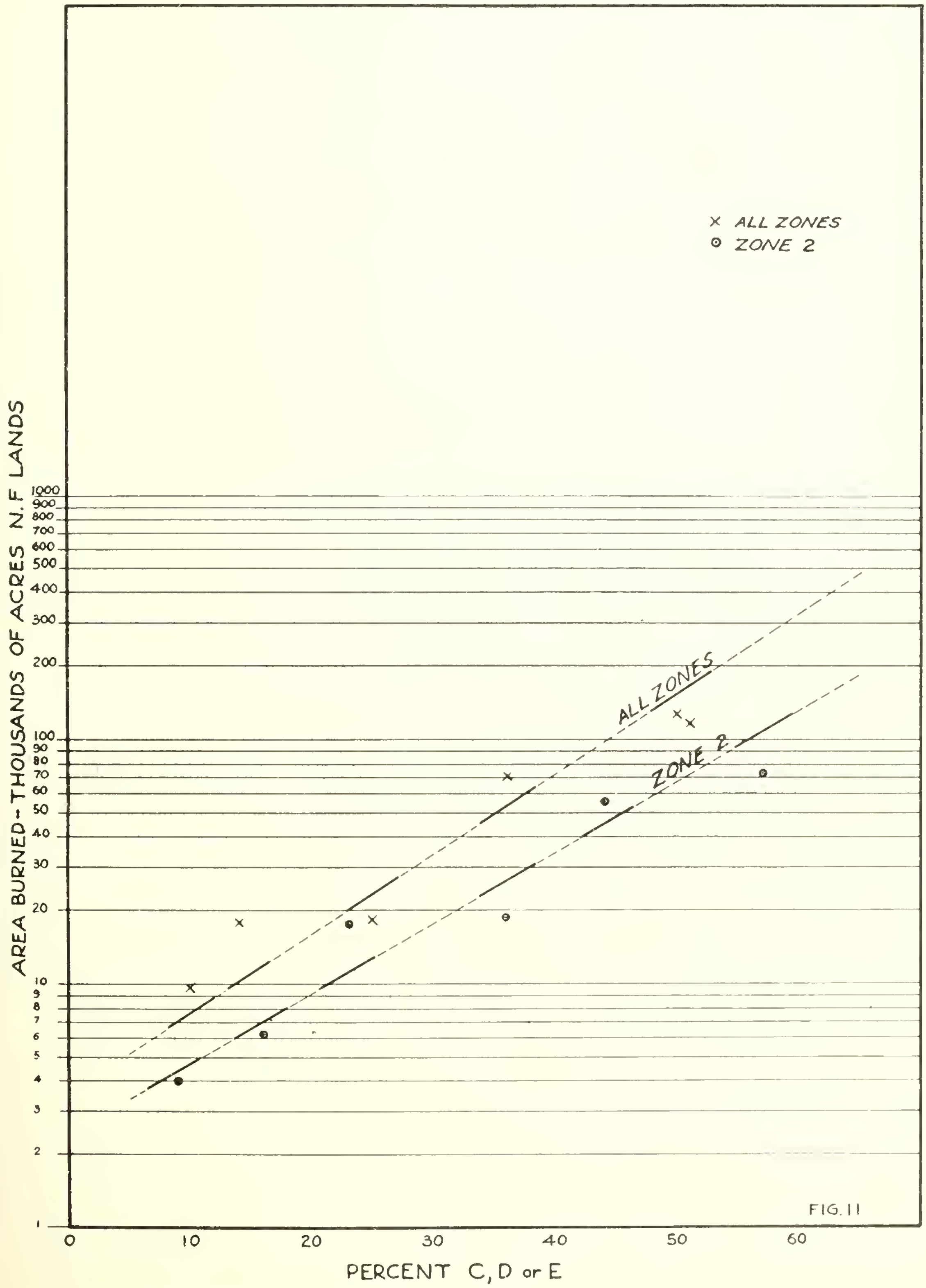

FIGURE 5.—Relation of area burned to percent of Class C, D, and E fires. (Weighted values used.)

Relation of Speed of Attack to Percentage of C, D, and E, Fires.—Leaving aside for the moment the important variables of strength of attack and size of fire when attacked, which will be examined later, the over-all relation between speed of attack and percentage of C, D, and E fires has to be established (table 25).

For the period 1932–39, 4.9 percent of fires in the brush zone (2) have, with attack 3 minutes after discovery become class C, D, and E fires. Of those attacked within 9 minutes, 8.0 percent are class C, D, and E. The cumulative percentage of C, D, and E fires rises gradually reaching 16.6 percent for the entire group of 512 fires. These figures are particularly important because this zone has the greatest area (69 percent of total), highest value, and the largest number of fires.

In the flash fuel zone (1) the percentage of C, D, and E fires is 8.4 for 9-minute attack, and increases to 23.8 for the entire group of 172 fires. Since the two zones intermingle, the average is of interest. This shows 7.3 percent of C, D, and E fires for 3-minute and 8.1 percent C, D, and E for 9-minute attack, rising to 18.4 percent C, D, and E for the entire group of 684 fires.

As previously shown, the accepted objective of holding individual fires to 2,000 acres or less, could be attained only with less than 10 percent class C, D, and E fires. Thus speed of attack in the brush zone (defined as elapsed time from discovery of fire till work began) is indicated as between 15 and 21 minutes. Since a few minutes necessarily are used for report and getaway time, a travel-time control of 15 minutes is indicated.

TABLE 25.—*Relation between elapsed time, discovery to arrival, and percentage of class C, D, and E fires on southern California national forests. All man-caused fires in inflammability Zones 1 and 2 during the years 1932–39, inclusive*

Elapsed time discovery arrival	Zone 1			Zone 2			Zone 1 and 2		
	All fires	C, D, and E fires	Portion of fires that became C's, D's, and E's	All fires	C, D, and E fires	Portion of fires that became C's, D's, and E's	All fires	C, D, and E fires	Portion of fires that became C's, D's, and E's
	Cumulative number	*Cumulative number*	*Cumulative percent*	*Cumulative number*	*Cumulative number*	*Cumulative percent*	*Cumulative number*	*Cumulative number*	*Cumulative percent*
3 minutes or less	28	4	4.3	81	4	4.9	109	8	7.3
9 minutes or less	71	6	8.4	199	16	8.0	270	22	8.1
15 minutes or less	94	10	10.6	277	24	8.7	371	34	9.2
21 minutes or less	121	16	13.2	326	30	9.2	447	46	10.3
27 minutes or less	128	19	14.8	361	35	9.7	489	54	11.0
33 minutes or less	137	22	16.1	282	41	10.7	519	63	12.1
1 hour or less	154	31	20.1	439	62	14.1	593	93	15.7
2 hours or less	164	37	22.6	482	70	14.5	646	107	16.6
3 hours or less	168	39	23.2	496	78	15.7	664	117	17.6
3 hours or more	172	41	23.8	512	85	16.6	684	126	18.4

In zone 1, the flash fuels, as already noted in the historical section (table 4) rate of spread is more rapid than in the brush zone. This is brought out in table 25 where 8.4 percent of C, D, and E fires result from 9-minute attack, 10.6 percent from 15 minutes, and 13.2 percent from 21-minute attack, all being higher than for the comparable figures in the brush zone.

The indications are that required speed of attack for this zone should be no greater than in the brush (about 15 minutes) and preferably a little less. But as the combined average of the flash fuels and brush zones (table 25) shows that 15-minute attack should hold C, D, and E fires to 9.2 percent, apparently 15-minute attack should be sufficient for both zones.

As a matter of practice, this will, of course, vary, generally tending toward faster speeds in the flash fuels, because attack centers will largely be located in this zone at the lower elevations where the flash fuels and brush join.

Analysis of performance under Forest Service attack showed this to be slightly more effective when measured by percentage of C, D, and E fires than when all sources of attack are considered. The differences are not significant, so the larger mass of data obtained by using records on all sources of attack has been used.

Relation between speed of attack and size when reached.—Increased speed of attack is effective in reducing percentage of C, D, and E fires in part through reaching them at smaller sizes and in part through increased efficiency of attack.

For the flash-fuel zone (1), all fires reached within 3 minutes were less than one-fourth acre in size when reached (table 26). But as further time elapsed by successive steps the rapid spread in this zone decreased the percentage of one-fourth-acre fires. In 9 minutes only 72 percent, in 15 minutes only 65 percent, and in 21 minutes only 59 percent were one-fourth acre or less when reached. At the end of 9 minutes 19 percent of all reached in that time were from one-fourth to 1 acre. Of those reached in 15 minutes 5 percent were already over 10 acres in size, and from that point the percentage that were already C when attacked increased to 11 at 21 minutes, 14 at 27 minutes, and 22 percent at 33 minutes. This is striking evidence of the aforementioned conclusion that speed of attack in the flash-fuel zone should be not over 15 minutes.

In the brush zone (2), rate of spread is generally substantially slower than in the flash-fuel zone. Still, at the end of 15 minutes only 77 percent remain in the 0–¼-acre size class, and in 21 minutes 6 percent are already class C in size. So in general, as concluded earlier, a possibly slightly slower but strong attack in the brush zone might be considered.

In the coniferous timber zone (4), the percentage of fires in the one-fourth-acre class remains at or near 100 percent for a full half hour, and there were no fires already over 10 acres on arrival of crew until over an hour had passed.

TABLE 26.—*Relation between speed of attack (elapsed time, discovery to arrival) and size of fire when reached by attacking force on southern California national forests. Percentage of fires attacked within specified time periods which were of designated areas upon arrival. Man-caused fires occurring in inflammability zones 1, 2, and 4 during the years 1932–39, inclusive*

[Percentage of fires in indicated time interval]

Size when reached	Elapsed time, discovery to arrival									
	3 minutes	4 to 9 minutes	10 to 15 minutes	16 to 21 minutes	22 to 27 minutes	28 to 33 minutes	34 minutes to 1 hour	1 hour, 1 minute to 2 hours	2 hours, 1 minute to 3 hours	Over 3 hours
Zone 1:										
0–¼ acre	100	72	65	59	--------	45	12	20	25	25
¼–1 acre	--------	19	22	15	57	22	35	20	--------	--------
1–4 acres	--------	9	4	7	29	11	12	--------	25	--------
4–7 acres	--------	--------	4	8	--------	--------	18	--------	--------	--------
7–10 acres	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
10 acres	--------	--------	5	11	14	22	23	60	50	75
Zone 2:										
0–¼ acre	98	86	77	76	66	57	32	46	22	19
¼–1 acre	2	10	10	6	8	14	26	21	7	12
1–4 acres	--------	2	8	10	8	5	12	16	7	19
4–7 acres	--------	1	4	2	6	14	10	5	7	13
7–10 acres	--------	--------	1	--------	3	--------	2	--------	--------	6
10 acres	--------	1	--------	6	9	10	18	12	57	31
Zone 4:										
0–¼ acre	95	95	95	90	92	100	75	87	67	43
¼–1 acre	5	3	5	5	8	--------	20	6	33	14
1–4 acres	--------	2	--------	5	--------	--------	5	--------	--------	--------
4–7 acres	--------	--------	--------	--------	--------	--------	--------	--------	--------	29
7–10 acres	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
10 acres	--------	--------	--------	--------	--------	--------	--------	7	--------	14

Percentage of C, D, and E Fires in Relation to Size of Fires When Reached.—An additional light on the mechanics of controlling fires of small sizes is afforded by the relation between percentage of C, D, and E fires and size of fires when attacked (table 27).

With a strength of attack of 1–10 men in the flash fuels (zone 1) only 4.7 percent of fires reached at 0–¼-acre size become class C, D, or E, 8.3 percent of those reached at ¼–1 acre, 12.5 percent of those reached at 1–4 acres, but 100 percent of those 4–7 acres when reached.

For the brush zone (2), 1.4 percent of the smallest size class become class C, D, or E, but in the next size class 23.5 percent are C's, D's, or E's, and this figure rises steadily to 38.5 percent in 1–4-acre fires, 46.2 percent in the 4–7-acre class, and 66.7 percent in the 7–10-acre group.

The pronounced difference between these two important zones means that, because of the far heavier cover and hence greater difficulty of control in the brush, suppression forces are more seriously handicapped by each increase in size of fire beyond the smallest size class. The question of whether this handicap can be measurably overcome by more general use of tank trucks in initial attack will be considered later. But it is evidently imperative to plan fire organization to reach brush fires at small size, and that means speedy attack.

TABLE 27.—*Relation between area of fire upon arrival of suppression force and its final size class. Percentage of class C, D, and E fires resulting from attack by 1–10 men according to size classes upon attack. Man-caused fires in inflammability zones 1, 2, and 4 for the years 1932–39, inclusive, on the national forests of southern California*

[Percent of fires in size, class, and zone which became C, D, and E fires]

Area	Area of fire upon arrival of initial attacking force					Number of fires in zone
	0.0–0.25 acre	0.26–1.0 acre	1.1–4.0 acres	4.1–7.0 acres	7.1–10.0 acres	
	Percent	*Percent*	*Percent*	*Percent*		
Zone 1	4.7	8.3	12.5	100	No fires	123
Zone 2	1.4	23.5	38.5	46.2	66.7 percent	355
Zone 4	0	18.2	50.0	0	No fires	176

Attacking forces have nearly a 3 to 1 chance in flash fuels, as compared with brush areas, to hold fires to less than 10-acre size when fires are reached at sizes between one-fourth and 4 acres. This greater effectiveness of attack seems to mean that despite the previously shown greater rate of spread in zone 1, about the same speed of attack as in the brush can be expected to be effective because of the relatively easier job of control line construction.

From studies of rate of spread of fires in zone 2 and corresponding studies of rate of fire-line construction, it is known that the average fire will make perimeter from three to six times as fast as a 10-man crew can construct fire line. Fires that are controlled in the smaller sizes are caught by reducing the spread of the fire through direct attack of the fast moving head, by the application of water or dirt, or removal of the fuel—thus providing time to complete the flanking lines. Since zone 2 is characterized by heavy brush cover, the probabilities that it will be possible to maneuver men safely in front of any but the smallest fire for these purposes are decidedly remote. This emphasizes the necessity for attacking the fires when small and, where possible, with tanker equipment and trained tanker crews.

In the coniferous forest zone (4) there are no C, D, or E fires when attack is made in the 0–¼-acre size class, but percentage of C, D, and E fires build up rapidly as size increases.

Particularly in the brush zone, a reasonable inference seems to be that reaching fires with small crews rapidly and when fires are small is likely to be more effective than slower attack at larger sizes with large crews. That is, in terms of fire-control organization, more attack centers with small crews, means of rapid transportation and supplementary tanker equipment, rather than fewer attack centers with larger crews and slower transportation. Further consideration of this inference, as well as of the question of what size attack crew is most effective in the different zones is postponed to a later section.

Increase in effectiveness of attack.—The period 1932–39 has been used in analyzing relation of C, D, and E fires to size of fire when reached for the very good reason that the relationship has changed rapidly from period to period, that is, as a starting point for appraising future fire-control needs the use of the full 18-year period would show a greater problem than exists today.

In zone 1, with 1–5-man attack, the percentage of C, D, and E fires of all those reached at 7 acres or under has been reduced from 35 percent in the period 1922–28 to 7 percent in the period 1932–39. In zone 2 the comparable reduction from 17 percent to 8 percent, while less striking is still substantial.

DETERMINING STRENGTH OF ATTACK

Strength, like speed of attack, is one of the key mechanisms in building fire-control organization to attain a specified objective. Operating experience shows that in southern California one man initial attack is hopelessly inadequate. Thus, two major questions require analysis.

1. What size initial attack crew in the major types is sufficiently effective in catching fires at sizes under 10 acres?
2. What effect does progressively heavier attack have in reducing size of those fires which reach class C, D, and E size?

Because, as already shown, speedier initial attack with small crews has had strikingly improved results from period to period, only the recent period (1932–39) is used in the analysis.

Initial attack strength.—For the flash fuel zone 1, 1–3-man attack held all but 4 percent to size C, if they were one-fourth-acre or less in size when reached (table 28). With the same strength of attack, there were 12 percent C, D, or E fires among those reached at one-fourth–1 acre-size and 25 percent C, D, or E's in the 1–4-acre class.

In this zone 4–5-man attack (based on only a small number of cases) shows higher percentages of C, D, or E fires in all size classes, but with 6–10-man attack the percentages of C, D, and E fires are substantially the same as in the 1–3 attack groups. This seems to mean that on initial attack the size of crew, at least beyond 3-man size, is not particularly important in itself in the open light cover of the flash fuel zone.

In the brush zone, on the contrary, there is progressive reduction in percentage of C, D, and E fires in each size class as strength of initial attack increases, except for one-fourth-acre fires on which 3-man attack is highly effective. But in the one-fourth–1-acre class 3-man attack has 26 percent C, D, and E fires, 4–5-man attack has 15 percent, and 6–10-man attack has but 12 percent. In the 1–4-acre class the percentages are respectively 45, 31, and 23; in the 4–7-acre class they are 67, 50, and 34 percent.

The consistency of the figures (based on a large number of cases) shows unmistakably that strength of initial attack is highly important in the brush zone. In general, the greatest decrease in percentage of C, D, and E fires is obtained by increasing strength of attacking crew of 1–3 men to 4–5 men, rather than by increasing from 4–5, to 6–10 men.

TABLE 28.—*Relation between size of fire when attacked, number of men in suppression force, and final size class of fire. Percentage of fires becoming class C, D, or E fires according to area when attacked and size of suppression force. Man-caused fires in inflammability zones 1, 2, and 4 for the years 1932–39, inclusive, on the southern California national forests*

[Cumulative percent of fire in zone which became C, D, or E]

Crew size and zone	Area of fire upon arrival of initial attacking force, acres				
	0–0.25 percent	0.26–1.0 percent	1.1–4.0 percent	4.1–7.0 percent	Curve values
1–3-man attack:					
Zone 1	4	12	25	75	
Zone 2	2	26	45	67	
Zone 4	0				
4–5-man attack:					
Zone 1	5	25	50	100	
Zone 2	2	15	31	50	
Zone 4	0				
6–10-man attack:					
Zone 1	5	12	25	75	
Zone 2	1	12	23	34	
Zone 4	0				
11–20-man attack:					
Zone 1					
Zone 2	0				
Zone 4					
Zone 1					123
Zone 2					356
Zone 4					176

Follow-Up Attack Strength.—Strong and aggressive follow-up attack on those fires which escape initial attack is clearly necessary to hold acreage as low as possible. In analyzing the relationship, the period 1932–39 is used, for the reasons already stated in the discussion on strength of initial attack and percentage of C, D, and E fires.

For the period, of the 469 fires in the brush zone reached before they were 10 acres in size (table 29) 48 became class C, D, or E. Of these, four became major fires (3,270, 3,550, 5,370, and 9,486 acres, respectively), and their acreage has been deducted. A fairly regular decrease in size of the average fire 10 acres or over (C, D, or E) is found as attacking strength increases. Once a fire on this zone has escaped initial attack, increased forces following immediately are evidently a good investment.

In the flash fuel zone, with rather scanty data, it is evident that increase of forces up to a moderate point results in reducing size of average fires 10 acres or over. But it seems doubtful from the data whether very heavy initial crews are particularly useful in this zone of light cover.

The problem in the coniferous timber zone (4) has already been disposed of as one of fairly prompt arrival of small or medium size crew when the fire is small in size. Class C, D, and E fires do not now occur when these conditions are fulfilled.

The most effective type of attack crew in the brush zone cannot be determined solely from this analysis. The cost becomes important, since the unit wage of 6–10-man crews is far greater than for 4–5-man crews. Since, as already shown, the greatest possible speed in reaching fires is imperative, hence the travel speed for 4–5- and 6–10-man crews has to be considered. The smaller crew usually can use motor equipment of the pick-up type, and travel safely as fast as the available roads will permit. A crew of 6 to 10 men, on the contrary, usually requires a truck, and hence slower road speeds are attainable than with lighter cars.

There is a strong presumption, considering these factors together with the conclusions from the fire data, that 5-man crew attack is in general the most effective basis to set up for the brush zone. Obviously, special cases may require special treatment.

The data showing effectiveness in holding down percentage of C, D, and E fires in the brush zone with initial attack by 11 men up to 50 men include relatively few cases, and individual class values are too irregular to curve. But, in general, there is little if any further reduction in percentage of C, D, and E fires below that attained by 6 to 10 men. The heavier attacking crews have not therefore been considered as a possibility or a need in planning fire-control organization.

TABLE 29.—*Relation between number of men in suppression force and final area of those fires which were attacked when smaller than 10 acres and finally became class C, D, or E fires. Man-caused fires in inflammability zones 1 and 2 during the years 1932–39, inclusive, on southern California national forests*

	Size of initial attacking force—number of men						
	1–3	4–5	6–10	11–20	21–30	31–50	51 plus
Zone 1:							
umber of C, D, and E fires	3	2	6	3	1	1	----------
Area burned, acres	3, 622	105	1, 567	203	360	75	----------
Area of average C, D, and E fires, acres	1, 207	52	261	152	360	75	----------
Zone 2:							
Number C, D, and E fires	14	8	6	8	4	4	----------
Area burned, acres	7, 004	1, 899	1, 219	1, 780	258	156	----------
Area of average C, D, or E fire, acres	500	237	203	222	64	39	----------

PROBLEM OF HIGH-DANGER DAYS

As previously shown, during the last period (1932–1939) all fires which reached sizes of 1,000 acres and over started on an average of only 2.9 days per season. That is, the vast majority of the burned area resulted from failure on from 1 to 2 percent of the total days in the fire season. For the same period the major fires of 5,000 acres and over started on not over a single day in any one season. A large part, though by no means all of the fire problem, is in more effective handling of the few fires occurring on the bad-fire days.

Part of this problem is clearly that of fully dependable and sure predictions of the weather conditions which cause bad-fire days. Much work has already been done and is continuing. The fire-danger rating system, based on current and widespread observation of such key elements as fuel moisture, wind, and relative humidity, is systematically used by the weather forecasting agencies.

The most spectacular type of bad-fire day—that of the "Santa Ana"—is apparently readily identified for forecasting purposes. This weather type occurs in late fall and early winter, and has been responsible for several of the major fires during the period of study, notably in recent years the Arrowhead fire, 10,814 acres, San Bernardino National Forest; and the San Antonio fire, 3,317 acres, Angeles National Forest, both starting in November 1938

But Santa Anas are not, contrary to common belief, the only kind f bad-fire day. August 14 and 15, 1939, on which all large fires of that ear started, were not severe Santa Ana days, nor was September 7, 932, the date of start of the largest fire, the Matilija. The problem f identifying and predicting the bad days during summer and early ıll, which includes milder Santa Anas, seems to be more difficult han forecasting severe Santa Anas.

The problem of critical weather conditions that develop in fire reas from the major fires themselves is one that requires special tudy and analysis. With a bad-fire day predicted, the problem of fire rganization has several possible fields in which solution may be ought.

The first is that of fire prevention. Although the normal season-ong practices are already fairly intensive, there is opportunity for dditional measures on key days. Closure of certain areas to use, in-ensified patrol, and general use of registrars to warn users are among he obvious steps.

A second field is in increasing strength of organized fire-suppres-ion units. Since bad days are reflected in more rapid initial spread f fires, it is clear that for a given station, fires normally reached at –¼-acre size may on bad days be expected to be ¼–1 acre on arrival f crew. Increased crew strength is certainly a necessity to over-ome such a handicap, and particularly in the brush zone.

The greater initial spread may in some cases be offset by installing dditional normal size crew units in hazard areas. These, by de-reasing the normal attack time, may be expected to reach fires on ad days at manageable size. This form of emergency action has the ractical difficulty that temporary and self-sustaining stations must e set up. But, since the emergency is short lived, there appears to e no compelling reason against use of temporary tent camps, with all ıcilities in proportion.

Once fires start on bad days, the existing tremendous capacity to oncentrate trained and organized crews on a given spot can be tilized. It is a demonstrated fact that powerful attack on fires in arly stages will on the average hold fires to a relatively small area.

More effective handling of the few bad days requires advance arning of their impending occurrence.

Effectiveness is also dependent on a highly trained crew working as coordinated unit. The effectiveness and popularity of tankers is xpected to increase, especially when units are developed to negotiate nder their own power more of the steeper brush-covered slopes while ravelling cross country from adjacent roads.

Relation Between the Occurrence of Large Fires and Continental Vinds (Known Locally as "Santa Anas").—In the late fall almost very year winds of high velocity and of from 3 to 5 days duration low across the suthern forests from northerly or easterly directions. 'hese winds frequently reach 50 miles an hour and are often accom-anied by very low humidities, especially in the flash-fuel and dense-rush area at intermediate and low elevations. Obviously the high inds and low humidities, which, during Santa Anas extend over areas ormally occupied by moister marine air, create conditions under hich it is extremely difficult to control fires once they gain headway.

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In the discussion that follows about Santa Anas the data are from Frazier Mountain, elevation 8,026 feet; Oat Mountain, elevation 3,756 feet; Keller Peak, elevation 7,863 feet; and Cuyamaca Peak, elevation 6,515 feet. Severe Santa Ana conditions were considered to be represented at these stations by noon relative humidity of 15 percent, or less, and noon wind velocity of 30 miles per hour, or more. These stations do not fully represent all geographical areas and altitudinal ranges affected by Santa Anas, but the information derived from their records, in spite of its limitations, may be taken as indicative.

In spite of the occurrence of these dangerous conditions practically every year the major proportion of the burned area has not occurred during these spectacular periods. Fortunately, in some years the heavy winds start after the fall rains have begun. Actually, large fires have developed during the Santa Ana conditions specified in only 10 out of the 18 years studied, hence the major fire problem in southern California is not the reduction in size of the few fires that became large during these periods.

As shown in table 30, fires that exceeded 1,000 acres which started during Santa Ana conditions covered but 45,868 acres within national-forest boundaries in the 18-year period. This was but 4.4 percent of the total area burned by all fires 10 acres and larger.

TABLE 30.—*Area burned during extremely dangerous fire weather (Santa Ana conditions)*[1] *on the national forests of southern California. Number of man-caused fires 1,000 acres and over, area burned within national-forest boundaries and percent of total area burned within the national forests, by years*

Year	Number of man-caused fires 1,000 acres and over	Total area burned within national forests	Percent of total burned area within national forest boundaries
1923	1	20	0.02
1924	1	950	.74
1926	1	9,790	37.20
1927	1	8,000	35.06
1928	1	5,600	3.54
Period total	5	24,360	3.65
1929	1	1,380	3.92
Period total	1	1,380	2.89
1933	1	2,140	5.34
1935	2	3,356	36.94
1936	1	60	.73
1938	2	14,572	93.80
Period total	6	20,128	5.84
Grand total	12	45,868	4.33

[1] Winds 30 miles per hour or more, relative humidites 15 percent or lower, both at noon, at Frazier Mountain (8,026) or Big Pine Mountain (6,500); Oat Mountain (3,756); Keller Peak (7,863) or Butter Peak (8,502); and Cuyamaca Peak (6,515).

Further analysis has been made of weather reports made from the four lookout points previously mentioned within and adjacent to the southern forests for the years 1932–39, inclusive. The data showed that during the following periods Santa Ana conditions were reported from one or more of the observation points, but no serious fires developed from those that started during such times

ABLE 31.—*Occurrence of extremely dangerous fire weather (Santa Ana conditions*[1]*) on any of the southern California national forests during which no major forest fires developed. Showing total length and number of dangerous periods by years, for the years 1932–39, inclusive*

Year	Number of periods	Total number of days
32	4	16
33	3	13
34	1	3
35	3	9
36	4	9
37	0	----------
38	5	18
39	2	7
Total	22	75

[1] Winds 30 miles per hour or more, relative humidities 15 percent or lower, both at noon, at Frazier or Big ne Mountain, Oat Mountain, Keller or Butter Peak, and Cuyacama Peak.

Periods of less than 2 days duration were not included in the fore- oing tabulation. The longest period reported lasted 6 days. The nalysis also shows that in many cases Santa Ana conditions do not btain throughout the entire area concerned in this study. In fact, ccurrence of highly dangerous conditions over the whole of southern 'alifornia at one time is exceptional.

The extent of the Santa Ana periods during which fires were pre- ented from becoming disastrous is surprising and represents real ublic cooperation and accomplishment in fire control. This state- ient is borne out by the record of 2 years of two forests that were elected as a random sample While two fires during the period ecame large, 11 fires that started when conditions were as bad were ontrolled as 6 A's, 3 B's, and 2 small C's, with a total area of only 32 acres burned. This shows clearly that a small percentage of the res that start in Santa Ana periods become conflagrations. Such res do present a major problem, but by no means an insurmountable ne.

PROBLEM OF RISKS

In the southern California national forests the problem of risks in re planning is almost wholly one of man-caused fires, for, as already hown, lightning fires are neither numerous nor so difficult to control s to be a source of serious difficulty. Coverage is required for light- ing fires, but that already existing has for many years resulted in not single fire of over 1,000 acres from this cause. Lightning fires have ever occurred in large numbers on a single day or group of days, as hey commonly do in northern California and in other western forest egions, so there is no organization problem in handling concentrations.

Debris burning fires remain a rather important cause (table 32), ith 106 fires, or 13 average per year. They are a factor on all four orests. Percentage of C, D, and E fires is moderately low, at 8.

Camper fires total 64, or an average of 8 per year. The percentage f C, D, and E fires is 11. Obviously the long-sustained prevention rograms, involving various steps, has reduced this once important ause to a relatively minor position.

Among the recognized human causes (table 32) lumbering is non- xistent. Only a thin sprinkling of fires have been due to incendiaries, ne of the major causes of trouble in the northern California forests.

But of the 51 such fires, an average of 6 per year, which are localized in a few restricted areas, 20, or 39 percent, were class C, D, and E. This is the highest percentage of C, D, and E fires from any cause, and, as in northern California, incendiary fires are individually the most dangerous cause.

TABLE 32.—*Summary of causes of man-caused fires on the national forests of southern California. Total number of fires, number of C, D, or E fires, percent of C, D, or E fires, and area burned by fires ascribed to different causes. All man-caused fires for the years 1932–39, inclusive*

Cause	Fires	C, D, and E fires	Portion of fires which became C, D, or E's	Area burned inside national forests	Percent of total area burned inside national forests
	Number	*Number*	*Percent*	*Acres*	
Debris burning	106	9	8	4,393	1
Camper	64	7	11	219,106	[1] 65
Incendiary	51	20	39	9,335	3
Miscellaneous	390	27	7	28,266	9
Railroad	58	4	7	362	
Smoker	435	65	15	74,263	22
Unknown	21	5	24	873	
Total	1,125	137	12	336,598	100

[1] Includes Matilija fire, 218,000 acres.

Railroad fires, 58 in number, are almost wholly on the San Bernardino National Forest where they average 7 per year. The problem is a specific localized one. Percentage of C, D, and E fires is only 7.

The two major causes are the miscellaneous group, with a total of 390 fires, and smoker fires, with a total of 435. The former are low in percentage of C, D and E fires with 7; the latter relatively high with 15.

Possibilities of prevention effort in reducing the several causes vary greatly. Debris burning fires occur in restricted and known zones around ranches and mountain recreation communities. The persistence of the cause indicates clear need for more systematic, on-the-ground, prevention effort and actual cooperation in and supervision of needed burning, rather than dependence on rare visits or on letters.

Further reduction of camper fires should be possible by expansion of past efforts—concentration in safe, prepared and fire-proofed campgrounds out of hazardous canyons, prepared fireplaces, registration, resident guards, etc. The persistence of the cause again indicates too thinly spread on-the-ground prevention effort, and too much casual, rather than systematic contact work.

The only remaining unexhausted remedy for incendiary fires in this portion of the region is law enforcement, attainable only through systematic and persistent year-long effort by men qualified to handle these unusual and difficult cases. Existing effort is sporadic and occasional, and has been ineffective. Experience elsewhere indicates that the cause can be practically eliminated by unremitting attention to it. Incendiarism in this area seems to be, as elsewhere in the State, largely a reflection of seriously submarginal hill agriculture. Use of fire to clear land in an attempt to obtain feed for stock is commonly associated with such ventures.

Railroad fires have been indicated as a local problem. The means › eliminate the cause are well known, but require sustained regular ressure if they are actually put into effect. This has evidently not een regularly given.

The smoker fire has been subjected to intensive prevention effort r many years, but obviously is nowhere near conquered. "No noking" ordinances and regulations, closing roads—even major ghways—to smoking, fairly good police effort in enforcing rules id laws, fireproofing of many main highways and lesser roads, and oncentrating recreational use in prepared campgrounds, in combina- on, have had the effect of reducing the number of fires per 100,000 sers, but have not succeeded in preventing an increase in the total umber of smoker fires. Evidently the problem is of the same per- stence and nature as that of obtaining safe driving on the highways. both problems police effort is effective up to a point, but it is un- inkable to have, in either case, enough officers to fully police every- ody all the time. In both cases, reducing the opportunity for care- ssness to lead to disaster has a place—in the one, by building safer ghways and cars and, in the other, by fireproofing roadsides and ımpgrounds. But not all (the trouble in start of) fires start from ıe edges of major or even minor roads or from campgrounds. In oth cases it is equally impossible to solve the problem by continu- ısly refusing all use. The highways are built for public travel and ıe national forests are administered for public use. Possibly on gh danger days, use of the national forests can be more generally stricted than in the past.

Solution of both problems finally must be sought in the slow, borious, and discouraging process of educating the public as indi- duals into habits of safe driving and safe smoking. Both programs ce the queer perversities of human nature, which leads individuals assert heatedly their own caution at the very moment they are king foolish and unnecessary chances.

The route to take in the necessarily long-time solution of the noker fire problem is clear. Continuation and expansion of polic- g, greater attention to fireproofing so that fires cannot start, and a stematic planned and continuous campaign of individual education, rhaps seeking out new and untried methods.

Two such ventures are already under way. The first involves ifting recreational use from the low elevation, hazardous canyons, to e higher elevation, coniferous timber plateaus. An extensive and pensive system of public highways is under construction as a first sential to accomplish this major shift. The usable new areas have en or are being developed to provide safe and convenient places for creational use.

The second method, particularly urgent on Los Padres National orest, but also important elsewhere, is to work out a major shift the deer hunting season. A very high percentage of the burned ea over a period of years has resulted from deer hunter fires, includ- g the Matilija fire (Los Padres 1932, 218,000 acres). This shift volves action by the State, and thus is less readily applicable than ethods within the control of the Forest Service.

Another possible method is the closure to hunting of all burns over 000 acres in size until the cover is reestablished as a deterrent to tentional hunter fires.

As a matter of fire planning, it has to be accepted that both numbers and distribution of smoker fires are likely to be reduced but slowly. The known zones of occurrence must be covered in the organized suppression crew network. Greatly expanded effort in all phases of prevention is required as a parallel program.

The catch-all class of miscellaneous fires includes the following specific causes:

Burning automobiles, automobile and farm machinery exhausts, burning buildings, spontaneous combustion, smoking out bees, burning out woodrats and rattlesnakes, friction in industrial operations, blasting, breaking or short-circuiting power lines, airplane crashes, tracer bullets, hot ash disposal, sun rays on broken glass, woodrats or mice with matches, children playing with matches.

It can readily be seen by reviewing the specific causes of this group that the problem of preventing fires caused by the large numbers of visitors seeking recreation in these forests is by no means the predominant part of the entire problem that one would at first expect. The problem of prevention of fires resulting from miscellaneous causes as listed is extremely complicated, elusive and of no small magnitude. The fires are scattered promiscuously over any area that is being put to use, and may be expected in rare instances to occur in areas not associated with regular human occupancy. Due to this peculiarity, resulting fires are not anticipated and the element of relative unpreparedness or inaccessibility of the fire generally is responsible for large resulting burned area, especially when adverse weather conditions, such as high winds, or drying out of the fuels contribute to the cause.

Prevention of this type of fire requires ingenuity and continuously sustained well-directed effort. Due to the fact that the fires start in the most out-of-the way localities or result from entirely unexpected occurrences, the prevention program must be carefully planned and applied on a widespread basis. Only through inspection, education and resulting corrective action can a portion of these fires be prevented.

One way to characterize the over-all problem of risks is illustrated by table 19, which shows the distribution of starting points of man-caused fires in relation to distance from roads, as well as percentage of C, D, and E fires, and area burned by fires grouped in this way.

On the Angeles, San Bernardino, and Cleveland National Forests, all of which already have relatively intensive road systems, 78 percent of all man-caused fires start within 265 feet of roads, but account for only 69 percent of the area burned. This group of fires is, therefore susceptible to rapid attack by crews, provided their attack centers are correctly located. They are also susceptible to use of tankers in the initial attack. And of course, a considerable number of these fires are "roadside fires."

On the same group of forests, 11 percent of all man-caused fires started from 265 to 800 feet from roads and accounted for 9 percent of total area. That is, the attack still held area burned to a lower percentage of total than that represented by numbers.

From 800 feet to one-fourth mile from roads, 5 percent of fires started and burned 10 percent of total area. The relatively slight increase in handicap to the attack meant a real difference in results. And the 6 percent of all fires starting over one-fourth mile from roads caused 12 percent of all burned area.

On Los Padres National Forest, with only part of the skeleton ad system completed, 60 percent of all fires started within 265 feet roads and burned 31 percent of the total area; 9 percent of fires arted within 265 to 800 feet and burned 10 percent of the area; percent started over 800 feet from roads and burned 59 percent of e total.

Both sets of data indicate that existing road systems facilitate fective attack on the majority of present fires, but that large numrs of fires start at a distance from roads, and on these the attack heavily handicapped. Another way to look at it is that without y more roads, fires will start in relatively inaccessible places. ith roads to reach them, the attack can hold down size to a figure arkedly lower than at present. As indicated earlier, many of the ecific causes grouped as miscellaneous fires are highly resistant to evention, and these fires are largely at a distance from roads.

The complexity of the prevention problem indicates need for ing much further than heretofore in developing and assigning ecialized personnel to specific prevention tasks. Methods and ocedures are needed for stepping up the tempo of prevention fort rapidly during periods of high danger, particularly extreme anta Anas." Possibly more general closure of critical areas to public travel and use is justified when other efforts are not holding e numbers of fires to an acceptable level.

PROBLEM OF SUPPRESSION OF THE LARGE FIRE

Even with a very intensive fire-control plan for preventing the cape of the small fire, the expectations are that periodically a small mber of these will not be successfully controlled by the initial attack- force. One of the main reasons is rapidity of initial spread.

Table 33 shows the extreme initial rates of spread associated with small percentage of the fires which occur. Ten percent of the fires zone 2 can be expected to have a rate of perimeter increase while e burning in excess of 80 chains or 1 mile per hour, and in the flashy els of zone 1 in excess of 115 chains per hour; while 5 percent can be pected to increase at rates in excess of 135 chains per hour and 175 ains per hour, respectively. It is at present inconceivable that an tial attacking organization can be created which will cope successly with all cases of such rapid initial spread, although the use of ter has so materially increased the chances of suppression by initial tack that maximum effort to control the fire by this means is amply stified. Plans, therefore, must be provided for the suppression of e large fire.

BLE 33.—*Rate of initial spread of free burning fire on the national forests of southern California. Percentage of fires which spread at specified rates*

Zone	Number of fires	Average perimeter increase	50 percent spread less than—	10 percent spread more than—	5 percent spread more than—
		Chains per hour	*Chains per hour*	*Chains per hour*	*Chains per hour*
e 1	160	45	20	115	175
e 2	572	30	20	80	135

Table 7, shows 1,035 acres to be the average area of the 21 fires which reached 1,000 acres and which were controlled before the second burning period began, and it is readily seen that satisfactory suppression of the large fires is dependent on securing control before the second burning period, at the worst. This is essential to reach any reasonable burned area objective (table 22), but in itself may not prove satisfactory, since some fires may be expected to burn a much larger area than 1,000 acres during the first period.

Records for the period 1932–39 show the action in respect to overnight control is far from satisfactory, since 70 percent of all fires over 1,000 acres have required more than one burning period to control. These fires have accounted for 93 percent of the total burned area.

That this problem is difficult and complex is well known. The chief difficulty lies in the inability to work large numbers of men effectively in direct attack until the night influences cause the fire to subside. Sufficient time is then not available to complete the entire control job, before the burning period of the second day and the extra period fire results.

Rate of line construction in typical zone 2 cover is notoriously slow. Studies of production in this type by fresh, trained crews show that, for short shifts of 2 hours, it requires from 20 to 30 men to build 10 chains of line per hour. The size of job in the dense brush and resultant low efficiency is a major reason for this low production.

Enormous rates of spread are evident, especially after the fire becomes established on the slopes and generates its own weather to a certain extent. Longitudinal advance of the fires during the period they are burning most rapidly averages between 1 and 1¼ miles per hour, according to the best information available. The resultant perimeter is terrific.

Consideration of this problem has resulted in planning a network of roads supplemented by firebreaks and fire lanes on the more important ridges. A large part of the plan has been put into effect. Approximately 2,500 miles of firebreaks have been constructed.

Experience has shown that the use of the firebreaks has as yet been unsatisfactory in controlling the initial run of fire. This has been due, first, to the impossibility of placing an adequate crew on the break in time to backfire it and at the same time provide for control by direct attack; second, that running fires have in almost every instance spotted over these breaks.

That the first reason is authentic and may be expected to repeat itself requires little imagination. The mobilization and travel time of an adequate backfiring crew of 50 to 100 men will require, under the best planning, a minimum of 1 hour after report of fire to place it on the more accessible firebreaks. During this time the fire has moved forward a half mile to a mile or more, as has been previously shown. The break must be prepared for burning, and the crew organized and put into action. All this is time-consuming, and time is a very important factor in establishing an effective backfire. Actual backfiring of these breaks in advance of threatening fires has been employed to a minor degree in the past on fires burning inside the national-forest boundaries.

The use of water in backfiring is becoming more and more important. Los Angeles County backfired 16½ miles of break successfully with water in 1935. Water was used extensively in the control the Arrowhead fire on San Bernardino Forest in 1938. This uires a road along or adjacent to the break for tank trucks to erate on, which limits its use seriously on the rougher steep topog- hy in the forests.

Firebreaks and lanes have, however, contributed materially to opression, in moving men and providing for their safety.

Tractors, preferably with trailbuilders and winch attachments, are coming more universally usee in line construction and other sup- ssion activities. The chief limitation to their use is extremes of pe or excessive rock, but it has been found that most large fires ve a reasonably large part of their perimeters on areas which are oject to work by this machinery. Their use will continue, doubtedly, in many diversified forms.

Better fire suppression practices which should result in a lower centage of extra period fires and much less burned area if properly ployed depend on:

1. Trained leadership, resulting in good judgment, decisiveness, d rapid, well coordinated action.
2. Proper equipment, with particular reference to tractors, tank cks, aerial photographs, maps, etc.
3. Effective service of supply.
4. Current information on fire, weather, and suppression efforts.
5. A supply of capable seasonal labor.
6. Physical improvements in the form of roads, trails, lanes and ebreaks sufficiently numerous to permit early access to the perimeter numerous points.
7. The will to backfire early and aggressively as an attacking asure and not solely as a last defense.
8. Greater skill in forecasting behavior of fire in the broken pography typical of the region.
9. Planning and providing for possible backfiring if initial attack ls to hold the line. This requires manning of the line which may used, concurrently with the initial attack.

ROBLEM OF ROADS AND OTHER FIRE-CONTROL FACILITIES

As indicated earlier, progress in solving the fire problem in southern lifornia has been closely associated with an expansion in the road tem. Increased road mileage has been the first essential in faster, onger, and more diversified and mechanized attack.

In the general expansion of road mileage, some watersheds or parts watersheds, particularly on the Angeles and San Bernardino tional Forests, have approached the present concept of an "ulti- te" transportation system. On other watersheds, notably on Los dres National Forest, not even the primary system of roads is yet npleted. These watersheds thus represent the immediate urgent oblem of carrying to a reasonable level of completeness methods of oven merit. Less urgent, but important, is completion of the nned transportation system on watersheds of particularly great ue.

Full use of the present road system is not being had. It has en possible to build the roads, but it has not been financially ssible to build the other things needed to get best use of the roads. particular, organized trained suppression crews, housing for them, transportation and other mechanized equipment for their use, and sources of water supply have been but partially developed. A large problem remains in obtaining balance between existing road systems and means for their effective use. At present, the two are seriously out of balance.

PROBLEM OF PERSONNEL

The need for the highest possible caliber of personnel to operate the complex, fast-moving job of fire supression has already been referred to. The problem is twofold. First, for the most skilled leadership. Many men have learned much from hard experience in fighting fires. But no armed service in the world depends on actual war experience to train its leaders. The job of directing fire suppression is parallel in difficulty to the problems of war. Altogether too much dependence has had to be placed on experience alone in training leadership.

Second, for the most effective suppression crews. Jobs on these crews have not been attractive to the type of man required in the swift-moving task of fire supression in southern California. The seasonal work for only a few months a year has resulted in rapid turnover, and consequent inability to maintain the highest type of crew organization. This must be remedied to hold capable personnel and obtain the accumulated benefits of their training and experience.

Selection and training, both of leaders and of crew workers is thus a step in raising the effectiveness of fire control, coordinate in importance with roads, mechanized equipment, and the other phases.

EXPECTED FLEXIBILITY IN APPLICATION OF RECOMMENDED STANDARDS

The study has resulted in recommendations of 15-minute attack time with five-man crew and tanker in the brush zone, and 15-minute time with three-men and tanker in the flash fuels. These should, of course, be accepted as averages for normal conditions and not prescriptions to be followed slavishly on each part of each watershed. Time requirements obviously will be much shorter during more dangerous fire weather. Many other modifying factors are important locally.

One known variable, for example, for which no arithmetical measure is available, is faster spread in the lower elevations of the brush zone except those with marine exposure than is to be expected in the higher areas of the same zone.

Another known variable, lacking in arithmetical measure, is faster spread on south than on north slopes within the brush zone at the same elevation.

Yet another unmeasured variable is significant difference in density of cover within both the flash fuel and brush zones at the same elevations and on the same aspects, because of minor differences in site or number of years since the last burn.

Yet another is the great variation in soil condition, that is, amount of rock, which is reflected in difficulty or ease of line construction, all other conditions being equal.

A further variable is the complicated way in which wind at a given time blows uphill and hence spreads fire rapidly, at one point, and elsewhere blows downhill and tends to retard spread. A highly nportant variable is topography, and particularly whether "wind-ips" cause abnormally high local winds and hence abnormally high te of spread.

The individual and combined effect of these and other unmeasured ariables is, of course, included in the averages by zones, which have een used as the basis for conclusions. The mere listing of the more nportant variables enforces the conclusion that the most skilful orking out of protection organization in the brush zone on a given atershed or national forest will probably involve a variation of om 5 minutes to as much as 30 minutes in planned attack time for articular crews. Determination of the actual on-the-ground organ-ation has not been a problem considered by this study. But flexi-lity in application, rather than rigid adherence to averages, is the esirable and indeed necessary course. As a matter of local planning, is not, of course, part of the subject matter of this study.

Similarly, the average crew strength of five men in the brush zone nd three men in the flash fuel zone is by no means expected to be flexible and unvarying. Local differences in line construction roblems or local rates of spread should be reflected in skillful varying f strength of individual crews.

Length of fire season, comparing year with year, varies materially. Vithin a single season, the change in rate of fire spread and hence in eeded size of crew varies greatly. Flexible and skillful use of crew embers on maintenance of improvement rather than on standby uring periods of subnormal danger can increase greatly the effective-ess of fire control.

Not only behavior of fires, but values at stake will have to be con-dered in local planning. On watersheds of very high value where iere are heavy investments in reservoirs, and particularly where res followed by floods would cause loss of life, protection organization ill surely aim at holding fires to much less than the 2,000-acre aximum size provisionally adopted in this study as a general average.

Consideration of values will mean that, since simultaneously uild-up of protection organization to the recommended levels can ardly be accomplished, regardless of money available, first priority ill be given to most urgent problems, that is, value at stake. And alues for a given watershed change radically from time to time, as or example, when a costly water conservation dam is built, subject o rapid silting up unless hitherto endurable rate of fire loss is sharply educed.

Most effective application of the general average formulas to local onditions will require a high level of planning and analysis.

But none of this means that, because local variations in planning re needed, the zone averages can be ignored. The latitude of ariation from average is probably of the order of from one-half verage to two times average, although this needs further study.

Characteristics of Required Fire-Control Organization

The study indicates, and this is indeed obvious, that the objective f fire control must be thought of in terms of holding losses in indi-idual watersheds to an endurable maximum. In very general terms, iis means no individual fires of over about 2,000 acres, and this gure is probably now too large on many of the more valuable watersheds. The ultimate level at which fire control must aim has not yet been fully and finally set.

The study indicates that, contrary to widely held opinion, the problem of fire prevention is by no means confined to reduction or elimination of fires caused by recreational use, that is, smoker and camper fires. Although recreational use is undoubtedly responsible for a majority of the fires, they could be eliminated and still leave numerous other obstinate prevention problems. A major conclusion of the study is that many opportunities remain for effective fire-prevention effort. In terms of fire-control organization, the indicated needs are principally in intensifying, expanding, and carrying out continuously the policing, hazard reduction, and educational programs already under way, and in developing more specialized means of attack on particular problems. Far greater volume of effort, as an integral part of the fire-control organization, is the essential; special prevention measures for bad fire days are needed.

The needed characteristics of the fire-suppression organization have been developed by the study. First, fast attack in the important brush and flash-fuel zones, averaging 15 minutes from discovery of fire to first attack. Handling of fires in these zones is the overwhelming bulk of the fire problem.

Second, small crew rather than one-man or large crew attack in these zones, averaging five-man crew in the brush zone and three men in the flash fuel zone.

Third, use wherever possible of tankers as an integral part of initia attack, rather than as follow-up of fires that escape. Full use of tanker is indicated as a major means to increase the effectiveness of attack or fires of a given size in a given zone by a given number of men.

Fourth, to attain the required speed of attack, a relatively larg number of attack centers with small crews, rather than a smalle number of centers with larger crews is indicated. And each crew uni needs as standard equipment, the fastest possible motor equipment The greatest economy is attained by quick attack by a small crew, no by slower attack by large crews.

Fifth, the attack crew must evidently be a highly skilled, integrated and trained team, with high-grade leadership. The need for the mos careful selection of men and leaders and the most thorough trainin of both are evident. The tempo of the required attack leaves no room for indecision, fumbling, lack of team play or mistakes in strategy, i the attack is to succeed.

Sixth, the problem of handling fires on bad days requires, first of al sure, reliable identification and forecasting of the weather condition causing bad days.

Seventh, advance plans and procedures are needed to increase imme diately both size and number of crew units when current fire dange ratings or fire weather forecasts justify it.

Eighth, known risk areas have to be covered within time limits, burned area is to be held to accepted rates of loss. The potentialiti of single major fires, resulting from slow or ineffective initial attacl are so great that partial coverage of risks is in effect no protection at al

Ninth, at least a skeleton organization will be needed almost yea long, even in the early and late months of the year, subject to buildin up when hazards are increasing rapidly.

Tenth, a full-road system is required so that all risk areas may be brought within the scope of rapid, mechanized attack. Firebreaks to be used when backfiring is required are another necessity.

This type of organization depends on uniform and balanced strength. Careful selection and training of men; the best possible mechanized equipment, both for travel and attack; employment for the full season of danger; and means to keep the entire complex physical plant and equipment in first-class shape are all required.

The major conclusion from the study is that full-scale attack in accordance with foregoing specifications can reduce losses, both for the area as a whole and for individual watersheds, to an endurable rate.

The study makes no attempt to develop the detailed program having the characteristics above enumerated. That is a job for planning, and this study has confined itself to establishing a sound basis for planning.

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and technique may flow to and from every worker in the field of forest fire control.

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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

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FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

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The value of this publication will be determined by what Forest Service officers, State forestry workers, and private operators contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire-fighting methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

Address DIVISION OF FIRE CONTROL
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IT ISN'T OUR FIRE

PERCY E. MELIS

Forest Supervisor, Helena National Forest

The use by forest officers of the expression "It isn't our fire" as an explanation for failure to take action toward the suppression of a fire on forest lands unprotected by organized agencies is deplored by the author. In particular, he argues that a complacent and self-righteous attitude should be avoided. The loss to the Nation by such fires is just as great as though they were on lands owned by or protected by the United States or by the States. Although there are major obstacles to the extension of Federal fire protection, it is especially timely—in view of our over-all problem of national defense—to explore the possibilities of developing some means of furnishing adequate fire protection even though such means are not now apparent.

How many times have forest officers used the expression "It isn't our re" and thereby disavowed responsibility for a fire burning on un-rotected forest land? As an organization we should not be content ith our own accomplishments and should avoid the appearance of omplacency or smugness regarding fires on lands not under Forest ervice protection. As a public agency, with well-developed fire-ippression facilities, we cannot afford to be self-satisfied nor should e be negligent in consideration and treatment of forest fires which o not endanger the national forests.

A recent incident will point up this discussion.

On the afternoon of July 9, 1940, a lightning storm passed over the icinity of Helena setting 17 fires, 15 on national-forest land and 2 n unprotected forest lands. By 10 a. m., July 10, the 15 fires on the ational forest were all either out or under control, while the two fires utside our protection boundary were booming along in crew-size roportions.

During the next 10 days we received several hundred inquiries about rogress on these fires. Each inquiry was answered with a full ex-lanation to the effect that our fire-control authorization does not ermit us to spend public money in suppression of fires which do not ndanger the national forests unless financial responsibility is accepted y the landowner. Many good citizens shook their heads in be-ilderment, wondering why the valuable natural resources which we iscuss so glibly should be permitted to burn so freely—especially when e maintain an organization trained and equipped for fire control.

In about 2 weeks the two fires on unprotected lands were finally xtinguished by a combination of showers and prayers, and volunteer nd private-owner effort, aided materially by lack of fuel.

The total area of the 15 fires on the national forest was held to about) acres, and the damage to natural resources was of no material con-equence. The two other fires spread over literally thousands of cres—perhaps 6 or 7 thousand—of low-grade forest land. The loss in timber and brush cover, potential timber growth, forage, soil productivity, wildlife habitat, watershed, recreation, and aesthetic values was just as distinctly a national loss as though this burned area had been on the national forest.

Should we indulge a feeling of satisfaction that this incident proves again the value of organized fire control and that the Forest Service has again demonstrated its effectiveness in fire suppression? No, not by any means. We should instead experience a feeling of futility and shame that after years and years of effort we must still stand by, more or less idly, with an efficient fire-fighting machine, all in gear and ready to go, actually watching our natural resources burn—merely because their burning does not endanger the national forest.

The incident I have just related is not an isolated case. During each of the last two fire seasons there has been more fire damage, more loss of public values, more loss to the Nation from uncontrolled fires on unprotected lands within sight of the supervisor's office here than on the entire Helena National Forest during these 2 years combined. The loss to the Nation is just as real and the damage just as great as though it were recorded in our fire reports and made the subject of a meeting of the board of fire review. I believe that a similar situation obtains wherever our national-forest lands are adjacent to other forest lands which do not have the benefit of organized fire protection.

Several obvious explanations may be made of this situation, but explanations do not solve the problem. It is easy to blame negligence by the counties or the States and indifference of the private landowner, and to say "It isn't our fire." But the loss still continues—loss that could be materially reduced were the real values lost better appreciated by all parties having an interest at stake.

It is high time that we thoroughly review the entire problem of the distribution of fire-control effort. Each year we willingly spend hundreds of thousands of dollars of public money in protecting from fire vast areas of inaccessible, almost unusable country of no commercial value. We do this because it is public property, because we have public money for that purpose, and because any forest fire is a recognized forest enemy. We spend this money without any material concern over the absence of commercial values at stake because we recognize the importance of the other forest values. Nevertheless, areas of far greater public value, although not publicly owned, are permitted to burn almost unchecked on account of the lack of recognition of the public interest. Is it not our fire?

One means of furnishing adequate protection would be to extend Federal protection, although it is recognized that the expansion of Federal forest-fire protection over other land ownerships would involve many complications, and that many practical as well as academic problems would be involved. No one, however, should balk at the abstract idea. Socialization in many ways has gone far beyond this and with less justification. In the control of predatory animals, plant pests and diseases, and in other instances too numerous to list here we recognize the public values at stake in private property. We now advocate the regulation of certain industrial operations of forest-land owners on account of the public interests involved. However, the extension of Federal protection is not necessarily the answer to this problem; it may be better to use all the resources of private initiative and inventiveness and of State cooperation.

Let us now recognize, however, with equal clarity that the public values at stake in forest land, regardless of ownership, warrant full and complete fire protection from one source or another.

It is not the purpose of this article to discuss the effectiveness of the Clarke-McNary law or of State and private fire-protection organizations. Also it is not the intention to outline a means through which adequate protection will be obtained for non-Federal lands, either through private initiative or Government assistance. The discussion should, however, stimulate thought so that thinking in the field of planning and cooperation will keep pace with developments in the more technical aspects of fire control.

The expression "It isn't our fire" cannot be accepted as fulfilling the responsibilities of the major forest-fire protection agency of the Nation. The situation described presents a challenge to the Forest Service that cannot be considered lightly.

Air Infantry and Smoke-Jumpers.—Development of air infantry is the subject of discussion in an article by Lieut. Col. William C. Lee in the January 1941 issue of the Infantry Journal.

Air infantry must receive parachute training similar to that given to men of the Air Corps for use in emergencies, although the training does not proceed to the point that it does with the parachute troops. Commenting upon the work of the Forest Service in Region 1, Colonel Lee says:

"Our new aerial development has naturally called for considerable study in order to find out what kind of equipment will serve best, especially for the parachute troops. In the course of this study it was found that the Forest Service, a branch of the Department of Agriculture, was using, out in the mountains of Montana, especially developed equipment for dropping groups of as many as six or eight men in isolated roadless forest areas to fight forest fires. Five officers representing the Office of the Chief of Infantry, the Air Corps, and the Infantry Board, went to Montana for a week to study the equipment and methods of the Forest Service. Every facility was extended to the visiting Army officers. This visit and the enthusiastic cooperation of the Forest Service enabled us to gain the full benefit of their experience and saved many weeks of experiment in the development of parachute troops."

FOREST DEFENSE IS NATIONAL DEFENSE

Crawford R. Buell

Division of Fire Control, Washington, D. C.

The slogan "Forest defense is national defense" which appears on the 1941 fire-prevention poster, might well have been applied to several articles in this issue of Fire Control Notes. It is fitting and proper that more thought than ever before be given to fire-control problems. Forest-fire protection is a recognized and direct part of the plan for total defense of the Nation.

Melis, in the preceding article, issued a challenge to all forest officers of all organizations to think of forest protection beyond the bounds of their own bailiwicks or protection zones—and to consider what changes of thought are necessary and what means will assist in providing Nation-wide forest-wide protection to the degree of refinement necessary.

Marsh, in his article, shows specifically what can be done in effectively mobilizing the efforts of small local grazing communities in eastern Montana—a cooperative job where all pitch in for the common good as at the old-fashioned "house raising." Klehm, along the Canadian border in Montana, in relating the story of possibly one of the worst lightning fire attacks recorded, graphically illustrates cooperation working at a high level of perfection in a grave emergency. Reading it, one pictures the enormous problem involved in planning for and carrying out cooperation on a State-wide or regional basis if the same situation had arisen over the broader areas.

Turning to the southeast, Cochrane relates the application of one of the principles of democracy—individual pride and dignity—to the fire-warden plan used in Virginia. Here again, planning and cooperation form the hub and axle of prevention and suppression. Then with the reading of Stone's article on municipal fire problems, as excerpted by Headley, of a city's fire defenses and the difficulties of the personnel managing them, a picture begins to form of the big task ahead of the Nation. Each of us plays a part in, and each of us can make some contribution of thought or action to the problem of National defense.

Writing this in January, some 3 months before it will be read, is difficult in these quickly moving times. However, it is evident that in some cases a reorientation of our thinking may be required, and in other cases a broadening of the base of our thinking and a quickening of our perceptions of needs and remedies may be in order. The formation of State fire-defense committees now under way may be a means of assisting in these changes.

COOPERATION IN FIRE SUPPRESSION

John T. Marsh

District Ranger, Custer National Forest

Cooperation is basic to successful fire suppression. Without it the individual crew will not function properly nor will it be possible to obtain real coordination between units. Particularly is cooperation necessary when unorganized crews must be relied upon. In recent years the use of crews paid from various emergency funds may have caused many persons to forget the days when the district ranger relied largely upon the cooperative effort of local residents who viewed the fire-suppression job as a community project. More emphasis may well be given to the approach used by the author.

The eastern ranger districts of the Custer National Forest enjoy more widespread cooperation in fire suppression than most other portions of region 1. These cooperative efforts doubtless had their beginning before creation of the forest, when it was necessary for ranchers to band together for mutual protection against fires that occurred on their livestock ranges.

The situation on the Whitetail district is similar to that on other eastern districts of the forest. The principal use made of the national forest is for grazing of livestock. The ranch properties of the permittees enjoying grazing privileges are widely scattered within and adjacent to the forest boundary. Men are therefore available to take action on fires in all but a few isolated areas.

A fairly good communication system exists, which adequately serves most of the area. It consists of Forest Service and private telephone lines. Numerous so-called roads, visible as dim wheel tracks through the grasslands and open yellow pine timber, make the area accessible by automobile. Fire-tool caches are scattered throughout the forest at road intersections and centrally located ranches.

The local people are very fire conscious and it is rare that man-caused fires occur. After severe lightning storms the local people are on the lookout for fires in their vicinity. They frequently go to vantage points near their ranches to get a better view of the surrounding forest lands. When a fire is discovered the men drop the work at hand and leave immediately for the fire, picking up tools from the caches en route. Reporting the fire is usually the responsibility of the ranchers' wives.

Because of the prompt action by cooperators and the fact that the ranches are widely scattered throughout the forest, it is unusual for a member of the Forest Service organization to be the first to reach a fire. Additional tools, water, subsistence supplies, and overhead are furnished by the Forest Service. Manpower at the fire is rarely deficient. An increasing volume of smoke brings increasing numbers of men. Often 15 to 25 men will report at class A or class B fires, particularly if the fire is visible for a considerable distance.

How such close local cooperation is obtained is not easily explainable. The basic reason for it is doubtless the dependency of the cooperators on the resources which fires destroy. The cooperators are grazing permittees, ranchers and employees dependent on the forest for timber. The Forest Service has had continuous business contacts with most of them over a long period of years.

Each rancher assumes responsibility for initial action on fires in his immediate vicinity. Where ranches are grouped, as in some of the larger drainages, the natural leader in that small community serves as per diem guard and takes charge of fires in the surrounding area.

The cooperative efforts in fire suppression have become a sort of community project. They offer a change in activity from the usual ranch work.

The ranchers are ambitious fire fighters and apply themselves to the job with a zeal rarely exhibited by other types of fire crews. Fire crews composed of such men do not require close supervision. Supervision can be handled almost entirely by suggestion.

When the fire is controlled, the men insist on taking a half hour of well-earned rest to talk over action on the fire, ranching and range operations, neighborhood gossip, etc. Such an abrupt let-up is rather disconcerting to one accustomed to handling ordinary fire crews. I believe it serves a valuable purpose and is also often enlightening to Forest Service personnel. The privilege is not abused, nor is there any intent of shirking the job. During the rest period, men occasionally leave the group to patrol and check on the more hazardous margins of the fire, without being specifically instructed to do so. When the group has had sufficient rest, they continue with the mop-up job.

The services of most of the cooperators are limited largely to the initial control period. It is the practice to release those that have urgent work at hand as promptly as possible. Volunteers are usually solicited from the group at the fire to complete the mop-up and patrol.

I believe that similar cooperation can be fostered elsewhere by impressing local people with their dependency on national forest resources. Mutual understanding and proper commendation for the part taken by the individual is essential. Throughout the job the cooperators should be treated in such a manner that they understand that they are doing the Forest Service organization a needed favor which is not demanded of them. This viewpoint or obligation on the part of the Forest Service organization is often more of a reward than the monetary payment for the services rendered. Respect for and appreciation of the other fellow's efforts are necessary in any sound cooperative effort.

THE KOOTENAI RECORD IN 1940

K. A. Klehm

Forest Supervisor, Kootenai National Forest

One who has read of the work of the Air Raid Precautions personnel (A. R. P.'s) during the fires caused by the bombing raids in England, must have wondered at the problems of organization and cooperation involved. Here is an example of cooperation to meet a vital emergency—of cooperation of governmental units and of private organizations, all bending their efforts to meet the fire threat. Cooperation and planning is the basis for action such as is described here. If the number of fires had been doubled or trebled within the Kootenai and adjoining areas, what other forms and degrees of cooperation would have been necessary? What part can isolated local residents play in such situations? How can local thought and action be mobilized and guided?

The term "blitzkreig" as I understand it, means lightning war or action. It describes exactly the happenings on the Kootenai National Forest from 2 p. m. on July 12 until the same time July 25, 1940. The following table, showing by years the number of fires on this forest from 1931 to 1940 inclusive, not only provides a comparison but also gives a better idea of the situation:

Year	Lightning	Man-caused	Total	Year	Lightning	Man-caused	Total
1931	25	42	67	1937	15	25	49
1932	30	51	81	1938	140	19	150
1933	26	30	56	1939	125	30	155
1934	48	32	80	1940	427	24	451
1935	64	25	89				
1936	105	43	148	Total	1,005	321	1,326

The record shows that 34 percent of all the fires occurred during the summer of 1940; 350 or 77.6 percent of the 1940 fires occurred during the period from 2 p. m., July 12 to July 25. The number of fires by days follows:

July 12	86	July 17	11	July 22	13
July 13	55	July 18	35	July 23	5
July 14	14	July 19	3	July 24	3
July 15	23	July 20	55	July 25	3
July 16	20	July 21	24		

The number of fires by classes follows: 234 A's, 85 B's, 24 C's, 2 D's, 5 E's.

Area burned over in 1940: 4,445 acres.

Weather records show: A dry fall in 1939 with more than average moisture during the period from December 1939 to May 1940, with a deficiency during June and early July. Only one light rain fell from June 9 to July 15, and a heavier rain on July 27.

Lightning action starting fires means the same action for control. The Kootenai Forest has only one CCC camp and no improvement construction crews of any kind. The forest is also located a long way from big centers of labor, such as Spokane or Missoula. Therefore, when the limited local sources of labor are exhausted, the regional office at Missoula is called upon for additional help when needed.

There are 8 ranger districts on the forest, 7 of which were hit. On one district alone there were 120 fires. The fires were scattered from low elevations in the valleys to the extreme elevations in the Cabinet Mountains, over a rugged area of 2,358,552 acres.

The forest had 2,400 men on fires by July 15. They arrived from far distant points—Butte, Anaconda, Miles City, Dillon, Billings, Missoula, Kalispell, Spokane, Lewiston, St. Maries, Sandpoint, and many other smaller places. They came by bus, trucks, and two special trains. Overhead arrived from Oregon, Idaho, Washington, and eastern Montana, coming by all types of conveyances including planes.

Numerous outside packstrings and trucks were employed in getting in fire camps and supplying this army of men in hundreds of places in rough country. Water had to be packed to several dry camps. One fire camp was put in by plane, and another dry camp was furnished with water by plane on two different occasions when the trail was blocked by fire.

Volumes could be written on what took place, including good and bad action. The main point is, however, that the unusual situation brought about on this forest by an outbreak of lightning fires was handled by an organization that could function to meet it. Cooperation within the organization, from the men on the ground where the fires occurred to those in higher positions, made possible success against what seemed insurmountable difficulties. No boundaries, either ranger district, forest, State, or regional, were allowed to interfere. The spirit was that expressed in, "We have a job to do, boys, so let's have at it."

[In addition to the cooperation of units and persons within the Forest Service, seen by Forest Supervisor Klehm, many outside agencies also cooperated. The regional office has given the following information:

Lumber companies supplied their crews and equipment in the usual manner. Transportation companies disrupted their schedules and generally gave fire control needs priority. Commercial radio stations cooperated in several ways, even to calling in trail crews for fire duty when there was no means of communication other than a commercial radio receiver. A telephone company furnished an operator who also functioned as an order clerk at a ranger station switchboard. Bus companies moved their equipment long distances and held it on standby, often with considerable financial loss. Grocery establishments loaned personnel to serve in warehousing capacities and a bank loaned men for timekeeping and accounts jobs. Many individuals also offered their services, from farmers with crops needing attention to former Forest Service employees, some living several thousand miles away.]

THE JEFFERSON WARDEN

Allen R. Cochrane

Assistant Forest Supervisor, Jefferson National Forest

The striking results obtained through the use of the warden system on the Jefferson National Forest offer encouragement to forest officers who have need for the services of such a group of men and have been searching for a key to successful use of such a plan. Democracy itself is the keynote of the plan used in Virginia. Forest officers are servants of the public; through enlistment of the hearts and minds, as well as the bodies of the local men who serve as wardens, cooperation is obtained in fire protection for the general welfare.

The essence of democracy lies in the fact that all men possess dignity and pride as individuals. The validity of this assertion is accepted by the forest personnel on the Jefferson National Forest who regard it as an important statement in fire-control policy.

Fire prevention and suppression on the Jefferson is built around the warden system. The wardens are humble folk, mostly small farmers, owners of simple homes on the mountain farms lying adjacent to the national forest. It may have taken a rather deep faith in the democratic principle as stated to have started the warden system more than a quarter of a century ago. Probably it would be more nearly correct to state that it was a mixture of faith and desperation that inspired that start toward our present warden organization.

Appearances are very deceiving. The warden may be somewhat suppressed and denied economic advantages, but intellectually he is shrewd and possesses considerable ingenuity and originality. Every measure of faith placed in the men in the warden system has been justified by performance. In fact, the mistake has been that forest officers have not placed more consistent faith in this organization and the individuals which make it up.

When the new training systems came into being a few years ago, some doubt was expressed as to whether much could be done with adults set in their ways as these men were. Meetings, it was supposed, would be confined to amusement and entertainment with propaganda effect. Yet, some of the most successful training schools have been among warden groups, using conference and one-step methods. Some of the warden conferences have been outstanding for their instruction and inspiration.

Wardens as a group, lacking special training, are not outstanding for their judgment and technique in fire suppression. They are fairly reliable, however. Strangely enough, practically every device which has been developed recently on actual suppression methods has been used previously by some member of the warden group on the Jefferson. Unfortunately, the knowledge of the individual was not made common knowledge, and, for all practical purposes, did not exist. The one-lick method of fire-line construction has been used on occasions for years by numerous wardens. It was embarrassing to discover this fact as did an instructor who thought he was springing something new. Warden C. C. Smith, living on top of the abruptly rising Alleghenies, described building a series of buffer lines to stop a fire on a steep hillside before the R–3 article was printed in Fire Control Notes. He had to do this to save his fences.

Some of our most unpromising men have made outstanding contributions to fire prevention. Doing a good job in their own local district without pay has added to their prestige as members of the community and provided an outlet for creative work. The work of a few outstanding men in fire prevention has justified all the time and effort expended by regular personnel on the organization.

No solution has been found for the slow average get-away time of a warden crew; gathering the men from their homes, the fields, and church on Sunday is time-consuming.

Forest officers appreciate the intelligence and ability of the wardens in fire prevention and meet them as equals. They assume that the wardens are glad to have new ideas presented, and solicit their opinion on how a better job can be done.

Good wadens are the answer to effective fire prevention in Virginia and perform a real public service. They know that the small contributions of individuals, when added together, make a impressive total. Each man is another "head power," and the Jefferson is plus 100 head power instead of 10 or 15 head power, which would be the case if the wardens were not considered as an integral and basic part of the organization and their opinions solicited on practically every phase of fire control.

FIRE INSURANCE CLASSIFICATION OF CITIES AND FIRE LOSSES

ROY HEADLEY

Fire Control, Washington, D. C.

Students of the financial management and economics of forest-fire control naturally turn hopefully to the elder brother, municipal fire protection, for pertinent ideas, methods of analysis, and tested ways of thinking. The result of such a quest is disappointing. Considering relative values, losses, and potential resources for searching study in forest-fire control as against municipal protection, forest-fire men need not feel apologetic about the fact that their thinking has advanced so little. A real start has not yet been made in either field, although it does seem that municipal management should have felt a stronger urge toward a serious attack on the subject than exists in forest-fire control management.

However, despite his disappointment, a forest-fire man can glean some things of interest and suggestive value from municipal protection literature. One of the more searching recent studies is by Harold A. Stone, published under the above title as a 25-page pamphlet, by the Public Administration Service of Chicago. The following excerpts will be of interest to forest-fire men.

Foreword

The fixing of fire-insurance base rates for cities affects municipal officials and taxpayers vitally. Here is one field of governmental service where public spending and private saving are obviously and clearly related. If the appropriation for fire protection is decreased so as to lower the city's classification, as set by the National Board of Fire Underwriters, the immediate result is to increase far beyond the tax saving the amount of premiums which taxpayers must pay.

Officials seeking legitimate economies in governmental costs find on the one hand that the fire insurance authorities are constantly demanding expenditures for mains, hydrants, and other physical equipment under pain of raising insurance rates; while on the other hand, the Board of Underwriters has taken a leading role in the campaign for tax reduction. And while the National Board of Fire Underwriters has painted vividly the blighting effect of taxes, the National Fire Protection Association has warned the public of the dangers of skimping on appropriations for fire protection.—Foreword by Charles S. Asher, director of publications.

Ability to Use Fire Defenses

As mentioned earlier, the basis of spreading insurance within a State, i. e., distributing losses, is the classification of cities set by the National Board of Fire Underwriters. This classification is based upon fire defenses and physical conditions; in other words, weapons. No consideration in grading a city is given to the loss record, to the moral hazard, and practically none to ability to use the weapons. Perhaps the omission of these factors will explain the lack of relationship between fire losses and defenses (classification) pointed out at the beginning of this monograph. These three factors will now be analyzed, with attention first to the city's ability to use its fire defenses.

A long-established axiom tells us that a skilled carpenter having excellent tools will do a better job than an unskilled worker with the same tools. Thus, it can be said that the city's ability to use fire defenses lies in the skill of the personnel employed. If the firemen are well trained and have achieved facility in the use of equipment, the chances of coping successfully with a fire are obviously much greater than with an untrained, fumbling company of men.

The National Board of Fire Underwriters gives some consideration to the ability of the personnel to fight a fire. Out of 34 elements considered in the schedule under the heading "Fire Department," the following 7 touch upon the subject of competency: Item 7, Operators; Item 3, Qualifications of Chief Officers; Item 5, Appointment and Promotion of Officers; Item 6, Enlistment and Promotion of Privates; Item 28, Regulations and Discipline, Item 29, Drills and Training, Item 31, Fire Methods. Although this is an imposing list of factors, nevertheless no consideration is given to the officer's "fire sense"; that is, his instinctive ability properly to size up a fire, to lay plans quickly to save the occupants and contents, to prevent its spreading, and to extinguish it. Generalship on the part of the officers is another element omitted in the ratings of the fire department. Hydraulic and engineering knowledge of hose streams, pumps, chemistry of a fire, ventilation, strength of materials, and a score of other elements are left out. The Los Angeles department is one of a few having a training school or college for the continual instruction of the old-line fighter as well as the recruit. Most departments seem to leave any quest for knowledge to the initiative of the men.

Rating Actual Performance

It is the author's belief that the factors of actual performance and skill are at least as measurable as some of the items now included in the standard schedule. Measurement tests of this character have been developed in the field of public administration since the standard schedule of the National Board of Fire Underwriters was promulgated. It is entirely beyond the scope of this brief study to detail the manner in which such tests should be adapted to the appraisal of fire departments; but it seems fair to conclude that the failure to include the elements of skill and ability to use defense weapons in rating a city is one answer to the question, Why are the losses in one city so much higher than in another when both have the same classification? There may be other reasons, now to be discussed.

Moral Hazard

Many explanations are advanced for the low fire losses in European cities. One of them is the absence of what is called in the United States the "moral hazard." It is the flippant, "I-should-worry" attitude of individuals who flagrantly violate fire laws. If it is generally absent in Europe, it can be eradicated in the United States. In fact, "moral hazard" varies considerably between cities, as a prevailing public consciousness of the dangers of fire has been cultivated in a number of cities. Thus, in Fresno, Calif., where a successful attack was launched against an unusually large number of fires, one of the methods used was a continuous educational campaign—not merely spasmodic efforts—culminating in "Fire-prevention Week" once a year.

Carelessness accounts for most of our fires. Fully half of them can be so classed. They are preventable, but no reduction in the number will be brought about until the "moral hazard" as gaged by the prevailing attitude of the inhabitants of a municipality is placed upon the same plane as in European cities.

Fire Prevention

Until recently, Kansas City, Mo., had one of the highest fire losses among large American cities. Moreover, it was consistently high, year after year. After a detailed study had been made by the Insurance Committee of the Chamber of Commerce the city got busy. The report said, "This exceedingly bad record furnishes a local condition which may be remedied only through increased fire-prevention work." Now Kansas City losses are much less, largely through persistent fire-prevention activities. Fresno, Calif., beginning in 1927, scored an excellent achievement in ending one of the worst continuous fire-loss experiences in the country. It conquered the trouble by a well-managed bureau of fire prevention, staffed by skilled engineers. Cincinnati has achieved the same result.

In his book on fire prevention Mr. Stone concluded, "There is a growing realization that fire-fighting units of the larger cities and in a great many of the lesser-sized municipalities have reached what may be termed their "marginal utility." This applies not only to fighting fires of conflagration proportions, but also to the upkeep and cost of the fire-fighting organization. Therefore, future progress and relief from the situation must be in another direction, viz, fire prevention."

Conclusions

Only one conclusion can be reached from the data and analyses presented in this study. Although a definite correlation should exist between the classification of a city set by the National Board of Fire Underwriters and the losses and number of fires in that city, no such relationship exists. There is as much chance of a good record with what the National Board of Fire Underwriters calls poor fire defenses as with what it rates as excellent ones. This statement was made at the beginning. It holds after a critical examination of the factors tending to throw doubt on it. Are insurance premiums being loaded on to people having small losses so as to pay for the carelessness of others having heavy losses? Insofar as the grading schedule is used as the basis for establishing rates, the answer must be yes. A city with a good classification and high losses is not always paying its fair share of the cost of insurance. Conversely, a city with an excellent record of losses, but burdened with a poor classification, may be unjustly paying for the carelessness of someone else.

Four Factors Omitted

There are at least four factors which we have attempted to show should be considered in the classification of a city, the omission of which undoubtedly accounts for the present discrepancy between classifications and fire losses. These are: (1) The ability to use fire defenses, which is a matter of personnel; (2) fire prevention; (3) moral hazard; and (4) the record of fire losses and number of fires. The argument for not including these factors in the grading schedule now used by the National Board of Fire Underwriters is that they are imponderables, not subject to exact engineering measurement like the elements now included in the schedule. It is our belief (although it has been beyond the scope of this analysis to elaborate the point) that some, at least, of these factors are as measurable as items now on the schedule, in the light of measurement techniques developed since the schedule was framed.

Schedule Alone Not Enough

But even if this be disputed, the clear inescapable fact remains that if these elements are not taken into consideration, the classification does not give a fair picture of the city's ability to cope with fire as shown in the actual record of fire losses and number of fires. The conclusion may then be that the elaborate engineering appraisal, summarized in the deficiency points established by the grading schedule, should be only one of the factors used in fixing the base rate for a city. Some evidence has been presented to show that in practice the authorities do give weight to other factors. If this is to be done, it is our plea that it be done openly so that public officials and the payers of taxes and insurance premiums can see how the base rate of their city is determined.

THE ARMY ON FIRE FIGHTING

AXEL LINDH

Fire Control, Region 1

The education of an individual does not come entirely from within his own personal experience. Man profits by the accumulated experience and wisdom of his group or society. So also, a profession draws when it can from the knowledge acquired by other professions. In this article a parallel is drawn between some of the tasks confronting one of the oldest professions with that facing one of the youngest.

A planner of Army strategy and tactics—Lieut. Col. Joseph M. Scammell—writing in the Infantry Journal for January 1941, might have been describing the fire suppression problems of region 1 in the following quoted from his article:

"Thus we see our ideas of 'normal' warfare are no safe guide. Time and space factors used in staff calculations must be radically revised; and even then may prove misleading because conditions are so uneven. The kind of instruction now given may be an actual handicap rather than an aid, except as regards principles and methods. Troops that on level ground move at 3 miles an hour and develop for combat in a few hours, at high altitudes will have to rest frequently and will move with excruciating slowness. The column, moreover, will be strung out for miles and will have to close up. An attack once launched will progress slowly, especially in the absence of strong and effective supporting fires and the necessity for maneuver. The coordination of arms will not be easy to secure. The approach, the development, and the attack will seem like a moving picture run in slow motion.

"The requirements of mountain warfare are a direct challenge to our organization, tactics, supply system, and above all the rigidity of the methods by which we select leaders of units especially in high commands. In the absence of special formations and special training, only a leader endowed with great flexibility of mind, of sound military judgment, and of independence of character can hope to succeed. He must have an appreciation of terrain and a strong sense of time and timing. He must be able to throw away his formal instruction. He must discard preconceived notions of concentration of force, discard the existing organization, and wage war with small, isolated columns. Superiority in numbers, in fire, or by surprise can be achieved only by making use of every possible avenue of approach, especially those which are 'impractical' and 'impossible.' * * *

"Nowhere else as well as in mountain warfare do small units exercise such decisive results. Only by maneuvering against flanks can success be brought about. The usual avenues of approach are blocked and swept by defensive fires. Only small units can climb like mountain goats and worm their way up, over, and through to a flanking position. Boldness, initiative, endurance, resolution are necessary. Even during the approach march these small bodies are indispensable; for the routes by which the larger bodies must advance usually run in defiles; and it is necessary to occupy the heights above before a column dare venture ahead. Mountain warfare is a game for young, strong men, with young, bold, and resourceful leaders. Mountain warefare is light infantry warfare to a superlative degree.

"Those who can wage war in the mountains, deserts, and jungles, can make war anywhere. But the reverse is not true. It is in minor warfare that we find the true test of generalship and the true training of soldiers."

Why Do Ideas Grow in Such Erratic Ways—From 1910 to 1935, creative thinking about organization for fire suppression confined itself largely to organization of facilities for feeding men and the division of fire-fighting jobs into zones, divisions, sectors, etc., corresponding to certain supervisory functions. Every effort to draw attention away from departmental and camp organization questions met with failure, despite the fact that actual production on line was notoriously low and the further fact that the best camps and overhead organization charts meant nothing unless they affected production on line. Creative minds clung to questions about the proper location of the cream and sugar table and how many sectors should be included in a division.

But times have changed. There is now a trend of thought which holds that our glorified camps are out of harmony with the nature of the job and due to pass on with the dinosaur. Delivery of cooked food by air or otherwise to workers wherever they may be at eating time is beginning. For a 72-hour job the 40-man crew is independent of any camp for either beds or food. And with respect to organization and management on line, ideas are sprouting in every direction. Experiments small and large are being made in many places. And why not? Here is an exceptional chance for the man who likes to think about better ways of doing his job. The district ranger who gets a new idea may have the fun of testing and developing it without having to persuade anyone that he should have a grant of funds for the purpose. If the Forest Service is to become really expert in construction, line holding, and mop-up, it must first pass through a stage in which scores of distinctive methods are under test—each the invention of some active minded man or group. It looks as if we are on our way to that wholesome stage of growth.

In 1935 when Kenneth P. McReynolds began experimenting with the long known but dormant one-lick scheme of organization and management on line, he must have broken the drought of ideas on the subject. At any rate, 5 years later we have a promising number of ideas and methods in circulation. In addition to the antique "man-passing-man" method and the individual assignment and one-lick methods, we now have the distinctive White Mountain 10- to 15-foot variation of the one-lick method, described in the July 1940 issue of Fire Control Notes; the Austin Rotary method described in the same issue under the title of the "Spinning Fireman Methods for Grass Fires," and in the October 1940 issue; and the progressive step-up method also described in the October issue.

In response to some pressure, Otto Lindh and Larry Mays admitted at the Ogden meeting that they had invented the germ of an idea for using the one-lick or progressive principle for line holding and patrol, as well as line construction. If this proves workable in practice, it will solve some acute difficulties which arise when line is constructed rapidly. It might in time turn out to be one of the major developments in organization for fire-fighting.

All of the foregoing developments are apart from the unified organization and management of men and machines which is a large field by itself. For too long, men were managed on a fire in disregard of any machines present, and, in turn machines were used as if there were no men around. Even in 1939 it was possible to see a hand-tool crew following a tractor-trail builder and making a silly little hand trench in the middle of the tractor made trench—just as hand-tool crews used to obliterate a perfectly good horse-plow furrow. But a creative trend is setting in toward a unified and coordinated use of men and machines. Not much has actually been accomplished yet, partly because machines have too often been unreliable. But the possibilities are very large. They invite the attention of men of inventive ingenuity.

These contributions to the management of fire suppression should hasten the day when western production of held line will pull up out of the bracket of six to sixteen hundredths of a chain per man-hour and eastern production will climb to Supervisor Bryan's standard of 6 chains per man-hour.—Roy Headley, *Division of Fire Control, Washington, D. C.*

AN ASPECT OF THE FIRE-CONTROL JOB

Roy A. Phillips

Forest Supervisor, Nezperce National Forest

Management and coordination of men and equipment is a field of fire suppression which is growing more difficult. With mechanical aids to suppression have come problems of training in the use of specialized equipment. Of greater difficulty is the problem of training personnel in the wise and timely use of such equipment—the coordination of manpower with equipment so that each will be used in a way which will best advance the total job to be accomplished. Even some of the management aids themselves, such as radio and telephone, bring problems for solution. A forest supervisor draws upon his 30 years of service in focusing attention upon this bugbear. He gets down to specific cases and finally proposes personal energetic action on his own unit.

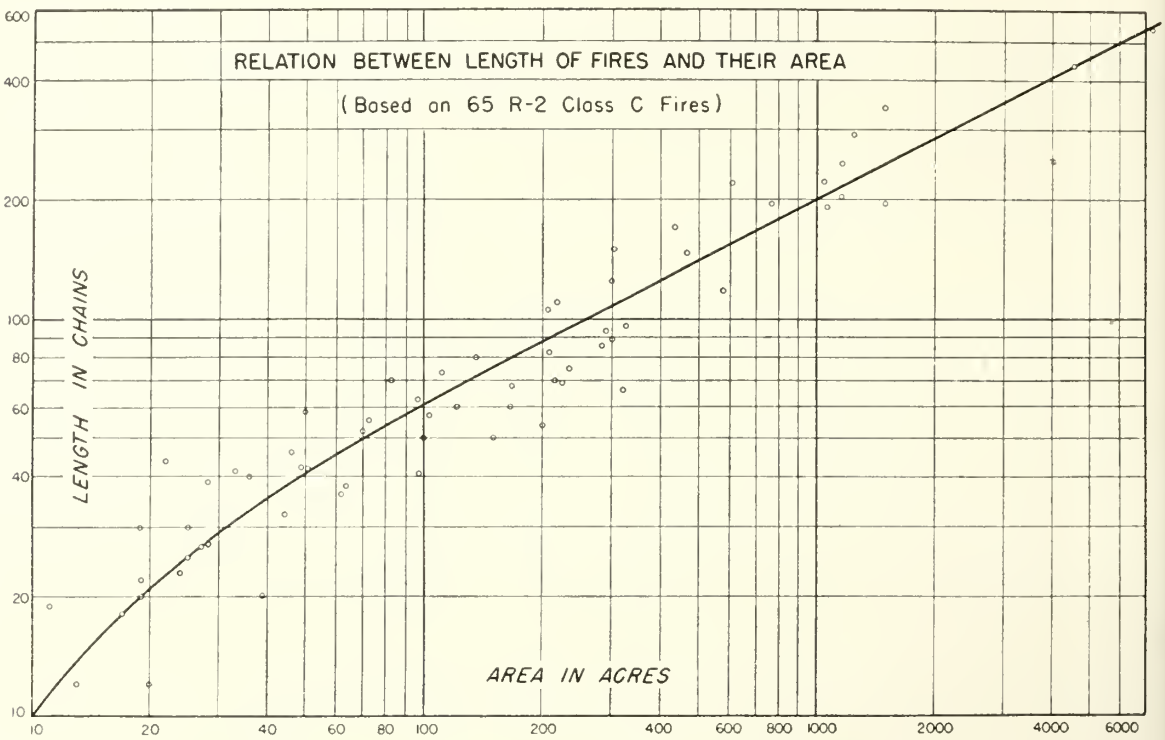
That "necessity is the mother of invention" is an old proverb and a true one that sometimes applies to fire-control action and methods as closely as to other things.

In 1914, as a ranger on the Lolo Forest, through the force of circumstances I commandeered a stumprancher's plow and team and saved the day of a 4,000-acre fire. In 1930 a 200-acre fire in a high alpine timber type in bug-killed timber threatened to leave the country, and this time the day was saved by getting a plane to drop a dozen back-pack pumps from the air. Many times I have used the one-lick, step-up, and other variations of line-contruction methods in emergencies when manpower was short and the situation critical. Many other men throughout the Service must have had like experiences, and I wonder if they feel as I do that we have failed to a very considerable extent to capitalize on them.

Take the horse and plow as an example. It is a poor one, I must admit, as the average forest officer uses a horse very little these days when high-powered motor cars are available to everyone and gasoline scooters are being seriously considered for trail travel. But old Dobbin still has a lot of potential value for fire-line construction if we can get men who can handle a horse and plow. A good horse-plow unit is equal to 25 to 50 men in any man's country, and it packs in to the fire line its initial needs for 1 day, and each following day requires only 60 pounds of hay and oats as compared to many times that weight of tools, mess equipment, food supplies, and beds needed for the manpower it represents.

Practically every piece of equipment and every fire-fighting method that has been developed over the years has a place on any large fire. Yet how often do we see plow horses tied up in camp eating their heads off; Bosworth trenchers standing idly by while men dig trench by hand; men clearing line and digging miles of trench when a few back pumps and a little water would do the job; pumpers set up and a lot of men dragging hose around, using thousands of gallons of water when a few hand pumps and a little water might do as much good; men standing idly by or in each other's way because the work methods are bad or the work poorly organized.

All these things and many more we see on any large project fire, yet what are we doing about it? When I see such a situation on the ground, I do the best I can to straighten it out, just as any other fire boss would do, and I set up a mental promise card to do something about it in the future. But somehow that something never reaches the degree of accomplishment that is expected.



Relationship between length of fires and their area.

I have decided that there is something wrong with our training methods, and this year we are going to do the job as we have never done it before. A horse-plow unit will not go to a fire unless there is a trained crew to handle it—a trained crew built around a 50-man unit that will go to a fire intact and operate in that fashion. The same thing will be true of the Bosworth trencher and other items of equipment. Men will be trained to fight fire systematically and in such a way that there will be no interference or confusion. The system may not be new or have a high-sounding name, but it is going to be efficient. We may not get much done but training, but we are going to do that. And if force of circumstance throws a green or poorly trained crew on to a fire, special overhead will be provided to see that that crew gets systematic training from the time it hits the fire line until it leaves. We all know that the most valuable training of all takes place right on the fire line, but we haven't been able to find the time to do it. From now on we are going to take time.

With each succeeding year becoming more dry and the forest cover more inflammable as a result of insect attacks, disease, and a natural accumulation of forest debris it is imperative that we use every resource at hand to combat the fire menace. Every method and piece of equipment developed and proved should be used, and it is essential that the organization keep alive to the development of new methods and equipment and train men to use them. At the present time there is greater need to look forward to the future rather than to the past than at any time in our history. And this holds true particularly of our fire-control job.

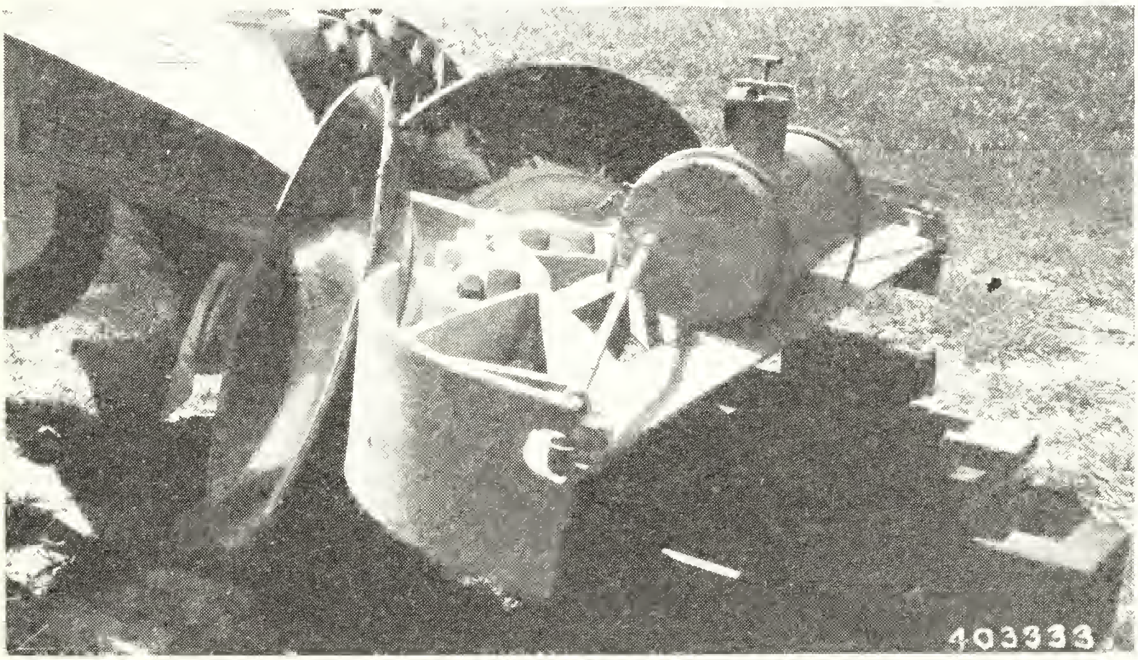
FLORIDA'S ONE-MAN FIRE "CREW"

DONALD J. MORRISS

District Ranger, Osceola National Forest

Mechanical equipment to control fires is a subject which intrigues most men responsible for fire control. The suppression plow is no exception. Here the addition of a backfire attachment has entirely changed the ideas of satisfactory fire-line production in certain flat country of the Florida national forests. Records of actual use will be awaited with interest.

As his special contribution to the Southern States' fire-control meeting recently held at Camp O'Leno, near Lake City, Leon Mathis, proprietor of the Mathis Welding Co., Lake City, Fla., added a backfiring attachment to his suppression plow. One of these attachments has been purchased for use on the tractor plow outfit on the Osceola National Forest.



Mathis plow with back-firing attachment.

The equipment described consists of a small high-compression tank and pressure gage mounted on the rear cross member of the plow, with metal lines to each side. In operation the tank is partially filled with gasoline, then air is added to 100 pounds pressure through a built-in valve. The air-gasoline mixture may be released through a small orificeon either side of the plow, and when igniated produces a flame from 3 to 6 feet in length (depending on need and controlled by a valve on each line). A small cup stuffed with lamp wicking immediately beneath the orifice relights the gasoline flame if it blows out.

On several trials one man drove the outfit, and by himself controlled a small fire. In ordinary use, of course, additional men would be necessary to hold the backfired line.

The entire outfit operates as follows:

A rolling coulter cuts the sod and small roots. Behind the coulter a middle buster opens a furrow which is widened by a disk on each side and immediately behind it. Following the disks a flange on each side prevents the sod from falling back into the line. Through holes in these flanges the flame from the backfiring attachment shoots out into the grass. The result is a clean line about 2 inches deep by 4 feet wide, automatically backfired.

Front view of Mathis plow with attachment.

The plow (which is mounted on rubber tires) is trailed behind the truck carrying the tractor. It is planned to keep this outfit in the woods with a small road crew during the coming winter, and to dispatch it by radio to each fire.

The type of small suppression plow to which the backfiring equipment is attached has been used experimentally by the Florida national forests for the past 2 years. It has proved to be our most valuable piece of fire equipment and has now been made standard equipment on this group of forests.

FIRE HAZARD REDUCTION, AN INSTRUMENT FOR DESIRABLE FOREST PROTECTION AND MANAGEMENT

Neal D. Nelson

Coeur d'Alene National Forest

Estimating the possibilities of fire in a particular area and then balancing the cost of desirable hazard reduction or other protection costs against the damage if a fire should occur is one of the difficult problems facing a manager of forest lands. In this article a forest manager discusses some of the factors which led to the decision to remove the hazard of a 1929 burn—an unlighted torch in the midst of a large area of valuable white pine virgin timber. Procedure in the reduction of the hazard by burning and the costs for the operation are given.

On a late August day in 1929 a passing lightning storm left in its wake a number of fires, three of which quickly spread to class C size. One of these fires on the Flat Creek drainage of the Coeur d'Alene Forest burned timber of the 200-plus age class. The composition of the mature stems of the stand by volume was as follows:

	M. ft. b. m.
Western white pine	1,495
Western larch	114
Douglas fir	80
Grand (white) fir	236
Western hemlock	322
Western redcedar	11
Lodgepole pine	3

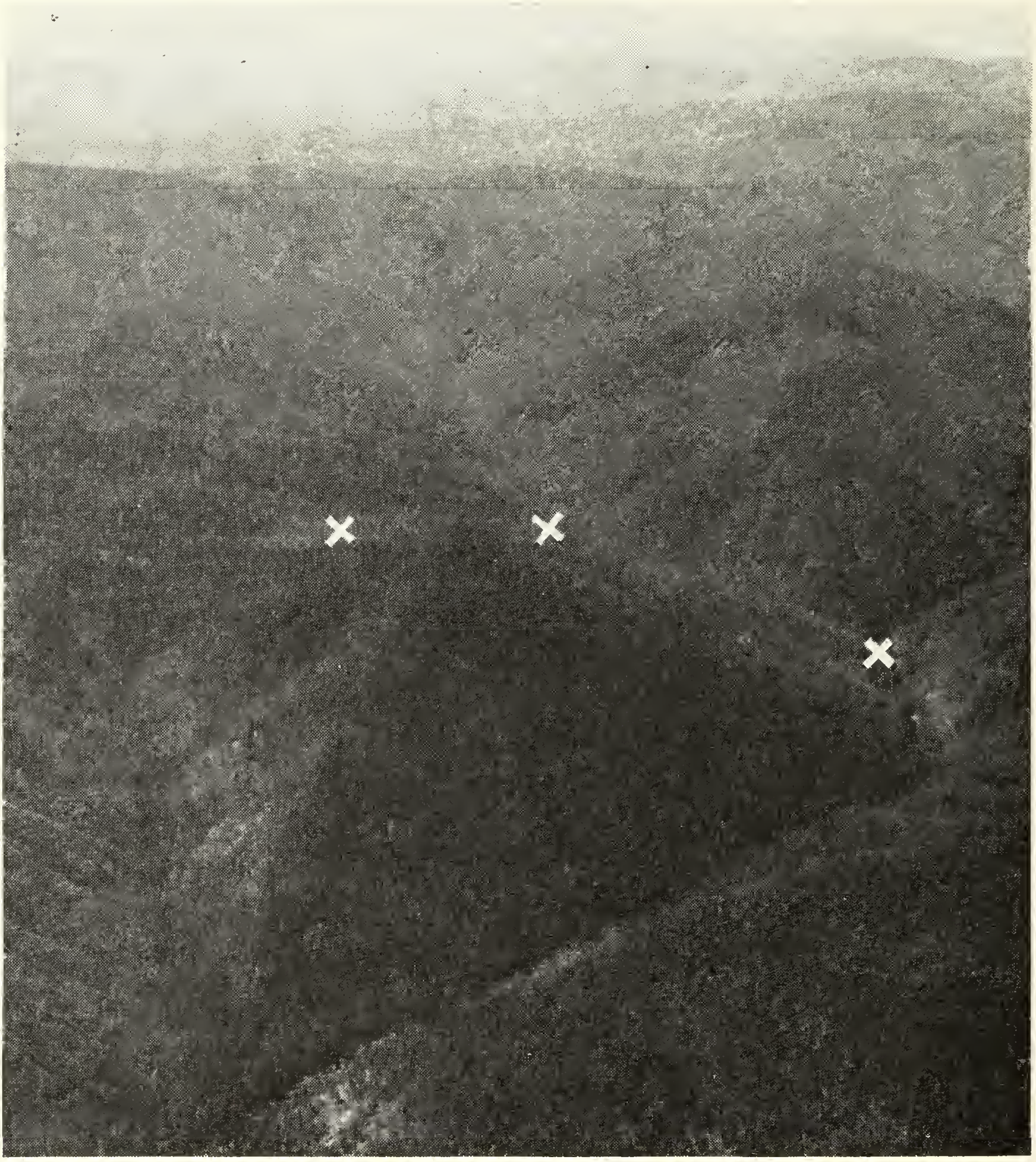
The general exposure of the area is north to northwest. The elevation ranges from 2,900 to 4,100 feet, with slope varying from 10 to 90 percent. The soil is composed of shaly loam with protrusions of igneous rock.

Unburned in the Flat Creek drainage there is now approximately 32,000 M ft. b. m. of merchantable western white pine. Within a circle of a 5-mile radius centering on this burn is an additional 120,000 M ft. b. m. of white pine exclusive of that lying in the Flat Creek drainage. There is a still greater volume of other species.

The merchantable white pine is being held in reserve in order that sustained yield may be practiced. Under the forest management plan the first sale is scheduled for 1949. Unless something occurs to upset the management plan some merchantable white pine will remain uncut 20 years hence.

The location of the burn, which was composed of "High high" fuel type, was such as to cause constant concern throughout the fire season. (In the fuel-type classification used by the Forest Service "High high" means high rate of spread and high resistance to control. The area surrounding the burn is generally that classed as "Medium medium" and "Low medium.") With lightning occurrence high in the general area during the past decade the burn stood as a constant threat to areas of valuable merchantable timber about it. Including all white pine timber within a 5-mile radius, it is estimated that there are values of at least $600,000, exclusive of other species, stumpage based on $4 per thousand. It was, therefore, considered worth while to reduce the hazard on the 291 acres burned.

Plans were made for accomplishing the hazard-reduction work. A nearby CCC camp dropped the snags on the area during the winters of 1937–38 and 1938–39. A fire line was constructed to a width of 20 to 50 feet, depending upon the degree of slope and adjacent fuels. All



A-59, COURTESY OF 116TH PHOTO SECTION, WASHINGTON NATIONAL GUARD

Looking west up Flat Creek drainage.

preparations prior to burning were completed by early September 1939.

While the preparatory work was being performed the burning job was being carefully planned. The burning of the area took place during the latter part of September 1939. As a result of the study made it was deemed advisable to burn the area in two separate pieces, the smaller area consisting of a small draw at the upper limits and running at right angles with the main body of the area to be burned.

Personnel participating in the burning was on the ground at noon of the day the burning was to take place. Plans were discussed fully with all supervisory personnel so that each man understood his duties and responsibilities. The men had an opportunity to rest so that when the burning started in late afternoon they were sufficiently rested to be able to cope with developments.

Fires were first started at the top, and burning progressed downhill until approximately one-third of the area had been set afire. The setting of the lower edges was withheld until the upper portions had been burned sufficiently to act as a buffer for the fire running uphill. The ranger in charge, in order to have command of the situation, installed three telephones at strategic points on the fire.

The resulting burn consumed all the fine fuel, burned a portion of the stems, but left the boles of some of the larger trees. Aside from the few unburned stems and stumps, all material was consumed to mineral soil. As in former controlled burns the heat generated by the burning of the lower two-thirds of the area was so intense that only through constant vigilance and the use of pumps was it possible to keep opposite hillsides, composed of mature green timber, from catching fire. Especially was this true in terrain of steep, narrow canyons.

From a forest-protection and timber-management standpoint reduction of such hazards are worth while undertakings. Not only was the danger from fire decreased, but control of white pine blister rust was facilitated. By the elimination of the fire hazard, ribes bushes, as well as stored ribes seed in the duff, were destroyed. Very few are expected to establish themselves on the area. A very expensive and almost impossible control job has been converted into a minor problem.

The area was left in an ideal condition for reforestation. The majority of the area was planted to western white pine during May 1940, the remaining 35 acres being planted in September 1940. Results obtained from the spring planting by examination in October showed 83 percent survival on the area, or an average of 684 white pine seedlings per acre as contrasted with a poor stocking of larch, white fir, and hemlock previous to the treatment.

The costs of the work in man-days was as follows:

4,510 CCC enrollee man-days felling and slashing.
878 CCC enrollee man-days construction firebreak.
250 CCC enrollee man-days burning.
260 CCC foreman man-days felling and slashing.
54 CCC foreman man-days construction firebreak.
30 CCC foreman man-days burning.
30 temporary guard man-days burning.

For the complete job 18.7 CCC enrollee man-days per acre were used, 1.2 CCC foreman man-days, and 0.1 temporary guard man-days.

The cost for the 291 acres was high. The removal of the high hazard, however, affords greater opportunity to practice good forest management. The threat of having to sell several million feet of timber because of fire kill has been reduced to a minimum. It is now possible to proceed with the forest management plan with assurance that it can be followed through without being disrupted by fire. Disease control has been facilitated and the area has been reforested to the most desirable species of tree in the locality. The cost of the job, when compared with the full benefits derived, is of minor consideration as the results have contributed much to the sustenance of a valuable forest resource, to a stable industry, and the economy of neighboring communities.

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MAN-HOURS OF WORK REQUIRED TO CONSTRUCT VARYING LENGTHS OF LINE UNDER DIFFERENT RESISTANCE-TO-CONTROL CLASSES

E. Arnold Hanson

Fire Control, Region 4

Computations and estimates of probable size of fire and the number of man-hours needed to catch up with and control a fire which has gotten out of hand are fraught with "ifs." The original decisions of a fire boss as to manpower needed to suppress a particular fire before a certain time has elapsed involve estimates of rate and direction of spread to be correlated with estimates of rate of line construction by the men available within the same period of time. The author presents a method of checking the results of such estimates by working backwards from the probable acreage the fire will attain. Though there may be question as to the adequacy of the sample upon which tables 2 and 3 are based, the approach seems to have distinct value. Further study will no doubt add to our knowledge in this field.

Believing that appropriate tables or reliable rule-of-thumb methods for estimating the number of man-hours of labor required to construct varying lengths of control line would serve a useful and advantageous purpose, the author made a statistical study designed to determine for conditions in region 4:

1. Relationship between total acreage of individual fires and total chains of control line built on these fires.
2. Rates of line construction in chains per man-hour under different resistance-to-control classes.
3. Man-hours of labor necessary to construct varying lengths of control line under different resistance-to-control classes.

The tables and rules of thumb developed were included in the 1940 amendments to the R–4 Fire Control Handbook and were discussed at the overhead training camps held in May 1940. The general opinion was that most firemen think first in terms of acreage, subsequently in terms of perimeter; and that the data would be helpful as a guide to the estimates of the dispatcher, but more especially to those of the fire boss, where airplane reconnaissance in the early stages of a blow-up fire furnishes the basis not only for accurately estimating acreage at the end of the first burning period, but also the character of the fire, i. e., whether clean, compact exterior, spotted condition, etc.

During the 1940 fire season a few field men applied the figures developed with satisfactory results.

The study is based on data accumulated prior to the advent, in region 4, of the modified one-lick method (also referred to as 1-minute method and step-up method). Consequently, whenever this method of line construction is used, the tables will give too high an estimate of the number of man-hours necessary to control a fire. It is planned to revise the estimates downward as soon as sufficient data on rates of line construction with the modified one-lick method become available.

Relationship Between Acreage and Control Line

Table 1 shows the average number of chains of control line built on fires of different sizes. The basic data were taken from the coded individual fire reports and cover B and C and larger fires which occurred during the period 1934 to 1938, inclusive, on the 7 Idaho fire forests—the Boise, Idaho, Payette, Weiser, Challis, Salmon, and Sawtooth. A total of 140 fires was used in the correlation study which resulted in the curve shown in chart 1. The equation for this curve is:

$$\text{Log } Yc = 0.574 \text{ Log } X + 1.003,$$

wherein Yc represents chains of line, and X final acreage of fire. The correlation coefficient was 0.894, very highly significant, and the standard error of estimate was 0.24554, which is in terms of *logarithms*. Of all observations, 16 percent will fall above the upper broken line and 16 percent below the lower broken line.

Table 1 was constructed by using the equation stated. The direct results appear in the table under the heading "Average" and are printed in italic. The figures in the "Maximum" and "Minimum" columns were obtained by calculating "Yc" for "plus one standard error" and "minus one standard error," respectively.

Rates of Line Construction

Table 2 shows the average rates of line construction in chains per man-hour, under each of five classes of resistance to control. These figures were obtained by an analysis of the rates of line construction on 28 class C and larger fires which occurred on the same 7 Idaho forests during 1939. These were the only reliable data immediately available for study.

The rate of line construction, in chains per man-hour, was taken directly from the Form 929 reports. These figures were then arranged in increasing order, from 0.06 to 4.50 chains per man-hour. A 100-point uniform scale was laid off as the X-axis on a sheet of cross-section paper and the rates plotted on the Y-axis. Since there were 28 observations, each one represented about 3.6 points on the 100-point scale.

Observation of the plotted points indicated a straight-line relationship to about point 65, and a curvilinear relationship from that point to 100. Accordingly, two equations were calculated and the curves plotted as shown in chart 2.

The equation for the data from 0 to 60 is:

$$Yc = 0.002{,}906 \text{ X} + 0.055{,}439.$$

The correlation coefficient is 0.978, very highly significant, and the standard error of estimate is 0.0128. For the data from 60 to 100, the equation is:

$$10 \text{ (Log } Yc) = 1.798{,}533 + 0.034{,}157 \text{ X}.$$

The correlation index is 0.859, also very highly significant. The standard error of estimate is 0.227, which is in terms of *10 times the logarithm* of *Yc*, due to coding.

The resistance-to-control classes were set up arbitrarily by dividing the 100-point scale into five equal parts. This is where an important assumption enters the study.

In setting up these resistance-to-control classes it was necessary to assume arbitrarily that the average rate of spread for each class is a reliable index of resistance to control. When topography, fuel type, fatigue, etc. are considered together as constituting resistance-to-control, this assumption does not appear unreasonable.

Man-Hours of Labor Necessary

Table 3, showing the number of man-hours necessary to construct varying lengths of control line, was constructed from table 2 by mathematical methods. For example, table 2 shows the average rate of line construction in the medium resistance-to-control class as 0.20 chains per man-hour. To build 100 chains of line then, the number of man-hours required would be 100 divided by 0.20, or 500 man-hours. The figure shown in table 3 is 498 man-hours because 100 was divided by 0.2007 instead of the rounded 0.20. The balance of the table was built in the same manner.

Use of the Tables

As an example of how to use the tables, assume that a fire boss has arrived on a fire with 10 men. After carefully observing the physical factors, such as topography, fuels, weather, time of day, etc., he makes an estimate of what the probable acreage of the fire will be by the time he can build the line necessary to control it. Perhaps he estimates 200 acres. Needless to say, this step is most important and requires sound and experienced judgment.

Then, by referring to table 1, he obtains an estimate of the number of chains of control line he will have to build, in this case 211 chains, or say 200. He can obtain this figure either from the table directly or from the rule-of-thumb which was developed by inspection of the tabular values.

Next, by roughly classifying the line job as to the class of resistance to control, considering all pertinent physical factors, he enters table 2 and obtains an estimate of the rate of line construction reasonably to be expected. Assume he estimates the class to be medium; table 2 shows that he can expect about 0.20 chains per man-hour. This particular item is not necessary to enter table 3, but is for his own information.

Now he is at the point where he has estimated the probable acreage to be 200 with 200 chains of line to be built under medium resistance-to-control conditions. He then enters table 3 and opposite 200 chains, under "Medium," he finds 997 man-hours as the estimate of the size of the job. For convenience, call it 1,000 man-hours. If it is intended to work men on a 10-hour shift, 100 men will be needed to bring the fire under control in 10 hours. He has 10 men, so he orders 90 more.

Or, say they are to be worked a 12-hour shift. By simply dividing the number of man hours (1,000) by the length of the shift (12 hours) he can obtain a close estimate of the number of men he will need, in this case 83.

Table 3 gives man-hours rather than number of men in order to provide this flexibility.

Discussion

In connection with the practical applicability of these tables, there are several points which should be borne in mind. One of the most important is that table 1 shows the number of chains of control line which have been built on fires of different sizes. The table is based on 140 actual cases and should be reliable. However, in order to obtain an estimate of the job size the fire boss must estimate what the acreage of the fire will be by the time he thinks it can be controlled. This is a weak point, but is exactly what fire bosses have always had to do. From this point the tables give a fairly accurate estimate of the number of man-hours necessary to control the fire.

Another point to bear in mind is that tables 2 and 3 are based on only 28 cases, the class C and larger fires of 1939. This is a small sample. However, the known range of rates of line construction is present. Therefore, it is legitimate to assume that the sample is adequate and representative.

The division of the 100-point scale into five equal parts as resistance-to-control classes is open to criticism. The main argument in favor of a nonuniform scale is that the proportions should correspond closely to actual conditions. For example, of the 28 cases used, 5 fall in the "Extreme" resistance-to-control class, and either 5 or 6 in each of the other classes. We know, however, that most of the observations should fall in the "Medium" class.

The reason for using the uniform scale is that reliable data were not immediately available for properly delineating nonuniform classes. Actually it can be seen from chart 2 that if nonuniform classes were used, the average rates of line construction, table 2, would be smaller than those tabulated. This would have the effect of increasing the number of man-hours in table 3.

Consequently, it is apparent that use of a uniform scale results in more conservative estimates than would otherwise have been the case.

TABLE 1.—*Acreage of fire and control line necessary*

Acreage of fire (acres)	Control line necessary to build (chains)			
	Minimum	Average	Maximum	
0	21	*38*	66	RULE OF THUMB
0	32	*56*	99	
0	54	*95*	167	1. Class B fires—4 chains perimeter per acre.
00	80	*142*	249	2. Class C fires—2 chains perimeter per acre.
00	120	*211*	371	3. Class D fires—1 chain perimeter per acre.
00	151	*266*	468	4. Class E fires—½–1 chain perimeter per acre.
00	178	*314*	552	
00	203	*357*	628	
00	225	*396*	697	
00	246	*433*	761	
00	265	*467*	822	
00	284	*500*	879	
,000	302	*531*	934	

NOTE.—This table can be extended without serious error.

TABLE 2.—*Average rates of line construction*

	Resistance to control								
	Extreme	High	Medium	Low			Very low		
				Minimum	Average	Maximum	Minimum	Average	Maximum
Chains per man hour	0. 08	0. 14	0. 20	0. 23	0. 39	0. 66	1. 22	1. 89	3. 18

TABLE 3.—*Man-hours of work needed to construct varying lengths of line*

Control line necessary (chains)	Resistance to control									
	Extreme	High	Medium	Low			Very low			
				Maximum	Average	Minimum	Maximum	Average	Minimum	
25	296	175	*125*	108	64	38	21	13	8	Rule of thumb: 33 men per mile of line per 12-hour shift for average resistance to control.
50	592	351	*249*	216	128	76	41	26	16	
100	1, 183	701	*498*	431	256	152	83	53	31	
200	2, 367	1, 403	*997*	862	513	303	165	106	63	
300	3, 550	2, 104	*1, 495*	1, 293	769	455	247	159	94	
400	4, 734	2, 805	*1, 993*	1, 724	1, 026	606	329	212	126	
500	5, 917	3, 506	*2, 491*	2, 155	1, 282	758	412	265	157	
600	7, 101	4, 208	*2, 990*	2, 586	1, 538	909	494	317	189	
700	8, 284	4, 909	*3, 488*	3, 617	1, 795	1, 061	576	370	220	
800	9, 467	5, 610	*3, 986*	3, 448	2, 051	1, 212	658	423	251	
900	10, 651	6, 311	*4, 484*	3, 879	2, 308	1, 364	741	476	283	
1,000	11, 834	7, 013	*4, 983*	4, 310	2, 564	1, 515	823	529	314	

NOTE.—This table can be extended without serious error.

Additional Airplane Accident Data.—In Mr. Headley's article, "Wings and Parachutes Over the National Forest" in the October 1940 Fire Control Notes, a request was made for corrections or additions.

The following have been received from region 5:

"July 10, 1920. Sergeant Wayman Haynie and Corporal Salicido were killed in an airplane crash in the vicinity of Alturas, Calif. Forest Service Observer Harold Robie also lost his life in this crash. [This is probably the 1921 accident mentioned by Headley.—Ed.]

"September 7, 1921, Sergeant T. J. Whissel and Cadet Robert Koelp, both of the Army, met death in the crash of a DH–4 Army type airplane while taking off the Montague Airport east of Yreka, Calif."

Forest Supervisor Myrick of the St. Joe National Forest submitted a corrected account of the accident Headley referred to as that of Howard Flint and Pilot Nick Mamer. The pilot was Jack Rose who was employed by Nick Mamer who had the Forest Service contract for 1928. The story of this accident is reported in Crocker's article in this issue of the Notes.

GUIDES TO THE JUDGMENT IN ESTIMATING THE SIZE OF A FIRE-SUPPRESSION JOB

A. A. Brown

Fire Control—Region 2

Basic to determinations of the manpower needed to control a fire is an estimate of perimeter of line which must be worked. The author develops a rule of thumb for determining perimeter from the length of the fire. The problem of estimating areas from the length of fires is approached from a different angle than the area determinations in Mr. Hanson's article in this same issue. The articles overlap only slightly. The two studied together may lead to further developments.

Fires vary so much in conditions, cover, and behavior that the generalizations which may be drawn for *all* fires can be summed up on the fingers of one hand. The more experienced the fire fighter, the more he avoids committing himself or his plan of control to any fixed or precise rules of fire behavior. Nevertheless, every valid generalization that can be made and every rule that does not have too many exceptions to be useful contribute to making a science of forest-fire control.

In the course of a preliminary study of the patterns of burns in southern California chaparral, conducted by the writer in 1935, it became apparent that within limits such fires tend to follow certain rules in their relative dimensions and shapes and, consequently, in their areas and perimeters. Such relations, particularly that of the long axis of a fire to its area and perimeter, were further tested in 1938 and 1939 using burned areas in the Central Rocky Mountain Region in lodgepole pine, ponderosa pine, and other characteristic types. The tests were based on all of the larger fires for which dependable maps existed. The resulting relationships were summarized by a rule of thumb and by a graph, which were included in the appendix of the Region 2 Fire Control Handbook in 1939. These have proved so useful as guides in preliminary estimates of acreage and perimeter of going fires that they are repeated here for possible reference value to other regions.

Estimating Perimeter From Area

The usual starting point is that of estimating area, then of converting to probable perimeter. Mr. L. G. Hornby developed a relationship for determining perimeter for region 1 fires which is being widely applied in other regions. According to this relationship, the perimeter of a fire is likely to be one and one-half times the perimeter of a circle of equivalent area. This gives a very conservative estimate in terms on fire line to be built if the fire is long and narrow or very irregular. However, the relationship of perimeters of burns to

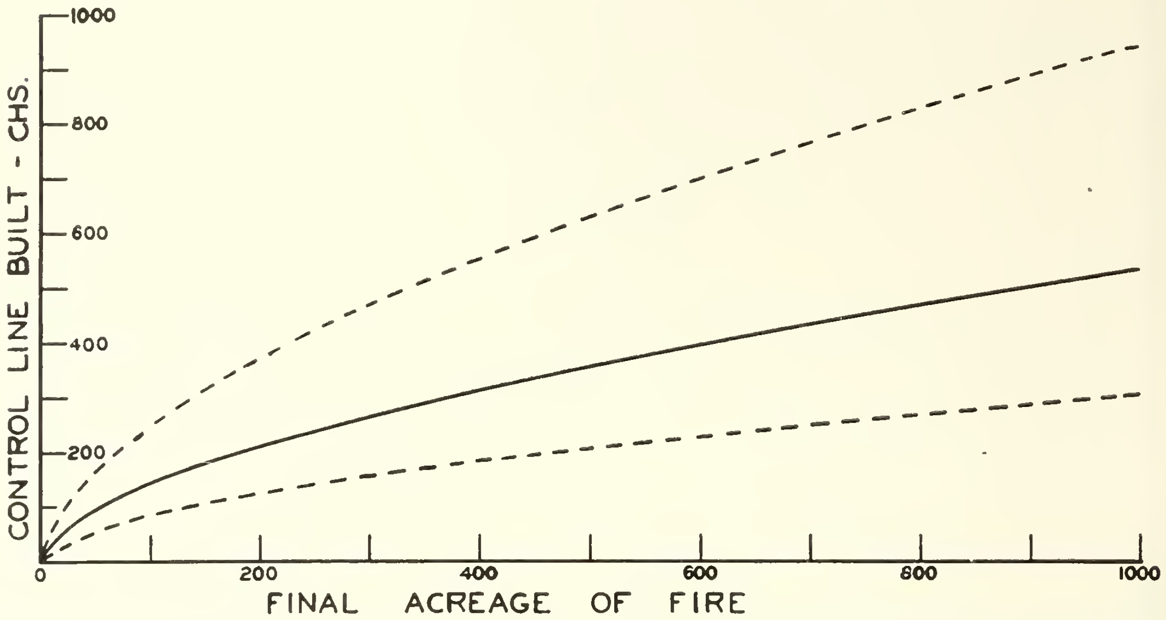

CHART 1.—Relationship between chains of control line actually built and final acreage of fire.

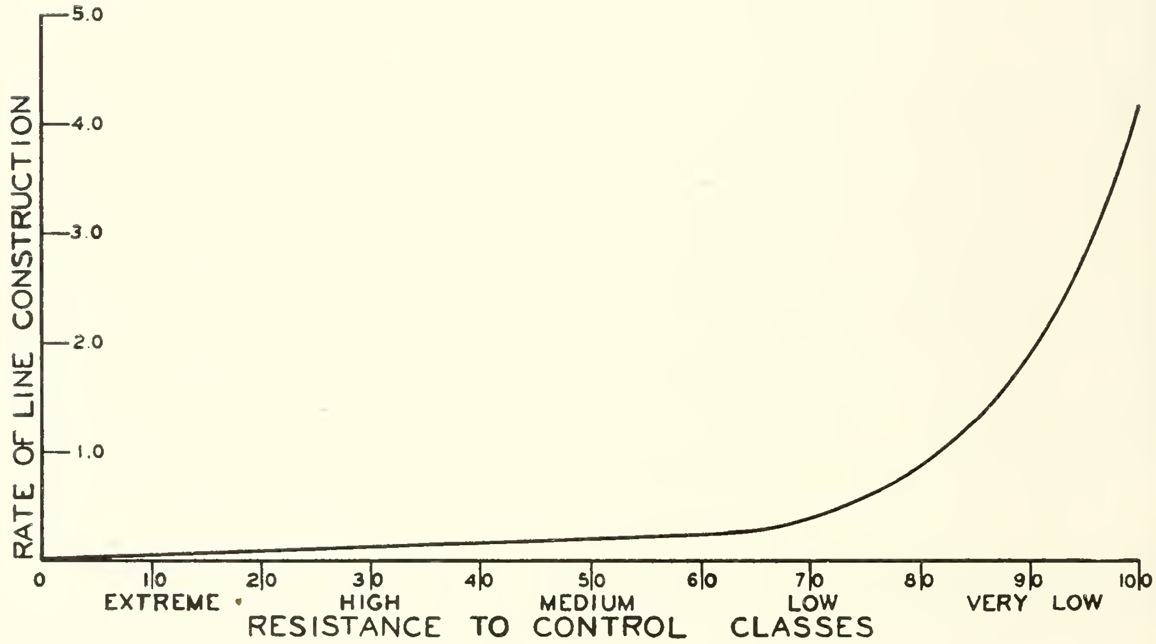

CHART 2.—Rates of line construction by classes of resistance to control.

the perimeter of a circle of equal area is a very useful one and can be applied whenever a good estimate of the area is available. For application in region 2, the relationship was found to be more nearly one and two-thirds the perimeter of a circle of equal area for fires under 20 acres in area, with a tendency of small, slow-burning fires to exceed even this ratio, but with a wide scatter of ratios.

A useful rule of thumb that can be applied as a check when the starting point of calculations is "estimated area" is that of converting the area mentally to a rectangle and adding up the sides. For example, an area of 3 acres can be visualized as a rectangle 5 chains by 6 chains in dimensions. If the sides are added up, the result is 22 chains, which is a fair approximation of the probable perimeter to be worked. One and one-half times the perimeter of a circle of this area gives 29.10 chains and one and two-thirds gives 32.3 chains. The dimensions assumed influence the result. If a rectangle 15 chains by 2 chains were assumed, the result would be 34 chains. Dimensions approaching those of the length and width of the actual fire will give the closest approximation.

The weakness of calculating the perimeter of a fire from its estimated area lies in the notorious inaccuracy of first estimates of the area. This is particularly true of large or fast-spreading fires which cannot be seen as a whole from some vantage point.

Estimating Perimeter From Length of Fire

Usually, the first information available is that of where the fire started and of how far the head of the fire has reached. If this is known, the total length of the fire can quickly be checked on any map and the long axis of the fire used instead of area in approximating the perimeter. A study of the burned-area maps of 65 fires from the regional record showed a very close correspondence between actual perimeter and the product of this long axis times $3\frac{1}{7}$ or π. In other words, the perimeter is likely to be equivalent to that of a circle having a diameter equal to the longest dimension of the fire, and fire producing a burned area 14 chains long in its direction of spread would have a perimeter of 44 chains. This appears to give the closest estimate of all for conditions in region 2 and has the further advantage of being well adapted to estimating the perimeter added by further spread. For example, if a fire has started to crown up a slope and cannot be checked until it reaches the top of the ridge which is 20 chains ahead, it is easy to extend the expected length by this amount in calculating the length of fire line that will be required. If the fire has assumed two heads which will be controlled separately, the axes of both should be added in calculating the perimeter. The perimeter of spot fires needs also to be added.

Estimating Area From Length

There is a fairly consistent relationship between the total length of a fire and its area, though there is potentially a greater margin of error in estimating area of small fires from length only than in estimating their perimeter from length. The accompanying graph shows this relationship for 65 class C fires from the region 2 record. The curve can be used as a guide to preliminary estimates of area for telegraphic reports as soon as the distance the fire has traveled is known. For example: If the fire is 50 chains long, an area of 70 acres is indicated. The curve will overestimate the area of very long narrow burns and underestimate the area of fires where the width and length are nearly equal. If a fire has two prongs, the best estimate will result from treating it as two fires. These estimates are all in terms of horizontal or map distance and need to be adjusted upward to cover the slope distances involved in chains of line. In country with an average of 30 percent slope this amounts to approximately 5 percent.

The McVey fire of 1939 in the Black Hills extended a distance of 11.3 miles, or 904 chains, and had a final area of 22,184 acres. By extending the attached curve or by dividing each of these values by 10, it is seen that it gives an area estimate corresponding to a long dimension of the burn of 904 chains, or over 21,000 acres, which is very close to the actual area. The total perimeter, which amounted to approximately 46 miles, would require a long axis of approximately 14.7 miles. This also is approximated if the two changes of direction of the fire are taken account of by breaking the axis into a three-direction line and the resulting perimeter is adjusted to average slope distances over which fire line will be constructed and measured on the ground.

Adjustments of Indicated Perimeter

On most large fires various barriers will be present which reduce the amount of fire line required. No estimate can be considered complete which does not take full account of reductions in the size of the job that will result from this source. At times, the job may be reduced 50 percent or more because of bare rock, green grass, or water surfaces which adjoin parts of the perimeter.

Harder Shoes for the Hard Tails.—The granite slopes of the central Idaho area are exceedingly rough on horse and mule shoes. Our back country packers and rangers say a set of ordinary blacksmith or pressed shoes lasts only an average of 6 weeks. On forests having several pack strings the cost of keeping the animals shod represents a considerable outlay.

One of the Challis guards conceived the idea of facing the shoe heel and toe calks with stellite (hard surfacing material used on bulldozer cutting edges, ripper teeth, etc.) for longer wear. He reports using the same shoes for an entire season, resetting them as often as necessitated by the hoof growth.

The same idea was tried out on our service strings this past season and found highly effective, cutting our costs for shoes by at least 50 percent. The cost of facing the calks is low, only about 8 inches of ¼-inch rod being used per shoe.

The stellite can be applied either with an acetylene torch or arc welder in a few minutes per set of four. The technique is simple: place the shoes on a flat surface with the calks up and apply about ¼ inch of metal evenly over the wearing surface of the heel calks and run a bead of the same thickness on the toe calk.

Shoes thus treated will last at least twice as long as ordinary untreated ones. Our experience indicated, however, that the heating of the shoe in applying the stellite tends to loosen the toe calks of blacksmith shoes and that they are apt to come off unless the precaution is taken to spot weld the toe calk to the shoe at the time the stellite is applied. Spotting them in a few places with ordinary welding rod will overcome this.—M. G. Markle, *fire assistant, Challis National Forest.*

TRAINING AND PLACING COOPERATORS ON LIGHTNING FIRES

Willis W. Ward

District Ranger, Malheur National Forest

A definite plan is offered for combining "training" and "doing" in developing a corps of cooperators trained in fire-suppression techniques. The plan is simple, and its efficiency rests to a great extent upon the ability of the district ranger to train his regular forest guards and his willingness to delegate the bulk of the training job to the guards. This plan for mobilizing and using cooperators in this manner on lightning fires on a ranger district has a direct relationship to the national-forest problem as presented in the previous article in this same issue. The organization and training of cooperators available to meet any fire emergency is a problem to tax the ingenuity of all personnel involved.

Various systems are employed throughout the regions to combat numbers of lightning fires that start in a single storm. The systems vary according to available manpower, accessibility of country, methods of travel, and many other influencing factors. However, with the roads, trails, airplanes, radios, and what-nots men and supplies can now be placed almost anywhere.

Coupled with the need for fast, energetic, and effective action on groups of fires is the problem of training cooperators and short-term men. To accomplish this the following plan of training "on the job" is used on the Malheur:

When a report is received that a lightning storm is approaching, the dispatcher calls for previously contracted cooperator crews and transportation. The number, location, and size of standby crews used depend upon the direction and intensity of the storm. The men are dispatched with food, tools, and bedding and placed on communication, either radio or telephone, and preferably immediately in the storm path. The men are then divided into crews of from two to four men. Each crew has its own food for 2 days, tools, etc.

The dispatcher designates one man in each crew to be in charge. The crew leader (for the purpose of training) is usually a guard or a cooperator who has had fire-chasing and fire-fighting experience. In the event the leader is a guard, his regular position is immediately filled by a man who has had training for the emergency. Each district has from one to three such men.

The ranger and usually one experienced guard are available to go from one station or fire to another and give the training necessary in look-out work, fire chasing, and fire fighting. Where all of the crew is inexperienced, he can make the final inspection to make sure the fire is out without additional time and expense. The ranger also can train his dispatcher and can give assistance when needed. Of course, the ranger keeps in touch with the general situation on his district by frequent contact via short-wave radio or otherwise.

The dispatcher keeps a record of the chaser crews and as they become depleted he immediately sends in fresh crews and supplies.

The system described has proved very effective from all angles. Through this plan cooperators have been given training, and a few small fires have been prevented from becoming large. It is true that there is plenty of hiking for the ranger and whoever helps in the same capacity, but this physical strain is nothing compared to the mental strain caused by a board of review on an extra-period fire.

ENLARGED PHOTOGRAPHS IN FIRE TRAINING

J. K. Blair

Wenatchee National Forest

The training of overhead and dispatchers for fire-suppression duties confronts most forest-land managers. Among the visual aids used in training are motion pictures, slides—especially if colored, sketches, relief maps, and enlarged photographs. The practical suggestions which are given concerning the use of enlarged photographs will point toward possible variations which will afford training to other types of personnel such as radio communication men. A series of such photographs taken during the progress of a fire offers much to a supervisor in meeting his training problem. If progressive pictures are not available, progress might be indicated by marking several prints of one picture.

Setting up for the trainee situations comparable to an actual large fire or a number of lightning fires is a problem that confronts forest officers conducting fire-suppression training for fire overhead and dispatchers. The use of enlarged panoramic pictures offers one approach.

Photograph enlargements may be of any size desired by the training officer and may cover as large an area as needed for the problem to be presented. A 6- by 10-inch picture enlarged to 24 by 40 inches has been found a workable size for most problems.

In setting up a problem for overhead, the training officer prepares his photographs in advance. With white signmaker's ink he sketches the boundaries of the fire, shows the area in acres and the perimeter in miles or chains, indicates direction of spread, spot fires, roads, trails, camp sites, distances, fuel and timber types, and any other information necessary to give a complete picture of conditions. On a supplemental sheet he gives weather conditions, manpower and equipment available, time of day, and additional information not shown on the picture. Each trainee is required to work out from the information presented his plan of action to control the fire. After each trainee has worked out his solution, he presents it to the group. Following each presentation the group discusses the pros and cons of action taken, summarizing with the determination of the proper action. Numerous other individual problems may be set up, such as backfiring, line location patrol, mop-up, communication, service and supply, and calculation of probabilities.

The use of photographs in training dispatchers has many possibilities also. On the picture the training officer may show a number of fires starting from a lightning storm; these may vary in size from class A to C, or larger if desired. Here again the location of roads, trails, guard stations, cooperators, forest crews, and CCC camps is shown, and on a supplemental sheet all other factors pertaining to the particular problem are given. The procedure of each trainee working out his own solution and presenting it to the group is the same as for the overhead problems. If deemed advisable by the officer conducting the training, immediately following the working of the first problem he may present to the group another problem on a different set of pictures. Frequently this is done to impress upon the trainees the fact that another lightning storm may follow, and to show the necessity for being in a position to handle the fires from storm No. 2 along with No. 1.

Since all fire training cannot possibly be done on actual fires and during the time of peak lightning loads, the use of enlarged photographs is just one of many ways to make the training program represent, as nearly as possible, actual conditions.

Data on Plane, Truck, and Packstring Transportation.—Planes, trucks and packstock were used to transport supplies to the Deer Creek Fire on the Idaho National Forest in 1940. Some interesting data on these different methods of transportation follow:

The 200 men employed in suppressing this fire used 34,230 pounds of supplies; 10,150 pounds were dropped from planes with condemned army chutes, 160 pounds to the chute and 850 pounds per plane load.

Trucks and packstrings transported 24,080 pounds of supplies to this fire. Trucks hauled the supplies 117 miles, pick-ups 12 miles, and pack strings 10 miles.

The truck haul was accomplished in 6 hours with a full load.

The 12-mile pick-up haul was over very difficult roads. With 800 pounds per load a round trip was accomplished in 3 hours.

A round trip of 20 miles was made with a 10-mule packstring, each mule carrying 185 pounds.

Problems of transportation on this fire are representative of those encountered in the Idaho Wilderness area, and it is thought that the following costs apply to approximately 800,000 acres:

Plane transportation, per pound	$0.063
Truck and packstring, per pound	.069

—F. E. Powers, *Idaho National Forest.*

On this fire airplane transportation was used for 30 percent of the weight of the needed supplies. Although costs were about the same by each method, the difference in transportation time was great. More studies like this one are needed to advance the field of knowledge of conditions which make desirable the use of airplane transportation. What measures should be used for determining the best method of transportation for any particular type of articles, considering different conditions and the urgency of their arrival? How can airplane and other transportation facilities be used in harmony with each other on the same fire in order to best accomplish the transportation job?—Ed.

FOREST-FIRE DANGER WARNING POSTERS

National Park Service

Efforts in the field of fire prevention take many forms. Posters or signs showing the existing class of fire danger for the day constitute one visual aid. The poster illustrated and described was developed by the National Park Service, Region 1, Richmond, Va, to arouse an intelligent interest in fire prevention. The letter and illustration were submitted by Fred H. Arnold, Regional Forester of the National Park Service.

August 26, 1940.
Regional Office Letter No. 566.

National Park Superintendents,
National Monument Custodians,
RD Area Managers,
Inspectors,
Foresters

Forest-Fire Danger Warning Posters

The fall fire season is near at hand, and in making due preparations for it all elements of the fire-protection system in each area should be examined and put in first class working order. This applies with equal emphasis to training, organization, equipment, detection, communication, transportation, and fire prevention. With reference to the latter activity we believe you will be interested in the ingenious poster device made at Acadia National Park which is illustrated and described on the attached sheet. On the basis of the demonstrated effectiveness of this means of inducing cooperation in fire prevention at Acadia it is thought that boards similar in principle, if not in design, could be used to equally good advantage in other areas.

Workers in the park as well as visitors are fascinated by this board; it arouses their curiosity, and their native inquisitiveness about something new leads them to explore its meaning. These reactions have been observed where the board has been displayed at Acadia and the interest thus aroused has resulted in employees' and visitors' increased realization of the need for exercising greater care with fire in the woods.

The Acadia board is not intended to be regarded as an adopted standard design but the information concerning it is issued to acquaint others with the idea and how it has been put into practice in one area. If such device might be helpful in your area, you should feel free to use local talent and ingenuity in adapting or improving the principle of the Acadia board to make it more effective with respect to your particular fire-prevention problems.

Fred T. Johnston,
Acting Regional Director.

Forest-fire danger warning posters.

HIGHWAY FIRE-PREVENTION SIGNS

Earl Tenant

Fire Control, Region 1

The use and effectiveness of fire-prevention signs is being currently studied by the U. S. Forest Service. One approach toward increased fire consciousness used by region 1 is the adaptation of the principle of serial signs to the subject of fire prevention.

Late in the fall of 1937 a study made of man-caused fires occurring along the main highways in the northern Rocky Mountain region, brought out the need for a suitable prevention sign. All available signs were studied, but none seemed to be suitable. The need was for something that would tell an interesting story in a very few words and be readable from a car traveling 50 to 60 miles per hour.

Ranger Stanley Lukens was given the job of designing a suitable sign. After several experiments a set of signs was developed following the principle of the Burma-Shave advertising plan but using a combination of illustrations and word messages instead of words alone.

The signs are designed to hang on gibbets at 500- or 600-foot intervals. They can be put on either side of the road and are placed in sets of four. The story is told in sequence. No. 1 reads, "Careless Smokers Start Fires;" No. 2, "Don't Be a Flipper;" No. 3, "Use Your Ashtray;" and No. 4, "Thank You." The picture painted on each sign illustrates the words. The signs are painted on both sides and from either direction the story reads the same.

The boards are 3 by 4 feet of ⅜-inch plywood. They are treated with three coats of paint before letters and designs are painted. Only pure colors in oil are used. The outline of the letters and figures is placed on the boards by the use of burnt sienna powder dusted along the perforated lines of the original paper copy. They are then painted freehand. After the paint is dry the boards are given three spray coats of clean, waterproof lacquer.

The frame is made of stained peeled poles which are bolted together diagonally at the corners. A groove is rabbetted out in the frame for the sign. The edges of the plywood are treated with white lead before being placed in the grooves.

The cost of constructing the first signs was high, being approximately $21 per sign exclusive of the frame and post. The costs were excessive because of the hiring of a skilled artist and the slow process of hand painting. After the experimental stage, it was decided to turn the job over to the CCC sign shop. The boys turned out excellent work (not quite as good as the artist, but very satisfactory) at a cost of $2 to $3 per sign, not including the CCC labor.

The reaction of the public has been surprisingly good, and has encouraged the region to the extent that 10 sets of these signs have been placed on main highways. Favorable comments have come from

Highway fire-prevention signs.

advertising men, editors of papers, numerous tourists, etc. The Chamber of Commerce at Felton, Calif., has set up a project to place these signs along the highway through the San Lorenzo Valley. A perforated copy of the letters and designs was furnished to them by this region. It is understood that this work is being done through the cooperation of the State forest ranger.

"EVERYTHING ELSE OUT ON FIRE"

Region 1, U. S. Forest Service

Region 1 has always been proud of its parade entries, particularly the packstrings and mules transported by truck. The lone and almost worn-out truck presented in the parade at the opening of Western Montana State Fair on August 22, 1940, was therefore especially significant. The ingenious dramatization of the existing situation is reported to have caused as much or more favorable comment than the usual ambitious entries.

Everything else out on fire; this picture almost speaks for itself.

Mr. Axel Lindh, in relating the circumstances which led to this exhibit, gave the following facts:

During the preceding 5 days the region had nearly 300 lightning fires from an almost continuous lightning storm. On August 21 there were 32 class C or larger fires going, of which 11 were class E. In the south, a fire in Yellowstone National Park resulted in the loan of 42 forest officers for a couple of weeks and the shipment of equipment and supplies for about 1,500 men. Considerable equipment had also been sent to region 4. To the north, efforts were being made to stop an old fire from entering the Kootenai National Forest from Canada. One 800-acre fire was burning within 5 miles of Missoula. Within the region all Government pack mules were at work with some 25 rented packs also on the job.

A METHOD FOR APPRAISING FOREST-FIRE DAMAGE IN SOUTHERN APPALACHIAN MOUNTAIN TYPES[1]

GEORGE M. JEMISON, *Forester*,

and

JOHN J. KEETCH, *Junior Forester*,

Appalachian Forest Experiment Station, Asheville, N. C.

Introduction

More than one million dollars is paid every year for forest-fire protection in the southern Appalachian Mountains.[2] This expenditure is made by Federal, State, and private agencies as insurance against the inestimable damage to human life and property, timber, water, and other values if the 11,000 fires each year were not controlled and if unrestricted setting of fires were not prevented. There is no way to place a realistic dollar value on the damage that would occur if there were no attempts to control the start and spread of fire. The most profitable expenditure for protection cannot be definitely determined until damage reduction from increased expenditures can be evaluated.

If the damage caused by fires under the present degree of protection amounts to several million dollars a year, it may be better business to increase expenditures. Perhaps the amount of fire damage in a region could be reduced two million dollars by spending an additional half million dollars on protection. If additional funds are not available, from the standpoint of potential damage perhaps more money should be allotted to some sections, less to others. The questions arise, How much should be spent on this protection, and in which areas to best advantage? Present-day fire protectionists cannot know the answers to these questions until it is possible to make accurate damage appraisals.

Although some type of damage appraisal is almost universally practiced by fire-control agencies, the lack of uniformity in the methods used, the difference in the underlying concepts concerning the nature of damage, and the values involved in the different schemes have blocked every attempt to determine logically how fire funds might be used more effectively. One method now in use requires that damage be considered only when merchantable timber is killed; another claims that most of the damage is to young growth, and that losses in merchantable stands are negligible. Because there is a dif-

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[1] Assistance in the preparation of these materials was furnished by the personnel of the Works Project Administration, Official Project No. 765–32–3–3.

[2] Based on partial information from incomplete reports over a 5-year period from 1933–37, inclusive, U. S. Department of Agriculture, Forest Service, Washington, D. C.

ference of opinion, each fire-control agency uses a different method of appraisal and there is no standard of comparison.

There is, therefore, definite need for a damage-appraisal system based not on opinion, but on a study of the true nature of forest-fire damage. To determine what this system should be, studies of fire damage to the major forest types in the Appalachians have been made. A system of appraisal has been worked out as a result of these studies which provides a standardized method for evaluating damage from three sources: First, that from mortality; second, that caused by cull (decay) following butt wounding; and third, that associated with slower growth rates of wounded trees of some species. The system described here is confined to losses in tangible timber values of trees of commercial species, including merchantable trees, and those below merchantable size which can reasonably be expected to become a part of the future crop. Extremely important are damages to intangible forest assets, such as aesthetic, recreational, and watershed values, and loss in income of industries and workers dependent on forest products, but these losses are not included in the proposed system as no means have yet been established for their determination.

Basis of Fire-Damage Appraisal System

The data for this proposed system of damage appraisal were derived from 150 random quarter-acre plot tallies on 41 recent burns in the mountains of North Carolina, Virginia, West Virginia, Kentucky, and Tennessee, and from 4 large permanent sample plots in North Carolina and Georgia.

From the records taken on these plots, the total volume of trees of sawtimber size, dead and dying because of the fire, was assigned a value based on the stumpage prices in table 1. These prices were chosen as fairly reliable averages over a long period.

TABLE 1.—*Average stumpage values*

Species	Value per M board feet
Yellow poplar and black cherry	$9
Northern red, white, and post oaks; basswood; ash; sugar maple; and black locust	8
White pine and shortleaf pine	5
Black and chestnut oaks; red maple; and redgum	3
Pitch and Virginia pines; blackgum; beech; hickory; hemlock; buckeye; southern red and scarlet oaks	2

The damage resulting from the fire-killing of trees below sawtimber size was measured in terms of the loss suffered by the timber owner by having to wait for his return for a period longer than would have been necessary in the absence of fire. This delay to future returns is the difference between two discounted values, one determined from future yields [3] with no fire, and the other from future yields following fire under the assumption that killed trees are replaced by others of the same species. In computing the future value of dead and dying tree (from stumpage prices given in table 1), a

[3] Forecasts of the time to reach sawtimber size were based on growth curves for many species presented in the following reference: Barrett, L. I., Growth rate of northern white pine in the southern Appalachians. Jour. For. 31: 570–572, May 1933.

value was placed only on those trees that would obviously have a place in the final crop. Thus, many fire-killed trees that might have died because of future suppression were eliminated from the appraisal.

The present worth of future yields was determined by discounting future values at 3 percent interest, compounded annually.

The damage to trees with basal fire wounds, was the discounted value of the cull volume (caused by decay) present when the wounded trees become merchantable.[4]

Damage caused by the reduction in rate of diameter growth was based on the reduction in merchantable volume per acre of stands containing fire-wounded scarlet oak and the discounted value of the loss in volume. Scarlet oak was the only species studied which showed a reduction in gross volume increment of individual trees as a result of basal wounding. Therefore, losses from this source are influenced only by the average representation of wounded scarlet oak in the various types and condition classes.

The total damages resulting from these kinds of loss were segregated into classes representing several degrees of fire intensity, condition class, type, and degree of stocking. All of these factors were found to have an important bearing on total damage.

With this classification as a framework, table 2 was completed.

Application of the Damage-Appraisal Table

The table can be applied on the basis of the appraiser's best judgment or with careful surveys of the burned area, depending upon the time and money available for the appraisal. Obviously, the most accurate appraisal will result from actual field surveys. The facts about a fire essential to the use of table 2 consist of the items discussed separately in the following paragraphs:

The first step in appraising fire damage is to determine the *acreage burned*. This area should then be classified in four ways.

1. *Danger class.*—Taken from the danger station nearest the fire for the day and hour when the fire made its greatest run. If danger ratings are not available, the fire severity will have to be estimated according to whether it is of low, medium, high, or extreme severity, corresponding to classes 2 to 5 in table 2.

2. *Timber type.*—Hardwood, pine-hardwood, pine. In the hardwood type, hardwood species constitute at least 75 percent of the dominant and codominant stems of trees of commercial species; pine species in the pine type are in the same proportion. In the pine-hardwood type, coniferous species constitute from 26 to 74 percent of the dominant and codominant stems of trees of commercial species.

3. *Condition class.*—Sawlog or under-sawlog. A volume of at least 600 board feet per acre in trees of saw timber size must be present before the stand can be considered as sawlog condition class. The minimum saw timber size for pines was set at 9 inches d. b. h.; for yellow poplar, basswood, cherry, and ash, at 11 inches d. b. h.; and for all other species at 13 inches d. b. h. Any stands wherein the volume per acre of saw timber trees does not equal 600 board feet

[4] Hepting, George H., Division of Forest Pathology, Bureau of Plant Industry. The prediction of cull following fire in Appalachian oaks. Submitted to Jour. Agr. Res.

TABLE 2.—*Average damage per acre in dollars*

Fire danger severity	Class 2 (low)		Class 3 (medium)		Class 4 (high)		Class 5 (extreme)	
Condition class	Sawlog	Under-sawlog	Sawlog	Under-sawlog	Sawlog	Under-sawlog	Sawlog	Under-sawlog
HARDWOOD TYPES								
Stocking:								
Good	0.30	0.55	0.84	1.40	2.20	3.38	5.02	7.27
Medium	.34	.45	.92	1.16	2.36	2.81	5.27	6.06
Poor	.40	.41	1.01	1.05	2.49	2.54	5.46	5.51
PINE-HARDWOOD TYPES								
Stocking:								
Good	0.37	0.61	0.99	1.49	2.44	3.34	5.24	6.78
Medium	.42	.54	1.10	1.34	2.62	3.01	5.53	6.13
Poor	.49	.50	1.21	1.25	2.79	2.85	5.76	5.82
PINE TYPES								
Stocking:								
Good	0.24	0.35	0.68	0.90	1.81	2.19	4.22	4.83
Medium	.28	.34	.75	.88	1.95	2.16	4.47	4.78
Poor	.32	.33	.84	.86	2.09	2.13	4.68	4.73

should be classed as under-sawlog condition class, except those areas which do not contain at least 80 well formed healthy seedlings of commercial tree species on an acre, dominant in relation to undergrowth, and well distributed. Areas that do not contain this minimum number of seedlings should be considered nonforest.

4. *Degree of stocking.*—Good, medium, poor. The degree can be determined by judgment or by using accompanying table 3 as a guide. The method of determining degree of stocking will depend upon the time and money available for field examination. The limits for each degree of stocking by condition class and type are defined in table 3, which gives net volumes in board feet per acre for sawlog condition class and net volumes in cubic feet per acre for under-sawlog condition class. The volumes should be based on trees of commercial species present in the burned area.

In actual practice it may be difficult to fit every fire, especially one larger than 10 acres, into only one of the 72 possibilities in table 2. For example, a proper classification of the acreage on a 100-acre fire might indicate that while most of the area burned with class 4 severity, some of it burned at night, or in a hollow, with a corresponding drop in fire intensity to class 2 or 3. More than one type might be represented, perhaps all three, and the same applies to condition class and degree of stocking. In such cases, weighted averages of the amounts read from table 2 would result in the most accurate evaluation of damage. An experienced man, well acquainted with his district, could probably classify the timber on the burned area by observation and estimate. The less experienced man might have to support his judgment with data from field surveys.

Possibly the most common use of table 2 is illustrated by the following example: Assume a 50-acre fire of medium intensity burned through a stand in which it was estimated that 60 percent of the dominant and codominant trees were pine and 40 percent oak.

TABLE 3.—*Degree of stocking* [1]

Type	Sawlog condition class (net volume in board feet per acre in trees of sawlog size)			Under-sawlog condition class (net volume in cubic feet per acre—trees 5 inches d. b. h. and larger		
	Poor	Medium	Good	Poor	Medium	Good
Hardwood	0-1, 000	1, 000-2, 900	2, 900+	0-80	80-430	430+
Pine-Hardwood	0-1, 300	1, 300-3, 700	3, 700+	0-90	90-510	510+
Pine	0-1, 800	1, 800-4, 600	4, 600+	0	0-660	660+

[1] From Forest Survey data, North Carolina Unit No. 4.

The stand contained an estimated average volume of 1,250 board feet per acre in trees of sawlog size. Therefore, the stand should be rated as *sawlog* condition class. Since neither pine nor oak made up three-quarters of the dominant and codominant trees, the type is *pine-hardwood.* In table 3, opposite the pine-hardwood type for sawlog condition class, 1,250 board feet fall under *poor* stocking. In table 2, for medium severity (class 3), sawlog condition class, pine-hardwood type, and poor degree of stocking, is the damage value of $1.21 per acre. This value multiplied by 50 acres equals $60.50, a total damage to timber stand.

Night Azimuth Readings.—Various methods have been used by forest lookouts to obtain satisfactory azimuth readings at night. Most of these involve some means of illuminating the vertical cross hair of the alidade without at the same time obliterating the light from the fire.

Knute Turnquist, lookout on the Oakridge Ranger District, has a solution which is both simple and accurate. A piece of heavy paper is fastened to the front sight, broadside and to the right of his line of sight with the edge exactly on the vertical cross hair. No light is used; the lookout sights through the rear peep slot and revolves the fire finder until the blaze is barely visible from behind the edge of the paper. He then turns on the light and reads the azimuth.

Instead of a piece of paper, a rectangular metal plate, the length of the vertical hair, could be used with one edge at the line of the vertical hair. It could be designed to revolve out of the way during daylight hours.

The device described would be somewhat similar to the small metal plate found on the newer fire finders, which enables the taking of a minus vertical angle at night.—[Adapted from article by R. M. BEEMAN, *Williamette National Forest*, in October 1940, Six-Twenty-Six.]

AN EFFECTIVE METHOD OF CLEANING KAPOKS

J. W. Farrell and Don Park

Idaho National Forest

The use of sleeping bags for fire-fighting personnel has grown rapidly within the past few years. Attendant upon their use is the problem of cleaning the bags. Although the method presented in this article does not reduce this task to simple terms, as in laundering the woolen blankets formerly universally used by fire fighters, it does offer a method highly satisfactory under conditions existing on the Idaho National Forest.

The Idaho National Forest, as well as others in region 4, has been confronted over the past several years with the problem of properly cleaning and renovating kapok sleeping bags. After giving other methods a fair trial and not being able to get a satisfactory job done by commercial cleaning establishments, the Idaho National Forest personnel developed a procedure that has proved very satisfactory. During the past fall 2,700 beds were cleaned at an average cost of 90 cents per bed. The cleaning job furnished employment to 8 fire guards for a period of 2 months beyond the regular guard assignment.

The Idaho plant has been gradually developed over a period of 3 years. It includes the following equipment:

1. A home-made washing machine consisting of an open tank of 200-gallon capacity using compressed air in lieu of a mechanical agitator.
2. A double, overhead track which runs from the storage building to the drying yard. Frames 6 by 8 feet in size are suspended from the track by roller carriers, and each frame is fitted with enough sliding hooks to hold 20 pads. (If a smaller or more temporary set-up is desired, lines can be used in place of tracks.)
3. A single hammer compressor with ordinary garden hose for the blowing operation and ¼-inch hose for the cleaning operation.
4. An ordinary garden hose nozzle to be used in blowing the beds and spray guns for applying cleaning fluid. (We were unable to find guns on the market with sufficient force to carry the proper amount of cleaning mixture well into the kapok filler, so we made our own, using ⅛-inch black pipe and ⅛-inch zerk fittings for jets.)
5. A supply drum for cleaning fluid. This is elevated about 10 feet from the ground.

Several worth while improvements could be made in the present plant. For example, a large industrial-type washer with a mechanical agitator might be an economical investment where the cleaning job is large enough to warrant it. Other types of equipment may be available which could be used just as effectively as those listed.

The statement which follows may help to clarify the procedure for other organizations that may be interested in developing a similar plant:

The beds are first dismantled by cutting the strings which combine the three parts; namely, the covers, sheeting bags, and the kapok bags.

The sheeting bags and covers are put aside to be washed in the contrived washing machine, using ordinary soap and water. The kapok pads are hung on the frame and drawn to the blowing station. Using the garden hose and nozzle the entire pad is blown thoroughly with air under 100 pounds pressure. This operation removes all loose dirt and dust and breaks up the lumpy mats in the kapok. The kapok becomes very fluffy and alive, thus prolonging its usefulness.

The frame with its load of pads is then drawn to the cleaning station. The cleaning fluid is highly inflammable so the station must always be located in the open and away from buildings. Common Stoddard solvent is used as the cleaning agent. The compressed air and solvent are supplied to the spray gun through separate $\frac{1}{4}$-inch hoses. No pressure is applied to the fluid in the supply drum, as the drum is elevated, but air pressure to the gun should be about 100 pounds. The fluid is applied liberally, about 1 gallon being used to each pad. During the spraying all grease spots and stains are rubbed with a stiff brush. As yet, no grease or dirt has been encountered that could not be removed by this spraying and brushing process. All adult vermin, larvae, and eggs are killed or destroyed.

After the cleaning operation, the pads are drawn on the frames to the drying section. About 3 hours under a warm sun are required for the pads to dry thoroughly. During cold weather, as much as 6 hours will be required. Regardless of the temperature, sunshine is important in the drying process. As soon as the pads are dry they are ready for reassembling.

The sheeting bags and covers are washed in the (washing) machine with ordinary soap and water. They are then hung on the frames and drawn into the yard to dry.

All necessary repairs are made to covers and pads before reassembling. Straps and fasteners are replaced, and torn and damaged parts are repaired by sewing in good pieces salvaged from beds damaged beyond repair.

When the beds are reassembled, No. 2 hog rings are substituted for the strings which normally hold a bed together. These are more easily and more rapidly applied, and are much more durable than the strings.

Size of the crew is important from the standpoint of economy. Drying conditions will govern the number of men used to a large extent. Generally two are used on the dismantling and washing, one on the dry blowing of the pads, two on the spray guns, and one track tender and one repairman. Necessary labor adjustments can be made on the dismantling and reassembling jobs.

The cleaning process was entirely new to all of the men this year, and we believe the cost per bed can be reduced by practice and experience.

Additional information on the process can be obtained from the Idaho National Forest.

SCOUTING FOR FIRE WITH AIRPLANES ON THE SAN JUAN

C. R. Towne

Assistant Forest Supervisor, San Juan National Forest

The "flivver" and other types of privately owned planes are becoming increasingly numerous in region 2 and are proving their value for emergency fire detection, particularly on forests where existing facilities are limited. Aerial detection may well justify a more prominent place in fire-control plans on such forests than in territory where intensive systems of fixed lookouts can be justified and maintained. Although the following article appeared in the region 2 bulletin, it was believed of sufficient importance to warrant broader dissemination.

During the hazardous periods in 1939 and 1940, some scouting by airplane was done on the San Juan National Forest. In 1939 no fires on the forest were spotted by the patrol. The training given the pilot, however, resulted in his picking up one fire on the Montezuma and two fires on the Pike.

In 1940 real results were obtained. On August 11, while traveling from Canon City to Durango, I sighted a lightning fire on the Piedra District in a heavy stand of white fir, some 10 miles from the nearest road or inhabitation. The fire had apparently started since earlier in the day when I had traveled the same course and had seen no sign of it. It was handled the following morning with two laborers, after it had reached a size of 0.25 of 1 acre.

On the following day, while scouting with a plane, a fire was picked up on the pine district in a ponderosa pine-oakbrush type in a blind area. This fire was sighted at 5:30 p. m., reported to Ranger Irwin at 6 p. m., and laborers were on the fire at 8:30 p. m. The fire had reached an area of 2 acres when laborers arrived and was held to that acreage when controlled.

Both of the fires described, if they had been allowed to burn until seen by cooperators, would, no doubt, have developed into large fires. As it was, they were held to class A and class B fires and extinguished with small costs.

On another occasion a fire was sighted some 10 miles northeast of Durango, where it would have been necessary in order to reach the fire to travel some 6 miles by truck and approximately 4 miles with pack outfit. Ranger Price figured that the fire was in the near vicinity of a stock association rider's camp, but, as it was Sunday, he was doubtful if the rider would be at the camp. Before starting a crew it was thought best to investigate the fire by taking a plane and scouting it. Accordingly, I took a plane and in 20 minutes was back with the information that there were men on the fire and they had it under control. The use of the plane cost $5. If a plane had not been used, it would have been necessary to send a crew into the fire, which would have cost much more than the use of the plane. The crew would, because of the roughness of the country, necessarily have had to remain overnight and return the next morning. In addition, the ranger would have lost at least 1 day's time and been away from telephone communication during a very hazardous fire period.

The San Juan is sold on fire patrol by airplane. Contracts were made this past summer with Norman Kramer, a local pilot, to do the flying. The contract called for $10 per hour for a small 65-hp., two-place plane and $12 per hour on a 145-hp., three-place plane. The two-place plane develops a cruising speed of approximately 90 miles per hour and can be throttled down to around 60 m. p. h. with safety, while the three-place plane develops a cruising speed of approximately 120 m. p. h., but can only be throttled down to a speed of around 100 miles per hour. Both planes have their place in scouting for fires. The three-place plane, which is much faster than the two-place plane, is the cheapest for long scouting trips but is not satisfactory or safe where it is necessary to drop down to low altitudes for checking fires. The two-place plane, although of less horsepower, is lighter and slower and can be dropped to as low an elevation as is necessary and be throttled down to a speed slow enough that ground conditions can be easily checked with the naked eye.

Simple Pick-up Barrel and Pump Outfit.—The best apparatus we have found for quickly extinguishing small fires on the "desert fringe," buffer strips, and No Man's Land is a simple pick-up barrel and pump outfit.

Most of the equipment needed for this outfit is available on any national forest or ranger district—a pick-up truck for transportation, four 50-gallon drums, an Edwards Midget pumper, and from 500 to 1,000 feet of ¾-inch garden hose.

One pick-up can handle two of the drums filled with water and the balance of the outfit. If needed, another pick-up, or truck, can keep the pumper pick-up supplied with water with the extra drums. We put a faucet in the bottom of the drums for filling back-pack cans.

This simple little outfit is useful for putting out small fires, without dramatics and with no heavy equipment tied up. It is better for the purpose than the heavier power take-off, high-pressure tankers, or chemical-pressure outfit.—W. E. ANDERSON, *Chelan National Forest.*

Comment on "The Stathem Fire Finder Disc" Article.—Readers who have for years used the tangent offset method for plotting the location of fires are somewhat confused in reading Mr. Strathem's article in the July 1940 issue of Fire Control Notes (p. 149), to note that the tangent offset for 1 mile is given as 69 feet rather than the approximately 92 feet per mile which is correct.

The error apparently arises in the first column of the profile table on page 155 where instead of vertical angles of 1°, 1½°, and 2°, the correct figures of ½°, 1°, and 1½° should be substituted to correspond with the differences in elevation given.

Likewise, in the examples on pages 149 and 150, the angle given as 2° should in each instance be listed as 1½° to make this angle correspond to the actual loss in elevation.—ROBERT E. REINHARDT, *junior forester, Region 6.*

BROKEN WINGS IN THE FORESTS

Clayton S. Crocker

Fire Control, Region 1

Airplane use in forest-fire control is constantly progressing. As equipment is improved so also should our knowledge be extended as to what to expect of planes and their human masters, the pilots. As the so-called adventurous years pass it is well to have a record, such as this, of some of the trials of those who pioneered in the use of airplanes for forest-fire control. Finally, lest forest flying be considered merely a prosaic activity such as distributing salt on a cattle range, the men who are to function as fire bosses should personally accompany the pilot on some of his flights. The experience will reinforce the author's final caution "* * * don't ask the flying boys to do the impossible or the obviously dangerous thing * * *."

The article "Use of Aircraft in Forestry" (Forest Service mineograph, January 27, 1940) gives a condensed record of attainments in various phases of aerial transportation over the forests. The story of success is interesting and informational. However, it falls short as a complete picture of development in the field. The more gloomy chapters of the story need to be told, else in the future it should be forgotten that aerial forestry too had its pioneering hardships, its obstacles, and its hazards.

Knowledge of the facts may safeguard against repetition of error and serious mishap in years to come. It is also well to remember that this is the one and only phase of fire-control work which has been developed entirely at the risk of forest officers' lives. It has been a gamble, with life wagered against the odds of chance. The pay-off for each flight could be but one of two stakes—better fire control if we won; a widow with forfeited life-insurance policies, or perhaps life as a cripple, if we lost.

Many hundreds of changes have been taken. As a result we have great areas of green forest, which otherwise might have been burned. The one loss in this region is marked by the grave of our pilot, Bob Maricich. Why there are no more such graves, must be attributed in some measure to luck. Skill, brains, and intestinal fortitude have beyond doubt, been responsible for our good fortune. Even so, when a plane engine "conks out" over rugged forest terrain, a hundred miles from a landing fied, some element of luck must be present when the pilot and observer walk away from the wreckage.

A brief history of region 1 airplane accidents follows: It is not written for the purpose of discouraging airplane use. To the contrary, it is given as *an argument for better equipment*, more stability in employment of pilots, and a more careful consideration of the needs of this important arm of our fire transportation system:

1926. Ranger Jack Jost, observer, and Pilot Jack Rose.

They were scouting the Snow Creek fire in the Kaniksu country. In climbing high to clear the rugged Priest Lake Divide near the edge of the forest, the main oil line broke. Jost reports:

"We were on top of the Priest Lake Divide and due to dense smoke had zero visibility except straight down. The motor was stone-dead and it was several miles to the edge of the forest. We glided into Snow Creek Canyon and down it to its mouth in the farming country west of Bonners Ferry. We landed in one of those little hay fields, among wire fences and haystacks; barely missed a crew of men stacking hay; landed Okey, but the field was so small we had to plank over several irrigation ditches before taking off."

Jack's statement is typical. It gives the facts in only such detail as an old-timer believes necessary for the official record. He fails to record the hazards attending his ride in a dead plane, sliding and slipping between heavily timbered, cliff-strewn canyon walls; the nearness of spike-topped snags and treetops to the delicate fabric of the wings; the buffeting of up- and down-drafts; and a dead-stick landing among fence posts and haystacks.

Jack continues, "During July 1926 Jack Brien, observer, and Lieutenant Priestly, pilot, were forced down while on detection patrol in the heart of the Kaniksu Forest. They rode one of the old Army DeHaviland planes down with a bad motor. Neither was injured."

1927. Ranger Jack Jost, observer, and Pilot Nick Mamer.

Jost reports, "Mamer and I were forced down by engine trouble on the edge of Blue Lake, Kaniksu Forest. In taking off at start of trip, a cross wind let us drop about 150 feet and the shock damaged the motor. It cut out while were were over Blue Lake. We found a small meadow and landed satisfactorily. We had to clear dead snags from the end of the meadow before trying a take-off. Local farmers held the plane while Nick opened the motor wide, then they turned loose. We barely got out as the tops of snags ripped pieces of fabric from the wings. Close shave."

1928. Fire Chief Howard Flint, observer, and Pilot Jack Rose.

A new plane, the most modern of that time was purchased by contractor Nick Mamer for use in forest-patrol work. A short patrol from Spokane to cover the St. Joe Forest was made as a maiden flight for the new ship. Howard Flint, then in charge of fire control in region 1, and the region's most experienced observer, made the trip with Pilot Rose.

When well over the central part of the rough and heavily timbered St. Joe, the motor stopped. A fabricated timing gear, an innovation, had broken into pieces. No clearing of any kind was in sight. The area had been burned years before and the second-growth timber bristled with gray snags, a hundred feet tall.

Both men wore parachutes (which is seldom the case), but with one glance at the spearlike snags both decided to ride the ship down. A patch of trees, more free from snags than the remainder of the hillside was selected, and the glide was pointed in that direction. Upon nearing the treetops, a side wind slipped the plane into a tall snag and it hurtled down through the tree trunks and logs, a mass of wreckage.

Upon regaining consciousness, the men determined that their injuries consisted of one black eye and numerous bruises; they had a 12-mile hike cross country to the road. "Just another thing in development of our transportation," according to Howard's statement.

1930. *Assistant Supervisor Albert Cochrell, observer, and Lieutenant Bigelow, pilot.*

A patrol flight in the wake of a severe lightning storm took Observer Cochrell and Pilot Bigelow along the high, rough Pend Oreille Divide. They had just passed over North Baldy Lookout (elevation 6,185) when, without even a sputter, the motor stopped. Ahead and on both sides were steep, heavily timbered mountains. The open country of the Pend Oreille River was too far away to offer a landing chance. Behind, about a half mile, was a grassy opening on the ridge. It was steep, rough, and faced a timbered canyon bottom far below.

It was only a matter of seconds but the pilot took time out to answer a questioning glance from Cochrell, with a nod toward the selected spot and a smile of reassurance. He turned the plane sharply, dived in over the scattered alpine trees and pulled against the steep beargrass slope for a perfect landing. That it was steep is indicated by the distance the ship traveled after first touching the ground—45 feet.

Bigelow's first and only comment was, "What do you suppose happened to the old girl?"

By using wire from a nearby telephone line, the ship was anchored to the mountainside to prevent its rolling into the canyon. Investigation disclosed that the fabricated timing gear had failed. New parts were ordered by telephone from the nearby lookout. A pack train with equipment arrived the following day and repairs were made.

After considerable maneuvering, pushing, and pulling, the ship was moved to the top of the mountain. An opening through trees and outcropping rock ledges was selected. It was a short runway and so steep that a saddle horse could be ridden over it only by switching back and forth on contours.

When time arrived for the perilous take-off, Bigelow crawled into the cockpit and tested his motor. Upon glancing back he found he had a passenger. In answer to his look of surprise Cochrell merely replied, "Well, I rode in here with you, didn't I?"

When the motor had reached its top speed, the smokechaser from the lookout station severed the rope which until then had held the ship to the mountainside. With a roar the plane started down the hill, bouncing over beargrass hammocks and rocks; performing like a frightened rabbit, it headed straight down toward the timber. After what seemed ages to the passenger the nose took to the air and the tail jumped out of the beargrass, and they were once more in the air.

1931. Supervisor Wohlen, Assistant Supervisor L. F. Jefferson, and Pilots Bob Johnson and Bennett.

Overhead personnel was needed for a fire burning on the east side of the Clearwater Forest. Ground travel from the supervisor's headquarters to the fire would require days. Travel time could be cut in half by ferrying the men by airplane. Such use was new in those days.

Supervisor Paul Wohlen, Assistant Supervisor Jefferson, and three others boarded the plane in a hay meadow at Weippe, Idaho. Their route lay across the undeveloped, roadless wilderness country comprising the north fork of the Clearwater River drainage. It was a route new to the pilots so they flew high, 8,000 or 9,000 feet.

Upon leaving the high divide the ship came out over the Clark Fork River. Jefferson, being acquainted with that area signalled to the pilot that they were over the small village of Superior, the point at which they were to land. The pilot reduced the spark and throttle preparatory to maneuvering for a loss of elevation. Instantly the motor backfired and apparently a quantity of unburned fuel spread over the fuselage. It burst into flames. The fire spread quickly back over the ship, burning through and into the cabin. Johnson signalled to Bennett who put the ship into a power dive. This maneuver was to confine the flames to the body of the plane and prevent them from spreading to the wings. The plan was to plunge the ship into the river which was directly below. However, when within 200 feet of the river, he sighted the nearby landing field, levelled off and instead of taking the river, he set the plane on the small field, at something like 200 miles per hour, safely!

Throughout the downward trip the passengers were busy trying to keep the fire out of the cabin, fighting the fire with hands and feet.

1937. Observer Bill Farris, and Pilot Penn Stohr.

The Toboggan fire on the Clearwater Forest had been scouted and the boys were returning to Missoula in a six-passenger Travelair. The return trip required a climb of about 6,000 feet to clear the rugged Bitterroot Range. The country was rough, burned-over land, cut up by sharp ridges and crooked, narrow canyons.

They had traveled some 14 miles from the partially completed Forest Service landing strip at Cayuse Creek and had about 4,000 feet yet to climb to clear the divide when the motor threw a connecting rod and piston. The motor went dead.

Between them and the field were 14 miles of snags and cliffs. Swinging the ship around they began a glide in the direction of the field, searching for a brush patch or thicket of green trees in which to pile the ship. None came to view and each second reduced the distance between the ship and the treetops. Even facing into the wind, the ship lost elevation faster than the creek over which they flew. The canyon walls rose high on either side and still there were no brush patches—just spike-like snags. Each turn and twist of the canyon was the same, another expanse of cliffs and snags ahead. The ship would settle almost to the spikes, then a friendly up-draft would give a margin for one more bend. Any slight down-draft meant disaster.

After what must have seemed a lifetime, the ship caught a strong head wind, held elevation, and coasted to the Cayuse field, landing cross wind on the end of the clearing. It was ground looped to avoid stumps.

That this was a close shave is indicated by a note attached to the instrument panel when the ship landed. "To finder: Crash was no fault of pilot. Number 7 cylinder shot over Black Hawk Lookout." Signed Farris and Stohr.

The boys hadn't expected to reach the field. Fate again, somehow permitted the seemingly impossible escape of our forest flyers.

1938. Dick Johnson, contract pilot.

With a load of iron water pipe, aggregating some 4,000 pounds, in a Ford Trimotor, Dick Johnson, star mountain pilot, dropped between the peaks of the Flathead Range into the canyon-bottom field at Big Prairie Ranger Station.

It was evening, following a hot, sultry day; the air was bad and Dick realized he must use every foot of the short runway. He dropped low over the stumps as he approached. When some 20 feet from the ground a down-draft struck the ship, smashing it to the ground. So quick was the drop that the shock cracked the pilot's chin on the control wheel. At that moment he had been in the act of reducing throttle and his hand rested upon the three ivory knobs. The blow on the chin rendered him unconscious. As he slumped down his hand somehow shut off two throttles; the third was left wide open.

The big ship hit, bounced, raced down the timber-bordered field, careened crazily into a wide circle, pulled by the one roaring wing motor; one man, unconscious in the pilot's seat, big trees ahead, two tons of iron pipe behind him, and traveling somewhere between 50 and 100 miles per hour. Straight for the ranger's office-cabin it bounded. Then one wing caught a tree trunk, its course was deflected, and it crashed into a clump of large trees between the office and barn.

Men in the station hearing the thunderous crash, rushed out to see a great mass of twisted aluminum, machinery and pipe, strewn over the entire grounds. The mass was dripping gasoline; big pools of it were forming in low spots on the ground.

From somewhere in this conglomeration of wreckage came Dick Johnson, crawling, staggering, bleeding, mumbling almost incoherently, "Don't any—light a match, she'll blow up!"

They sent another plane and stretcher for Dick. Three weeks later he finished the hauling job to Big Prairie.

1939. Clarence Sutliff—Dick Johnson.

Several trips had been made, dropping supplies to crews on the Roaring Lion fire. It was in an extremely narrow canyon formed by sheer rock walls extending thousands of feet into the air on either side. It was typical mountain-goat country, *where not too rough.*

On this last trip the boys found that the crowning fire had run down canyon, destroying the site which had been selected for their camp. To find a new one meant getting close to the canyon bottom. This they did, close to the edge of the running fire. Some 500 feet above the creek bottom and probably that close to the heavy smoke column, they banked for a turn which at best would be tight.

Just as they completed the turn the ship plowed into a waterfall of air; a down-draft caused by displacement of atmosphere heated by the fire. With motor wide open the ship fell lower and lower. To avoid the rock cliffs it was banked and more elevation was lost. Still the rush of air poured down on the plane. The trees and rocks jumped closer, and the top of an alpine fir was clipped by a wing. Dick shouted to Clarence who was in the rear of the cabin, "We're going down!" Then a big Douglas fir tree loomed directly in front.

Clarence felt sleepy when he awoke, rubbed his eyes, shook his head, and wondered what the sizzling noise was. Then he became conscious of a red glow—fire—the ship was on fire, wrecked. Or was the crown fire over them? Frantically he ripped at the walls that pinned him in. Through a hole half large enough, he somehow got out. The ship, or rather, the tangled mass of wreckage was not on fire. The noise was oil dripping on hot parts of the motor and the crackling and roar of the approaching forest fire. The wreckage was on a steep boulder slide; some parts of the ship hung from nearby trees.

Clarence found Dick, head down, smashed among the twisted cowling and controls. He was streaming blood, unconscious or dead—examination proved his heart still beat.

With rocks, clubs, fingers, and shoes, Clarence beat away the tough steel enmeshing the pilot. Dragging him out, he attempted to bandage the exposed wounds to stop bleeding. Then he tried to set up a radio which had been brought for the new camp. It failed, and knowing that the fire was getting closer each second, he dragged, rolled, and carried Dick down the boulder slide to the creek. Here he could drag him no farther, so selecting a moist spot, most free from inflammable fuel, he left Dick and started for help. It was then dark so he blazed a trail through the jungle of brush and timber with a jack knife. Clarence was bleeding badly and each slash at a brush with the knife, also painted a red splash which could be followed days later.

To make the story short, Clarence found help and sent men to get Dick. A shift of wind direction held the fire away from the crippled pilot.

A few days in the hospital, a couple of weeks' rest, and these fellows were again in the air, fighting fire with airplane service.

1940. Del Clabaugh and Pilot Maricich.

The deluge of lightning fires in July 1940 had caused placement of 8,000 fire fighters in the forests. All reserves of ground transportation were working double shift, but still there were crews that could not be supplied by such means in the remote, inaccessible back country.

Regular forest contract pilots were flying every daylight hour. Reserve ships were available, but experienced mountain pilots were not to be found in the northwest.

A crew, struggling with a nasty fire in the Alp-like Bitterroots was known to be without food. They had no communication. Lookouts reported evidence of a nip-and-tuck battle, which would be lost unless supplies were delivered immediately.

A good, mountain-tested ship, (a six-passenger Travelair) was loaded. Bob Maricich, a skilled transport pilot but possessed of little mountain experience, was employed to take the load. Del Clabaugh, also a pilot, was to serve as cargo dropper.

Without event, the boys crossed the badly-wrinkled topography of the Montana-Idaho Divide and dropped down among the sharp ridges to search out the spot on which their load was to be dropped.

In this area, the ground surface is a jumble of white rock cliffs, slides, alpine timber, and spike-like crags. The creeks run white, foaming down courses which are continuous cataracts. In such a canyon, well toward the upper end, the pilot spotted what he thought to be a white "X," the target. Unfamiliar with the treachery of mountain air, he slid down to within a few hundred feet of the creek bottom. Then traveling upstream, he approached the spot, dropping a load with a cargo chute. Immediately he gunned the motor to climb out for another swing over the spot. At that point, the ship was well down between the canyon walls, facing up the steep grade of the creek bottom. A sharp bank was necessary and was attempted. The 330 horses in the Wright whirlwind responded to a full throttle and the turn was one-half completed when the force of a terrific down-draft caught the heavily loaded ship. The space for maneuvering was too small.

Lookout Harry Neilson, from his station on Cub Point, had watched the plane as it bobbed in and out of view among the ridge tops. He saw the cargo chute, a white dot, as it slipped into the canyon bottom. He heard the motor humming as the last turn carried the ship out of his view. He heard a crash or explosion; then from the canyon came a puff of dust or steam. The hum of the motor was heard no more.

Upon reaching the wreck, Neilson found Bob Maricich crushed and dead. Clabaugh was badly injured, but alive. The ship rested, a jumble of wreckage on the edge of a small, rock-bound pond among the trees. Another plane soon arrived overhead. First, a cargo chute bearing medical supplies and blankets, then a larger chute opened and a smokejumper trained in first-aid, landed close to the scene of the accident.

Clabaugh fully recovered. Bob Maricich's is the first grave in this region for which forest flying is responsible.

Pioneer Pilots

The Forest Service and Fire Control, in particular, owe a great debt to those individuals who, with an almost uncanny ability to master the uncertainties of machines and elements, have made forest flying a successful venture.

Many of these fellows have come to their untimely, final landings, not among rivers and forests, but in places where the most modern of safety facilities were available. Some who have felt their motors die in the center of a horizon of peaks, have met violent death in centers of civilization.

Lieutenant Priestly, who pioneered region 1 detection scouting in one of those DeHaviland death traps, crashed out while doing stunts at an air circus, in a "Jenny" at Spokane. The controls of the ship froze.

Lieutenant Bigelow, who landed a dead motor and took off again from the side of Mt. Baldy, met death in a crash while piloting an airplane at Pasco.

Jack Rose, veteran air patrolman and scout, who went down and walked out of a St. Joe jungle, died in a fall down a stairway of a building in Amsterdam, Holland.

Nick Mamer, pilot-idol of the northwest, who perhaps more than any other flier encouraged and promoted forest flying in the 20's, was killed while piloting an airliner near Bozeman. The tail assembly of the big ship dropped off in mid-air, at 250 miles per hour. Nick lacked only a few feet of making a safe landing in a small clearing.

Howard Flint, regional fire chief, and perhaps the best known of this region's foresters, was without doubt the real pioneer in Forest Service aerial work. Howard, a pilot himself, was for many years in direct charge of all airplane activities in the region. He acted as observer during the 20's when all sorts of "crates" were in use. He dropped the first supplies ever delivered to fire crews. He scouted the forest fires to be mapped by air. He sought out most of the landing field chances in the region and planned their development. He initiated aerial photography as a mapping device and flew hundreds of hours on such work. He died as a result of pneumonia, contracted while making a raft trip down the Salmon River, "The River of No Return."

Conclusion

While this chapter has dealt with the disasters of forest flying, it is not written to frighten or intimidate those who must participate in such activity. Its purpose is to emphasize the fact that despite the good record, we have many times escaped by narrow margins. If there is a law of averages, applicable to accident frequency, the odds must be mounting against our good luck. Utmost care and foresight must be used in planning and conducting forest flying, else our record may be blemished.

As a needed precaution, the Forest Service should be permitted such authority as necessary to employ and retain year after year, the services of skilled, trained pilots, experienced in this particular type of flying. Authority for hiring ships and equipment designed especially for mountain flying is also necessary to safety.

Continuing, renewable, or long-term contracts would permit obtaining such facilities. At present, under legal restrictions which require solicitation of competitive bids each year for airplane service, there is no assurance that our lives will be entrusted to the most capable mountain pilots.

And one final word to dispatchers and fire bosses: Don't ask the flying boys to do the impossible or the obviously dangerous thing. Before putting them in a tough canyon on a hot afternoon, make sure you can't delay until the cooler evening air makes it more likely that they will return.

Closure of National Forests for National Defense.—As a measure of national defense it may be necessary to close certain areas (such as those surrounding power plants, etc.) of national forests to unrestricted entrance and travel. On January 22, 1941, modification of Regulation T–9 of the U. S. Department of Agriculture signed by Paul H. Appleby as Acting Secretary of Agriculture became effective. The following section was added:

"(k) The unauthorized going or being upon any area which, in the public interest, has been closed by the regional forester as a means of preventing the malicious destruction of, or injury to, property or works located thereon, or adjacent thereto, regardless of the ownership of the property or works. The boundaries of each area shall be defined by the regional forester, and, insofar as practicable, indicated by posting notices along such boundaries and on roads and trails leading into the area."

RAILROAD FIRES—A CHALLENGE

A. H. Abbott

Forest Supervisor, Cabinet National Forest

Fires started on railroad rights-of-way by locomotives, hot boxes, and so forth have been a cause of major concern to the fire-protection agencies involved and to the railroad companies who pay the cost of suppression and damage. There are few places where the problem is as great as on the Cabinet National Forest. The unusual situation found on the Cabinet is discussed in the following article, and light is shed on some of the problems of equipment and organization and the need for further effort. As these serious situations are sometimes coupled with a low reservoir of available manpower in the Forest Service and local communities because of emergencies elsewhere, the best in equipment, hazard reduction, and cooperative suppression plans is essential.

When the St. Regis ranger district was transferred from the Lolo to the Cabinet National Forest in January 1931, a large part of the region 1 railroad right-of-way fire hazard was concentrated on one forest. Since then, the Cabinet has consistently had more railroad fires than all the other forests in region 1.

The Northern Pacific Railroad runs through a canyon on this forest—an area of high temperatures, low humidities, erratic and gusty winds, and fast spread fuels. A study of the reportable fires occurring on and adjacent to the Cabinet for the 9-year period 1931–39 showed that 237, 25.1 percent of the total, were "extreme spread" and that of these "extreme spread" fires 168 or 70.9 percent were started by the engines operated by this railroad. Incidentally the average time on all "extreme spread" fires was 38 minutes from origin to arrival of the first man, average size when reached 3.4 acres, average spread per minute 0.09 acres. These averages cover only reportable fires. In addition, there is through the fire season the ever-present menace of nonreportable railroad fires, of which there were 405 in 1931, most of which are potential reportable fires.

Considering the acreage involved on the Northern Pacific right-of-way as against the rest of the acreage protected by the Cabinet Forest organization, and based on the number of fires which occurred, nonreportable and reportable, 1931–35, the chance for a fire on the right-of-way was 1,255 to 1 for the balance protected. Considering man-caused fires only, the chance was 2,290 to 1.

The Northern Pacific Railway Co., under the agreement of September 1921, furnishes fully equipped speeder patrolmen as called for by the forest supervisor. In 1940 nine such patrolmen were employed. Section crews, track and signal maintenance men, and other railroad men who travel by speeders are fully instructed about what to do in case of fire. Nonreportable fires are generally controlled by these men, but we never know when any fire will be more than they can handle and will require Forest Service action, or as usually happens, when a faulty ash pan, spark arrester, or a hot box will set a string of fires which the local patrolman cannot possibly control alone.

About 1929 the Northern Pacific started using lignite coal, mined at Coalstrip at a cost of about 75 cents per ton on the cars, thus cutting fuel costs a very considerable amount. However, the coal throws a tremendous volume of sparks. Cyclone spark arresters were installed. When these spark arresters work properly, there are practically no sparks from the smoke stacks. Improper installation, friction wear by the ashes, etc., not infrequently occur, with resulting right-of-way fires. Moreover, spark arresters alone do not solve the problem, for about half the fires are set by sparks from defective ash pans. One engine set 29 fires in 40 minutes on the St. Regis ranger district in August 1940, during a dry lightning storm, while the district ranger was on fire-suppression work in the Yellowstone National Park. Other equipment failures are usually negligible, although one train with a hot box made 175 sets (reported as one fire) in less than an hour.

Each year crews employed by the railroad burn a large amount of inflammable material along the right-of-way. Cheatgrass (*bromus tectorum*) is the worst fuel. Burning this is a headache. Frequently cheatgrass will not burn at 9 a. m.; by 10 a. m. it will burn safely; by 1 p. m. it is explosive, and gusty winds make burning absolutely unsafe. It is usually inflammable from a week to a month earlier than other grasses. The uneven ripening, because of topographical and moisture conditions, further complicates the burning problem. Either burning must be deferred until all of the cheatgrass is ripe, and chances taken on fires starting in the patches of early ripened grass, or the ripe grass must be burned and chances taken on that which is not ripe enough to burn at the time.

Following the work done on the Shasta National Forest in California, the Northern Pacific Railway Co. expects to try out soil sterilization by use of arsenic trioxide on sample strips on each railroad division. If this proves feasible, permanent firebreaks should be made, which should be far better than the present plowed breaks. Such breaks can be made where topography and rock content make plowing impractical.

Burning rights-of-way, building firebreaks, quicker detection, and faster control are all desirable, but they do not solve the problem. The problem is to keep the sparks from leaving the engine, and that is primarily the responsibility of the railroad. Although their costs have been reduced, there is no good reason for letting up on the real prevention problem. It is not to be expected that the Forest Service organization will always be on hand to fight the railroad fires. We have repeatedly had every available man on fires. And sooner or later, when certain condition exist, i. e., a class 5 to 7 fire danger, large going fires, or a dry lightning storm, a fire-setting engine will go through and we will not have the manpower available to meet the situation. Such a condition existed in 1931, when the Kildee Fire started. The fire jumped the Clark Fork of the Columbia half an hour after it started, although there were 14 men on the fire in the first 20 minutes.

Many of us remember the labor situation we had to contend with from 1915 to 1919. Apparently we will have much the same situation to meet in 1941. The Northern Pacific is not the only railroad that sets fires. Isn't it of prime importance from a Nation-wide preparedness viewpoint for the fire-setting railroads to put their equipment in safe condition and thus eliminate the probability of tying up needed men, food, tools, and equipment on preventable fires?

AN AID TO ALIDADE ORIENTATION

Wendell Moran

District Forest Ranger, Payette National Forest

In manning three new lookout points on the Bear Valley district of the Payette National Forest during the summer of 1940, it was found that guards or lookouts who had had previous instructions in alidade orientation could complete the necessary operations, with a check-up later by the ranger. The method employed was as follows:

The alidades were set up in their proper positions and adjusted for level. The men on the new points lighted their gasoline lanterns at 9 p. m. on a specified date, placing them over the center pin of the alidade for a period of 1 hour. Mirrors, such as all lookouts and guards have for their personal use, about 4 by 6 inches, or a round mirror of the same size and preferably of glass, make satisfactory reflecting mediums. The lookout stood directly behind the lighted lantern with the mirror's reflecting surface in a vertical position about 6 inches from the light. With the mirror in this position, he slowly walked around the alidade, keeping the mirror's reflecting surface behind the light. Walking around the alidade caused the light to flash in much the same manner as the revolving screen in a lighthouse. The resulting flash was penetrating and could be seen satisfactorily for 15 miles.

The other established lookouts took readings of the flashes at spaced intervals; that is, until they were sure it was a light and not a star. These readings were communicated to the respective new lookouts, and the alidades were adjusted by sighting the established points—using the reverse readings. The alidade map was adjusted to fit the readings obtained. Because of an error in map printing, a slight adjustment of the map was often necessary.

If the alidade is located on an exposed point, the lantern should have a mica or glass globe to prevent the wind from blowing out the flame. Also, without the use of the mirror it is hard to see the lighted lantern any distance and practically impossible to see it if the lookouts on the established points are looking toward a light sky background such as prevails in the summer evenings.

A RUST-PREVENTIVE TREATMENT FOR FIELD CACHE TOOLS

Samuel W. Orr

District Forest Ranger, Routt National Forest

Fire tools will not be rusty when they are needed if they are treated in certain ways. Some effective methods of treatment are rather expensive; other methods may lack effectiveness and have other disadvantages. The method described herein will appeal to district rangers or forest guards at isolated stations where both money and facilities may be scarce.

Tools stored in field caches are exposed to more or less dampness. Various treatments, using different kinds of oil and grease, have been tried to prevent such tools from rusting. Nearly all of them have had some objectional feature.

The need is for a rust preventive that is cheap, efficient, and easy to apply. Following is a summary of experience with ordinary commercial paraffin, such as is used for sealing jelly jars and which sells for 10 to 15 cents per pound:

Two new double-bit axes were thoroughly cleaned of all foreign matter by several washings in clean gasoline. They were then wiped dry with a clean rag. We next made a solution of brine, consisting of 1 part common table salt to 5 parts of water. Ax No. 1 was covered with a heavy coat of oil and ax No. 2 was given a coat of paraffin which had been heated until it liquefied. Both axes were placed in the brine solution for a period of 24 hours.

After removing the axes from the brine solution and cleaning off the oil and paraffin, it became evident that the paraffin was the better of the two rust preventives. Ax No. 1, which had been treated with oil, was badly discolored and spotted over its whole area, and after it had been out of the brine for ¾ to 1 hour it commenced to show evidence of rusting. Ax. No. 2, which had been coated with paraffin, showed no evidence of discoloration or stain except at two places where the paraffin coat had been scratched in handling. These two places had become slightly discolored, but the discoloration rubbed off easily with steel wool. Since it is very doubtful that any ax in a cache would ever be exposed to the treatment given these two axes, it does not seem that small cracks in the paraffin coat would ever allow enough moisture to penetrate to even discolor the metal as it did in this experiment.

The paraffin has the advantage over oil of coating the tool with a moisture-proof covering. It is much cheaper than oil, does not cake on the metal, and when the tool is placed in use does not need to be removed since it flakes off readily. Furthermore it is easily applied.

Oil has the disadvantages of being dirty to handle and of getting all over everything if not put on carefully. It takes time to apply oil, and if the tool is not coated all over, rust spots appear on the exposed parts. Oil is also more expensive than paraffin.

Several tests were made in coating tools in the field. The first was undertaken in February 1940. Melted paraffin was mixed with benzine in a ratio of 1 pound of paraffin to 1 gallon of benzine. The mixture was wiped on with a rag over 23 double-bit axes and 8 Pulaski tools. All parts were covered, as were the ends of the handles. The total amount of the mixture used for treating the tools was 1 pint. The use of a rag for wiping the mixture on the tools did not seem satisfactory because of the daubed appearance it gave, and the uneven coating of the tools. However, not one tool shows any evidence of rust at this time and not a single loose handle has been found among the lot.

A second test was undertaken on the tools in one of the field caches, the results of which are not yet known. Melted paraffin was mixed with white gasoline in a ratio of 1 pound of paraffin to 1 gallon of gasoline. Instead of applying the mixture to the tool with a rag, as was done in the first test, each tool was dipped in it. However, in treating a saw it was necessary to use a rag to apply the mixture.

In applying the paraffin mixtures it was found that the tool to be treated had to be warm to the touch. When cold tools were treated, the paraffin immediately congealed on contact with the metal and an unnecessarily heavy coating was deposited. It was found also that the mixture of paraffin and gasoline, which seemed to be the most desirable of the two mixtures used, would keep in liquid form for only a few days because the gasoline evaporated and the paraffin congealed. However, this might be avoided by placing the mixture in an air-tight container or by mixing it only as needed, which is even more desirable.

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The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire-fighting methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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CONTENTS

ADAPTING ADVANCED PRINCIPLES OF ORGANIZATION AND FIRE-LINE CONSTRUCTION TO CCC SUPPRESSION CREWS

Rolfe E. Anderson, Boyd L. Rasmussen, and Verne V. Church

Siskiyou National Forest

Greater use of 40-man CCC crews in some regions was foreshadowed in the April 1940 issue of Fire Control Notes (The 40-Man Crew—A Report on Activities of the Experimental 40-Man Fire-Suppression Crew) by the statement: "It is believed that this system can be applied to other crews organized from picked CCC enrollees . . ." The Siskiyou organized a number of these crews and here reports on the success of one of them. Region 6 now advised that every CCC Camp is required to have a special 40-man crew, and that steps are being taken to equip these crews progressively.

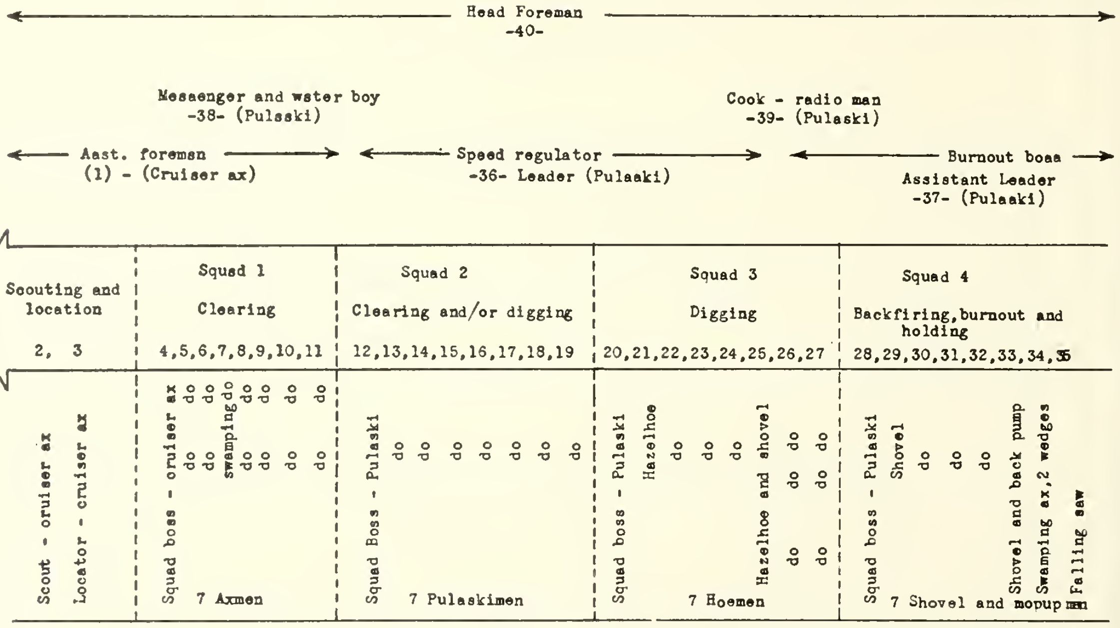
In 1940, special suppression crews, patterned after the original 40-man crew organized in 1939 on the Siskiyou National Forest and located at the Redwood Ranger Station, were set up in CCC camps and forest-guard organizations on most of the national forests in the North Pacific region. A 40-man CCC crew was organized at the Iron Mountain spike camp, China Flat CCC camp, on the Siskiyou, in the spring of 1904. About midseason, David P. Goodwin, Assistant Chief, Division of Fire Control, in the Washington office, observed this crew on a practice demonstration and was so impressed by its action and apparent high level of morale, that he requested a report on the organization of the crew, methods of training, and accomplishments on fires. The story of experiences and accomplishments which follows might be duplicated by any one of several forests in region 6 where similar CCC crews were trained.

Organization of Crew

1. *Selection of men.*—In making up the China Flat CCC 40-man crew, an effort was made to select enrollees who were best fitted physically and emotionally for fire-fighting duties. The best men were taken from work crews on every work project. In some cases this caused a temporary handicap to current projects, but it resulted in development of a suppression crew made up of better-than-average enrollees. The majority of the men were accustomed to hard work at relatively low wage rates.

Two of the best qualified CCC foremen in the camp, Walter Barkow and Ralph Reeves, were chosen to take charge of the crew—Barkow as head foreman and Reeves as assistant foreman. These men were in charge of the road-construction project on which the crew was engaged while not training or fighting fire. In this way the men on the fire crew worked under the same foreman at all times, resulting in a unity of thought and action essential for good teamwork and the up-building of morale.

2. *Selection of site.*—The Iron Mountain spike camp, where a road-construction project was in progress, was chosen as the most favorable site for the development of the crew. It provided work necessary for the training and conditioning of the men. It was located in a place where it could provide quick service for two ranger districts; and, not the least important, it kept the crew in a unit during off-duty time. No outside influence interfered with the concentration of interest of every man on fire duty.



Organization chart for the CCC special 40-man suppression crew.

The men were housed in tents which were framed and floored. Mess was provided in a portable frame building. The camp met all Army regulations as to water supply, sanitation, and camp facilities.

Training

Training began soon after the spring enrollment and was carried on 1 day per week during the first half of the summer. After the crew had gained experience on going fires, one-half day per week was considered ample. Intensive training was in progress at the time of the July enrollment and the few recruits that were added to the crew were absorbed into the organization and given individual attention as needed. Training processes were segregated into five divisions: Use of tools; get-away action; fire-line construction; special job training; and off-the-job training.

Use of tools.—Fundamental training in the use of hand tools was necessary because many of the enrollees included in the crew were green recruits. The first step in training was to teach every man the correct use of an ax. Only a relatively few enrollees were judged proficient in ax work following the first tryout. Detailed instructions in handling an ax were given to each unskilled enrollee under the close supervision of the foreman. As the men became qualified in ax work they were excused from further training with this tool

The individual detailed training was done on road right-of-way logs arranged in safe positions for the unskilled axmen. This step involved training for a minimum of 1 day to a total of 5 days before all enrollees were qualified to use the ax. After the necessary skill was acquired in the fundamentals of ax work, practice was continued throughout the summer on the road right-of-way clearing project.

A similar system was used in teaching the use of digging tools. It was found that less time was required to gain proficiency in these less exacting tools.

Get-away action and travel to fire.—This share of training was considered vitally important because it eliminated much waste of time which would have occurred had the men not known exactly what they should do in getting away to a fire with full equipment. To facilitate assembling of men for roll call, loading into trucks, unloading and receiving packs at the point where foot travel began, the men were numbered from 1 to 40, according to position in the crew. Each man's pack was tagged with his number so that each individual would receive his designated tool. Packs and tools were stored in a separate building at the spike camp and a truck assigned for transporting them.

A separate crew, consisting of the regular spike camp cookhouse staff, who were not members of the 40-man crew, were trained to load this equipment while the suppression-crew members were getting their work clothes and loading into two passenger trucks which were assigned to the crew.

Considerable time was spent practicing get-away on fire calls and by constant practice, get-away time was reduced to 7 minutes when enrollees were at camp at the time of the fire call. Training also included unloading from the trucks at the point where foot travel began and assembling in hiking order with packs and tools. Unloading required 2 minutes and the receiving of tools about 5 minutes. The crew was then hiked over trails and cross country to gain practice and get the "feel of the pack."

Fire-line construction.—The next training step was actual fire-line construction. This training included a demonstration of what a model fire line should be, followed by practice in the construction of such fire line. The crew worked as a unit using the one-lick method of fire-line construction exclusively under all fuel types found on the Siskiyou National Forest. The important element in the one-lick method was the spacing of the men, coupled with the regulation of the speed of construction. This was taught by actual practice of line construction in the various types likely to be encountered on a going fire. Training was carried on 1 day a week until the crew had reached the necessary degree of proficiency, and one-half day per week thereafter even after the crew had gained experience on going fires. Practically all of the line constructed during training was located around slash areas where the work was needed for hazard reduction and fire protection.

Training for special jobs.—Outstanding men were given special training on fire-line scouting, line location, speed regulation, burning out, and cooking. Most of these important jobs were necessarily taught during line-construction practice, although additional training was given off the job. Cooking dehydrated rations required some experimenting which was done in camp at the cook house by the men selected for the cooking detail.

Off-the-job training.—The foregoing training was done entirely during regular CCC work hours. In addition, however, the foremen gave off-the-job training in safety, fire behavior, and similar subjects.

Recreation and Morale

Recreational facilities available were utilized as fully as possible to build up morale. Each man proudly wore a red felt shield-shaped barge, stenciled "CCC, 40." Considerable competition developed among other members for the "CCC, 40" positions. When the boys went to town on recreation trips, all fire-fighting equipment and clothes accompanied the crew.

Equipment and Supplies

Each member of the crew carried a pack of tools and equipment, weighing about 36 pounds, similar to the ones used by the 1939 Siskiyou 40-man crew. Extra tools and supplies were carried in the supply truck. Lightweight goose-down sleeping bags and ample, condensed, high-quality rations are two essential items of equipment. The ration list was adapted from the list used by the 40-man crew in 1939, and weighed $11\frac{7}{8}$ pounds for 1 man 3 days.

Most of the food items were packed in individual sizes, but it was found most practicable not to break some of the items down into individual packages. The quantities were so distributed that each pack weighed about the same. Linen tags were attached to each pack listing the items it contained so that the cook could easily determine which pack to open so secure rations for any one meal. A few sad experiences with spilled food demonstrated that it was important that the rations be packed in cloth sacks as paper bags would not endure the wear and tear of cross-country travel.

The question of whether or not to carry prepared lunches was carefully considered in the operation of the crew. It was decided that prepared lunches would be packed if securing them did not delay get-away action and travel to fire. If the time did not allow for preparation of lunch, the first meal on the fire line was made from items requiring no cooking. Plans were made to obtain lunches if possible en route to the fire by ordering them by phone at some point along the route. This method was used in travel to one fire in 1940.

Fire packs and rations were always stored in complete readiness in the spike camp where they were hung in sequence of numbers in double rows on the walls of a special fire-equipment shed. In case of fire these packs were loaded into a truck in reverse order from which they were issued at the end of truck travel. They were placed flat in the truck bed in tiers three deep. In order to eliminate lost motion and misplacement of packs, the equipment truck driver placed all packs in the truck when loading and removed them when unloading at the point where foot travel began.

Transportation

Two truck drivers, not members of the crew, ate and slept on each of the three 1½-ton trucks used.

Action on Fires

The CCC 40-man crew took complete action or assisted on seven fires during the fire season. The name, size, and dominant fuel type of each of these fires are listed in the following table:

List of fires fought by the CCC suppression crew

Name	Date	Area in acres	Held line in chains	Fuel type
Lone Tree Creek fire	July 6, 1940	7.0	40	MM
Scott Creek fire	July 6, 1940	7.0	51	HM
Green Knob fire	Aug. 7, 1940	32.0	80	MH
Two Mile fire	Aug. 10, 1940	.2	7	MM
Bingham Mountain fire	Aug. 11, 1940	30.0	85	MM
Scott Creek fire No. 2	Aug. 21, 1940	23.0	126	HM
Water Pipe Creek fire	Sept. 1, 1940	15.5	58	MH

No time studies were made on speed of line construction for this crew while on fires, but it is well known that their accomplishments were much greater than those of an average CCC crew of 40 men, and better than the average crew composed of pick-up laborers.

Six of the seven fires upon which action was taken during the season were of incendiary origin. Five of them were located on the Agness Ranger District within a 3-mile radius and were presumably set by the same person or persons. These incendiary fires were set at times when burning conditions were most critical, and the prompt control by the CCC 40-man crew with the assistance of forest guards and other CCC enrollees is considered a fine accomplishment.

The following comments on one fire based on firemen's and dispatchers' notes are indicative of the rapid getaway, fast travel, and hard striking power of this fire-fighting team.

The Bingham Mountain Fire.—The CCC 40-man crew was called at 5:30 p. m., and instructed to proceed to the Bingham Mountain fire. The men were in camp at this time and no time was lost in assembling the crew. Truck travel distance to the fire totaled 31 miles. The crew arrived at the fire at 7:50 p. m., and immediately went to work. Three squads of men were already working on the fire. The 40-man crew took over the line-construction work and the other squads were assigned to line holding and burning out. At 11 p. m. the crew had built 5,610 feet of fire line to control the fire. The fuel type was "moderate resistance-to-control." Along the fire trail there were a number of burning snags and these were felled as the fire line progressed. The crew did an exceptionally fine job on this 30-acre fire.

Summary and Conclusions

In organizing this crew, 40 better-than-average men were selected from all current projects. Because of loss of experienced men during reenrollment periods, many green men were also selected and much fundamental training was given in the use of hand tools.

It was found desirable that all men in the crew attain a certain degree of skill in ax work. After training the entire crew, the most adept axmen were chosen for ax work on the established crew. Learning to use the hoe and shovel is a relatively simple accomplishment after the enrollees attained a degree of skill with the ax.

As a suggestion for future crews of this type, it is believed advisable to provide a snag-falling or road-clearing project on which to train fellers and axmen beginning about 6 months before the opening of fire season. Experience has shown that at least that much time is necessary to develop green enrollees into experienced timber fellers.

Two CCC foremen are necessary for a crew of 40 men. These foremen must possess real leadership ability and should be well qualified in fire fighting, training, and morale building. Pride in accomplishment must be tactfully instilled into each member of the crew by the foreman. He must be able to mix with the crew in a judicious way and at all times keep the respect of the men.

CCC crews have these outstanding differences from civilian crews of the same type:

1. Qualifications required of candidates for the civilian crews call for experience in use of hand tools. A large percent of CCC candidates are inexperienced and must be given fundamental training in the use of tools.

2. CCC crews will respond more readily to systematic training since they are more amenable to discipline and will adapt themselves without question to the positions assigned in this form of fire-fighting team.

A high degree of morale is the most essential attribute of this type of organization. To cultivate this rather intangible spirit so necessary in a first-rate crew, much attention was given to recreation, good food, and work shifts on the fire line not excessively long with short rest periods as judged necessary by the foreman in charge.

The psychological effect of fast progress in line construction resulting in a quick decisive suppression of each fire attacked gave rise to ever-increasing confidence of each member in the strength of the unit. A series of failures would no doubt produce the reverse effect. It is especially important with an inexperienced crew that the first attempt be successful. Not the least important, from the enrollees' viewpoint, was the distinctive 40-man badge differentiating these men from other CCC men which fostered a healthy pride in the organization.

The special CCC 40-man fire-suppression crew demonstrated that CCC enrollees organized and trained in accordance with advanced principles of organization and fire-line construction were superior to the average CCC fire-fighting crew which does not have the advantage of special training and lightweight equipment; and better than the majority of civilian fire crews composed of pick-up laborers.

OREGON'S "RED HATS"

George H. Schroeder

Assistant Professor of Forestry, Oregon State College

The constant and prompt availability of "snap" crews is most important in the use of a crew like the Red Hats. The author's description of a cooperative approach to the problem indicates how the 40-man-crew principle may be adapted to varying administrative conditions.

During the summer of 1940 the School of Forestry at Oregon State 'ollege instituted a program for organization and training of forest re-suppression crews. Cosponsors included the National Youth Ad-inistration, State Forester, United States Forest Service, Oregon 'orest Fire Association, and others vitally interested in the protection f Oregons forest wealth. The objectives of the program were:

1. Furnishing the State of Oregon with an efficient fire organization or call in handling emergency fire situations.
2. Training of forest-fire overhead.
3. Furthering the forestry education of participants.
4. Providing deserving students with a means of earning money for hool attendance.

Based at a camp on the McDonald State Forest 7 miles from the 'orestry School in Corvallis, the crews participated in a unique train-ig program. Two hours of study, 2 hours of training, and 4 hours f hard work on approved N.Y.A. projects constituted the day's sched-le. Study included a wide range of practical forestry subjects such s first aid, use of the compass, tree and shrub identification, knot ying, and life saving. Among other things training consisted of ractice construction of fire line, scouting of fires, use of hand tools, nd long hard hikes over the rought topography of McDonald Forest. mong the work projects were the following: Road and trail con-truction, road and trail maintenance, thinning of forest stands, prun-ig of forest stands, soil-erosion control, white pine blister rust control, nd snag felling.

During recreation hours some of the men went swimming in the earby lake, others played games or passed the time by reading the iaterial furnished by parents and well-wishers. Leave from camp as allowed, but not more than 10 percent of the camp strength was ranted leave at any one time. Those who were fortunate enough be on leave went skating at the nearby roller rink or enjoyed a now in town.

Having advertised themselves as ready to report to a forest fire at moment's notice, the Red Hats were necessarily very highly or-anized. The basic unit was a squad of 4 men and a straw boss. One f the straw bosses in each group of 10 was the ranking officer, and a oreman was assigned to each crew of 25. Equipped with pick-ups, rucks, and three 25-man busses the camp had ample transportation. Iand tools and mess equipment were packed ready to go at any time. Vhen a fire call came in, the supervisor designated the responsible of-cer; drivers slipped behind the wheels of the trucks; men who had racticed the procedure beforehand slid tool caches into pick-ups; traw bosses checked off their squads; bed rolls were stacked in the ear end of busses and the men loaded in, caulked boots in hand.

On the fire line the crews worked as originally organized or ex-anded by absorbing civilian fire fighters into their squads. On at least two large fires assistant foremen were detached from their squads and given civilian crews to supervise. Orders were that an assistant be trained for all overhead positions so that supervision would always be available. Since the training program provided timekeepers, torch men, truck drivers, cooks, scouts, and other workmen, members of the crews were often used to facilitate the handling of pick-up labor hired for a given fire. Whenever possible, the foreman of the Red Hat crew involved would rebuild his forces from pick-up labor assigned to him. If such substitution was impractical, however, the crew proceeded with control operations as best it could.

The Red Hat crews were trained in the progressive method of fire-line construction. They did not, however, confine themselves to this operation alone, but burned out their line and mopped-up the area after backfiring operations. The men were assigned positions because of aptitude shown in training and practiced the duties of those positions in order that the need for supervision in emergency situations might be minimized.

While on fire-suppression detail the men were paid a minimum of 40 cents an hour plus their expenses, the overhead jobs paying more according to their importance. Agreement on the wage scale was reached with the forest-protective agencies in the area before the fire season. The agencies all seemed pleased with the results and their average daily earnings of $5.48 also proved satisfactory to the fire fighters.

While participating in the base camp training and N. Y. A. work program, the men were only allowed $1 per day, but since this amount covered expenses, it did make it possible to train and organize the crews in readiness for fire duty. The resulting total average earning (fire fighting and N. Y. A.) was $120 per man above expenses for an average enrollment period of 52.71 days. In addition, 24 men were placed in summer jobs with the forest-protective agencies. The average income per man on these positions was approximately $100 a month plus expenses.

The program enrolled a total of 113 men. The largest number enrolled at one time was 87. Three 26-man crews were active during the peak of the fire season, and 2 such crews were available for practically the entire 4 months (June 1 to October 1).

The camp was initiated for the benefit of first-year students in forestry who were unable to obtain other employment. Because of an abundance of summer jobs last year, all except a small number of the foresters were placed in positions before the fire season opened, and the camp was thrown open, therefore, to any young man in need of employment who was physically fit and wished training in the forestry field. Men were enrolled from almost all of the institutions of higher education in Oregon. College men from at least six other States took part and older high-school students proved very good material.

Popularity of the training program is indicated by the fact that, although plans for the summer of 1941 are at this time very incomplete, applications are already on hand from several States showing the interest of young men who have heard of the organization but did not take part in 1940. With a strong force of veterans returning and with the probability of a guarantee of minimum earnings in prospect, it would seem that Oregon's Red Hats have proved their value and established the program as a permanent institution.

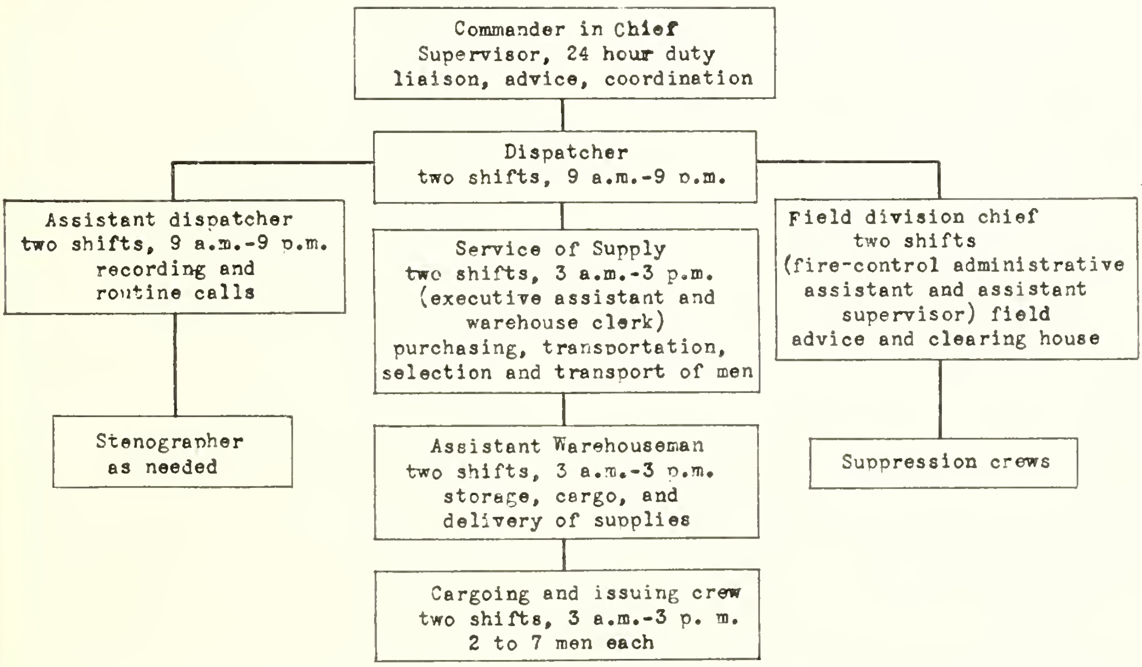
OVER-ALL CORRELATION OF THE SUPPRESSION JOB

F. W. Godden

Forest Supervisor, Salmon National Forest Region 4, United States Forest Service

The author was induced to write the following article only by insistence, fearing he might be accused of boasting. He outlines a basic organization plan which is probably much too rare in practice and unfortunately suggests no method short of experience by which the type of training he says is needed can be conducted or acquired. Different conditions and the experience background of local forest officers may necessitate a different division of responsibilities. The chart with the article is the editor's visualization of the organization described.

Much has been written in Fire Control Notes and elsewhere about line organization, the technical phases of fire-suppression planning, equipment, and other features of prevention and presuppression. Very little has been written, however, on over-all forest coordination covering the actual suppression job when a particular forest is having a concentration of fires, some big.



The editor's visualization of the Salmon overall fire-suppression organization.

In the writer's experience in fire suppression in central Idaho for the last 12 years, it has seemed that failure to suppress fires promptly or cope with a bad situation has in large part resulted from poor correlation of the over-all suppression effort on the forest. True, there have been errors made on the fire line and in field technique, but in general these errors have been relatively small when compared with failures to provide adequate overhead or sufficient manpower, a flow of supplies as needed, proper equipment. transportation facilities, or some of the many other things over which the fire boss has relatively little control. Almost everyone with much fire experience has gone hungry or slept without beds or received crews without tools or seen transportation failures.

The degree of failure has usually been in direct proportion to the size of the job, indicating an organization failure that is difficult to correct through commonly accepted methods of training. The training of an overhead and staff organization that can direct and back up the field forces is a critical need. Dispatcher instructions, fire-control handbooks, job lists, etc., are inadequate in an overload situation when all of the personnel is engaged in suppression, and worry and physical exhaustion are the expected thing. More emphasis should be placed on basic, over-all, organization training.

Beginning with the 1940 season, the personnel of the Salmon National Forest anticipated a suppression overload and organized to try to provide over-all coordination. The organization and training program are outlined in this discussion in order to direct thought and criticism toward this very essential part of the fire job.

A staff organization chart was first made up definitely assigning duties and responsibilities and hours of work to each member of the supervisor's headquarters organization. Needed additional personnel to fit into a off-shift set-up were selected and partially trained ahead of time. The entire organization was patterned on a full two-shift basis through and including the dispatcher's office. The two-shift idea was absolutely essential to enable people to function to the top of their capacities when on the job.

The overhead organization was, of course, headed by the supervisor. The administrative assistant in charge of fire control and an assistant supervisor were designated as field-going suppression overhead. The supervisor fitted himself into the program for the critical overload days as a headquarters officer who would keep in constant touch with all fires, with the regional office, with the routing and the assignment of overhead, with requests for borrowed suppression forces and equipment, and in general to see that no phase of the job was forgotten by the field or the dispatcher or any other link in the organization. Such functions cannot properly be performed by a dispatcher under a constant load of newly occurring lightning fires.

The administrative assistant in charge of fire control and the assistant supervisor went to big fires with radio-communication equipment and acted when necessary as division headquarters officers in the field during the critical days of the fire. They were not fire bosses in the usual sense. They established themselves at a point where diversion of supplies and men was made to the line, at a base camp at the end of the road, or at an airport, where they immediately set up communication with the fire or fires. A ranger or ranger alternate was assigned as actual fire boss. He likewise had radio equipment, which on the larger fires was a *PF* set carried along.

The division headquarters officer acted as coordinator, advisor, and clearing house for the local fire or territory in case of more than one fire. He dealt directly with the supervisor's headquarters on one end and with the fire line on the other. All movement of men and supplies on the fire cleared through him and was coordinated there. He kept in touch with supervisor's headquarters and alone dealt with it as division chief.

The system set up relieved the headquarters officer of all of the matters that could be acted on by the division chief, relieved the fire boss of thousands of details, and provided a direct overhead check on strategy and procedure. It provided immediate expansion to handle new situations, new fires, large spot fires, and direct correlation between these suppression units. It made possible the prompt and proper attention to many other details that simply cannot be handled by a headquarters officer or central dispatcher.

At the supervisor's headquarters, the dispatching was broken into shifts with a ranger who was an ex-dispatcher taking the opposite shift on about a 12- to 13-hour basis. The shifts changed at about 9 a. m. and 9 p. m., which enabled the regular dispatcher to be on duty to handle all of the regular first-line organization work during the day. The second dispatcher was on duty at night.

A dispatcher's assistant was provided for each shift. He did all routine calling and transimssion of messages, but primarily kept a running log of all action. Each time the supervisor or dispatcher made a call of any importance, a time record was kept with a brief statement of the action. The incoming dispatcher and the supervisor were thus enabled to acquaint themselves quickly with everything that had transpired during their absence; the action record also proved useful in many other ways. Under extreme pressure when things were happening fast with several project fires being handled, a stenographer abstracted and took down a record of actions discussed over the radio or telephone.

The office executive assistant and the clerk in charge of the warehouse were assigned to opposite shifts operated from 3 to 3. These men were in full charge of all purchasing, transport, cargoing of supplies, and selecting, contracting for, and sending out fire-fighter forces. They were advised by the supervisor each day the approximate number of forces that would be on duty for the next 24 or 36 hours. They could guide their purchasing accordingly. They were responsible for keeping sufficient trucks serviced, truck drivers properly rested and ready to go at any time, and for getting supplies to airplanes promptly with complete shipping instructions.

Under the men in charge of service of supply a warehouseman for each shift was also used. His responsibility was the actual storage, cargoing, and delivering of the supplies or forces. The regular warehouseman took the busy day shift and a quickly trained experienced man took the other shift. These two men coordinated their efforts as between shifts. Under them a cargoing and issuing crew functioned on each shift headed by a straw boss who knew the cargoing job well. All supplies that went out were cargoed in canvas, weighed, tagged as to contents, with a routing slip attached. The cargoing crew varied in size from two to seven men, depending upon the work load. This crew likewise operated on a 3 to 3 shift.

All rations were packed according to standard menu lists for bulk lunches to be made at the fire, individual sandwich lunches, hot breakfasts, and hot dinners for airplane transport. A brief ration list was supplied in the event food was to be cooked in camp. These were prepared prior to the emergency. In one instance the crew completely assembled, cargoed, and labeled for pack string delivery

200 man-days' supplies of subsistence and commissary in 15 minutes. Accomplishments of the warehouse organization on the line are summed up in Ranger Lester Gutzman's comment on the Bear Creek fire. The Bear Creek fire was 60 miles to the end of a truck road and 18 miles by foot trail to the west side of the Middle Fork of the Salmon in the Idaho primitive area. It burned 2,460 acres, had 15 miles of perimeter, and was controlled by 200 men during the third burning period. Gutzman said, "This was the first fire in my 18 years of experience on which I never missed a meal or a bed."

Upon receipt of a telephone or radio order from division headquarters to the dispatcher's desk, four copies were promptly made indicating the name of the fire, the items, and the method of transport to be used, naming the particular airplane or pack string if possible. Copies of these orders went to the purchasing division, to the warehouseman, and to the cargoing crew; one was retained at the dispatcher's office. All property and commissary issues were noted on these orders for the warehouse record. Corrections or changes were made and property charges entered on the warehouseman's copy, which was retained as the key copy after the order had been checked and sent. The packing copy went with the order.

Under the system described the supervisor functioned as a commander in chief. He relied on the ranger and the division headquarters officer for field action. He was in regular communication with the fire, the regional office, and neighboring forests. He correlated action between the different parts of the forest, saw that each part of the organization was functioning, and was largely in the business of remembering. Those under the gun are bound to forget; he who is in a detached position is not so likely to do so. The supervisor slept when there was a lull, and there were many during the 24 hours, and he was not particularly overworked. He could consequently do his over-all job better. He was tied to no details except for short periods and where most needed, such as at the dispatcher's desk when a concentration of lightning storms occurred. He then stepped in and helped.

The Salmon organization plan had a thorough test on the forest last summer. It handled 162 fires during the season. At one time during August 22, 23, and 24, in addition to having crews on 1 class C, 1 class B, and 3 class E's that had occurred on the days just preceding, 52 class A's, 8 class B's, 6 class C's, and 2 class D's were handled, with 500 men and no supplemental outside overhead. Fifty-two of the sixty-eight fires occurred on August 22 and there were also many reports that proved to be false. One of the A's, 2 B's, and one D were extra-period fires.

The kind of situation indicated and worse probably can be expected frequently on the Salmon. The fact that there were any extra-period fires and one outstanding mismanaged fire shows a weakness in the organization. It indicates that much yet remains to be done. Improvement will come in fire-line technique, better equipment, and better trained men, but largely in a better correlated organization.

The history of all wars and all military campaigns indicates that organization from the top is one of the primary keys to success. Critical scrutiny of fire-control efforts should therefore include forest and regional organization set-ups. Thought and training directed toward improvement in over-all organization will really pay dividends.

WAR GAMES ENDANGER FORESTS

LEIGH HILLIKER

Forest Ranger, Wisconsin Conservation Department

We do not ordinarily think of the national defense program as adding new hazards to our work. However, the author describes one phase of this program as it affects the fire-protection work of foresters. It is particularly illustrative of the results which can be obtained through wholehearted intelligent cooperation between the Army and a forestry organization.

Central-area forest-protection personnel in Wisconsin had some serious misgivings early in the summer of 1940 when it was announced that maneuvers of the Second United States Army were to be held in the area during August, potentially a month of the highest forest-fire danger. Maps showed the five base camps and scattered training areas covered large tracks of some of the worst fire country in forest-protection districts 9 and 10. A force of about 65,000 men and 7,500 motorized units was expected.

Action was started through the forest-area supervisor's and district rangers' offices to meet the increased risk from smoking, campfires, motors, and visitors. A memorandum listing forest-fire dangers, Wisconsin fire laws, means of preventing and methods of suppressing forest fires, and asking cooperation was sent to Army headquarters. Army authorities responded by including a section in their manual of instructions about fire dangers, prevention, and control. All troop units were given these instructions before leaving home bases. Conservation Commission Order M–171, restricting the use of fire in Wood, Juneau, Jackson, and Monroe Counties was also invoked.

On August 8 a meeting of central-area personnel was held at Black River Falls. At this meeting were Forest Area Supervisor H. T. J. Cramer, District Rangers Vern Hilliker and Einar Jensen, rangers, towermen, cooperating foresters, and conservation wardens in and adjacent to the maneuver area. Radio communication schedules, information to be secured from the Army, labor, equipment, and other details were discussed.

Five rangers were assigned to Army base camps to act as technical advisers to the Army on fire prevention and control and coordinate information to the dispatchers' offices. Assignments were as follows: Cooperative Ranger Pauly to Camp McCoy at Sparto, Cooperative Ranger Sylvester to Warrens, and Ranger Papke to Wyeville, all in Monroe County; Ranger Fisher to Shamrock, Jackson County; and Ranger Hilliker to Camp Williams and Necedah, Juneau County. Extra two-way short-wave radio and truck equipment had been supplied from northern areas so that each man would have a complete transportation and communication unit.

On August 9 a conference was held with the Second Army provost marshal, Colonel Baldwin, and assistant provost marshals, at Camp

McCoy. Provost marshals act as military fire marshals. It was learned that rangers stationed with the Army would be accorded officer's accommodations in the way of quarters, mess, etc. Also that all troops had been instructed in care with smoking, campfires, and motors, and would take the initiative in reporting and suppressing any fires starting. Trench tools, wet sacks, and boughs were to be used and reinforcements of men or equipment were to be called as needed over Army or WCD communication systems or both. Colonel Baldwin stated that the Corps of Engineers had special equipment and skill for fighting large or stubborn fires. Officers were instructed that forest-fire suppression would take precedence over all other operation and to furnish labor to rangers on request.

On Monday, August 12, all five rangers assigned to the "war" were at their camps with fire trucks and radio equipment and engaged in meeting commanders of specialized units, gathering maps, information on type and location of operations, and special fire hazards. In many cases, copies of the field order covering the immediate maneuver or problem were furnished.

Adjacent to each base camp was a training area. The lands consisting of about a township had been previously leased by the Army from the owners and were widely used for cross-country movements. The owner of any land suffering unusual damage was to be reimbursed by the Army Rents and Claims Section. The territory used provided several types of topography from the rugged hills of western Monroe County to flat stretches of marsh and jack-pine plains of central Juneau County. Comparatively small problems in battle tactics, transportation, service of supply, communications, etc., were carried on daily in these areas by infantry, artillery, cavalry, and observation squadrons or combinations of such forces.

Smoke screens were to be reported to rangers in advance and sample pots were set off for the purpose of drilling towermen to distinguish them from forest fires. No incendiary or tracer ammunition was to be used, thus eliminating a serious risk of fire. Blank cartridges were to be used except on the target range. Flying officers explained that flares would be dropped from planes at such an altitude as to be burned out and cold on reaching the ground. Orders were to watch Very pistols closely so that they would not cause fires. Campfires, smoking, and field kitchens were to be allowed only in safe places.

Each ranger followed a similar schedule in gathering and condensing information from the command post each morning on the type and extent of the day's operations and then sent a report by radio and telephone to dispatchers at Friendship and Black River Falls so that areas of greatest fire risk were anticipated. Advance plans and location of units available for fire fighting and communications were also reported. On many days the ranger accompanied troops in areas of hazard, watching for signs of carelessness with fire by soldiers and the public and always ready to rush to a danger spot. Rangers kept in radio communication with towermen at 15-minute intervals.

Old Jupiter Pluvius was very accommodating to the fire-control force, if not to the Army. Some rain fell on 13 of the 20 days of the maneuver period, which made it possible for rangers to return at times to their regular stations and attend to other duties. To many troopers, Wisconsin is the land of swamps, rain, and mosquitoes.

On August 23 the entire Second Army divided into two forces composed of the V Army Corps, called the Blues, and the VI Army Corps, called the Reds. The two forces drew apart and established secret concentrations near Necedah and the Mississippi River, respectively. At 12:30 p. m., August 24, a large "battle" started. Scouts were sent out to locate the "enemy" and report back to headquarters. Forces moved up during the night to the "front lines" in the vicinity of Tomah, Warrens, Millston, and Purdy Valley. The operation was to be continuous, night and day, until August 27, but incessant rain and the fact that the tactical problem was completed ended the battle on General Ford's order the afternoon of August 26. On cessation of "hostilities" the Reds had pushed the Blues back, according to umpires, but the Blues were organizing a counter attack.

During the battle troops, trucks, and other equipment covered about one-half of forest-protection districts 9 and 10. No doubt there would have been more foreset fires if more than twice the normal rainfall had not fallen. The month was the wettest August in some years. Smoldering campfires and burning cigarettes were observed, possibly where a speedy retreat was made, but as a whole the Army gave the forest-protection division and helpers very fine cooperation and service.

Only two fires, burning a total of 2.1 acres, were caused by the Army and required assistance from the forest-protection division.

Errata—January 1941 Fire Control Notes.—In Fire Control Notes for January 1941 appeared an article entitled "A Planning Basis for Adequate Fire Control on the Southern California National Forests," by S. B. Show, C. A. Abell, R. L. Deering, and P. D. Hanson of Region 5 and the California Forest and Range Experiment Station, U. S. Forest Service.

This article was preceded by an "Introduction," intended by Fire Control Notes as a leader, which was written in the Division of Fire Control of the Washington office. The leader should have been printed in smaller type with the indentation customary for such leaders and not in the regular type, under the heading "Introduction."

As the leader was neither written nor reviewed by the authors of the article before publication, it therefore, should be considered entirely independently and should have been so indicated. Any review of that article should be made with this correction in mind.—Division of Fire Control. W. O.

Errata.—The chart on page 78 of the April 1941 issue of Fire Control Notes should have appeared with Arthur A. Brown's article, replacing those on page 90. These two charts on page 90 should have appeared with E. Arnold Hanson's article just preceding Brown's.

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FIRE NEWS BROADCASTS TO FOREST OFFICERS—WITH PUBLIC CONTACT ASPECTS

Albert E. Straub, Jr.

Bighorn National Forest, Region 2, U. S. Forest Service

What is believed to be the newest method of giving the latest up-to-the-minute fire news and information to forest officers and others interested in fire protection; that is, by broadcasting from a commercial station, without remuneration from the Forest Service, was inaugurated at Sheridan, Wyo., in July 1940. Although the programs have direct value on the forest, Straub believes they have at the same time been of far more interest to the public, because of the psychology used in their presentation, than the usual program designed entirely for publicity purposes.

After consulting with the local forest supervisor, the manager of Radio Station KWYO at Sheridan, Wyo., inaugurated a forest-fire protection program to be broadcast as "The Rangers on the Mountain" each morning except Sunday, at 7:15, and on Sundays when fire conditions made a broadcast necessary, the program to be known as "Your Ranger Station Program." The manager of the station is Jack R. Gage, formerly State Superintendent of Public Instruction in Wyoming.

Because it was thought that the public would be more interested if they felt they were listening in on something not meant entirely for their ears, the program was broadcast to the rangers and gave them fire data and other information.

Each day data was furnished radio station KWYO, on going fires, fire-danger station readings from one of the lookouts, weather readings from the local office of the Weather Bureau, time of sunrise and sunset, time signals, fire conditions in general, and the outlook for the day, news of local interest to forest officers pertaining to their work, or information on the movements of both local and visiting forest officers. Some humor was also thrown in so that the program would not bore the listeners. To round out the programs, spot announcement transcriptions, prepared by the Washington office, were furnished, and for another season it is planned to use more of these so that they will not become tiresome.

Following is a complete broadcast as given over KWYO for one morning:

"Good morning. This is the Ranger Station Program. The date is Tuesday, August 13. Sunrise this morning was at 5:07; sunset will be at 7:18. The weather report this morning is * * *. Report from Black Mountain Lookout at 3 p. m.: Northeast wind, 12 miles per hour; wet-bulb reading, 51; dry-bulb reading, 72; relative humidity, 25; fuel stick, 7 percent; no rain reported; deduction for condition of annual vegetation, 3; daily evaporation, 5.9; total cumulative evaporation, 37 plus; fire danger 74 * * *. Get ready to set your clocks and watches (time signal).

"Fire reported 13 miles southeast of Lodgegrass on the Indian reservation. They called for help and a foreman and 25 men were sent from the Turkey Creek CCC camp. They left during the night. No report back yet as to progress.

"It has been called to our attention that the readings as taken from the lookouts do not give a true picture of the actual hazard. For very obvious reasons, the lookouts are located on exceptionally high spots, and as a result of location in the high country, the hazard is never as great as it is in the lower parts of the mountains. So when we get bad reports from the lookouts, you can know that the conditions on the mountain in general are much worse than the reports indicate.

"It is reported from the Forest Service office that the Assistant Supervisor, Mr. Clark, left for the Burgess Ranger Station, where he will remain until Tuesday night. We reported last week that Mr. Connor was making a trip on the mountain and would end up at the Porcupine Station, where we understand he is now and will remain until the end of the week.

"A report from Ranger Post that might be of interest to Ranger Vinacke was to the effect that in the continued search for the body of Donald Long, in Lake Solitude, fires had been built around the shores of the lake and from these fires there had started a creeping fire in the slide rock which fire is reported as still burning. We gather from the report that the fire is not now of a serious nature but will bear watching. Being ignorant of the forest and the way of fires, we made the obvious remark that it must indeed be a dry season when slide rocks caught fire. The boys in the forest office were very nice and explained that these rock fires were not bad and that the only reason they paid any attention to them at all was to keep from burning the tops of some of our higher peaks. Yes, if it were not for the boys in the forestry office we would probably go along never knowing these interesting things about rock fires. *Until tomorrow, have a good day, and no fires.*"

[Bighorn personnel believe that these broadcasts are obtaining the results desired. Information of general and special interest is distributed to various forest officers, to visitors in the forest, and to local communities. Rangers are religiously tuning in when they can, and a great deal of interest is shown generally.—Ed.]

Emergency Rations on the Pisgah.—One of the problems of fire fighting in the Appalachians is to supply "grub" to men on fires. Attempts have been made to provide hot lunches, but usually the lunches were cold or the fire fighters had to walk a long way to get them. Cold lunches, consisting of sandwiches, were next tried, but usually these were soggy and unappetizing.

The emergency rations now used on the Pisgah are prepared for the standard 18-man crew, and are carried in a portable box by the truck driver and water boy. The box is standard equipment on all fire trucks, and accompanies the fire-tool box.

The emergency rations consists of: 2 pounds coffee, 1 pound sugar, 4 pint cans milk, 2 pounds hard tack, 1 gallon fruit, 1 coffee pot, 5 pounds corned beef, 4 quarts pork and beans, 1 gallon tomatoes, 1 can opener, 1 knife, 2 large serving spoons, 2 dozen each of paper plates, cups, and spoons.

Some of the districts on the Pisgah have been using four loaves of bread in the emergency rations, changing the bread daily. The general set-up, however, is the same.—John B. Fortin, district forest ranger, Pisgah National Forest.

A PROGRAM FOR THE VIRGINIA-KENTUCKY-WEST VIRGINIA "HOT SPOT"

An analysis of statistics revealed that in the area where Virginia, Kentucky, and West Virginia join, containing but 7 percent of the protected area of region 7, 14 percent of the total number of fires occurred, and burned more than 34 percent of the total area burned. To formulate a comprehensive fire-control program for this "hot spot," State Forester D. B. Griffin, of West Virginia, called a meeting of representatives of the three States concerned and the United States Forest Service. The following recommended program was developed at this meeting:

1. Contact the larger timber landowners and operators and solicit their support in an intensive fire-control campaign in the districts within which their lands lie.

2. Request owners and operators to notify by letter all employees, lessees, and tenants on their lands of their intentions and to solicit their cooperation in the prevention of forest fires on their particular leases and on lands in general. The notices are to be signed by the highest company official that can be reached.

3. Request each company to post a notice on company bulletin boards or at other conspicuous places on its property, warning all employees, lessees, and tenants to use care to prevent forest fires.

4. Where there are inadequate brush-burning laws, ask each company to insist on employees, lessees, and tenants living on its property securing a permit from the company before burning brush or debris on their leases.

5. Request each company to appoint a warden who will have direct supervision of the first-control work on company lands and who will have the backing of the company in such fire-prevention activities as may be initiated and authority to summon employees, lessees, and tenants of the company to assist in fire-suppression work and with whom the State's district forester or his representative may collaborate in the preparation of a definite written fire-control plan for the lands of his company, which will show:

(*a*) Fire-prevention methods to be adopted.
(*b*) The distribution of manpower and equipment.
(*c*) The detection and dispatching system.
(*d*) The set-up for handling the normal fire load.
(*e*) The set-up for handling an emergency fire load with provisions for replacements and reinforcements after regular crews are dispatched to the fire line.
(*f*) Definite assignment of responsibility for the various phases of the fire-control job.
(*g*) Definite detailed written instructions listing the jobs to be accomplished.
(*h*) Provision for follow-up supervision and inspection; coordination of the efforts of all agencies on the company lands or within the community capable of contributing to the forest-fire control program.
(*i*) Selection of a supression crew of from 5 to 25 employees, lessees, or tenants of the company.

(Continued on p. 153)

FIRE-CONTROL WORK IN ISOLATED SECTIONS

J. H. Sizer

Assistant Supervisor, Tonto National Forest, Region 3, U. S. Forest Service

Upon request, the author prepared this article with the thought of raising question about some of the fire-control problems in isolated sections and offering suggestions for meeting them.

Success in fire-control work in isolated sections, as in other places, depends on having the right man at the right place at the right time with the right kind of equipment. To do this with a limited organization of men and equipment is not easy, however. In isolated sections, where fires almost invariably involve the moving of men, supplies, and equipment considerable distances over mountainous terrain on foot or with pack animals, it is particularly difficult. Moreover, the men arrive on the fire line exhausted several hours after the fire is first discovered to find that the fire has developed from an insignificant smudge to a roaring inferno that singes the brush and cover from an entire slope before a tired fire fighter can scramble a dozen yards in an attempt to beat it to the top.

To meet the needs of such a situation, it is necessary to send out a weary messenger with a call for more men, who may arrive a day or two later to find the initial crew worn out but still working at some hazardous point on the line, while the greater part of perimeter of the fire burns on undisturbed. Obviously, the needs are communication, transportation, and a reasonable supply of manpower distributed through isolated fire-hazard areas during fire-danger periods.

Throughout the Forest Service much thought has been given to the problem described and a great deal of progress has been made in organization and in the development of special equipment, ranging from hand tools to fire finders, portable pumps, and radio phones. Airplanes are being used to transport men and supplies, but their use is still in the experimental stage and may not prove the answer in all cases. Most, if not all, of these developments have been put into use throughout the Service insofar as funds permit and local conditions require, but the allotment of funds to isolated areas is not always sufficient to provide needed protection.

In an effort to provide better protection, trail crews, made up of two local, dependable, experienced men, are stationed at strategic points in isolated areas during the fire-danger periods. They are provided with one saddle and one pack animal each and the necessary tools and camp equipment for hand work on trails or fire fighting, and are used in construction and maintenance of horse trails needed for better transportation.

These crews are equipped with an S or SV radio transreceiver set, which, in conjunction with type T stand-by sets installed on lookout points, provides a quick and efficient means of communication. A fixed schedule is arranged for communication with lookout points, and when a fire is discovered it is reported by radio to the nearest trail crew, which immediately goes to the fire. If additional help is needed, the lookout is called by radio and the next nearest trail crew is dispatched to the fire, and so on.

This arrangement is effective in handling fires in isolated areas until a situation develops in which the number of men available within reach is insufficient to handle the situation and larger crews must be provided. In the fire-organization plan for each ranger district the sources of man power, the numbers of men, tools, and equipment, trucks for transportation, and pack and saddle animals available are indicated. In theory the plan provides that in case of a serious break requiring a large crew, it can be obtained by calling upon manpower and equipment nearest the scene of action. This is all right insofar as truck transportation is concerned, but in handling fires in inaccessible, isolated areas, it may be difficult to obtain sufficient pack and saddle animals without undue delay. Such animals must usually be obtained from local ranchers, who normally turn out on the range the saddle and pack animals they are not using, and although ranchers may have the number of stock indicated on the organization chart, if more than a few head are needed they must be gathered from the range and shod before they can be used. Several hours delay frequently occurs in getting pack animals needed to transport supplies to a big fire.

Under such circumstances it is necessary to walk the fire fighters from the end of truck transportation to the fire, and frequently each man must carry his tools and a small amount of food and water on his back. A fire fighter is frequently well-nigh exhausted by the time he arrives at the fire and his efficiency is materially reduced. An orderly check of men and supplies arriving at the fire is extremely difficult, as men are apt to discard their packs and start work on the fire where they first strike the line. This disrupts organization and frequently results in a surplus of manpower at some points on the line and a shortage of help at others with an unknown quantity of supplies and tools, the location of which is known only to the men who carried them in.

Maintaining a reasonable number of Government-owned pack animals at a point where they can be placed in service on short notice would meet this situation. Such an arrangement might mean locating a pack train where the animals could be transported to the nearest point to the fire accessible by truck, which normally would be the truck supply base for use on that fire. It would necessitate having ready for service trucks equipped with stock bodies and tail-gates suitable for loading and unloading pack animals. Pack trains could go in when men and supplies were dispatched, and delivery of tools and supplies for a fairly large crew could be made at the fire line by the time they were needed. If additional pack animals and a larger crew where found to be necessary, the additional animals could be obtained from other sources in time to avoid disastrous results.

For use in rough mountainous country, such as is found in the southwestern region, where grass is frequently scarce and pastures nonexistent, burros may be more desirable than mules for pack animals as they are more easily kept around a camp, are less apt to stray, will ubsist on scant forage, will carry almost as much load, are easier to oad, travel almost as fast, and are less likely to stampede with a)ack.

During periods when the pack train is not needed and fire condiions do not necessitate keeping pack animals available for use on hort notice, they can be turned out on pasture or kept on forest range vith little or no expense until such time as they are again needed. The uggestion for such use of pack animals is not offered as new, but ather as a recommendation for wider use of an effective and economical neans of transportation.

Radio on a Forest Fire.—The first use made of radio in Wisconsin Fire-'rotection District 7 was to ascertain how far messages could actually be sent nd received satisfactorily. In testing best results were obtained in communiation from ground to forest-protection lookout towers. The tests were sucessful over distances up to 18 or 20 miles.

October 3, 1939, was a bad fire day; the humidity was low and the temperaure high, and a brisk southwest wind prevailed. Several crews working out f the Hayward Ranger Station had been dispatched to fires and shortly after p. m. the Pipestone towerman picked up a smoke to the northwest. The ispatcher checked with other towermen but because the visibility was poor, he towermen could not see the smoke.

After checking on our map the reading and distance given by the Pipestone owerman and the type of forest cover, it was decided that I would go immeiately with a crew and a radio to the fire. When we arrived in the vicoinity f the Chippewa Flowage, we spotted a smoke, but it looked so close we were lmost certain that it was out on one of the many islands on the flowage. Iany comments were offered by the men while the radio was being set up, uch as, "Towerman must have been wrong; that smoke is out on the flowage s sure as I am a foot high."

The Pipestone towerman had been instructed to be on "stand-by receive" nd was contacted immediately. He informed us that the fire was in the ardwood and hemlock slashing south of the Chippewa Flowage and also outh of the Indian village called New Post. I asked him to inform the ispatcher at Hayward of our location and that we were proceeding to the re immediately.

We finally arrived at the fire and soon had it under control, making use of he radio frequently to communicate with the towerman, and, by a combination f radio and 'phone, with the dispatcher and other stations.

Had we not had the radio, I am certain that in this case we would have topped at the nearest boat landing and gone out on the Chippewa Flowage in uest of this fire, which would have resulted in our not finding it for several ours. The radio set is now taken along to every fire and considered just as mportant as the regular fire-fighting equipment.—Clarence Johnson, Wisconsin Conservation Department.

Spread of Cheatgrass Increases Fire Hazard.—During the last 10 years lowny chess or cheatgrass (*Bromus tectorum*) has extended its range perceptibly n and adjacent to the Holy Cross National Forest. Overgrazed areas in the ower to moderate ranges of elevation and roadside zones have in many places everted almost solidly to cheatgrass.

In normal years the spread of cheatgrass would cause little concern from a fire standpoint. However, during the last few years the dry seasons have forced consideration of this plant as a serious fire menace. It is understood that Region 1 rates cheatgrass as one of the flashiest of fuel types, and this rating is well substantiated in the few fires which have occurred in this type on the Holy Cross. Because of relatively heavy human use the roadside strips present the greatest hazard.

Heretofore restricted in intensity by elevation, a limited range, and an abundance of moisture, the cheatgrass fire hazard must now be given a high rating in fire planning.—D. S. Nordwall, assistant forest supervisor, Holy Cross National Forest.

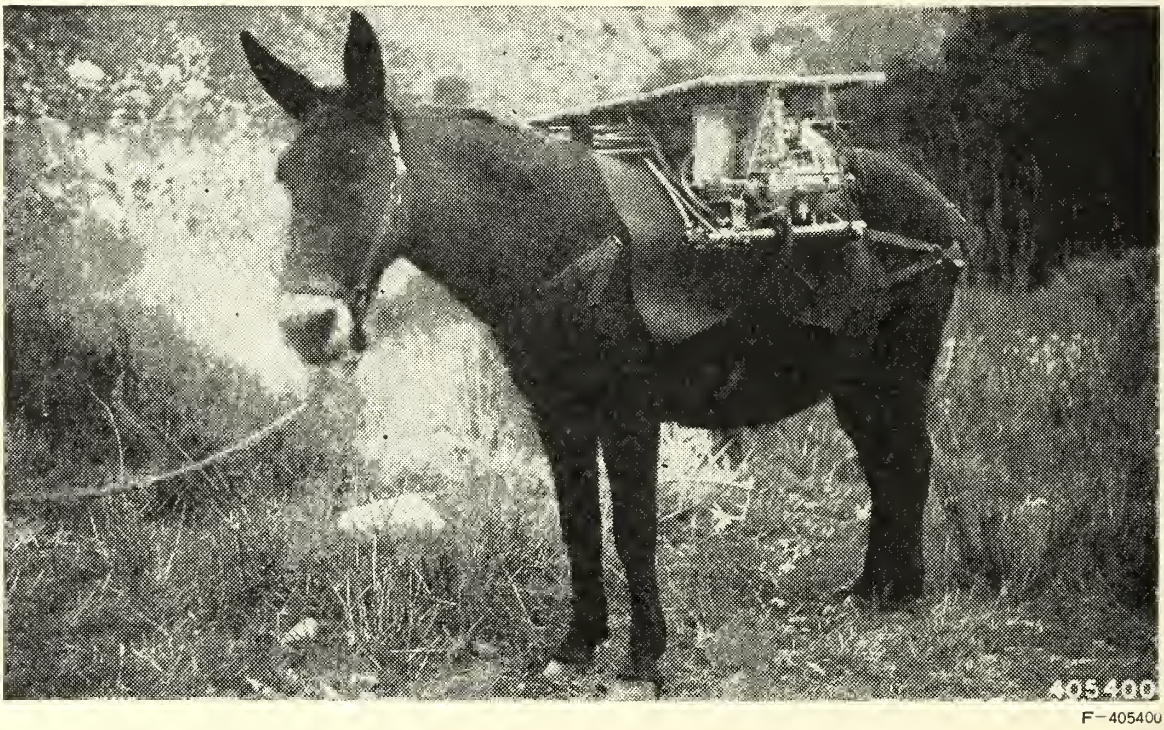
A PORTABLE FLAME THROWER

Neil L. Perkins

Los Padres National Forest, Region 5, United States Forest Service

Mobility of tools and equipment over all types of terrain greatly increases their usefulness. This new unit, which was adapted from equipment described in a former issue, will add to our ever-increasing store of knowledge. Local ingenuity has adapted the practice of using a shield for protection in oil and gas fires to forest-fire fighting conditions.

When the mobile flame thrower described in Fire Control Notes (July 1940, Mobile Flame Thrower) was sent to Los Padres National Forest for a try-out, Forest Supervisor S. A. Nash-Boulden and his associates were quick to perceive its possibilities. In its original design, however, the flame thrower could be used only on roads or truck trails—a serious restriction to its use on forests where



Ready for the trail into the back country with flame thrower on board.

most of the fires occur in rugged country accessible only by steep horse and foot trails.

Los Padres mechanics went to work on the new machine. Removing it from the trailer entirely, they mounted the pump, engine, and a small tank on a special stretcher frame to be carried by two fire fighters. This was better for use on the Los Padres Forest, but involved the services of four men for transportation—two carrying and a two-man relief crew. As manpower in the back country is often at a premium, the idea of mounting the outfit on the back of a pack mule was suggested. The suggestion was met with a series of dubious grins since the idea smacked a good deal of tying a bunch of firecrackers to a mule's tail. However, the supervisor had not handled mules in the southern California mountains for some 30-odd years without knowing their possibilities. After a special pack frame had been made and tested, "Jack," the selected animal, could carry his snapping, crackling burden quietly and efficiently. Moreover, a dozen of his four-footed associates also have been trained and are now ready to traverse the fire lines under this unusual load.

In field operations with the flame thrower the intense heat at times made it necessary to protect the operator. After considerable experimenting, a tip made by a No. 70 drill was installed at the end of the 6-foot aluminum pipe 1/4 inch in diameter.

To give additional protection from the heat, a reinforced asbestos aluminum shield that weighs only 6 pounds was added. The shield is 24 inches wide and 42 inches high, with the top slightly curved. There is a 3- by 3-inch peephole, covered with a Coleman Mica

Los Padres portable flame thrower in use as a stretcher-type unit. Note the protecting shield.

lens, centered 8 inches down from the top, and a 6-inch handle centered on the shield 19 inches up from the bottom. An oblong hole was cut with a 1/2-inch radius at the top and bottom 2 inches long to the right of the handle, 17 inches from the bottom, and 9 inches from the righthand side. Through this hole the 6-foot aluminum pipe of the flame thrower passes. It is then fastened in place by bolts through the shield and a bracket fastened to the flame-thrower pipe. The end of the pipe is fastened to the hose or control line and has a slight downward bend for comfort in handling.

On each side of the stretcher two telescopic handles slide inside of the pipe frame and are held in place by wing-nut bolts. When desirable to use this unit stretcher style, the two inside handles are pulled out to their proper position and tightened by the wing-nut bolts. The outside handles have to be pulled clear out of their keeper and placed inside the opposite end of the inside holder and tightened by the wing nuts provided. The operation described, although sounding quite complicated, is actually simple.

The flame-thrower unit is easy to pack. The shield is fastened firmly by wing nuts to the top of the pack, and the flame-thrower assembly fastened to one side of the pack frame in a suitable position to permit packing without difficulty. The 50 feet of hose can be coiled around the pack frame and held in place by a strap on each side.

The engine and pump weigh 49 pounds, the 5-gallon can full of Diesel oil weighs 50 pounds, the 50 feet of hose, frame, and other parts weigh 54 pounds. The unit, therefore, carried in stretcher style, including the 6-pound shield, weighs 159 pounds. The addition of an 11-pound special rubber pad for the protection of the mule makes the total weight 170 pounds, mounted on a pack animal.

The unit, as finally made up, may serve three purposes. First, it can be placed in a truck or pick-up, connected to a barrel of Diesel oil, and used to backfire along roads or any place where it is possible to drive the vehicle. Second, it can then be put on a pack animal, and the backfiring can be continued until the fire line becomes too rough for pack stock to travel. Third, by use of the telescope handles it becomes a stretcher-type unit, and can be carried by men into country accessible only by foot travel.

The whole unit is held firmly on the pack animal by an extra cinch buckled to the exterior part of the frame on each side. This simple device eliminates the use of rope which might cause injury to the mechanical parts of the unit. An empty first-aid can is fastened to the engine frame upside down and contains an extra spark plug, cranking ropes, and tools required for repair work.

The capacity of the tank on the pack or stretcher unit is 5 gallons. The 5 gallons of oil will burn for 18 minutes continuously, or about 30 minutes as used on most backfiring jobs. With two pack animals carrying 20 gallons each, and another 5 gallons in the flame-thrower unit on another animal, it is possible to do a 5-hour backfiring job.

Fires, Insects, and Game.—In the field of agriculture and in agricultural literature there are many facts and much evidence that fire-control men may find useful in their presuppression educational work among the public.

Some people are of the opinion, for example, that by burning off fields, marshes, and fence-rows, they will destroy noxious weeds and insects that attack farm crops. Such burning often results in wood fires. It is true that fires may destroy the weeds, but surprisingly few farm pests are destroyed by burning. It has also been found in experimental work that burning kills the better grasses and forage plants, that burning weeds only destroys the current year's crop, and that seedbed conditions following burning are improved so that the next year's weed crop may increase.

On the other hand, the fires destroy the birds that prey on the insects. The birds would destroy more in one season than would be destroyed by burning in many seasons. Grasshoppers, for example, make up a large part of the diet of pheasants. It is true that pheasants eat a few garden crops, but the damage that would be done by the grasshoppers they eat would greatly outweigh the damage done to the crops by the pheasants. I have never found an agriculture or soil-conservation expert who approved of burning to eliminate insects.

What do these facts and observations have to do with the technique of fire control? Perhaps very little directly. However, they do make effective arguments for use in fire-prevention educational work among farmers. The point here is that fire-control men can make their prevention work with the public more effective by learning to talk the language of the groups they are trying to reach, knowing something of their problems, and of the answers to them.—R. C. Kirkpatrick, forest ranger, Wisconsin Conservation Department.

WATER—THE FIRE EXTINGUISHER

F. W. Funke

Specialist in Fire Control Equipment, Region 5

The beneficial effects of the spray nozzle have been recognized for some time, but the cost of suitable nozzles for forest-fire control work, together with a lack of available information, have been problems confronting many forest officers. The author, after many trials, developed a new and inexpensive nozzle which may materially stimulate this phase of fire-control work.

In the early days of organized forest-fire protection water was considered of questionable value as a supplement to hand-tool equipment. Limited crews and poor transportation being the rule, it was a rare occasion which permitted the use of manpower to haul water. It was seldom that water played a part in first attack. Over the years the picture has changed considerably. Water-using equipment has reached a high state of development, techniques have been established, and in the area which can best be served by tank trucks, water is now the primary initial action weapon.

Of the many factors which have contributed to this development probably the most important is the large percentage of man-caused fires which occur within a relatively short distance of roads and can be reached with tank-truck equipment. Equally important is the fact that a high-pressure hose line in the hands of an experienced suppression man is much more effective in extinguishing a hot fire than the standard five-man crew equipped with hand tools.

The Value of Water in First Attack

It has been demonstrated beyond question that it is always possible to attack a fire directly with water. The judicious use of water enables a crew to secure much more rapid control and hold a greater length of line per man and permits doing a given job quickly and with a minimum of fatigue. Fire perimeter being reduced to the most practical minimum, the result invariably can be expressed in terms of small area burned and low suppression cost.

In first attack it is not always possible to use direct-attack technique with hand tools alone. Rate of spread, intensity of the fire, and other conditions usually create situations which call for indirect treatment. The latter method is an entirely practicable and satisfactory approach; however, it does have one serious disadvantage. In flashy fuels the increase in fire perimeter which must be handled because of the method of attack quite often proves disastrous. It is generally accepted that indirect attack on an initial-action job always introduces possibilities which are hard to evaluate at the outset.

Tests have been conducted at various times by fire-suppression specialists to determine the value of water in first attack. Such tests have never been carried to a conclusion which can be supported by statistical data because of the simple practical fact that when water is used to support hand tools the action is so completely changed that it bears little resemblance to the usual performance. There is no question in the minds of suppression men as to the value of water in first attack, and while it is difficult to measure the effectiveness of water as compared to manpower, accepted opinion seems to indicate that for an average fire condition, a crew of four men equipped with the usual hand tools and one back-pack outfit is a more effective unit for direct attack than a six-man crew equipped with hand tools. When water is used there is a very definite economic advantage in manpower.

Concurrent with Forest Service development in water-using equipment, the States, counties, and various cooperative agencies have followed a parallel plan from which, it would seem, that the five-man suppression squad equipped with a standard tank truck and its auxiliary equipment has proved to be the most flexible and efficient unit for general fire-suppression work. The power pumper permits attack under conditions which would be hopeless for much larger crews equipped with hand tools. As compared to hand-tool work, the power pumper extends the effectiveness of suppression crews in the ratio of about three to one. However, it should be kept constantly in mind that tanker use must be coordinated with and supplemented by hand-tool work.

Water Volume or Efficiency?

In municipal fire departments the technique developed for the application of water appears to vary as widely as the individual experience of the supervisory personnel. A somewhat similar situation exists in forest-fire control agencies, yet all will agree that the basic principles are the same whether applied to structures or forest cover. On one point at least there is general agreement—entirely too much water is used to do a given job.

With respect to water it is known that:

1. No element or substance has greater heat-absorbing qualities.
2. The efficiency of water as a fire-extinguishing agent depends almost entirely on the surface area of the water exposed to the fire.

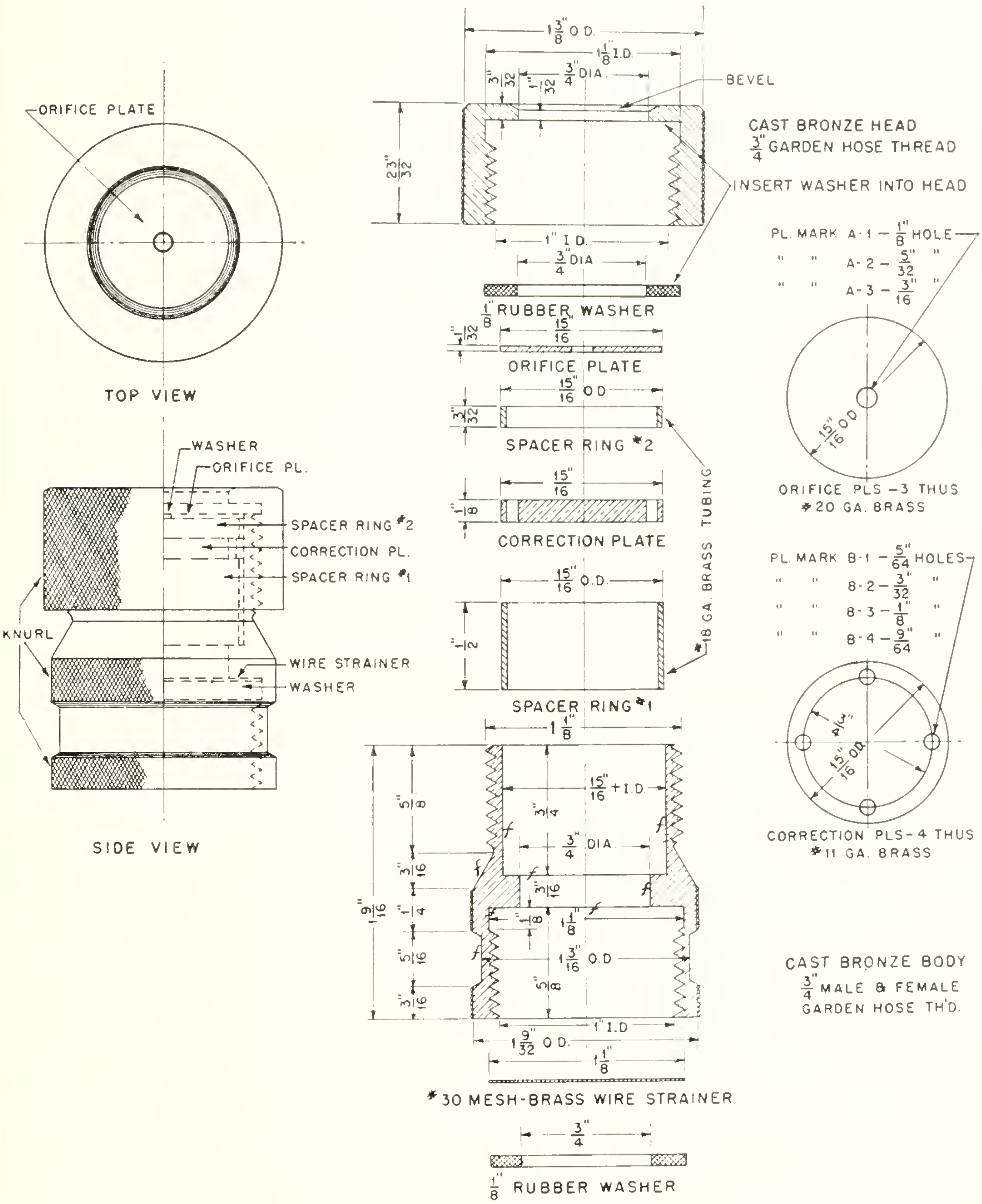
If thinking is confined to the potential effectiveness in each gallon of water projected through a hose nozzle, a number of interesting problems appear. A simple test arrangement will answer many questions.

Using 250 feet of 1½-inch hose:

Pump pressure: 95 pounds per square inch.
Nozzle tip: One-fourth inch.
Nozzle pressure: 80 pounds per square inch.
Approximate discharge: 16.3.

Under the conditions given water is flowing through the nozzle at a velocity of approximately 118.9 feet per second at a rate of 0.27 gallons per second, or slightly more than 1 gallon for each 4 seconds of operation. Even with the low pressures indicated a considerable quantity of water is flowing. A ¼-inch stream presents a very small diametrical head to any fire and efficiency is at a low point. Also, it should be quite clear that slight misdirection of the stream can be expressed as waste. Referring again to the rate of flow, 16.3 gallons per minute, little imagination is required to realize that for a given quantity of water projected through a fire hose, a surprising total is lost. The loss can be reduced by careful application but can never be eliminated. From the standpoint of efficiency, the only useful functions of the straight stream are:

1. Drilling into soil and duff.
2. To reach heights greater than 25 feet.



Hose nozzle designed for use in forest-fire suppression.

Despite the fact that the vapor tip is generally accepted to be the most efficient water applicator known to science, it has not been well received. There are many reasons for this attitude on the part of the field, but it is quite likely that the most important one is cost. Until quite recently, vapor nozzles have been priced well beyond the reach of lean budgets. A second reason and quite as important, is lack of information on the utility of the device.

Nozzle Types

Quite a number of so-called fog nozzles are available but very few produce anything more than a fine spray without resorting to excessive working pressures. Practically all nozzles designed to produce spray or vapor have been developed to meet a particular condition with the result that there is a wide range of performance. None is entirely satisfactory for forest-fire suppression work because:

1. All have been designed primarily for particular applications which are not comparable to the forest-fire problem.
2. Spray velocity is lacking, or, if velocity is available,
   (*a*) the spray is too coarse,
   (*b*) the spray is a hollow-cone pattern.
   (*c*) the spray is a shallow curtain.

The vapor tip was first used in oil-field fires to provide an insulating shield so that cappers could approach intense fires without danger. From this field they have been applied to practically every fire problem.

The ideal vapor tip for forest-fire suppression is one in which:

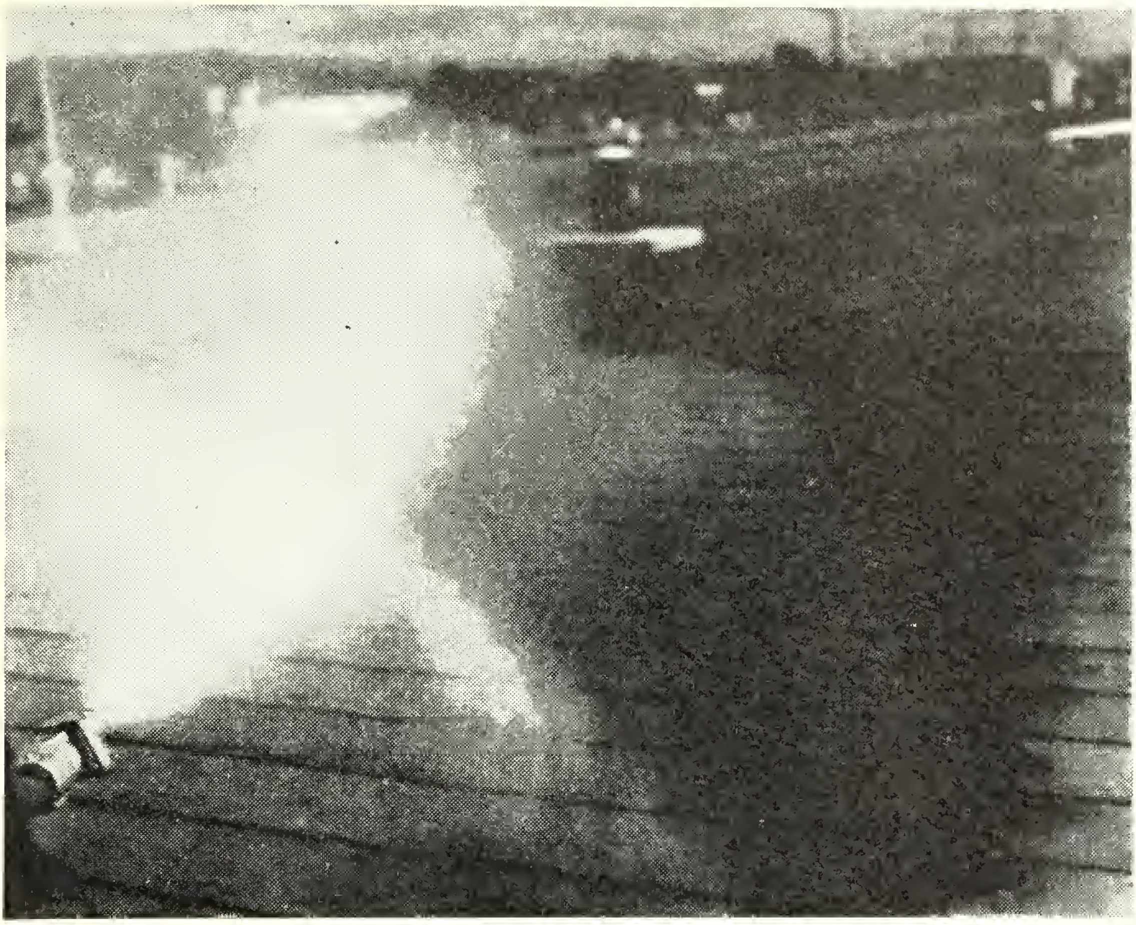
1. Maximum volume of vapor is produced per unit volume of water.
2. Theoretical discharge velocities are maintained in order to secure maximum projection of the vapor.
3. Vapor pattern is uniformly dense with a diameter of not less than 6 feet at a distance of 20 feet from orifice.
4. Complete vaporization will be secured at pressures not to exceed 300 pounds per square inch for discharge capacities up to 12 gallons per minute.

The writer has conducted various experiments with novel designs of spray tips for several years in an endeavor to secure a satisfactory compromise design which would meet the conditions suggested. Early in 1940, a suitable model was perfected which has since been placed in service in the field. An application for patent is pending which, if allowed, will dedicate the patent to public use. The tip is simple in form, can be attached to any standard ¾-inch garden-hose thread, and is so designed that it can be manufactured as a production item. Cost is approximately the same as that of any well made garden-hose nozzle.

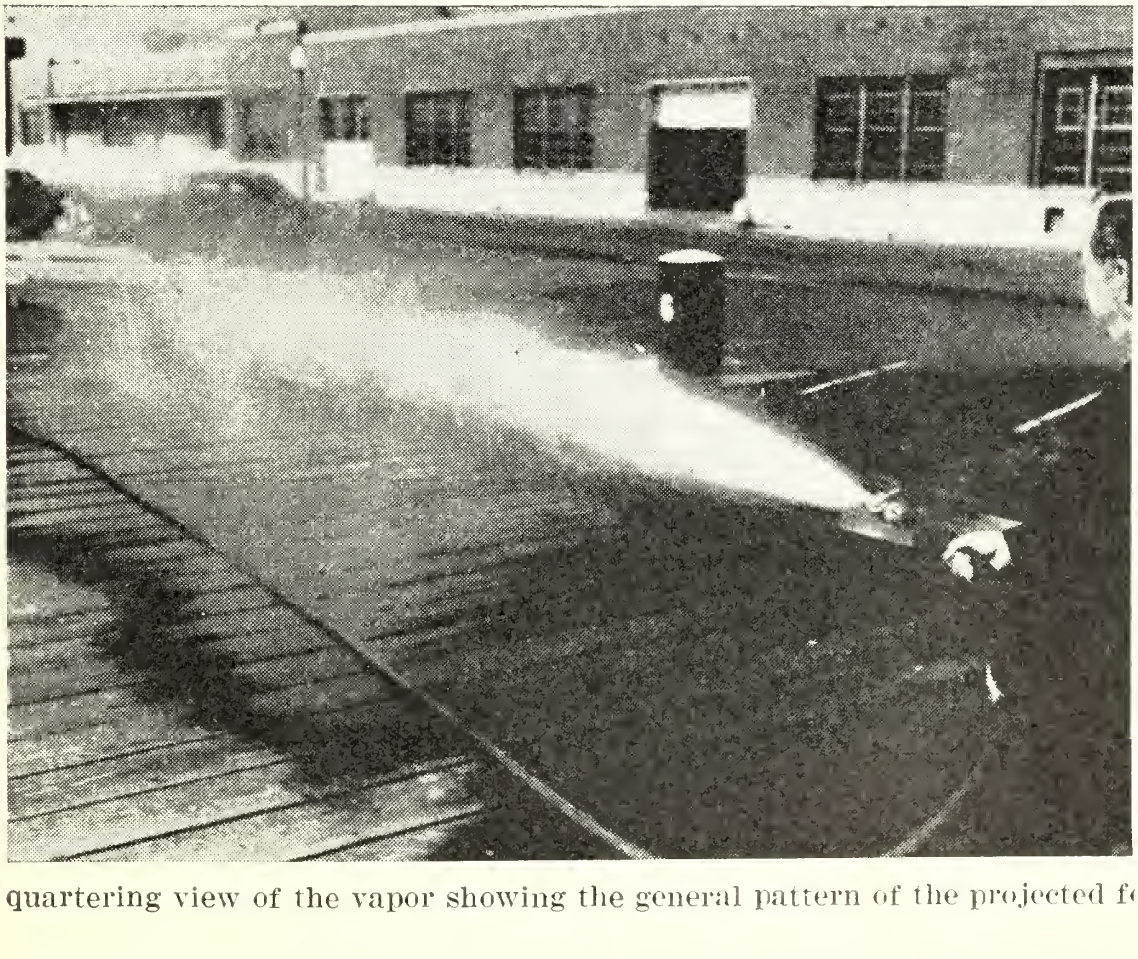
Comment on Water Applicators

Obviously, the primary object of all water-projecting equipment is to secure maximum wetting effect for a given volume of water. This is true regardless of the type of stream used. Experience with water-projecting equipment makes one realize more and more the extinguishing power of a relatively small quantity of water. When cost of the protection plant is considered and its components analyzed, little imagination is required to emphasize the need for efficiency whether it be water or manpower.

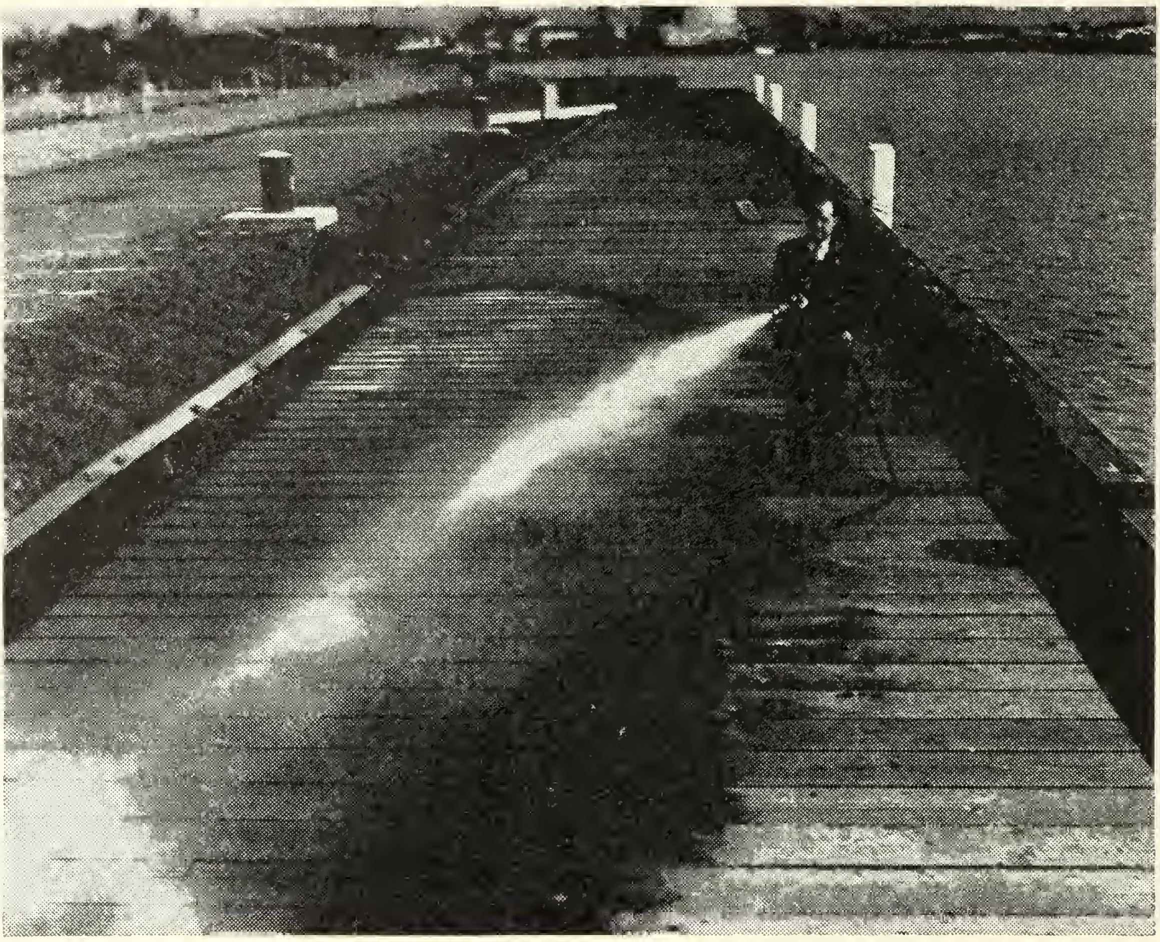
A very simple test with a common garden-hose nozzle using residence-service pressure will quickly illustrate the difference in wetting power of a solid stream and a wide solid-pattern spray. In



The nozzleman's view of the vapor discharge using a nozzle pressure of 250 pounds per square inch, volume being approximately 10.5 gallons per minute. Note the rainbow effect. Diameter of pattern 10 feet from the nozzle is approximately 3 feet. Twelve-inch boards on the dock give an approximate relation of projection distance to diameter.



A quartering view of the vapor showing the general pattern of the projected fog.



A front view showing the dissipation of the concentrated vapor at a distance of 20 feet from the nozzle. The actual blast of saturated atmosphere is much greater than indicated by the photograph; the vapor is so finely divided that it is estimated that not more than 50 percent of it is recorded by the camera.

fire-suppression work power pumpers provide a greater range of pressure and it is possible to break down the water with suitable nozzles so that a fine fog or vapor is produced.

In considering the extinguishing effect of water it is helpful to think in terms of relative humidity. It is known that if the relative humidity increases 30 to 35 percent, fire spread will be reduced to a low point, usually to a rate which is determined by the ability of the fuel to absorb moisture from the air. The rate at which reflected or radiated heat from the fire will dry out fuel in its path will also be affected. Although far from technically complete that simple explanation makes it apparent that there is a definite point at which relative humidity is the determining factor in the control of fire. And, the most practicable method of producing a high relative humidity in the vicinity of fire is by means of the vapor nozzle.

In the nozzle design presented it is possible to utilize the velocity of the stream in projecting a large volume of vapor. With a discharge of approximately 14 gallons per minute at 300 pounds pressure per square inch, the combination of vapor velocity and head resistance results in a heavy inrush of air at the nozzle. The spray expands in conical form from the nozzle presenting a diametrical front of approximately 6 feet at a distance of 20 feet. The velocity is sufficiently high that with a rate of flow of 14 gallons per minute the nozzle is producing a practically saturated vapor at a volume of not less than 10,000 cubic feet per minute. A stream from an ordinary nozzle with an equivalent rate of flow is estimated to produce not over one-tenth of this vapor volume.

In buildings or other confined areas, a vapor projection such as that described has maximum effect. While convection currents created by open fires in brush and timber stands reduce the effectiveness of the vapor to some extent, even under these conditions it still is by far the most efficient method of water application available. Any vapor spray is better than a straight stream if the fire can be reached with it.

Efficiency of Per Diem Guards.—Per diem guards can usually be so selected with respect to location that they are able to attack the average fire in the assigned area more quickly than any other person. Normally the transportation available to any per diem guard compares favorably with other transportation in the locality, and the equipment furnished him by the Service should be adequate.

In selecting the man, consideration should also be given to qualities of leadership, fire-fighting experience, and general ability. In other words, the local per diem guard should be the best prospect available.. His efficiency and the results obtained in both presuppression and suppression depend very largely on the efforts of the ranger or other individual responsible for the organization.

On the Santa Fe National Forest per diem guards are generally dependable and most effective. While observation on this forest has shown that the initial enthusiasm of a per diem guard may be the result of personal liking for the ranger rather than of belief in the prevention and suppression of fires, he will normally come to agree in the main with the Service policies and will carry on under successive rangers. A number of per diem guards on the Santa Fe have served continuously for more than 20 years. They are frequently contacted by the rangers, group training is given when feasible, and a special bulletin is used in an effort to keep them on their toes. As a rule these men can be depended upon to handle lightning snags and small fires without assistance from the regularly paid organization. Many of them are experienced on larger fires and make excellent foremen. They are actively on 71 percent of the fires that occur and have handled as high as 25 percent in a year without help from the regular force.

Frequently the influence of a good per diem guard in prevention work with local people is more important than his efforts on actual suppression. They can, and do, save the ranger and his helpers long hours of travel and work, to say nothing of worry. They save the Government a considerable amount in burned area and cost. In the opinion of the Santa Fe fire force a good per diem guard group is the backbone of the fire organization on any district where such a group is available.

On the other hand, it is agreed that per diem guards do not get the constant exposure to fire prevention and suppression material that, for example, CCC personnel does. They are accustomed to working short-handed and, with some exceptions, do not turn out the finished job of a special crew. Also, these men have their own work to do, are apt to be away from the phone, and cannot be expected to match the starting time of a drilled stand-by unit.—Perl Charles, assistant supervisor, Santa Fe National Forest.

A PROGRAM FOR THE VIRGINIA-KENTUCKY-WEST VIRGINIA "HOT SPOT"

(Continued from p. 140)

6. Provide for collaboration between the States and between the States and national forests in the areas where interstate fires, or fires threatening State or Federal lands, are likely to occur.

SLOPE INDEX DETERMINATIONS

H. M. Shank

Forest Supervisor, Idaho National Forest, Region 4, United States Forest Service

For those areas where slope is an appreciable factor in the spread of fire, the technique of mapping slope indexes offers possibilities in the study of previous fires which may show correlations that could be used by fire-control men in future suppression jobs.

Forest administrators have long recognized that slope is an important factor in the rate of spread of fires and, to some extent, in resistance to control. Some investigators have systematically examined the problem and made some important discoveries of slope-spread relationships.

Most of these investigations, at least insofar as the writer is aware, have been made on controlled-burning operations and on slopes with selected degree of steepness; in short, they have been controlled experiments. Such conditions are desirable from an experimental standpoint. The studies should produce a maximum of dependable conclusions with a minimum amount of original data. They fail, however, to furnish any basis for classifying a forest or parts of it as to slope or a practical method of applying the knowledge gained from these experiments and studies.

Without having made a recent review of available literature, Show and Kotok found that fires spread at a rate approximating the square of the wind velocity. Curry and associates found certain fairly definite relationships between rate of spread and slope and that slope and wind were interchangeable within certain limitations.

On the majority of western national forests, a range of slope up to 50 percent is quite common for distances of several miles. For short distances, slopes of 70 to 80 percent are common. Accepting the correctness of the findings referred to, it would have to be conceded that slope alone is of vastly more importance than wind alone, since it is obvious that the range of slope is normally greater than is the range of normal wind movement or even abnormal wind movement, except in rare instances of gale or hurricane conditions.

For areas that are topographically mapped, a slope index is exactly determinable quickly and easily within the limits of error of the map itself. Along a line of given length, slope in percent is:

$$S=\frac{Ci}{d}$$

in which C is the number of contours intersecting or crossing the line, i the contour interval, and d the horizontal distance.

The principle suggested can be applied to an area of any size or dimension, by gridironing with as many lines as desired. A forest of a million acres, if in roughly the shape of a square, would be approximately 40 miles on the sides. The gridironing of such an rea at 5-mile intervals in two directions and the calculations might. or example, be completed in a single day. Even that degree of ntensity might not be required. With each line divided into uniorm parts and the count for each part tabulated separately, tests ould be made that would prove or disprove the necessity for proeeding beyond a certain point to keep the results within a fixed limit f error.

It is hardly necessary to point out that the larger the map scale and greater the detail), theoretically, the more precise the results vould be. Within the range of map scales ordinarily available, owever, this seems to be unimportant. Some tests were made on n area with a map scale of 1:25,000 and a contour interval of 0 feet, a part of which was subsequently mapped on a scale of :125,000 and a contour interval of 100 feet. The average error for 5 pairs of slope readings for identical horizontal distances was percent, accepting the value from the large-scale map as being orrect. The maximum error on any pair was 7 percent.

It seems probable that the best value that could be obtained for effective" slope would be along lines at right angles to the axis of mountain range. It is obvious that a line paralleling the main xis of a range not cut by deep canyons would show less slope than hose at a 90° angle.

The writer has been guilty of some loose thinking and talking bout steepness of slope and seems to have plenty of company. Slopes teeper than 65 percent for distances greater than a mile are just bout nonexistent, except in places such as the Grand Canyon.

The principle outlined might be used to particularly good advanage in analyses of big fires, the area of which could be gridironed o any desired degree of intensity. Provided analysis of fire beavior by slope classes produced significant relationships, the result vould be invaluable in setting up corresponding action standards or areas on the same forest, assuming that the classification is made y areas rather than for the forest as a whole.

Harvesting the Berry Crop.—Forest rangers or patrolmen in their contacts vith blueberry pickers often hear the remark, "If we had another good forest re, we could have berries again." With the right approach that remark pens the way for convincing argument against the popular notion that burning he woods increases subsequent yields of berries.

In harvesting this food crop of the soil and forests, people come close to nature, and often will tell eagerly of signs of deer or bears that they have een. As a rule the berry pickers are in a receptive mood. They can be nterested in an explanation of how the berry bushes grow, how experiments ave proved that fire does not necessarily contribute to a good crop of berries, ow fire will completely destroy the berry bushes if the area is burned too xcessively, and that moisture is the important factor in yields.

Often local happenings will supply the most persuasive facts. For example, ire burned over several marshes in Lincoln County, Wis., in 1933. In 1935, wet year, one of these marshes yielded blueberries in clusters as large as rapes. The following season was, however, extremely dry. And the blueerry crop was very poor.

Isn't that good technique in fire-prevention education?—John Zach, forest anger, Wisconsin Conservation Department.

DETERMINING THE DESIRABLE SIZE OF SUPPRESSION CREWS FOR THE NATIONAL FORESTS OF NORTHERN CALIFORNIA

P. D. Hanson

Lassen National Forest, and

C. A. Abell

California Forest and Range Experiment Station, U. S. Forest Service

In the July 1940 issue of Fire Control Notes, "Effect of Size of Crew on Fire-Fighting Efficiency," Donald N. Mathews indicated that studies in Washington and Oregon had shown that "there is a strong tendency for output per man-hour to decrease as the size of the crew increases." This statement, bearing on only one of the factors to be considered in controlling fires, is given support by the present authors, who here analyze data under conditions where hand-constructed lines must be depended upon for the control of most fires. Studies such as these will help the dispatcher to answer the question: "How many men should be sent to this fire?"

The major steps used in the fire replanning project in California discussed by P. D. Hanson, I. C. Funk, and E. L. Turner in the October 1940 issue of Fire Control Notes (A Study of the Volume and Location of the Fire Load and the Determination of an Effective Presuppression Organization to Handle It. Fire Control Notes 4: 161–172, 1940) were: (1) to measure and locate fire load; (2) to provide for expected changes in fire load; (3) to evaluate suppression station locations; (4) to provide proper protection for special areas; (5) to determine the desirable size of crew for initial attack; and (6) to determine the best locations for tank trucks.

The purpose of the present report is to describe the method of analysis and the data used in determining the desirable size of crews for initial attack.

Preliminary data on three factors were used for this study, as well as for other phases of the replanning project. The first factor was the established time standards for initial attack in the major inflammability zones that have recognizable differences in rates of fire spread. Accepted time standards are a necessary basis for the inevitable adjustments between desirable size of crew, desirable speed of attack, and a reasonable intensity of preparedness. The time standards used in this study were established by S. B. Show and E. I. Kotok in an earlier analysis published in 1930 as U. S. D. A. Technical Bulletin 209, The Determination of Hour Control for Adequate Fire Protection in the Major Cover Types of the California Pine Region.

The second factor was inflammability zone maps, which were used in classifying individual fires and to facilitate studying occurrence groups as indicators of expected fire load. Delineation of inflammability zones, based on the study by Show and Kotok and later reised for comprehensive planning of transportation systems in 1936, as used in the present analysis.

The third factor was initial rate-of-spread data on free-burning res, which served both to characterize the inflammability zones and nk them to the data on desirable size of crew, expressed in this tudy according to initial-spread rates. Calculation of initial rates f spread for individual free-burning fires (see California Forest nd Range Experiment Station mimeographed research note 24, ssued 1940, "Rates of Initial Spread of Free-Burning Fires on the National Forests of California," by C. A. Abell) was done as a part f the current replanning project. Through these data on rate of pread the requirements for size of crew are tied to inflammability ones and the established time standards.

The main characteristics of the two important inflammability zones germane to the discussion of crew size are briefly: Northern California inflammability zone 1, containing much of the flash-fuel type nd generally found at lower elevations, occupies some 5½ million cres within the Forest Service protection boundaries. The established travel-time standard for this zone is 30 minutes or less. Fires which spread from the start increase in perimeter at an average rate of 20.6 chains per hours, with but approximately 25 percent spreading faster than the average. Zone 2, in less inflammable cover, occupies 7 million acres, for which the established travel-time standard is 1 hour or less. The average rate of perimeter increase for zone 2 is 9.1 chains per hour. The greater part of the fire load with respect to both number and severity of fires occurs in zone 1, which s consequently the heart of the fire problem.

For estimating the desirbale size of crews, approximately 8,400 fires that occurred in northern California during the seasons of 1925–37, inclusive, were grouped first, according to rate of spread in 7 classes and then according to the number of men who controlled them. For this purpose the number of men included those initiating attack plus those making up the first reinforcements if they arrived within a reasonable time. From the tabulations for each rate-of-spread class individual curves were prepared which showed (in percentage of total) for each of the 7 classes, and for the average of all fires, the cumulative percentage of fires which have been controlled by different numbers of men. These curves are presented in chart A.

Since the fires shown in chart A were controlled by the numbers of men indicated, it is reasonable to assume that this set of curves represents successful action which can be repeated; that is, the fires certainly were not undermanned, because they were controlled, but, on the contrary, must have been overmanned to some degree and therefore contain a certain factor of safety.

To study this degree of overmanning an investigation was made of 1,030 suppression crew reports, on each of which was stated the crew foreman's judgment of the number of men in the initial attacking force that he considered necessary to assure control of the fire when he and his crew arrived. These suppression-crew reports were identified with the original individual fire reports and constitute a representative sample of more than 12 percent of the 8,400 cases which form the basis of this study. Computations of the relation-

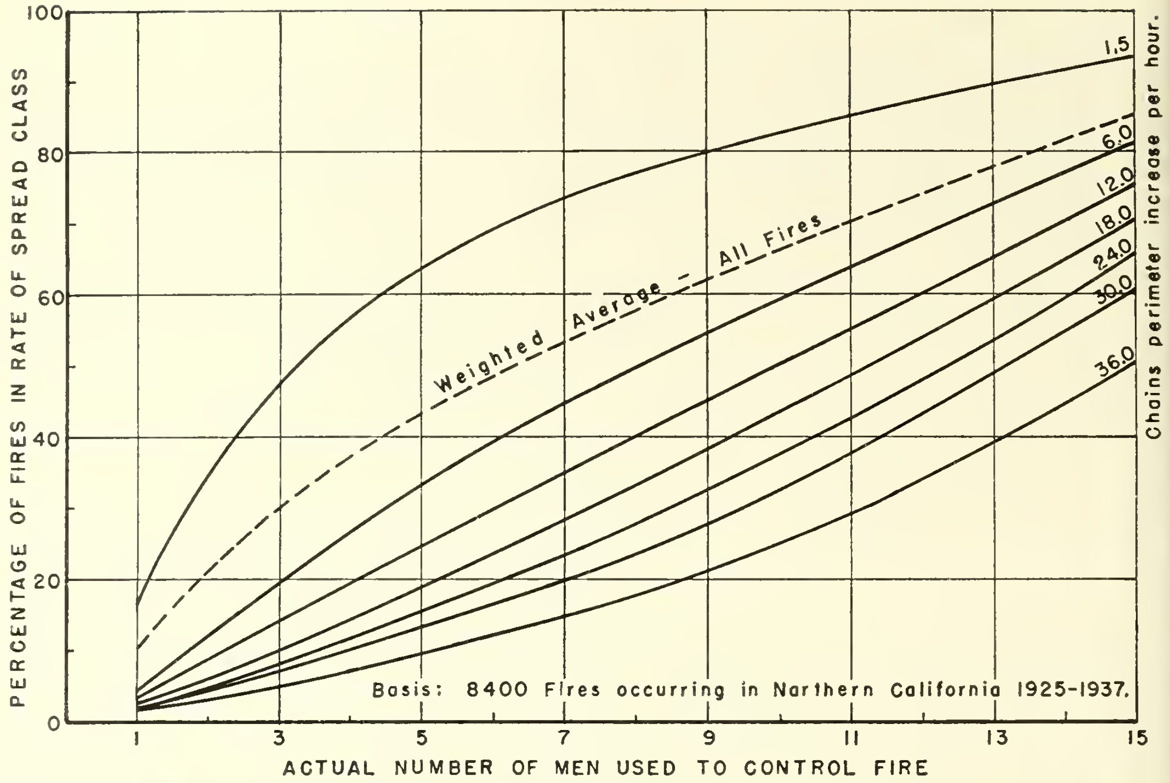


Chart A.—Percentage of fire in seven rate-of-spread classes actually controlled by different numbers of men (includes first reinforcements).

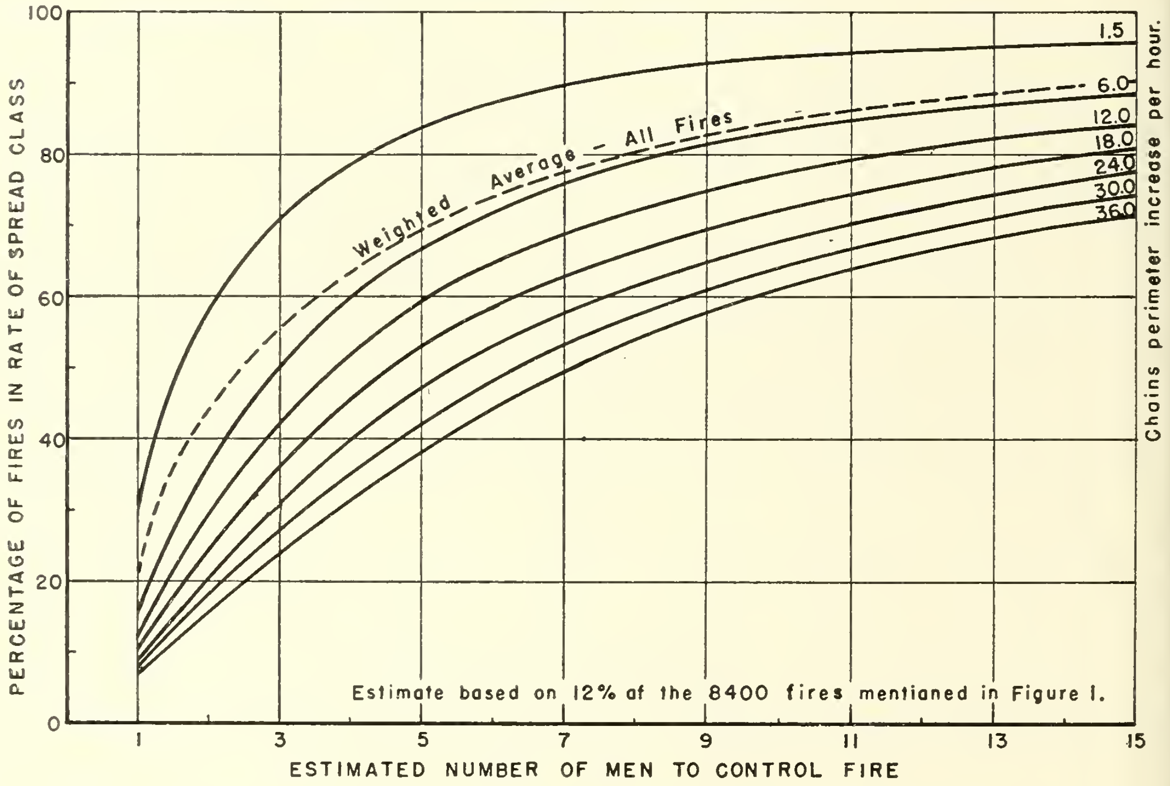


Chart B.—Percentage of fires in seven rate-of-spread classes which was estimated could be controlled by different numbers of men.

ship between the number of men that actually controlled the fire and the number that in the foremen's estimation would have been adequate were made independently for two sets of data. The first was based on 464 fires that occurred on the Shasta National Forest, and the second upon the 566 remaining fires, which occurred on other northern California forests. The two relationships derived in this way agreed very closely and were therefore combined.

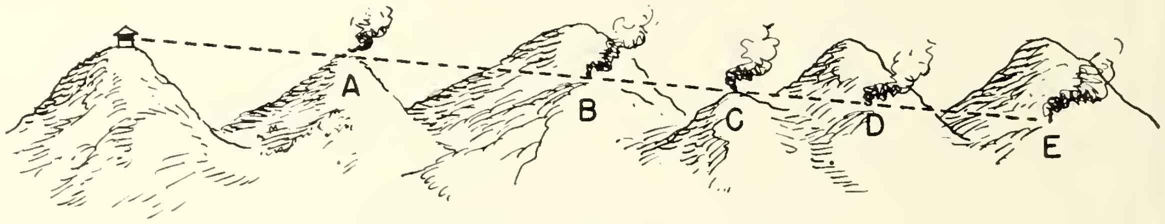
On the basis of these combined data the curves in chart A were elevated to show the potential suppression capacities of different size crews. The resultant curve set, chart B, is the best basis yet obtained for determining what should be expected from different sizes of crews in fuels with different rates of spread. For example, these curves show that where the average rate of initial perimeter spread is 20 chains per hour (inflammability zone 1), one-man attack has controlled about 2.5 percent of the fires and the top estimate of one man's potential capacity to control is 10 percent of the fires spreading at this rate. It thus appears evident that one man should be considered inadequate in this zone when fire danger approaches or exceeds normal.

Recognizing that a good presuppression organization should make available at the majority of fires, within a reasonable length of time, at least 1 and preferably 2 or even 3 reinforcing crews, in addition to a crew making fast first attack, and considering maintenance cost and difficulty of rapidly transporting the larger crews, this study leads to the conclusion that a crew of about 5 or 6 men would be the most efficient size in areas of rapid rate of spread. Reference to chart B will show that a 5- to 6-man crew may be expected to handle well over half of the fires in zone 1 (average perimeter spread rate 20 chains per hour). Enlarging the effective attacking force to 10 or 12 men would raise the percentage to a little less than 75. Building the crew up to 15 men would, according to these curves, add only another 5 percent of the fires to the control capacity of the crew. The rapidly diminishing benefits from relatively large expenditures for salaries thus indicated shows definitely the undesirability of larger crew units. In addition, consideration of the cost of equipment to transport larger crews and the slowing down of travel resulting from larger trucks led to the judgment that it was better to maintain smaller, faster, 5- to 6-man units more widely distributed and to count on the mutual supporting actionof these crews to enlarge the attacking force when and where needed.

A similar line of reasoning indicates crews of 3 to 4 men to be the most efficient size for inflammability zones 2 and 3, in which average rates of perimeter increase are 6 to 9 chains per hour. For any zone the size of crew decided upon depends to a considerable extent on whether or not reinforcing crews are available within a time which bears a reasonable relationship to the hour-control requirements of the zone. If they are not available, the size of crews mentioned would appear too conservative.

The use of tank trucks should tend to decrease the size of crews only slightly, since the necessity of allowing some measure of safety for handling faster spreading fires is evident. In zone 1, approximately 25 percent of the fires will spread faster than the average of 20 chains per hour. The 5- to 6-man crews with planned supporting action will catch some of these fires, the number depending on the size of the fire when the crew arrives and on other circumstances. On the average, it would take a crew of 15 to 20 men to build line as fast as the average fire makes perimeter in this zone. Obviously smaller crews are able to control some of these fires only because they cut off the head and thereby reduce the initial spread rate. On faster fires and in more difficult situations water or power line-building equipment or both are necessary to do this and to increase the percentage of the more difficult fires that will be caught on initial attack. All crews still must be prepared to handle the majority of fires through hand-constructed lines, and the tankers should be considered as a means of making the crews more effective in stopping faster spreading fires rather than as a justification for reduction in crew size.

The Stathem Fire-Finder Disc.—The article, The Stathem Fire-Finder Disc, by Paul Stathem, which appeared in the July 1940 issue of Fire Control Notes, is interesting and the method described has possibilities. However, the use of the disc may result in difficulties not only in flat and low rolling country, as the author admits, but in rough, broken country as well. Where the lookout is stationed in the center of a topographic system that recedes in concentric circles, the disc would operate best, but as the topography differs from such a pattern many errors become possible. The sketch is illustrative.



Is the fire at A, B, C, D, or E?

Although Stathem's theory is otherwise sound, in practice the location of a spot fire within 100 yards by use of his disc would be coincidental rather than the general rule, since the constant and probable errors of the disc added to those of the fire finder would lead to inaccuracies generally greater than 100 yards. However, the idea seems valuable and the instrument might well, with the use of proper trigonometric functions, prove a sound, supplementary device in the location of one-shot fires.—William P. Dasmann, Ochoco National Forest.

A Fire Organization Training Device.—A mechanical device for training personnel in the fundamentals of organization on a fire line was developed and used with some tangible results on the Wallowa National Forest in the spring of 1939. It was used only as one part of the entire program of fire training.

A piece of heavy cork gasket is used as a base to which a map, preferably a fuel-type map drawn on a topographic map, is tacked. Ball-head pins of various lengths and colors are also placed on the cork opposite a legend, which has been previously prepared. The legend may, for instance, indicate that a long pin with a red head stands for a foreman of a shovel squad, and smaller pins of the same color may represent laborers with shovels. All conceivable positions on the fire line may be thus designated by different types of pins.

To simulate actual fire conditions as closely as possible the trainee may select a map of an area with which he is familiar. The instructor may state conditions affecting the fire, such as wind and other weather conditions, rate of spread, available labor, equipment, etc. The trainee finally is given the task of lining out his crews, represented by the pins, according to instructions on fire-fighting fundamentals previously given.

Training by use of the map device described may be suited to any particular job on a fire line and may be adjusted to the abilities of the trainee. It may reach a climax when actual weather reports, fuel-type maps, calculation of probabilities, strength-of-force plans, suppression plans, etc., are all brought into the picture and integrated with the final organization. As the training progresses other variations may be revealed which may test the theoretical abilities of even the best firemen. The training need not necessarily be limited to jobs on the fire line.

The combination of color, manipulation, and working with actual facts and plans helps to crystallize in the trainee's mind the multitude of factors which must be considered in any particular position.—Richard P. Bottcher, assistant forester, Region 6.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information, should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Legends for illustrations should be typed on a strip of paper attached to illustrations with rubber cement. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing illustrations, place between cardboards held together with rubber bands. Paper clips should never be used.

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Vol. 5 OCTOBER 1941 No. 4

FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and technique may flow to and from every worker in the field of forest fire control.

/olume 5 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

FIRE CONTROL NOTES is issued quarterly by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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located 1½ miles east of Bentley. The highways, railroad, firebreaks, and other physical improvements on the fire area are shown on the accompanying maps.

Description of the Area

The area is typical of open cut-over longleaf pine land in the Upper Coastal Plain. The topography ranges from flat to gently rolling, with occasional depressions of wet and boggy land. Several small creek bottoms occur on the area, but because they are in general very narrow, they contribute little or nothing as natural barriers to fast-spreading fires. The principal fuel in the area is grass, broomsedge (*Andropogon* sp.) being predominant. Other components of the fuel are various herbaceous plants, pine needles and cones, and hardwood leaves.

Approximately 150 acres covered by this fire were burned over on February 21, 1935. The remainder of the area, or about 950 acres, had been unburned for at least 6 years. Inasmuch as all of the area had been unburned for 3 years or longer and the site is better than average, a uniform and extremely heavy stand of grass covered the entire area and contributed markedly to the intensity of the fire. Also scattered residual seed trees and some reproduction were present in the western half of the area and the eastern half supported moderately well stocked stands of longleaf pine saplings, light to heavy stands of blackjack oak, and open grass. Following the 1935 fire, 20-foot-wide drivable firebreaks were constructed over portions of the area. An 858-acre plantation of slash pine was established by the Forest Service in the center of the burned area during the 1936–37 planting season.

All of the burned area lies with the national-forest protection boundary, but only the east half is national-forest land, the remainder being privately owned.

Weather Conditions

The weather conditions that prevailed in the region immediatel[y] before the fire started and on the 2 previous days are shown in table [1].

TABLE 1.—*Weather conditions preceding the Honey Fire (observations made [at] Catahoula Tower)*

Date	Temperature: Maximum	Temperature: Minimum	Rainfall	Time of rainfall	Sky condition	Wind: Direction	Wind: Rate	Visibilit[y]
	° F.	*° F.*	*Inch.*					
Jan. 23	73	62	0.93	Noon–6 p. m.	Cloudy	South	Light	Poor.
Jan. 24	66	48	0		Cloudy and threatening.	SW–NW	Moderate	Poor ... miles).
Jan. 25 [1]	42		0		Clear	NW	Moderate	Good.

[1] 10 a. m.

Since this fire was mapped for rate of spread in connection with a study of fire behavior and the recording of current weather data was an integral part of that study, weather records were made, beginning shortly after the start of the fire. The factors measured were relative humidity (by a hand-operated psychrometer), air temperature, wind movement, wind direction, and sky condition. General notes also were made. Wind movement was taken at 1-minute intervals with a portable anemometer developed by the California Forest and Range Experiment Station. This instrument consisted of a Byram-type fan anemometer resting on a universal joint and mounted on a tripod. The instrument was placed a sufficient distance from the fire to be unaffected by the drafts and currents created during rapid combustion. The anemometer was set with the spindle 3½ feet above the ground, the standard height for measuring wind velocity in all studies of rate of spread.

A record of the average and maximum wind velocity, relative humidity, air temperature, and fuel and soil moisture content (based on dry weight) is presented in table 2.

TABLE 2.—*Record of weather, fuel moisture, and soil moisture conditions during Honey fire*

Period	Wind velocity		Time	Relative humidity	Air temperature	Time	Moisture content (dry weight)	
	Average	Maximum					Fuel	Soil
	Miles per hr.	*Miles per hr.*		*Percent*	*°F.*		*Percent*	*Percent*
10:07–10:37 a. m.	6.7	9.9	10:06 a. m.	33	42	10 a. m.	15.8	34.1
11:28–11:59 a. m.	11.3	16.6	11:20 a. m.	27	50	11:55 a. m.	12.1	34.1
12:20–12:33 p. m.	12.7	14.3	12:33 p. m.	26	46	1:45 p. m.	11.6	....
			2:17 p. m.	26	46			

The Fire

Time of Start.

The Honey Fire started at 9:50 a. m. January 25, 1938, in the manner described. The fire-behavior crew, having been traveling south along U S 167 about 1 mile behind the train, arrived at the fire at 9:53 a. m. At the moment, the fire had advanced more than 100 feet.

Rate of Spread.

Three members of the crew started mapping the fire at 9:55 a. m., while the fourth member collected fuel and soil samples and set up instruments to obtain weather data. The main head of the fire and the north flank were mapped at that time and at each 5-minute interval thereafter. After the first 5 minutes, during which it had moved almost 6 chains forward from the point of origin, the head of the fire advanced at a rate ranging from 25 to 35 chains for each 5-minute period. This head, labeled *A* on the accompanying map showing the progress of those parts of the fire that could be reached for mapping with the limited fire-behavior crew available, stopped

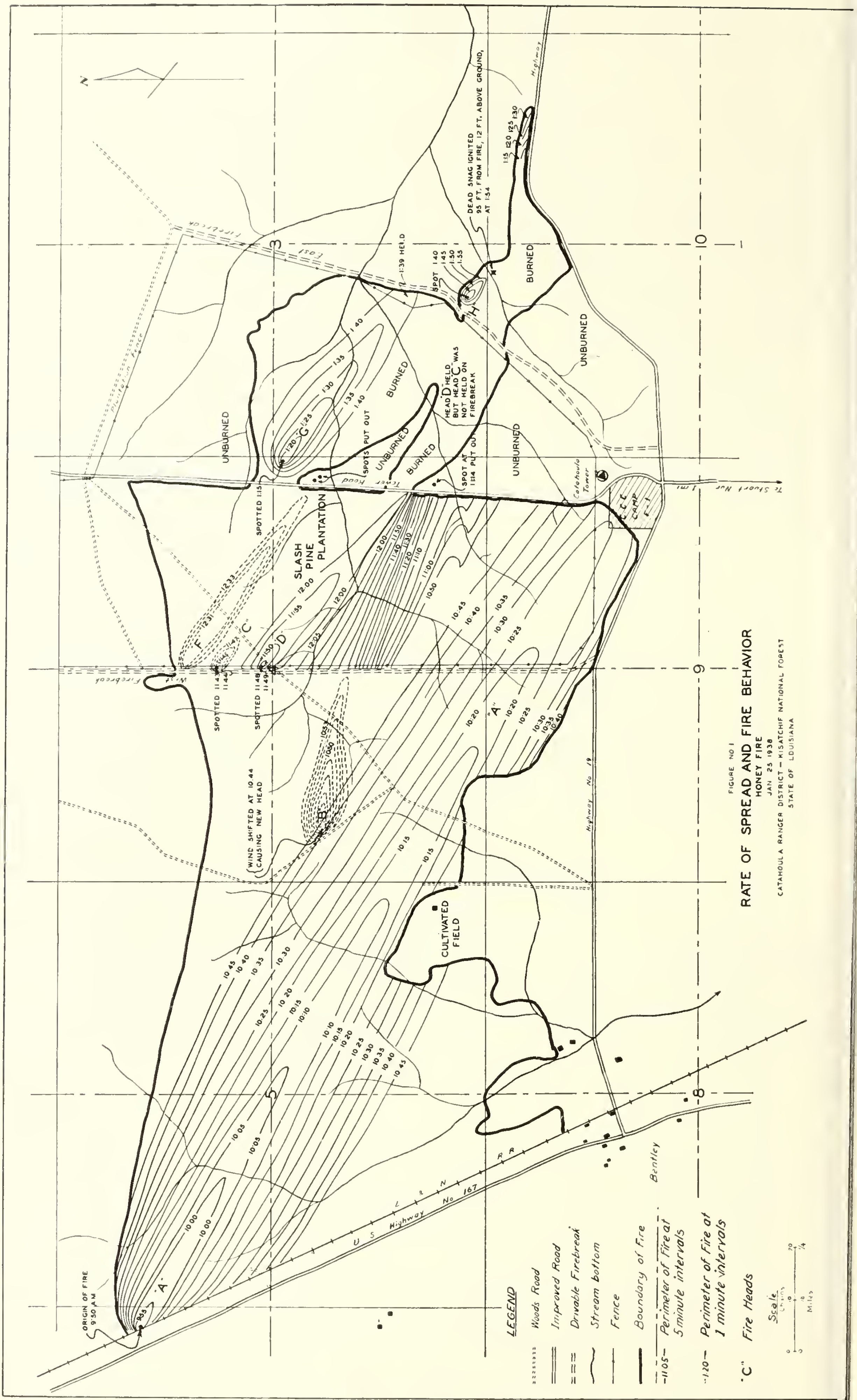

FIGURE NO 1
RATE OF SPREAD AND FIRE BEHAVIOR
HONEY FIRE
JAN 25 1938
CATAHOULA RANGER DISTRICT – KISATCHIE NATIONAL FOREST
STATE OF LOUISIANA

of its own accord when it reached an abandoned CCC camp site on which a heavy cover of carpet grass was present. Because of distinct shifts in wind direction from northwest to southwest, however, a new head *B* developed along the north flank. A total of eight heads were mapped during the course of this fire; all of the heads labeled from *B* through *H* developed either by wind shifts along the north flank of the main head *A* and its subsequent heads or from spotting across roads or burned firebreaks. There were great differences in the rates of spread of the flames at different points on the fire. In the main, however, the fire spread forward at the rate of 5 to 6 chains (330–396 feet) per minute. The greatest rate of spread measured in a forward direction was 8 chains (528) feet in 1 minute. In the easternmost part of the area, where the fire was finally brought under control and where there were dense stands of blackjack oak in which the carrying fuel was considerably less than on the open longleaf pine areas, the forward rate of spread dropped to as low as 1 chain (66 feet) per minute.

The perimeter and area increases that accompany the forward rates of spread on fast-moving fires are also very high; the figures for the main head *A* are given in table 3.

TABLE 3.—*Rate of spread on main head (A) of Honey fire*

Time elapsed after start, minutes	Forward progress				Perimeter				Area	
	Total		Increase in last 5 minutes		Total		Increase in last 5 minutes		Total	Increase in last 5 minutes
	Chains	*Feet*	*Chains*	*Feet*	*Chains*	*Feet*	*Chains*	*Feet*	*Acres*	*Acres*
5	5.7	376	5.7	376	13.6	898	13.6	898	0.9	0.9
10	32.8	2,165	27.1	1,789	70.4	4,646	56.8	3,749	10.2	9.3
15	57.4	3,788	24.6	1,624	121.3	8,006	50.9	3,359	27.1	16.9
20	93.4	6,164	36.0	2,376	195.9	12,929	74.6	4,924	60.5	33.4
25	126.0	8,316	32.6	2,152	263.4	17,384	67.5	4,455	109.2	48.7
30	148.2	9,781	22.2	1,465	311.9	20,585	48.5	3,201	167.4	58.2
35	175.9	11,609	27.7	1,828	368.6	24,328	56.7	3,742	250.8	83.4

Fire Behavior.

Besides collecting data on the rate of spread of the fire, the mapping crew recorded observations of various items of fire behavior that influence fire-suppression action. Among these were flame height, width of the burning line, incidence and distance of spotting, and difficulties experienced by the fire fighters.

The flames at the head frequently reached out in long tongues extending 100 feet or more in advance of the actual burning of the fuel; on the flanks, a slight shift in wind direction would increase the flame height from an average of 3–4 feet to 20–25 feet, with the width of the burning line 15 feet or more.

There were numerous cases of spotting for a considerable distance ahead of the fire; in one instance, when the wind velocity was 13 miles per hour, fire spotted over 200 feet in advance of the head. An unusual case of spotting occurred when a dead snag, located 95 feet from the nearest edge of fire, ignited at a height of 12 feet above the ground. Hardwood leaves, especially those from blackjack oaks, were responsible for all spot fires noted.

The spread of the fire was stopped and the fire corralled at 2:43 p. m.; the fire was controlled and mop-up completed at 6:45 p. m.

The final total area burned in this fire was 1,092 acres, of which 493 acres were on national-forest land and the remainder, or 599 acres, on privately owned land within the national-forest boundary. Of the national-forest land burned, 396 acres were in the slash-pine plantations mentioned earlier.

Available Suppression Crews and Equipment.

On the morning of January 25, nine crews of fire fighters were available to the fire dispatcher for fire duty. The crews were made up of CCC and WPA men who worked either at the Stuart Nursery or on planting and road maintenance jobs within easy driving distance of the central tower. The crew organization is shown in table 4.

TABLE 4.—*Crews and equipment available for suppression of Honey Fire*

Crew No.	Number of fire fighters	Supervisory personnel	Total	Equipment
1	1	1	2	Pumper truck, 350-gallon capacity.
2	12	1	13	Standard fire tools.
3	5	1	6	Do.
4	24	1	25	Do.
5	20	2	22	Do.
6	21	1	22	Do.
7	17	2	19	Do.
8	18	1	19	Do.
9	11	1	12	Do.
Miscellaneous supervisory personnel			8	
Total available manpower			148	

The standard fire tools, with which all except crew No. 1 were equipped, consisted of flaps (swatters), hand-operated back-pack pumps, fire rakes, water buckets, railroad "fusee" torches, axes, etc., all of which were kept in a wooden box on the trucks transporting the men. The pumper truck was equipped with dual wheels, a 350-gallon water tank, and a pressure pump unit driven from the fan-belt of the engine.

Discovery.

The fire was discovered by the lookout on the Catahoula Tower, located 2 miles to the east, at 9:52 a. m. (2 minutes after the start) and reported immedately to the fire dispatcher. A cross-shot was obtained from the Colfax Tower lookout, 4 miles to the west, at 9:53 a. m. The fire dispatcher, therefore, had a reasonably definite location of the fire within 3 minutes of its start. At that moment, however, it was impossible to determine with absolute certainty on which side of the railroad track the fire was burning. There was still a possibility that the fire was burning in the 150 feet of grassland between U S 167 and the west side of the railroad track or even west of the highway.

Crew Dispatch and Initial Attack.

The map showing the initial and subsequent crew locations, indicates the points at which the fire was attacked before control was attained.

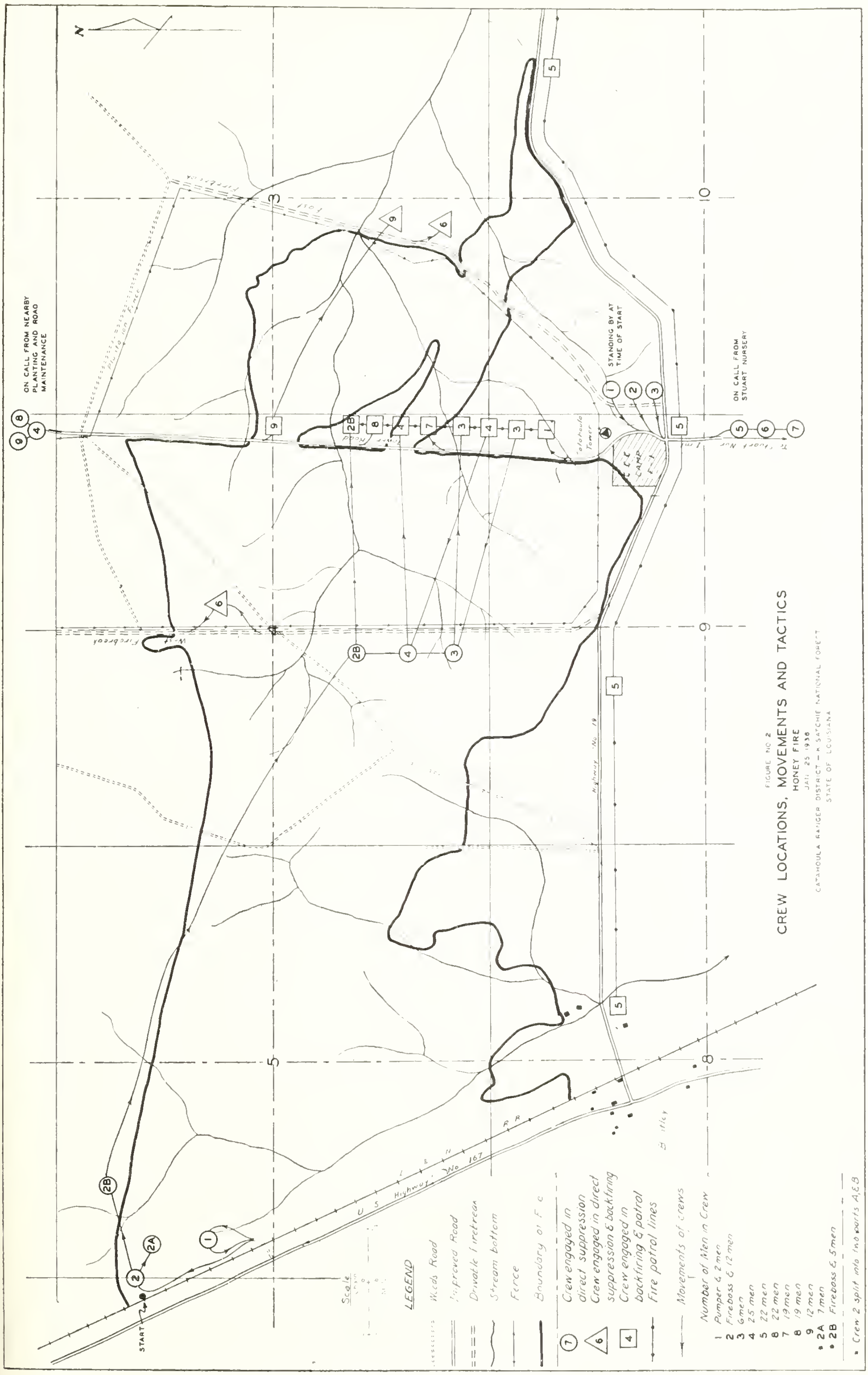

FIGURE NO 2
CREW LOCATIONS, MOVEMENTS AND TACTICS
HONEY FIRE
JAN 25 1938
CATAHOULA RANGER DISTRICT — KISATCHIE NATIONAL FOREST
STATE OF LOUISIANA

Crew 1, consisting of the pumper truck with a driver and hoseman, was the first crew dispatched to the fire. It left Catahoula Tower, where it was standing by for emergency use, at 9:53 a. m. and went directly to the origin of the fire near U S 167. While en route, the driver determined definitely that the fire was on the east side of the railroad track. The train momentarily delayed him by blocking the road crossing leading into the fire. He then made an attempt to reach the fire, but the pitcher-plant (*Sarracenia* spp.) land in which it was then burning was so wet and boggy that this was impossible. He returned, therefore, to Catahoula Tower and received instructions to wet down the fuel and be prepared to extinguish spots along the east side of Tower Road, starting near the Tower, while crews 3 and 4, who had meanwhile reported at Catahoula Tower for fire duty, burned a backfire along the west side of Tower Road.

Meanwhile, crew 2, the leader of which was fire boss, left Catahoula Tower for the fire at 9:55 a. m., going to the point of origin. This crew was momentarily delayed by the train at the road crossing. It is estimated that the fire had a perimeter of 40 chains (2,640 feet) upon their arrival. They started to extinguish fire along the north flank near the head for the purpose of checking the fire by cutting it into a cultivated field located about three-quarters mile southeast of the origin. These tactics failed when the head passed to the north of the field; the forward progress of the south flank, however, was checked when it reached the field. The crew leader then split his crew; he left 7 men to suppress the fire, starting from the tail and working toward the head, and led the remaining 5 men (crew 2B) on foot across country to the west firebreak. The main head of the fire, meanwhile, had reached Tower Road, where it was stopped by the abandoned CCC camp and the fireline burned by crews 3 and 4 and the pumper truck; crews 3 and 4 then went to the west firebreak to burn more backfire similar to that which they had just completed on Tower Road. There the fire boss assembled crews 3 and 4 and his own 5 men (a total of 37 men) on the west firebreak and attacked the north flank near the head and worked toward the tail. Progress by this large crew in extinguishing the fire along the north flank was encouraging; a boundary length of 33 chains (2,178 feet) was put out and being held successfully. Up to this time, the wind had blown steadily out of the northwest, with little or no evidence of shifting markedly in direction. At 10:44 a. m., the wind distinctly veered from northwest to southwest, resulting in a big sweep in the flank and the formation of a new head. The suppressed crew was forced to yield ground. The new head (*B*), which wiped out all the line that had been held up to that time, reached the west firebreak in 9 minutes (at 10:53 a. m.) and was held at that point when the head hit the backfire.

Later Attack and Tactics.

Following the initial attack described, during which two different heads on fast-moving fires were stopped by indirect attack or backfiring but on which the fire on the north flanks was not controllable, the crews resorted to further backfiring along the west firebreak, Tower Road, State Highway 19, and the east firebreak, and to patrolling the east side of these roads to prevent the formation of new heads by spotting when an oncoming head reached a backfire

Efforts to extinguish the north flanks were made only when it was reasonably certain that the head could be held at the backfire. In all the heads mapped, the backfire effectively stopped the progress of the head of the fire. Heads *G* and *H* resulted from spotting across Tower Road before adequate backfires were completed.

In extinguishing the fire along the north flanks, the crews, with one exception, attacked the fire from a point near the head and worked toward the tail. The only fire fighting on the north flank from the tail toward the head was done by the original crew (2A) of 7 men, who were left near the tail when crew 2 was split. As a consequence, a considerable distance along the north flank (for the most part, 1 mile or more) between the tail and the west firebreak was left to burn freely, and with each shift in wind direction to the southwest new heads would develop. Examples of mapped heads that resulted from this situation are heads, *C*, *D*, and *F;* several unmapped heads developed previously in the area west of the west firebreak, causing heads *C*, *D*, and *F* by spotting across this firebreak.

Fire along the south flank was of minor concern during the run of the fire, small roving patrols were stationed at strategic points along State Highway 19 to backfire wide strips and to watch for spotting across the road when heads reached the road. The large cultivated field located three-quarters of a mile southeast of the origin did much to lessen the fire danger along the south flank. The shift in wind direction from northwest to southwest also reduced the fire danger along the south flank, since it resulted in a relatively slow-moving flank burning into the wind with only occasional minor sweeps when the wind changed back to the northwest.

Final Attack.

In the final attack on the fire, during which it was brought under control, wider firebreaks were burned along Tower Road and the east firebreak. The suppression crews also attacked the north flank of the fires from the tail toward the head by reinforcing the small crew left originally at the tail to work east. The pumper truck did very effective work along the north flank where the ground was solid enough so that it would not bog down. Throughout the final attack, effective and rapid suppression on the north flank was accomplished by working from the tail toward the head and mopping up the edges of the fire simultaneously.

Output of Held Line.

During the course of the fire, measurements were taken of the line extinguished by various crews. The amount of line held per man-hour varied greatly at different points on the fire, depending upon the behavior of the fire and the conditions under which it was being fought. In table 5 a record is given of the output of held line per man-hour for different sized crews with remarks concerning the conditions under which they worked.

Record of Stringing Backfire.

Data on the rate at which backfires or burned firebreaks were strung by different methods were obtained at several points on the fire. These data do not include the manpower required to keep the

TABLE 5.—*Rate of held line per man-hour at various points on Honey Fire*

Location of suppression action	Number men in crew	Held line per man-hour		Remarks
		Chains	*Feet*	
North flank—head *A*	19	4.7	309	No shift in wind.
North flank—head *A*	6	−11.6	−765	Line lost—shifting wind.
North flank—head *D*	14	5.8	385	Some crew members idle or resting.
North flank—head *G*	14	9.1	601	In heavy cover of oak leaves.
North flank—head *H*	18	9.15	604	In heavy oak brush—medium fuel.
North flank—heads *F* and *G*	(1)	126.6	8,356	Average difficulties with trees and soft ground.
North flank—head *A*	10	5.03	332	Average conditions—men placed too much reliance on water.
North flank—head *A*	15	4.67	308	Shifty winds, hot fire—well-organized crew.

[1] Pumper truck.

backfire under control by patrolling and mopping up spot fires. The data given in table 6 are only for stringing fire in a straight line without regard to the width of the backfire burned.

Ratio of Line Actually Extinguished to Total Needed for Control.

As pointed out above in the discussions of the initial attack and the output of held line, considerable line was lost because of the behavior of the fire at certain points. No accurate record of the total line extinguished but later lost is available. It has been conservatively estimated by Kisatchie National Forest personnel, however, that of the 864 chains (57,024 feet) of line actually built to corral

TABLE 6.—*Rate of stringing fire for backfires on Honey Fire*

Backfire location	Length burned per man-hour		Medium used	Remarks
	Chains	*Feet*		
West firebreak—near heads *C, D, F.*	52.7	3,480	Gasoline torch	Inexperienced men.
Tower Road—head *D*	26.9	1,776	Bunches of grass	Backfire only 20 feet wide, not wide enough to keep head *C* from crossing Tower Road.
Tower Road—head *F*	51.8	3,420	Rakes	
Highway 19—head *E*	26.2	1,726	Bunches of grass	In oak brush and leaves.
East firebreak—head *G*	20.9	1,378	Bunches of grass	In heavy blackjack oak.
Tower Road—head *D*	45.1	2,978	Rakes	

the fire, 240 chains (15,840 feet, or 27.9 percent) were lost during the suppression action and did not contribute toward the control of the fire. The difference, or 624 chains (41,184 feet), therefore, would have been sufficient to attain control of the fire. The ratio of line actually extinguished, but later lost, to the total needed for control is 240 chains to 624 chains; thus, 38.5 percent more line was built than actually needed. The final perimeter of the fire when controlled was 934 chains (61,644 feet). The discrepancy between the final perimeter and the length of line actually needed for control, or 310 chains (20,460 feet), is accounted for by the fact that practically none of the south flank required suppression, because the fire went out of its own accord when it reached the cultivated field, the abandoned CCC camp, Highway 19, and the backfire along Tower Road.

Difficulties Encountered by Fire Fighters.

The suppression crews were under tremendous handicaps and personal discomfort, caused by the heavy, choking smoke and the dense cloud of ashes, soot, and sparks, when patrolling an onrushing head as it hit a backfire. At such times, it was impossible for them to face toward the head; not only was the visibility extremely bad, but also the dense ashes and sparks, carried swiftly by the draft of the fire, compelled the fire fighters to turn their backs to the fire and cover their smarting eyes with their hands. The fire fighters experienced considerable difficulty in walking against and in using their equipment in the strong wind currents created near the head of the fire. Thus, the efficiency of the fire fighters stationed at these points to extinguish break-overs and spot fires was greatly reduced. Further, the roar of the fire and wind at these points made it impossible for the crews to hear verbal orders of their foremen.

The heat on the north flanks when the wind shifted was oppressive, and the danger of a crew getting trapped by the high, oncoming flames was great. The hose man on the pumper truck was particularly handicapped by the heat because he had to get very close to the fire to place the water effectively.

Because of the relatively flat terrain and the dense smoke, the fire boss was unable to get the clear and complete picture of the progress of the fire that he needed for the most effective use of his men in controlling the fire.

Critique

Recognition of Danger.

In evaluating the suppression action taken on this fire, it must be realized that no satisfactory methods and technique were then available to the fire dispatcher to rate the fire danger existing at the time of the fire. His experience in judging fire danger during several preceding fire seasons, however, made it clear to him that the weather conditions then prevailing would cause a fast rate of spread and that speedy and adequate dispatch of suppression crews was essential. Consequently, he had prepared and organized all crews for speedy dispatch. Even after dispatching all available fire fighters, he was quick to recognize the extreme conditions and to inform the supervisor's office that the fire was out of control by reporting, "I cannot hold it."

A fire-danger meter, recently developed by the Southern Forest Experiment Station,[1] should prove exceedingly useful to a fire dispatcher in recognizing fire danger, particularly under conditions similar to those prevailing at the time of the Honey Fire. The present fire-danger meter, for these conditions, would have shown the danger as class 5, or extreme. With a prompt recognition of the fire danger and with adequate plans for the fire action to be taken in the event of a fire, it is expected that fires occurring during times of great danger can be checked early and controlled while still of small size.

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[1] "A Tentative Fire-Danger Meter for the Longleaf-Slash Pine Type," by C. A. Bickford and David Bruce, Occasional Paper No. 87, Southern Forest Experiment Sta., Nov. 10, 1939.

Fire-Discovery Time.

Fire-discovery time was excellent and the towermen are to be commended for their alertness. With good visibility and with a clear view of the origin of the fire available from Catahoula Tower, conditions were very favorable for quick discovery. Furthermore, when the train made an unusual stop, it was viewed with suspicion by the Catahoula lookout.

A cross shot was quickly obtained from Colfax Tower, located 4 miles west of the origin. Because of the obtuse angle of this cross shot, which the fire dispatcher received within 3 minutes of the start of the fire, it was impossible to get a precise location. Moreover, he was under specific orders from the ranger and forest supervisor to dispatch the stand-by crew immediately upon obtaining a cross shot. Under ordinary conditions the location of the fire, as indicated by the reported conditions, would be highly satisfactory for a prompt attack. In this particular case, however, a precise location was essential, since the subsequent fire action depended upon this point. Had the fire started on the highway west of the railroad track, the logical action would have been for the fire boss to lead the first crews to the tail of the fire; but since this fire started on the east side of the track the preferred action, had the real danger been fully recognized, would have been to place the initial crews along the west firebreak to string backfire and send subsequent crews to extinguish the fire along the north flank. It can be argued that, under the circumstances, the fire dispatcher should have momentarily delayed initial dispatch of crews until he had received verification from the Catahoula towerman on this seemingly trivial point. However, to have made such verification at that time would have been contrary to the forest supervisor's instructions; under other circumstances, even the slightest delay in dispatch would have been costly insofar as size of fire was concerned.

Preparedness.

Adequate preparations and crew organization had been made for fighting fires on bad fire days. A total of 148 men, divided into 9 properly supervised, trained, and equipped crews, were ready to respond promptly to a fire call from the dispatcher. These crews were distributed at strategic points on the ranger district and had telephone connections with the fire dispatcher's office. All feasible measures of preparedness had been taken.

Dispatch of Crews.

The dispatch to the fire of all the crews available on the ranger district was effected promptly and with a minimum of confusion. Their assignments to specific points on the fire were given clearly and definitely by the fire dispatcher. The chain of communications to the individual crews previous to their initial dispatch to the fire was, for the most part, very satisfactory. Some delay was experienced in reaching the crews that were working in the Stuart Nursery quickly, because the telephone in the nursery office was unmanned for several minutes; when word finally reached the nursery, the three crews were promptly dispatched to the fire.

Supervision.

All the crews were supervised by men who had had considerable experience fighting grass fires in the cut-over longleaf pine type. Fires of the extreme intensity and rate of spread of the Honey Fire, however, are the exception rather than the rule. Consequently, it was natural to expect that some mistakes in judgment and action on the part of the supervisory personnel would be made. The writer points out what he considers as mistakes only to guide the actions of supervisory personnel in the future under similar circumstances.

Every member of the supervisory personnel, including the fire boss, used a flap, a back-pack pump, or some other fire-fighting tool. It is commendable that they were so earnest and eager to get the fire extinguished that they helped in the physical work, but it is much more important and necessary for those in charge of fire crews to expend their energies and use their superior training in analyzing ever-changing situations on a fire, in directing their men to work efficiently, in discovering and remedying weaknesses in their work, in anticipating and planning actions, and in urging the men toward their best efforts. The crew leaders should use their heads and eyes instead of their hands. Had this been done, they would have quickly realized the futility of suppressing the north flanks from the head toward the tail of the fire. Actually, the physical efforts of the supervisory personnel in suppressing the fire were of minor consequence, considering the fire as a whole.

The fire boss should make it his job to keep up with every change in the situation, know the location of all his crews, and continually plan the action to bring the fire under control at the earliest moment. His decisions should be direct, definite, and well-planned. On the Honey Fire, the fire boss, instead of placing himself at all times at a central point to gather information regarding the situation and to direct and dispatch crews, was off on the fire line with suppression crews for considerable periods of time. As a result, the desired movement of some crews to critical areas was delayed.

Anyone on the Catahoula Tower could have obtained an excellent grasp of much of the situation. When the fire passed close to the tower the smoke was heavy and visibility was bad; later, however, the view from the tower would have given the fire boss a comprehensive picture of the fire and helped him tremendously in planning crew locations and actions. In similar situations, the fire boss should always size up the fire either from a high point such as a ridge or tree top, or by cruising the area by car, sending scouts out for information, or by referring to aerial photographs. It is strongly recommended that on a large fire the fire boss have at his disposal two or three men to reconnoiter and to serve as messengers to carry his orders to the leaders of the individual suppression crews.

Morale of Fire Fighters.

The morale and determination of all men were excellent, and in many cases remarkable. Virtually all of them used their flaps and back-pack pumps effectively, showing that the training they had received was very much worth while. During the hot flank attacks, however, the flapmen relied heavily upon the pumpmen spraying water to knock down the flames. The men should be trained to rely less upon water in fighting the flanks by having the crew leaders temporarily stop suppression and rest the crews when the wind shifts on a flank, resulting in a very hot fire to fight. More line on the flanks will be extinguished and held by resting a crew while the fire is burning intensely and then efficiently directing them when the heat and flames have diminished.

Crew leaders should strive to keep their crews working in units of five or six men. A crew of this size is very flexible and mobile and, when trained for perfect coordination and teamwork, it can hold a long line. Large crews working as a unit are generally inefficient either because they stumble over one another or because the work is unbalanced, the first men bearing the brunt of the attack and the stragglers expending their energies chiefly by running to keep up with them and doing relatively little productive work. The morale of a crew weakens when the work load is not evenly divided among all its members.

Equipment.

On the whole, the fire-fighting equipment was in excellent condition. In only one instance was failure of equipment noted, namely, the railroad fusees intended for stringing backfire, which would not ignite, undoubtedly because they had become damp from atmospheric moisture. The crew attempting to extend the backfire along the west firebreak one-half mile north of Highway 19 was delayed while trying to make the fusees ignite. The result was that heads, *C*, *D*, and later *F* crossed the graded firebreak, and eventually led to heads *G* and *H*. The need for having *all* equipment in perfect order was strongly exemplified by this one small but important failure.

The supply of tools for all fire fighters was automatic in that each crew had an adequate amount of standard fire-fighting equipment in the truck on which they traveled to the fire. No delays were noted on this account.

The urgent need for accessory equipment on fires of this type was brought out by the handicaps and difficulties encountered by the fire fighters. Emphatically, the crews assigned to backfiring and patrolling backfires should be supplied with smokeproof goggles so that they can work efficiently in the smoke and flying ashes. The value of such goggles was indicated by the fact that one fire fighter, normally working as a welder in the shop, wore his dark welding glasses while patrolling, and later commented that he experienced no great discomfort from ashes, soot, or sparks when the head reached the backfire. Respirators should also be investigated to determine whether or not the patrol crews could perform more effectively with such equipment. Since the hose man on a pumper truck is subject to intense heat and smoke over a prolonged period, he also should be provided with special equipment to enable him to do his job better. Asbestos hoods and suits have already been developed for such use and might upon trial prove ideal for this specific purpose.

Technique of Attack.

The logical point of initial attack on the Honey Fire, as already discussed, depended on a very accurate location of its origin. As soon as the fire boss saw that the fire was definitely on the east side of

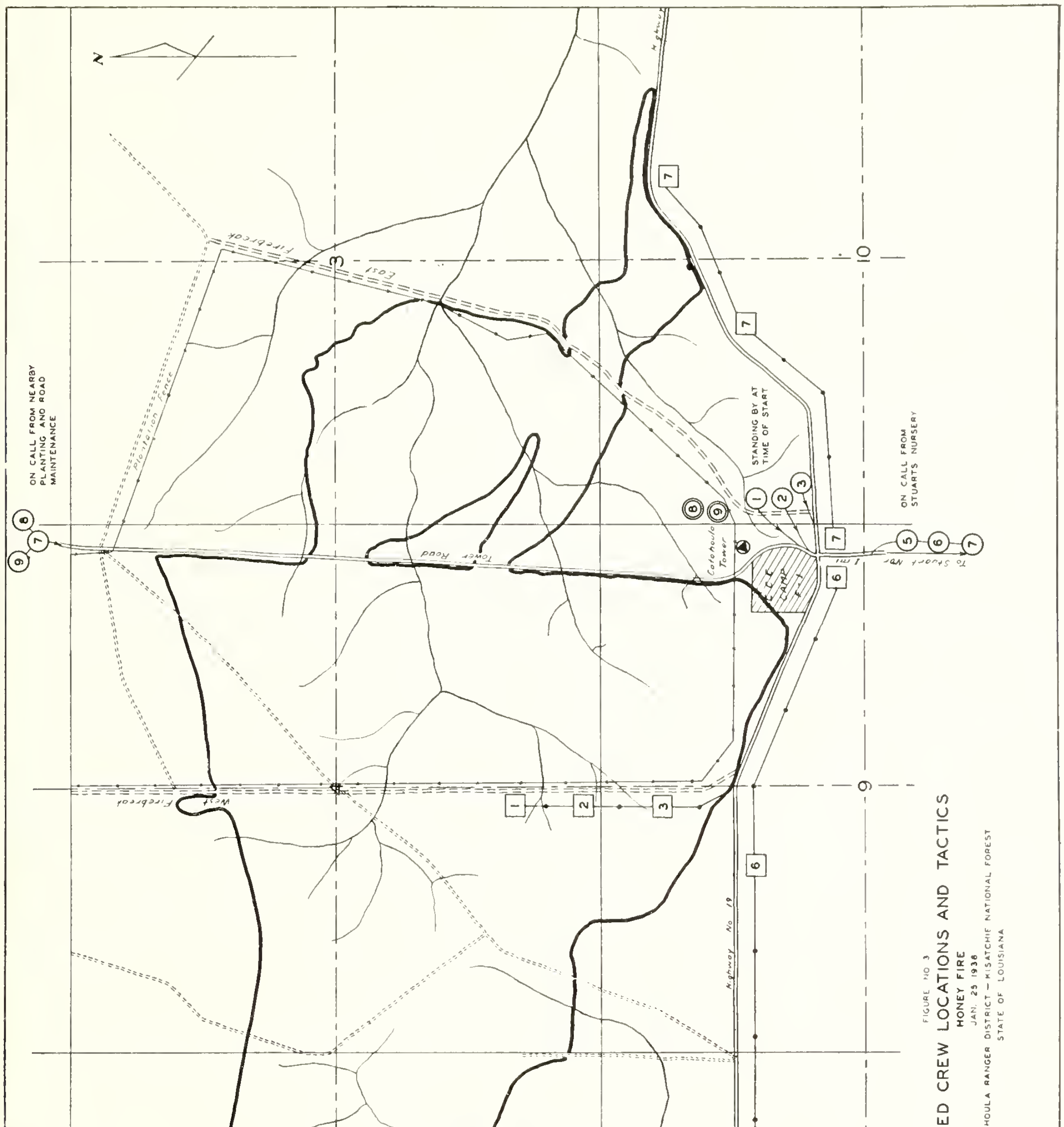
FIGURE NO 3
SUGGESTED CREW LOCATIONS AND TACTICS
HONEY FIRE
JAN. 25 1938
CATAHOULA RANGER DISTRICT – KISATCHIE NATIONAL FOREST
STATE OF LOUISIANA
LEGEND
Woods Road
Improved Road
Drivable Firebreak
Stream bottom
Fence
Boundary of Fire
Crew engaged in backfiring & patrol
Crew engaged in direct suppression from tail to head
Standby crew for reserve
Fire patrol line
Movements of crews
Number of Men in Crew
1 Pumper & 2 men
2 Fireboss & 12 men
3 6 Men
4 25 Men
5 22 Men
6 22 Men
7 19 Men
8 19 Men
9 12 Men
ON CALL FROM NEARBY PLANTING AND ROAD MAINTENANCE
STANDING BY AT TIME OF START
ON CALL FROM STUARTS NURSERY
East Firebreak
West Firebreak
Tower Road
Catahoula Tower
Plantation Fence
Highway No 19
U S Highway No 167
L & N R R
Bentley
To Stuart Nur 1 mi
START

the railroad track with a large area of dense grass before it for its run, he should have directed his crew (No. 2) together with crew 3 to start backfiring immediately and liberally along the west side of the west firebreak. The pumper truck should also have been available at this point to support the fire fighters. Crews 4 and 5, comprising 47 men, should then have been dispatched to the tail to extinguish the north flank from the tail toward the head. Crew 6 of 22 men and, if needed, crew 7 of 19 men, should then have been dispatched to patrol Highway 19 and the south flank. The 2 remaining crews, comprising 31 men, if called at all by the fire dispatcher and fire boss, should have been held at the Catahoula Tower as stand-by crews. These positions are shown on the locations and tactics.

Initial backfiring should have been started promptly along the west firebreak instead of along Tower Road. The woods road, located one-half mile to the west, could not have been used for the initial backfiring because (1) insufficient time would have been available to string an adequate backfire along the woods road before the main head reached it, and (2) there could be legal complications and violation of policy had a backfire been strung on privately owned land not bordering a Government-owned land, even though national-forest land was seriously threatened. Prompt backfiring along the west firebreak would have overcome both of these difficulties. At least 20 minutes would have been available to the crews for stringing backfire along the west firebreak, since the main head did not reach this point until 10:20 a. m. This would have been ample time for the three crews available to have strung at least one-half mile of backfire 100 or more feet wide. It was impossible to burn such a protection strip around the plantation earlier in the season because the land involved was privately owned. The 20-foot-wide graded firebreak surrounding the plantation was scraped clean of all vegetation and was an excellent line from which to backfire safely.

Had the initial attack of stringing backfire along the west firebreak failed so that the fire spread into the plantation, the next attack should have been to string backfield along the Tower Road, using the stand-by crews available at Catahoula Tower.

At all places where an adequate firebreak had been burned, the onrushing head was checked and the few spots that started in the unburned grass across the firebreak were quickly extinguished by the patrol crew. The checking of heads *B*, *D*, and *F* are good examples of control with backfiring. When the backfiring is delayed or the patrol crew inadequate, as for example on heads *C*, *G*, and *H*, breakovers occur almost invariably, greatly delaying control of the fire.

Backfiring.

Backfire can be safely strung at a fast rate even with the crudest equipment, as shown in table 6. The greatest precautions must be taken, however, to keep the backfire always under control and to avoid the misfortune of letting it get away. At the same time, a backfire, to be effective, must be of sufficient width and length to hold the main head being fought as well as any additional heads that may subsequently develop before the flanks are controlled. On the Honey Fire, the backfiring crews strung fire too timidly, particularly insofar as the length of the backfire was concerned. It was most fortunate that the backfires were so successful, since they were seldom more than 50 feet wide. Furthermore, had the crews not been so reluctant to string long backfires, control of the fire could undoubtedly have been gained much earlier. This reluctance can in part be accounted for by the fact that backfiring along the Tower Road and the east firebreak would necessarily mean deliberately burning part of the plantation. The acreage consumed in a backfire, however, is negligible; each mile of backfire 100 feet wide requires only 12 acres. This would have been a trivial loss for the great protection it offered.

The following technique for stringing backfire has been effectively and safely used and is recommended for use whenever backfiring must be resorted to in order to obtain control: Organize the crew into fire stringers and patrolmen. The latter should take their positions across the line from which the backfire is being burned. Their only job is to keep alert for possible spotting along the entire backfire line and to extinguish spots quickly as they occur. The stringers, three or four selected men in each crew, should be given special training in the methods of stringing fire, using bunches of grass, a fire rake, a torch, or other available equipment. The first man should string his line of fire parallel to and approximately 10 feet from the line from which the backfire is being made. The width will, of course, depend upon numerous factors, among which are the type and density of the fuel, the wind velocity, and the width and condition of the line (road, etc.) from which it is being made. The greatest precautions should be taken to put the initial backfire line in safely. Waiting until the first man has safely burned approximately 100 feet of his line of fire, the second man should start his line of fire parallel to but 20 feet from the first line. The third stringer, in turn, should wait until 100 feet of the second line has been safely burned and then string his line parallel to but 30 or 40 feet from the second line. If four stringers are used with intervals between lines of 10, 20, 30, and 50 feet, a backfire 110 feet wide can be burned with great rapidity. There should be an interval of at least 100 feet between stringers at all times.

The crew foreman must be very alert when backfires are being burned so that they do not get out of control. If two crews are available, the backfire should be started at a point where the main head is expected to hit and the crews string backfire in opposite directions along the line from which it is being burned. The crews should continue to string fire for at least seven hundred or even 1,000 feet beyond the points where the danger is critical; a crew will not be criticized for stringing too much backfire if it has done so safely.

Stand-by Crews and Reinforcements.

As previously brought out, all of the fire fighters available on the ranger district were dispatched to this fire before it was finally brought under control. Two other fires occurred on the Catahoula Ranger District during the Honey Fire; they were extinguished by crews dispatched from the Honey Fire without undue loss of time or acreage, indicating that the fire organization was prepared to cope with serious fire conditions. The local force was strengthened by the fine cooperation and judgment of the ranger on the adjoining district, who, upon passing the scene of the fire while en route to his office after attending a court trial in Alexandria, on his own initiative phoned ahead to his dispatcher to call in all work crews for the emergency and to send two of them to stand by at a CCC side camp located about 10 miles north of Bentley. The ranger is to be commended because he took definite action when he saw the need.

Summary

A detailed analysis of the Honey Fire is presented in order (1) to show the rapid rate of spread and the behavior of a fire burning under critical weather conditions in the southern pine type of a coastal plain, (2) to describe the suppression action taken, and (3) to offer constructive criticism and suggestions as a guide in planning suppression action for future fires burning under similar conditions.

The combination of high, shifting winds and low fuel-moisture content prevailing at the time of the fire created critical burning conditions. The rate of spread was extremely high, the maximum forward increase measured being 8 chains (528 feet) in 1 minute or at a rate of a mile in 10 minutes.

In order to control such a fire it is necessary to have an adequately equipped suppression force available at a moment's notice. The difficulties experienced by fire fighters at various parts of the Honey Fire are stated and suggestions are made for the use of accessory equipment in overcoming such handicaps. There is a distinct need also for efficient supervision of each crew, as well as able leadership, including well-planned tactics, by the fire boss.

The futility of attempting to control the flanks by suppressing a rapidly spreading fire from a point near the head toward the tail of the fire is brought out. Such tactics lead to a great loss in what would otherwise be held line and make it possible for new uncontrollable heads to form with each relatively slight change in wind direction.

The heads of rapidly spreading fires cannot be stopped by direct attack with the equipment now available; one must resort to an indirect attack involving the use of backfiring. Fighting fire with fire can be very dangerous, however, and the greatest care must be exercised in its use if an adequate backfire is to be attained and if break-overs are to be prevented. A method of backfiring, in which fire is simultaneously strung by three or four men separated by definite distance and width intervals, is outlined. It is very important that backfires be sufficiently long to stop the onrushing head even in case its direction of burning has been changed by a shift in the wind, and sufficiently wide to prevent spotting across the backfire which may start new heads.

THE WILLAMETTE FLYING 20

Roy Elliott

Staff Assistant, Willamette National Forest

The use of fire guards selected from all parts of a forest represents an interesting adaptation of the 40-man-crew idea. It is understood that these crew members performed regular guard duties at their own stations when not needed for suppression or stand-by work; when needed, they assembled at some point agreed upon where their equipment had been delivered from the central cache.

A crew of 20 experienced forest guards was organized, trained, and put into practical use on the Willamette National Forest during 1940.

The guards themselves named it "The Willamette Flying 20." It proved to be a "20-mule team" for strength and in pulling our fire-fighting record out of possible disaster on three occasions.

The idea for the Flying 20 grew out of the experimental special Siskiyou 40-man crew of 1939 with alterations here and there to improve organization and to meet conditions peculiar to the Willamette Forest. Indeed, the forest was fortunate in having the help and experience of one of the original Siskiyou crew to lead in organizing and training the men and to act as foreman of the local crew.

The Willamette Forest embraces an area within its protective boundary of nearly 2,000,000 acres consisting of five ranger districts which stretch north and south along the crest of the Cascade Mountain Range for nearly 125 miles. Crew members were selected from the guard organizations of each of the five ranger districts. Essential qualifications were industry, good health, native ability, and an agreeable temperament.

The organization and use of forest guards for such duty was a radical departure from former practice, notwithstanding selection, training, and ability of the guards for fire-line work. As a matter of fact, in the past the guards of have been left pretty much to themselves and to routine guard duties while forest officers have been content to use of the fire lines the physically unfit, inexperienced, ill equipped, and inefficient pick-up labor from nearby cities and towns. Care in selection, training, and equipping the guards and finally rounding them into expert fire fighters is commendable. The trouble is that as a general rule the full possibilities of their use have not been explored and most certainly full advantage has not been taken of this source of expert fire fighters in building up a fire-fighting organization. The 20-man crew was organized in an effort to harness the available manpower on the forest to get the best out of it where needed the most.

The size of the crew would make little difference in organization. It should, however, be made to fit the particular ranger district or forest conditions, depending on number of personnel available to draw upon, trained replacements available, transportation facilities, equipment, and effect on the regular protective force. Cooperators, R and T crews, organized industrial crews, and other competent woodsmen, when available, are all good sources from which member of such a crew may be obtained. An 8- or 10-man crew may be al a given administrative unit will support. The main idea is to mak better use of available experienced guards in whom the Governmen has a training investment both in money and labor.

The organization within the crew consists of one foreman and tw straw bosses, one of the latter having charge of the clearing and line location work and the other having charge of the digging crew Specific duties of members other than foreman and straw bosses shoul be worked out to fit conditions on ranger districts or forest concerned such as fuel types, topography, forest types, etc.

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The Flying 20 at work.

The equipment and supplies are important and must be given co siderable attention in planning. Again so many factors must be co sidered and there is so much variation in the tools needed in differe localities that a standard list is impractical. A 2-pound double-b woodsman's ax was found preferable over the conventional 3-poun ax commonly used in fire fighting. The lightweight 5-pound slee ing bag is highly recommended. Dehydrated foods are preferabl but it was found advisable to allow each guard to add particul articles of food desired. The crew will be more contented if indivi uals are allowed to select certain kinds of food to their liking; eac man has a number and his pack has a corresponding number so th this favor can be easily granted with little inconvenience.

Each outfit for the Willamette crew contained a complete a independent complement of food supplies, tools, and equipment. T equipment in one pack consisted of a radio outfit, and the man carr ing this pack acted as radio operator and also as a first-aid ma

All 20 outfits were kept centrally located and were dispatched by truck when the crew was called out. All outfits were promptly returned to the central location at the termination of the fire, where contents were checked and replenished, equipment repaired, and the packs otherwise made ready immediately for the next call. A trapper-Nelson type packboard was used for packing. Average weight of the packs was 35 pounds. Tools, equipment, and supplies recommended for such a crew are now stocked by the Forest Service in the North Pacific region, Portland, Oreg.

The primary function of the Flying 20 crew has been to cut off the head of the fire and control it within the first work period, or as soon thereafter as possible. They expect to be called on and to reach the head of the fire usually far in advance of untrained and unconditioned crews which are often used on a fire. Upon reaching the fire they must be physically able to carry on the job of control at a high rate of efficiency, know how to proceed with control work without loss of effort, and be always mindful of their own safety. They are the spearhead of the attack. The ideal situation is for them to proceed from one hot spot to another, turning the constructed line over to the less expert crews to hold and mop up.

On more than one occasion on the Willamette it was found that hot spots or spot fires in advance would just about be lined by the time the other crews arrived, making it convenient to turn over patrol and mop-up to them. The 20-man crew was thus released for other more important assignments.

Two days, preceding the annual group guard-training camp, were used in training the crew. The first day was spent in review and discussion of improved fire-fighting techniques to be used by the crew, and the second by putting into practice the theories and techniques discussed. The efficiency of the crew was evident from the start when they constructed three-fourths mile of line at the approximate rate of 1.4 chains per man-hour.

It was fortunate that the crew was trained and made ready at that time for an emergency. Less than 2 weeks later they were called on one of the potentially worst class E fires experienced on the forest. Two class D fires, following at regular intervals, provided ample opportunities for training.

Following is a report of action by the Flying 20 crew:

Gates Creek fire, 165 acres:

July 18.—7 p. m. Hiked 8 miles to Cougar springs where bedded down for night—carried packs.

July 19.—

- 3 a. m.: Prepared and ate breakfast.
- 4 a. m.: Left with packs for fire.
- 5:45 a. m.: Started work on fire line.
- 7:20 a. m.: Completed first sector, 21 chains.
- 8:45 a. m.: Follow-up crew took over and Flying 20 started on the second sector, built 50 chains of line—burned out and held this line for the remainder of the day; fire very hot on this sector. Snag fellers were kept very busy.
- 3 p. m.: Called for assistance on another sector where fire was escaping; reorganized crew on that sector and helped rebuild and hold that piece of line.

The Gates Creek fire was located 11 miles from a road and 2½ miles from the nearest horse trail. It was a day's work to get to the fire and return to camp. A trail was later constructed and the camp was moved nearer the fire line. Civilian crews were until 7 o'clock reaching the fire for the initial attack the first morning. Several found the going too rough and walked off the job. Without that, 71 chains of held line constructed by the crew in the first work period where they were needed most, this fire might have been disastrous. The aid given the organized crew, on whose sector the fire escaped, also indicates the effectiveness of the Flying 20 compared with the less experienced organized crews and the totally inexperienced pick-up crews sometimes relied upon in fire suppression. Other emergencies also occurred during the season on which the crew as a whole or members individually gave valuable fire-fighting service.

Summarized briefly the following points should be given careful consideration for success in organizing a forest-guard special fire-fighting crew.

1. Select crew members who possess good health, industry, experience or native ability, good temperament for such assignment, and agreeableness.

2. Assign members of crew to guard stations as accessible to automobile transportation as possible. The crew should be used primarily as a second line of defense, however, and get-away time is not so important as with the first-line personnel of the protective force.

3. Provide well-trained and available replacements.

4. Make advance arrangements for transporting and assembling the crew with the least possible delay.

5. Work out in advance a list of food supplies, tools, and equipment with consideration for reducing weight of the packs to the lowest minimum practical. It will take time to obtain and assemble the material since some of the articles are difficult to purchase and may have to be obtained by special order.

6. Work out a schedule of wage rates between members of the crew as equitable as administrative procedure and funds will permit.

7. Set up a project for training the crew as early as possible. They should be instructed in all phases of improved fire-fighting technique and also be given the opportunity of applying their knowledge by actual doing. Training on actual fires on or off the forest is recommended when available and it can be arranged.

8. Keep members of the crew physically fit for the job by assignments of hard work or a 5- or 6-mile hike daily. The Willamette crew was required to walk 6 miles daily when not engaged in an equally good physique-building occupation.

9. Make the organization of the crew subject of discussion in a ranger meeting well in advance of the fire season and work out at that time by conference procedure the details of what is going to be done, how it is going to be done, and by whom.

The Willamette Forest is well pleased with the performance of the Flying 20 crew during 1940. Improvements can and will be made and the forest expects to have an even better outfit with which to go into 1941.

WARDEN AND COOPERATOR TRAINING

U. J. Post

Forest Ranger, Bighorn National Forest, Region 2, United States Forest Service

In transmitting the following article to Fire Control Notes, Acting Regional Forester Stahl said: "The training of wardens and cooperators is perhaps the most difficult training job attempted by the region, particularly where these men are ranchers whose homes are distributed over a considerable area."

Post's method of controlling the progress of line-construction crews is somewhat different from most other previous approaches to the problem.

During the last few years, the use of CCC labor on fires on the Bighorn Forest has led to less dependence upon wardens and cooperators except in cases of large fires when the "all-out" call is given and then the local men compete with trained crews.

On fires that have been handled all or in part by local cooperators there has been a rather bad showing in line construction, entirely because of lack of training and practice. Willingness and spirit have been evident but results have been lacking. The situation was discussed with individual cooperators and all favored preseason training and demonstration of new methods.

Since the birth of the one-lick method, a lot of effort has been expended in trying to apply it to use with local fire cooperators. The method is the best that has been developed if a large enough crew is available and ground cover and soil conditions are favorable. Such conditions are not always found on fires in the Rocky Mountain region, however. And on the Bighorn most fires are small, the soil is usually so rocky that mattock work is not effective, and there are heavy windfall and reproduction to contend with. To overcome these difficulties, it was decided to remodel the method to apply to local conditions, yet use the conveyor-belt idea if possible because it definitely eliminates confusion and lost time of men hunting for work to do. The next step was to get the proper balance of tools that would meet most types of work found locally and fit a 10-man crew. This done, notices were sent out for an outdoor feed for the coming Sunday.

Sunday morning men, women, and children began to arrive at one of the best improved campgrounds on the forest. The ladies, with the help of a round-up cook, prepared the dinner and the men were introduced to a lot of tools. Two fire lines were marked out where timber and ground conditions were average, including rock, windfall, reproduction, and mature open timber.

The first line was attacked by the entire crew, using the local haphazard method, each man selecting his own job and with no one in command. Trench was dug in uncleared line, under logs, and around trees, and at times there were two men chopping the same tree. The whole gang tried, of course, to see how fast that line could be put through, but if it had been a real fire it would have gone over the hill. Finally the line was finished and someone yelled, "Well, we got 'er, let's eat."

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The second line was still to be built, and this time the crew was divided into clearing and trenching gangs, one group to work while the other watched. A crew boss was designated and men in the clearing gang were spaced about 8 feet apart and given a demonstration of how to do the job. Each man was to work in one spot until the man behind moved up and not move around or leave the position unless ordered to do so. The boss was a busy man at first, but it required only a few minutes for the crew to get the idea and soon the line was being opened up at the rate of a slow walk with no overexertion on the part of the men. Once the clearing was out of the way, the trenching gang went into action with the clearing crew observing.

The trenching was handled in the same manner as the clearing, each man digging out about 2 feet and moving up, the rate of speed being controlled by the boss. Shovels were used for this job, with a few mattock men to work up and down the line as needed. Upon completion of the trench the whole crew was talking about the work and had forgotten about dinner. One warden said, "You got something there."

The men built more line, all working together, and then sat down to talk it over. They agreed to use the method on fires during the coming season and expressed a desire to get together each spring to practice and discuss new methods and developments. All were in favor of any new method that would do the job faster and thereby enable them to return sooner to their own work at the ranches.

Two weeks later about half of the men at the demonstration were at work on the forest branding calves. A fire broke out in the afternoon about 20 miles away. They proceeded to the fire and found men from a road-construction crew and several others who had not had training already there. The fire was burning in mature tie timber and reproduction and some windfall. Soil conditions were average. The fire was traveling with a light wind. Two of the wardens were placed in charge, one for the clearing crew and one for trench construction. The wardens took complete charge of the work, including the instruction of the untrained men who were placed in the line alternately with the trained men. Each trained man elected himself an instructor and the dirt began to fly. They handled the job well and left a finished and completed line behind them, with no lost time.

The results: The fire was controlled in 1 hour; length of line 45 chains, size of crew 30 men. The cooperators were convinced that they had found a way to get the fire-control job done quickly. The owner of the road outfit wanted his men trained as soon as possible and was sold on the method.

GROUP TRAINING FOR FIRE ORGANIZATIONS

R. I. Boone

Assistant Supervisor, Gila National Forest, Region 3, U. S. Forest Service

Systematic group training has been given to guards and other field men for many years. Thoughtful readers will wonder how the author has solved problems arising out of training "beginners" and experienced guards at the same time. Have selected experienced guards been used as instructors, or perhaps "demonstrators" in training beginners?

During the last 2 years group training camps for fireguards have been held on the Gila National Forest. The result of the training given is reflected in more effective fire-suppression action over a rough, isolated, forested area which is accessible mainly by pack trails.

Fire crews usually have to walk in to fires, and supplies are transported by pack outfits. The greater part of the fire-occurrence zone on the Gila falls in a wilderness area, so it cannot be opened up with truck trails. In the future airplanes will be tried out for delivering supplies and equipment.

During the 1940 fire season 276 fires were handled, 220 of which were held to class A size, 52 to class B, and 4 to class C, with a total of 259 acres burned over during the entire season. The size of the job can therefore be appreciated.

The group training camps are planned and conducted as follows:

If possible, a central location is selected for the camp site in order to reduce travel costs. Consideration has also been given to accessibility of the camp site by truck so that supplies and equipment could be transported at minimum cost. Another consideration is presence of the more hazardous fuel types in the immediate vicinity, so that fire-suppression problems can be given that will fit the guards to handle fires in the most hazardous areas on the forest with due regard for the safety of the crews.

The guard personnel is divided into groups, according to the duties that they will be called on to perform. For example, lookout men are placed in one group, fireguards in another group, and trail and construction foremen are assigned to a separate group.

Experience with the organization during the past season determines subjects covered in the training course. For instance, the record may indicate that the fireguards showed lack of judgment in line location and mop-up work; lookouts failed to keep the dispatcher informed on the condition of going fires and the necessity for prompt follow-up action; or that trail and construction foremen lacked training in handling small one-crew fire camps, timekeeping, and property records, in the use of first-aid kits, and in providing for the safety of their crews in dangerous locations.

District rangers are used as instructors. Training subjects are assigned to the men who are best fitted by experience and their general knowledge to handle them. After these teaching assignments are made a conference of the instructors is held, and an agreement is reached concerning the best method of teaching the different subjects. Each instructor is then required to prepare a written training outline covering the subject he is responsible for, the method decided on for teaching, and the amount of time needed to train the particular groups.

The traing-camp program is prepared from the data supplied by the instructors. Classes are held down to a maximum of 12 men, as it has been found that training in small groups is much more effective than in larger classes. Following is an example of a program for one day:

Date—Tuesday, April 8

Subject	*Time*	*Instructor*
Telephone line construction	8 to 10 a. m.	Jones.
Care and use of tools	10 to 12 noon.	Reed.
Fire packs	1 to 2 p. m.	White.
Fireguards' reports	2 to 4 p. m.	Brown.
1- and 2-man fires	4 to 5 p. m.	Smith.
Law enforcement	7 to 9 p. m.	Bell.

The law-enforcement training period is devoted to a prearranged mock trial to bring out important points.

The instructors rate each man who is assigned to their classes, indicating his ability in different lines of work and specifying just what additional training is needed when he is placed on duty and in the inspection contacts that are made during his period of employment. The rating records are then given to the district ranger for the district on which the guard will be employed during the coming fire season.

The self-inspection forms used by the guards furnish an excellent guide for training purposes, as they naturally rate themselves low on the subjects which they do not fully understand.

The last day at the training camp is spent in the suppression of an actual fire set for that purpose. An administrative guard, or one of the older fireguards, acts as fire boss and directs the suppression work. The rangers closely observe this action and make notes of good and bad points for discussion when the fire has been handled. Guards and foremen take a keen interest in such discussions, and from the pooling of ideas obtained, many interesting points in fire-suppression technique are brought out.

AVIATION AND WISCONSIN FOREST PROTECTION

LAURENCE F. MOTL

Communications Engineer, Wisconsin Conservation Department

Forest-protection agencies, although beginning only comparatively recently to use the airplane, are finding it offers many advantages in their work. Generally speaking, in forest-protection work airplanes are used for transportation of materials, scouting and reporting progress on fires, aerial control of fires including location of spot fires, reconnaissance work, mapping generally and of burned-over areas in particular, locating tower sites, impressing the public with the need of fire-prevention measures, and rapid transportation of personnel. The uses of a plane by any given agency will be determined by the nature of the country under protection, the facilities already available for its protection, and the organization of the unit responsible.

Utility of the airplane in forest-protection work has been increased manyfold by developments in the field of radio, which have been rapid in the past year. It is now possible for a plane to stay over a fire and maintain continuous communication not only with fire crews on the fire but also with dispatching stations many miles away. In an airplane ultrahigh frequency radio communication is possible with stations five or six times farther from the fire than is possible from the ground stations on the fire. In many cases in addition to its other functions an airplane may thus be used as a radio relay station to supply or dispatching stations many miles away.

In view of Wisconsin's highly developed tower system, it is questionable whether under normal conditions an airplane should be used for locating fires. Also, the road and fire-lane system should, except on rare occasions, preclude the necessity for using an airplane to transport fire-fighting equipment to fires. However, all of the other uses of a plane in forest-protection work which have been named should be applicable in Wisconsin.

Because of the airport and hanger facilities at Tomahawk, the fire-protection forces have been able to make a trading arrangement with a local airplane owner whereby in exchange for storage space a plane for use on forest-fire work is available a certain number of hours each year. Experience both interesting and valuable has resulted.

The plane concerned is an Aeronca K, 40-horsepower monoplane. Experience has shown that it has several disadvantages for efficient application to fire-suppression work in that its cruising speed is too slow, its rate of climb is too low, and its cruising range is rather limited. Nonetheless its use has been greatly beneficial. With a field SV radio set installed in the plane it was found possible to communicate remarkably well with various tower stations over ranges as great as 65 miles. One concrete example of its use will illustrate its practicability:

Late in the afternoon of October 20, 1939, D. W. Waggoner, cooperative ranger for the northern cooperative area, telephoned to ask if an airplane could be put at his disposal the following day in the vicinity of Medford. He explained that there were four fires burning in that vicinity and all of them were potentially bad. The weather had been dry for several weeks, the humidity was low, the wind high, and the crews working on the fires were inexperienced. Consequently and because the fires were several miles apart, he was having great difficulty supervising the crews. Provided the weather continued unchanged, it was agreed that the plane would be furnished.

The following morning gave every prospect of the beginning of another 24 hours of bad fire weather. The air was dry, visibility poor, and there was about a 25-mile wind blowing from the west. The towerman on the Corning fire tower, which is located about 15 miles west of Merrill, was notified to turn his radio to "stand-by receive" for 3 minutes every quarter hour to pick up messages from the plane. Because the plane was slow in air speed and there was a strong head wind, a rather large amount of time was consumed in reaching Medford. An interesting fact might be pointed out here. Given an airplane with a speed of 75 miles per hour flying into a 35-mile-per-hour headwind, in 1 hour the plane will cover only 40 miles. If the speed of the plane is increased by 35 percent, making it cruise at 100 miles per hour when flying into the same wind, it will cover 65 miles. In other words, the range of the plane will be increased by 62.5 percent. Thus when flying into a very strong wind, a comparatively small increase in speed will increase the ground speed by a much greater percentage.

After landing at Medford and taking on additional gasoline, the plane was headed west to where the fires could be observed. Radio tests on schedule back to Corning tower revealed that contact to Tomahawk via telephone relay could be maintained if desirable. Contact was then made with Waggoner, who was equipped with a portable radio set. He had heard the plane motor, anticipated the call, and answered immediately. For the next 2½ hours while the plane was over the fires continuous contact was maintained with Waggoner. He was given information about the fires which he was in no position to obtain quickly on the ground. Waggoner stayed on the fire considered most serious while the plane periodically flew over the other three fires, informing him of progress and developments. Waggoner later pointed out that from his point of view, this information which enabled him to stay on the most serious fire but at the same time almost continuously keep up with activities on all four fires was one of the most valuable features of the plane service. After the fires were definitely under control the plane returned to Tomahawk, arriving about 6 p. m.

Another point worthy of note in connection with the fires discussed was the effect of the airplane on the morale of the fire fighters. These were local residents, since the fires were in cooperative territory. It was noted that immediately upon arrival of the plane not only did the men on the fires put forth greater effort but that additional men also volunteered for service. One of the men who worked on the fire was later heard to remark to a friend, "Doggone! There I was sitting by a fence post when that airplane came along. I'll bet my hat those suckers were looking right at me and told Waggoner about it. You know he looked at me sort of funny when he came around afterward."

The presence of the plane over the fires not only served to emphasize to the public the seriousness of the fires in a way no other means could, but it also brought home to everyone in a conspicuous way the State's interest in suppression of the fires.

Aviation has made a substantial contribution to almost every form of public service that has given it a fair trial. The Federal Forest Service and some State forestry services have already clearly demonstrated that airplanes can also be of great service in forest-protection work. Forest-protection personnel at Tomahawk firmly believe as a result of both experience and observations that the airplane must of necessity eventually be recognized as a tool for the suppression of forest fires which will be considered as essential as tractors, plows, pumpers, and even the back-pack can.

Grasshoppers and Forest Fires.—Burning of debris along fence rows, roadsides, and marshes by farmers often results in disastrous forest fires. Such burning is often done without full knowledge or without full consideration of the disadvantages as compared to the benefits. Farmers will always have to do some burning, but if they can be encouraged to burn only when real benefits result and only when conditions are favorable, the job of forest protection will be easier.

Often farmers applying for burning permits indicate that they want to kill grasshoppers or their eggs. Usually they want to do the burning during the dryest part of April or early May. In many cases the burning includes not only roadsides and along the fence lines but also the borders of fields adjacent to woods or grass marshes where the fire cannot easily be confined to a limited area.

Consider now these facts about grasshoppers as given in Farmers' Bulletin 1691. The grasshoppers over-winter in the egg stage. Egg laying takes place in late July, September, and October, and until the first good frost. Most of the grasshopper eggs are laid in the top 2 inches of soil.

Wouldn't fewer "wild" fires result if farmers could be persuaded to do their burning for grasshopper control during the winter when the danger of fires in the woods is perhaps not so great as during the dry parts of April and May?

The Bureau of Biological Survey has found that birds play an important part in the natural control of grasshoppers. Yet the burning of fence rows, roadsides, and marshes destroys the nesting places of the birds.

Obviously unless the fires are very hot many of the eggs deposited 2 inches deep in the soil will not be affected. Why, therefore, burn at all? Why not give the birds a better break?

In the light of these facts it appears that fire-control men can profit occasionally by browsing far afield in the literature of other sciences, even in entomology. It also appears that on districts where there is a "grasshopper burning" problem, presuppression technique may include some educational work among farmers on grasshopper control.—Arnold Buettner, forest ranger, Wisconsin Conservation Department.

RADIO IN STATE FIRE-CONTROL WORK

H. R. Dahl

District Forest Ranger, Forest Protection Division, Wisconsin Conservation Department

The use of portable radio sets in forest-fire control work is not limited to any one group or unit. In contrast to other articles in this issue of Fire Control Notes, the author of the following article describes the use of radio in more populous areas of greater motor accessibility.

The value of radio in forest protection has been the subject of extended discussion the last few years. Experiments conducted by the Wisconsin Forest Protection Division during the fall of 1939 and the spring of 1940 have definitely proved the worth of radio for fire protection in this State to those who have used the equipment.

The United States Fire Service type SV portable radiophone has been found to be the most practical type for field work. The working range of this set varies with topographical and atmospheric conditions, with a maximum range of 80 miles between advantageously located stations. Independent transmitting and receiving stations are mounted on the same chassis. All batteries are contained in the set cabinet, and the same antenna is used for receiving and transmitting. The weight of the set, complete with batteries, is 18½ pounds, and its compact construction makes it easily portable over rough terrain.

In Wisconsin the most extensive tests have been made in Forest Protection District No. 5, in Marinette and Florence Counties. Although only four sets have been available in an area of more than a million acres, the equipment has been of invaluable assistance on many fires where radiophones were used to supplement existing telephone lines. Two of the radio sets were permanently installed in lookout towers, one set in the Thunder Mountain Tower in Marinette County and the other in the Buckeye tower in Florence County. The field sets worked out of the district headquarter's hanger station at Wausaukee in Marinette County and the Florence Ranger Station in Florence County. Communication was possible directly from the fire line to the towers, from which the information regarding conditions at the fire line was relayed to the dispatcher at the district headquarters, where the messages were translated into orders for the quick movement of fire crews or essential equipment. Communication by radio proved a decided improvement over the old method, where the dispatcher had to depend upon his own judgment of conditions as determined by information received from the towermen, who were usually several miles from the fire.

The investment for radio equipment in District No. 5 was amply repaid by its service in the 940-acre fire in the vicinity of Athelstane on May 10, 1940. It served as the chief means of communication in the desperate battle waged by 150 fire fighters on the most stubborn blaze in the district in several years. The fire occurred in a high-hazard area of unbroken jack pine and scrub oak plains, at a time when forest fuels were tinder dry as a result of extended drought and low humidity. Fanned by a 20-mile wind, the fire threatened to result in a major catastrophe.

Upon the arrival of the initial crew from the ranger station at Wausakee, a radio station was installed, and the district dispatcher was furnished with an up-to-the-minute picture of progress. Fire-suppression crews and equipment moved with clocklike precision to meet the growing demands as the fire progressed. The burned area was confined to a relatively narrow strip and the fire was brought under control in about 4 hours. It is the conviction of the district personnel that only by the use of radio, which afforded prompt action in dispatching crews and equipment, was the Athelstane fire prevented from becoming one of the most disastrous conflagrations that have occurred in this part of the State.

Because of the successful results with the skeleton equipment now in use, the Forest Protection Division plans an intensification of its radio coverage. Radio schools for its personnel have been established, and practically every member now holds a radiotelephone operator's license which permits him to operate such equipment. Thirty additional sets have been ordered which, together with those now in use, will make a total of 68 sets on the forest-protection areas of the State.

Many possibilities are envisioned for the use of radio communication in fire-control work. Radio communication is being considered for service to emergency lookout points where the cost of radio would be more economical than the construction and maintenance of telephone lines. Radio may also be used to advantage for contact with stand-by crews to be located at strategic points during periods of high fire hazard. It can be used to contact CCC crews on work projects in the forest areas and thus make them instantly available without interfering with their regular conservation activities. Also, on large fires, scouts may be stationed at various points along the fire line to report the requirements on the entire front. It appears that the use of radio in fire-control work is about to write a new page in the forest-fire history of this State.

ACCENT ON YOUTH

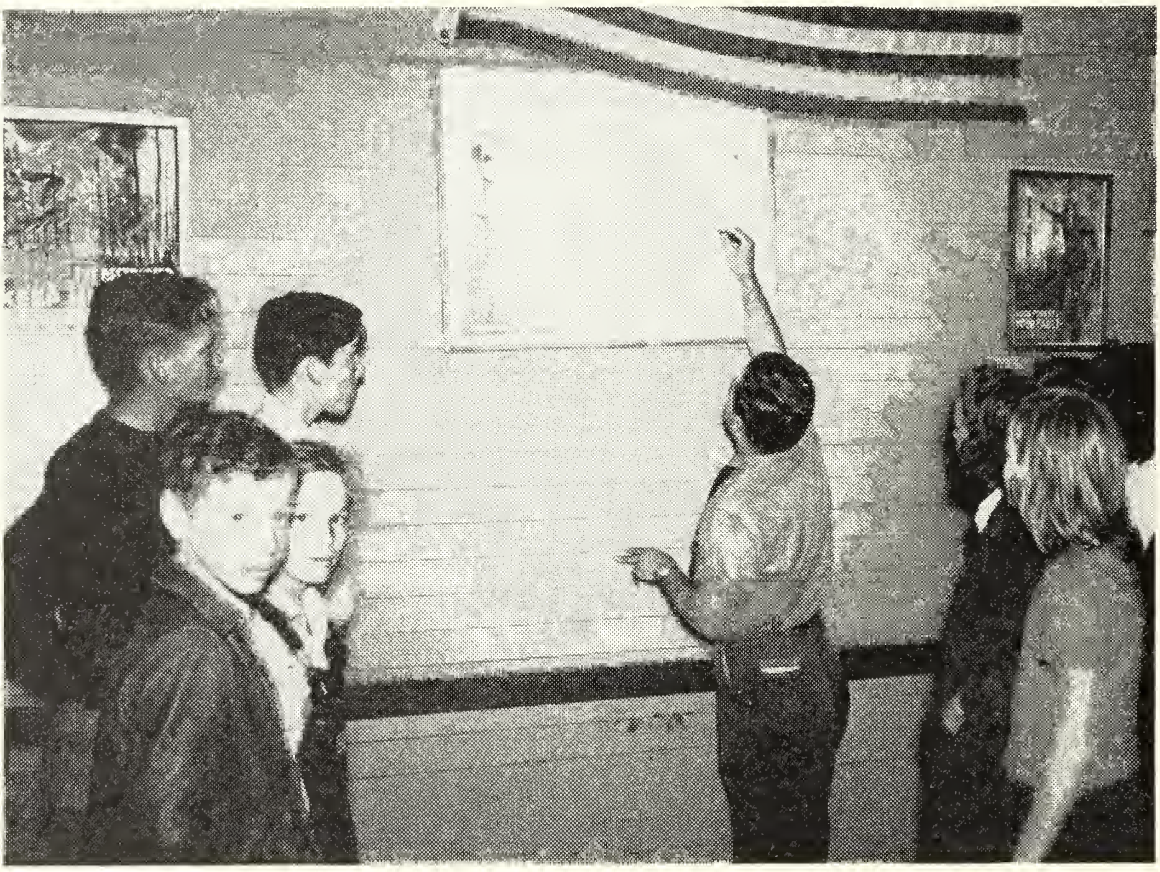
V. B. McNaughton

Fire Assistant, Mississippi National Forest, and

R. M. Conarro

Regional Fire Assistant, Region 8

The problem of forest-fire prevention will not be solved by any one program but by cumulative effect of many direct and indirect programs. One such program which is "paying off" today and will continue to do so for many years to come has to do with competitive fire prevention in rural schools in the national forests of Mississippi.



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Bringing the record up to date.

Each school competing is allotted an area to keep free from fire An attractive colored map showing all competing schools and thei respective protective areas is hung in each school. Once a montl this map is brought up to date by a forest officer. At the end of a 6-month period (which coincides with the fire season and schoo term) a climatic "forestry day" is held at which the winners are presented with their prizes. In some cases a rather elaborate forestry day program under direction of a master of ceremonies, and consisting of a declamation contest, music by a local band, talks by prominen speakers, and various contests is arranged. Sometimes even a specia edition of the local paper is issued and a radio hook-up is used for th program.

The purpose and thought behind such relatively intensive school programs seem to justify their existence. Reduction in the number of fires occurring is only one of the results—only a means to the final goal.

Officers on the national forests are concerned with trees and men, and in the past few years have become somewhat more acutely aware of their obligations to the forest residents than heretofore. However, the man in the forest has not in most cases become aware of his obligation and responsibility to the trees.

The school programs help both the men and the trees. If administration of the national forests is successful, work will become more pletniful and stabilized. The per capita income of the forest residents will be increased. Higher standards of living will follow.

And as for the boy of today, who will be the man of tomorrow, he will be a better, more responsible citizen of his community; for fire prevention is nothing more than respect for the property rights of others. And small though it may seem to some, the principle of property rights is highly important in maintaining law and order in a forest society.

Finally, the fire prevention programs offer to even the smallest of the children an opportunity to contribute directly to national security. It gives the children a concrete, definite "something" to do. It is their part in making America strong and self-sufficient. Far-fetched? Well, perhaps, but don't forget the intense juvenile educational programs in the totalitarian countries, programs aimed at inoculating the youth with doctrines of hate and prejudice.

Do not expect the youth of America, especially the rural youth, to grow up to be good citizens with no training or guidance. Every opportunity must be used to teach intelligent and responsible patriotism to those who tomorrow must carry the torch of democratic ideals in a world where ours may be the only existing light for free men.

The contest rules may vary with local problems or conditions. In some places only grammar schools compete; in others high schools are included. Following is a typical set of rules:

(1) Each school is allowed 1,000 points to start the contest.
(2) For each man-caused fire 50 points is deducted.
(3) For each acre burned 1 point is deducted.
(4) For each false alarm 5 points is deducted.
(5) Fires suppressed by local people before the arrival of crews will not be counted against the schools' records.
(6) The contest will run from October 1 to March 31. The school having the highest number of points remaining from its orginal 1,000 will be the winner.
(7) In case of ties duplicate prizes will be awarded.

Adequate prizes must be secured to get the best results. It is usually not difficult to "sell" the program to local business firms who willingly contribute merchandise or cash for the winners. Try not to have any absolute losers; give all contestants something in recognition of their participation. Be sure to give the prize donors their share of publicity; the next year's prizes will be that much easier to solicit.

Back up the program with plenty of publicity. Don't overlook the forest personnel and cooperators in "talking up" the program throughout and adjacent to the forest.

Get the public approval of the State and county superintendents of education for the program. Generally the teachers are very enthusiastic over the idea, but once in a while a "preceding letter" is necessary to avoid a lukewarm reception.

As for the children—well, don't worry about them. Their bubbling, contagious enthusiasm will thrive on surprisingly little attention. The big job will be to keep them within bounds. After all, it is one thing to go home and ask Pa to be careful with his debris burning, etc., and it is something else to climb a neighbor's fence and tear apart his burning brush piles when he has not cooperated with either the school or the national forests by notifying the forest supervisor of his intention to burn.

School fire-prevention programs will not solve the fire problems entirely. Aggresive law enforcement, personal contacts, notification systems, publicity, good detection and suppression action, and all the other many tangible and intangible things that affect fire control will still be needed.

Forest Fires.—The power-pump unit of the Lebanon crew was detailed to hold a section of the woods on the edge of Marlow Village. The forest fire, backed by a stiff breeze, roared about 600 feet away but, suddenly, with a shift in the wind, headed toward the village. Thick, dense smoke settled over the town and the pump crew put out many spot fires from flying sparks and coals. The crew stationed at the village water hole, stayed at its post in the face of the surmounting difficulties. Suddenly the power pump began to sputter and operator Raymond W. Langley discovered that the water-feed pipe to the cylinder which cools the motor had become disconnected. Disregarding burned fingers he eased the motor and repaired the damage. Almost at the same moment the flames jumped into patch of Christmas-tree size spruce and fir less than 100 feet away and the grove became a mass of flames. To add to the excitement, snakes driven ahead of the fire began sliding into the water hole. It was estimated that at least 50 of them were swimming around, and they became so numerous that they clogged the intake hose of the pump. A man was even detailed to keep the intake open with a stick. In spite of everything the crew stayed with the pump, the buildings were all saved, and the fire roared on its way in another direction where there was less opposition.—Netsa NEFE News.

THE BEAR VALLEY HIGH-HAZARD PLAN

H. Robert Mansfield

District Ranger, Malheur National Forest, Region 6, U. S. Forest Service

The development of a simple, workable high-hazard area plan which will insure fast action on fires has been one of the major concerns of the Bear Valley district of the Malheur National Forest for the past year. A brief statement covering the need of such a plan, the problems encountered in its development, and the form which it is assuming may prove of general interest.

The Hines Co. has been operating on the Bear Valley district for a number of years. In 1936 their cutting system was changed from 80 percent to the light-selection system. At that time the slash-disposal system was changed from a complete pile and burn to no disposal whatsoever except piling and burning about a 100-foot strip along roads which were to be maintained. From 1936 to the spring of 1940 about 70,000 acres of slash had accumulated and the area was increasing at the rate of approximately 20,000 acres per year.

The Hines Co. is, of course, responsible for fire protection of the area under sale contract. In the spring of 1940, however, the original sale contract covering in the neighborhood of 60,000 acres was closed. This released Hines from responsibility on that area and turned full responsibility back to the Malheur Forest.

In the Malheur area the progress toward normal of hazard created by slash is extremely slow, and the slash on Hines' operation presented burning conditions somewhat comparable to those in a powder factory. If this area were to be protected from fire, plans had to be perfected which would reduce elapsed time to as near the zero point as possible. The size of the hazard area and limited funds made it necessary to develop a plan which would make the fullest possible use of existing control features, rather than to superimpose on the ground a theoretically complete and perfect plan drawn up in the office.

Quick action appeared to be the key to the situation and quick action depended upon a complete road system and complete information concerning fire-fighting conditions in the area. The information needed to be in visual form for fast use, hence the necessity for a map.

Because of the importance of topography in planning fire action, the timber-survey topographic map was chosen as a base. Prepared on a 2-inch scale this map gives a good picture of the topography and allows room to show needed information in detail without being too large to handle. To further simplify use, the completed map is being made on a township basis with the township sheets bound in a reduced-size atlas binder.

The timber-survey maps do not show a great amount of detail other than that necessary to timber management. It is therefore necessary to ink in names of streams, mountains, lookouts, springs, etc., so that points on the map may be quickly correlated with the ground. It is also necessary to place the road system on the map.

The Hines Co. does truck logging and endeavors to keep skidding distances to a minimum. As a result, the country is left with a maze of roads, all of which need only be freed from logs in order to be usable for fire control. Taking the map to the field and sketching the roads in by use of section lines and topography proved to be the most satisfactory way of getting the roads accurately located on the map. Such a complicated road system is developed by the company that a simple, foolproof naming plan was needed so that even a guard familiar with the country could easily find his way to a given point. The most simple plan seemed to be to give the main roads names according to the drainage which they followed and to number the spurs from these named roads. On the ground the naming was done by use of informational signs of a temporary nature and on the map the naming was shown in detail. For example, a person traveling up the "30–30" Springs Forest Truck Trail will come to an informational sign indicating the Flagtail Creek Road. Following up the Flagtail Creek Road he will find signs indicating Spur 1, Spur 2, etc. Following Spur 2 he will find Spur 2A and 2B.

Pump chances, water storage, company tool caches, Forest Service tools, firebreaks, fuel types, etc., are being shown on the map by appropriate symbols as rapidly as they are developed or accurately located.

The final maps will be blueprints which are relatively cheap and are easy to correct to show changes in or additions to the plan. The legend used provides for the protective positions, water storage, pump chances, live springs, running creek water, available camp spots, and section-line crossing markers to be shown in blueprint form, while features, such as roads piled and burned, areas of extreme hazard, large scabs or meadows, and boundaries of slash, are to be shown by color.

Malheur personnel believe that the plan will help a guard to find a fire more quickly, aid the protective assistant to dispatch men and materials more effectively, and enable a fire boss to size up promptly the situation confronting him without overlooking any good bets. Each guard will be furnished a map for each township in which he will work. The protective assistant, ranger, and supervisor's office will have complete sets of the maps of all townships covered and reserve sets will be kept on the ranger district for use on project fires.

The plan is being developed for the new sale area as well as for the old area of which Hines' fire responsibility has ceased. This is being done because the Forest Service has (without in any way releasing the company from its contractual responsibility for fire protection of the area) taken over the direction of the extra patrolmen and lookouts which the slash area requires and because it will be only a matter of a few years before the entire responsibility will revert to the Forest Service as a result of the time-limit clause in the sale contract.

As extra guards, the company is financing two patrolmen provided with pick-ups fitted with Panama pumps, 100-gallon water tanks, hose, tools, and radio; one added lookout with stand-by radio; and

(Continued on p. 213)

REDUCING MAN-CAUSED FIRES

HENRY A. HARRISON

District Ranger, Whitman National Forest
Region 6, U. S. Forest Service

Fire-prevention guards have been used successfully throughout the country, but this is one of the few reports of their activities that has appeared in FIRE CONTROL NOTES.

In the spring of 1940, data compiled by the Pacific Northwest Forest Experiment Station showed that the Sumpter district of the Whitman National Forest was very close to the worst of the 100 districts in region 6 for man-caused fires. A careful analysis of causes was made, and a comprehensive fire-prevention plan for the district was formulated.

The Sumpter district has a large protective area of private lands adjacent to and intermingled with Government lands. The district is all in a mineralized area, and use by miners and prospectors is heavy. From three to five major logging operations are active each year on the private lands. The combined use of the entire area by loggers, woodcutters, miners, prospectors, stockmen, settlers, hunters, and others makes the fire risk from human activities great. The analysis indicated that one of the weak points in fire prevention on the district was the inability of the ranger, because of limitations in time, to maintain enough contacts with local residents and users.

During the 1940 season, for the first time, a special guard, whose duties were primarily fire prevention, was used on the Sumpter district. The guard was a man of varied experience chosen for his ability to meet and talk to people. He was carefully trained and instructed in his duties, which included:

1. Making scheduled trips over the entire district to contact users and forest residents to the fullest extent possible.
2. Leaving auto tags at parked cars where no contact was made.
3. Visiting logging operations at regular intervals to contact loggers and check fire equipment.
4. Making a record of smaller slash and other fire hazards. A plan for removal of hazards was made and put into effect by the ranger and prevention guard.
5. Going to all man-caused fires, usually in addition to the regular suppression crew. Unless urgently needed to help suppress the fire, the prevention guard's job was to make a complete investigation and effect law enforcement if possible.
6. Maintain fire-prevention signs on the district in accordance with the posting plan.

The guard traveled in his personally owned car and carried a type SV radiophone equipped with a fishpole antenna. Communication with radio-equipped lookouts was possible over most of the district, so the guard was in almost constant touch with the protective assistant. On several occasions he chanced to be the closest man to a fire and was dispatched for initial action.

The use of a fire-prevention guard is only one of a number of fire-prevention activities being carried out on the Sumpter district;

(Continued on p. 213)

A PLAN IN CHART FORM FOR THE PLACEMENT OF THE PRESUPPRESSION ORGANIZATION

H. G. Hopkins

Assistant Forest Supervisor, Monongahela National Forest, Region 7 U. S. Forest Service

The fire-danger meter is casting off its swaddling clothes and management is directing the baby's growth. The Monongahela is another of the organizations that is putting this youngster to work in its everyday activities.

Burning Conditions

Burning conditions change rapidly in the section of the Appalachian Mountains where the Monongahela National Forest is located. It is not unusual, during the spring and fall fire seasons, for fires to be reported in the afternoon of a day that started off with the forest floor dripping wet or even covered with a light snow. The loose top layer of hardwood leaves, and the dead grass, ferns, and weeds dry quickly before sun and wind and will carry fire at a surprising rate while the lower, tighter packed layer of leaves is still wet.

Burning conditions may be developing rapidly on the south slopes all unsuspected by a ranger or guard working on a damp or snow-covered north slope. Or, fire danger may creep up on a man while he is working on a past-due report in the shelter of his office. To further complicate the picture, there is nothing dependable or regular about fire weather. The Monongahela fire season is usually defined as March 15 to May 30 and October 1 to December 15, but burning conditions may develop at any time of year. Further, there may be stretches of a week or more, during the so-called burning season, when the clouds hang low and fire conditions do not develop.

Under such circumstances, a mechanical method of determining fire weather is of great benefit, and so forest personnel have grown to lean heavily upon fire-danger station reports, and the fire-danger class as recorded by the Appalachian Station fire-danger meter.

On day early last spring I was inspecting the fire-danger station set up at Camp Woodbine on the Gauley district. A reading was taken and the data applied to the meter, resulting in a class 3 day reading, indicating moderate burning conditions. The observer, a local enrolled man with many years in the woods behind him, looked across at a snow-covered north hillside and with evident scorn for those "danged Jemison" sticks, remarked, "Now you know fire wouldn't burn today." That very afternoon, right under our noses, a little brush fire spread over 3 acres in 10 minutes, and we became convinced that those "danged Jemison" sticks would bear watching.

Such rapid charges in conditions indicate a need for great flexibility in the fire-control organization. Guards are paid by the day when actually employed, and may be called up for duty at almost

F
PLANS
Presuppression
White Sulphur

Elkins, W. Va., *January 1, 1941.*

SAMPLE PLAN FOR PRESUPPRESSION ORGANIZATION
WHITE SULPHUR RANGER DISTRICT

Danger class—Fire season	2					3			4				5				Expected number man-days	Average wage	Fund
Visibility (—=Normal; L=Low) / Risk (—=Normal; H=High)	— / —	L / —	— / H	L / H	— / —	L / —	— / H	L / H	— / —	L / —	— / H	L / H	— / —	L / —	— / —	L / H			
Expected number days—Fire season	22	2	5	1	34	5	10	1	16	1	5	1	1			1	105		
Ranger					°	0	°	°	°	P	P	S	S	S	S	S	3		
Dispatcher	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	105	4.16	P&M
Smoke chaser	P	P	M	M	M	M	M	M	M	M	M	M	M	M	M	M	81	4.16	P&M
Lookouts:																			
Hopkins Mountain	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	105	3.66	P&M
Paddy Knob	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	105	3.66	P&M
Sharp Knob (Gauley)	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m			
Beaver Lick (W. Va.-F. S.)	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	10	3.33	FF
Meadow Creek Mountain										M		M	M	M	M	M	4	3.33	FF
Elk Mountain										M		M	M	M	M	M	4	3.33	FF
Patrolmen:																			
Auto										M		M	M	M	M	M	4	3.33	FF
Slaty Fork											M	M	M	M	M	M	8	3.33	FF
Wardens:																			
Browns Creek—H. Dilley									°	°	M	M	2	2	3	3	28	1.60	FF
Cloverlick Run—J. H. Higgins					°	°	°	°	M	M	M	M	M	M	M	M	8	1.60	FF
Slab Camp—A. Bowen									°	°	°	°	M	M	M	M	2	1.60	FF
Crooked Fork—G. Gay									°	°	°	°	M	M	M	M	2	1.60	FF
Cummins Creek—J. S. Lee							°	°	°	°	M	M	2	2	3	3	11	1.60	FF
Blue Springs—R. Hannah											°	°	M	M	M	M			
Auto—A. Perry					°	°	°	°	M	M	M	M	2	2	3	3	28	1.60	FF
Frost—K. Chestnut					°	°	°	°	M	M	M	M	M	M	M	M	25	1.60	FF

(Only selected positions shown.)

Legend:
- L—Low visibility; averaging less than 5 miles.
- H—High risk as defined in instructions for use of plan.
- P—Man working on project funds near phone in vicinity of fire-control duty station, and to report in hourly or as required by dispatcher.
- °—Man or crews contacted, location and availability determined, but no stand-by order given.
- S—Man to stand by at phone on project funds.
- M—Manned or stand-by on fire-control funds (P&M or FF).
- 2—Number of men to stand by including warden.
- m—Man needed but expected to be paid by State or other cooperator.

any time of the day or night. Most of the guards are local residents, living within an hour's drive of their presuppression station. Roads to many lookout points aid in quickly and economically adjusting the detection organization to the needs.

The Plan

A plan for placement of the presuppression organization has been prepared for each ranger district in concise chart form. Placement varies with the three variables of fire danger—weather, visibility, and risk—and, of course, is based on consideration of the static factors of fuel type, topography, and values.

Five classes of fire danger are recognized, as classified by the Appalachian Forest fire-danger meter. This is designed to take into account all of the factors, as fuel moisture, wind velocity, length of burning period, condition of vegetation, etc., which determine, for a fire in a given fuel type and topographic situation, the rate at which it will spread and the degree to which it will resist control.

Two classes of visibility are recognized: (*a*) Normal or regular visibility. Studies have indicated that lookouts on the Monongahela can see 7 miles 70 percent of the time, and 5 miles 90 percent of the time. The same studies have indicated that seasonal variations in visibility are insufficient to form a basis for planning changes in the detection organization. (*b*) Low visibility. Visibility is low when a $\frac{1}{8}$-acre fire could not be detected over 5 miles away, save for rare intervals or minor fractions of the day. This condition may be expected less than 10 percent of the time during fire weather. Short periods of low visibility, lasting less than one-half day, must, of necessity, be disregarded as a basis of increasing detection personnel, except during class 5 weather, when any reduction of visibility below normal will be the basis for organizing as indicated for periods of low visibility.

Two classes of risk are recognized: (*a*) *Normal risk* refers to the usual risk for any particular area. It is recognized that the normal risk in some areas, as along a logging railroad right-of-way, may be much greater than in others, as in an area closed to all entry. However, the normal risk for each particular area has been considered in arriving at the plan for placement of the organization during periods of normal risks. (*b*) *High risk* refers to unusual conditions of risk such as exist weekends during fishing seasons.

The chart constitutes a basis for both financing and inspection of the districts. It is revised annually as indicated necessary by new or additional experience.

A "PUSHER" FOR SNAGS

Merle S. Lowden

Deschutes National Forest, Region 6, U. S. Forest Service

A large saving in snag-felling costs has been effected on the Deschutes National Forest during the last 2 years through use of a snag-felling machine. This "pusher" has reduced the average cost of felling ponderosa pine snags in hazard-reduction work on fire lanes to approximately one-half of what it was when the work was done by hand with crosscut saws.

The Deschutes machine consists of a 40-foot boom mounted on a "60" caterpillar tractor equipped with Hyster. The lower one-half of the boom is built of 8-inch channel iron and the upper one-half of 6-inch material. The entire length is reinforced with heavy channel-iron cross bracing.

Side view of pusher snag-felling machine used on the Deschutes National Forest.

The boom is fastened on the lower end to the caterpillar frame and is held in place by five ¾-inch guy cables and a ⅞-inch lift cable. The four guy cables from the top of the boom are attached to the protective frame over the driver's seat and the guy from the lower side is attached to the front of the caterpillar frame. The lift cable is attached near the upper end of the boom and to the Hyster. It is used to raise and lower the boom when repairs or adjustments are made. It is not used when the machine is in operation because the guy cables would need to be detached. The guy cables keep the boom in a relatively fixed position and help prevent it from slipping up the snag. The end of the boom is fitted with three large triangular teeth cut from ¾-inch boiler plate which catch on and assist in preventing the boom from slipping from the snag.

The driver is protected from falling limbs or pieces of the top by a heavily braced frame of 3-inch iron pipe welded together, on which is attached a roof of ½-inch boiler plate. The canopy has large holes in it to enable the driver to see up along the snag.

The beetle-killed snags in the area being worked rot in the roots within the first year and are comparatively easy to push. Snags up to 36 inches in diameter and 150 feet in height are pushed without difficulty. With a 2-man crew of operator and helper, the machine pushes 200 snags per day in clearing fire lanes 300 feet wide. It has traveled as far as 9 miles per day doing this in areas where the snags average less than 2 per acre. Where the snags are farther apart the costs per snag increase because of travel time between snags. Just when the snags become so thinly scattered that it pays to fell them by hand has not yet been determined, but studies are now being carried on to determine this point.


F—404497

The Deschutes snag-felling pusher in action.

For a number of years a local logging operator has used a snag pusher consisting of a boom mounted backwards on a high arch, which is pulled by a crawler tractor in the usual manner. Snags and live trees on railroad rights-of-way are pushed over with this machine by backing the arch-mounted boom against the tree or snag. The machine appears to work satisfactorily, but there are more hazards in using a machine that is backed up than in using one that works forward. The present "pusher" mounted directly on the tractor was designed to overcome some of the risks.

During the first year the pusher was used, a number of "bugs" were eliminated. Getting teeth for the boom that did not break or bend was a problem, but the present short, heavy, triangular buzz-saw teeth are doing the job.

While it is questionable whether the machine could be used on heavy Douglas-fir snags or on similar species, modifications could probably be made and a similar machine worked out to do the job. On pine snags the machine has worked well and its use has resulted in savings that can be used in doing more slash piling and burning. So far no snags have been felled with the machine in suppression of a fire, but a try will be made on the first available fire.

OIL CURE FOR LOOSE HANDLES

Idaho National Forest

On all forests, despite the greatest care, how to keep handles of fire tools from becoming loose is no doubt the cause of a constant "headache." Handles inspected regularly and found to be well fitted and perfectly tight will often show up badly on the job.

Humidity apparently has nearly as much effect on handles as it does on forest fires and loose handles and fires made a bad combination. It is hard to realize that changing weather and use play such havoc with them.

Some forests or agencies may be interested in an experiment carried out in region 4 by the Idaho National Forest. The idea is not new, but we have never heard of it being used on a large scale or any notes being made on the results of such an experiment.

A well-dressed handle, perfectly fitted and properly wedged, is about the ultimate in loose-handle prevention, but it is not enough to stand extremes of hot and cold and wet and dry weather conditions. With this in mind experiments were made with the use of oil.

The oil is applied after the handle is properly fitted and wedged with wooden wedges. A small hole $^{11}/_{32}$ of an inch in diameter is bored in the center of the end of the handle which is within the eye of the tool. The hole is, in most cases, about 2 inches deep, depending on the depth of the eye of the tool involved, but not deep enough to weaken the handle. The tools are placed in racks with the tool end up and the hole is then filled with No. 10 S. A. E. motor oil and allowed to stand overnight or an equivalent length of time. It is then filled again and plugged tightly with a $^3/_8$-inch plug $^3/_4$ of an inch long. The most suitable plug is made from ordinary $^3/_8$-inch birch doweling. The handle should be tight and thoroughly dry at the time of treating.

The oil is absorbed by the handle in the eye of the tool, but not enough to soften the wood or make it spongy. The treatment makes the handle more resistant to weather and much less likely to shrink or expand because of varying moisture content.

Last season more than 2,000 fire tools (axes, pulaskis, and hammers) were so treated and our loose handles decreased more than 75 percent. A loose handle is now more rare than common. The treatment is not expensive and can be given at the time of reconditioning with very little more time or trouble than rewedging.

A GUARD FOR DOUBLE-BIT AXES

SAMUEL W. ORR

Forest Ranger, Routt National Forest, Region 2, United States Forest Service

During the last few years a number of different types of ax guards have been devised and experimented with, none of which has proved entirely satisfactory. Either they have been too expensive to manufacture or have been impracticable in one way or another.

About 3 years ago experiments were commenced with the idea of improving upon previous efforts. Several types of guards were devised, none of which seemed to fill the bill. In the spring of 1940, however, a guard was completed which brought favorable comment from those who examined it. This guard had the advantages of durability, cheapness of manufacture, effciency, and lightness. The material used in making it was condemned 1½-inch unlined linen fire hose such as that used with power pumps on suppression work. Rubber lined hose was rejected because of weight and bulkiness, and the tendency of the rubber to deteriorate.

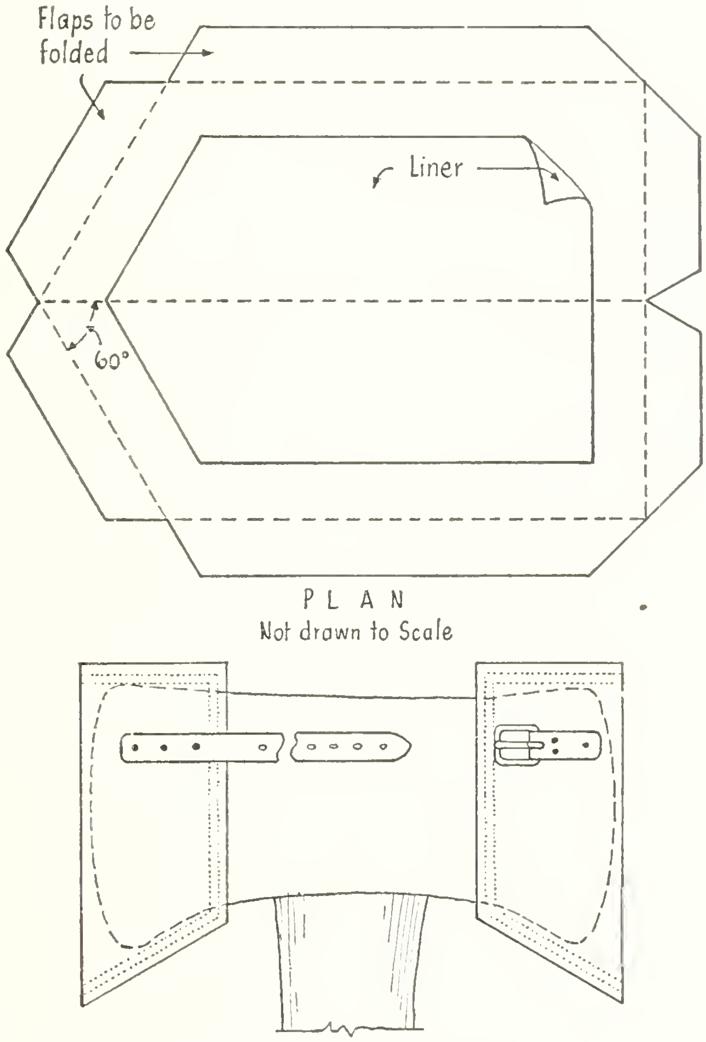
In making the first satisfactory model of this guard, a section approximately 10½ to 11 inches long was cut from a length of unlined 1½-inch linen fire hose. From one end of this section a 4-inch length was measured and cut off. The part remaining was cut once lengthwise so as to give a flat piece of material approximately 5 inches wide and 6 inches long.

A template, or pattern, was made of paper (metal would be much better). Using the template as a guide the 5- by 6-inch section of hose material was marked with a pencil and cut to shape. Tinner's snips or sharp heavy shears seem best for this operation. Or a safety razor blade in a holder may be used, dispensing with the marking of the material by following the outline of the template with the razor blade.

Having cut the 5- by 6-inch section to shape, the uncut 4-inch section removed from the original piece was cut twice along its length, thus securing 2 pieces, measuring approximately 2½ by 4 inches, which were cut as shown in the illustration. These 2 pieces, which were named "liners,' were then sewn to the exact center of the piece previously cut. Linen harness thread seems to be the best material for this purpose. The two liner pieces were used in order to avoid an undesirable bulge in the completed guard. After attaching the liners as indicated, the flaps of the larger piece were folded inward, so that their inside edges butted against the outside edges of the liners and were sewed down into position with linen harness thread.

The ends of the guard were folded, butted, and sewed in the same manner as the sides except that instead of linen harness thread, wire was used for sewing, in order to prevent the edge of the ax from cutting through, should it by chance come in contact with seam. One end of the guard was folded and sewed on an angle of about 60° By folding and sewing in this manner a pocket was made which when slipped over the heel of the ax took advantage of the slight curvature at this point of the implement, and prevented the guard from slipping off the blade.

Upon completion of two separate guards as described, a buckle was riveted to one guard and a strap to engage the buckle was riveted to the other. Both buckle and strap should be placed about one-half to three-fourths inch below the center of the guard, to prevent any possible slippage of the guard off the toe of the ax.



THE FINISHED GUARD

Showing method followed in folding and sewing, and the guard as it looks when completed.

The speed of production and production costs probably can be shaved by the use of a die to cut the guards to shape and size and by the use of wire staples similar to those used in Bostich stapling machines in place of the wire used on the end seams. It is understood that heavy staples of this type are available for uses similar to that proposed.

Exact dimensions for the guard are not given, since there are slight differences in dimensions of double-bit axes of different makes and weights. However, length of the template and the liner can be varied, or as a last resort, guards can be made sufficiently large to fit all axes. The last-named alternative is not desirable, however, since a snug fit which gives the guard the advantage of holding itself on by use of the curve at the heel of the tool is highly desirable.

FIRE-DANGER RATING IN WISCONSIN

Wilmer S. Carow

Forest Ranger, Wisconsin Conservation Department

The number of State and private agencies engaged in forest-fire control activities developing and using fire-danger ratings is constantly growing. The author presents a picture of some of the thinking and action which is taking place in Wisconsin in an effort to avoid a repetition of catastrophies of earlier years.

Just as military forces have to be organized and equipped for easy expansion or contraction as necessity dictates, so too must fire-control forces be organized and equipped. In Wisconsin a permanent skeletonized force is always in readiness at forest-protection headquarters to handle small emergencies, but this small force must be quickly augmented as fire danger increases. Heavy equipment and large quantities of hand tools and supplies must always be available and in condition for easy distribution as great emergencies arise.

When may such emergencies be expected? How often? And for how long a time will they last? How much equipment and manpower will be necessary?

Great forest fires and such holocausts as the Peshtigo, Hinckley, Phillips, and Cloquet fires do not just happen. Weeks in advance of the climactic events a dangerous fire situation begins developing. Hot dry winds, brassy skies, and anemic-looking forest cover herald the arrival of innumerable fires in woodland areas. Through espionage and reconnaisance the strength and nature of the enemy—fire—must be determined. Opposing forces must be prepared to meet the situation that is presented. A fire-suppression army must be recruited and instructed, and its various units must be placed in strategic locations with easy communications and efficient detection services.

Down through the years practical woodsmen have noted many useful signs of rising fire danger. The common enemy, fire, has betrayed itself so often that many of its traits are now well known. It is easily possible to detect the enemy's approach, but in what numbers will it attack? How fast will the enemy travel? And how difficult will it be to stem tne advance?

Fortunately, in recent years through the efforts of many investigators, good answers to many of such questions are becoming available. The study of these problems is known as "fire-danger mensuration." It could be termed more simply "fire-danger rating." The objective is to measure the danger of each fire day as one would scale a board.

If an army travels on its stomach, a fire travels on its fuel; and just as an army needs air to breathe, so a fire needs oxygen to burn. Any investigation of fire danger will then naturally be directed to a study of the fuels—referred to as the *hazard*; and of the atmosphere—*weather*. Only one more factor need be considered—the probability of fires starting; that is the kindling agencies. It is called *risk*. Now if the hazard contributed by the fuels and by the atmosphere can be successfully rated, and, in addition, the approximate risk of fires starting can be determined, the result is a practical solution to the problem of accurately estimating the total fire danger.

The forest-fire problem is divided into three primary factors: (1) The kindling agencies which cause fires to start, (2) the weather which allows them to burn, and (3) the fuels which they burn. Now let us scrutinize the fuels, or hazard, more closely.

Since the fuel—both type and amount—prevalent in any given locality changes slowly, it can be regarded as an almost constant factor. Fuels are quite easily classified as to speed and intensity of burning under given conditions. A grass marsh, for instance, burns rapidly but with relatively little heat and the actual flames cover only a narrow band along the edge of the fire. On the other hand, an area of heavy pine slashings burns more slowly but is very much hotter and its control is much more difficult and slower because the actual burning area extends in much deeper from the fire line. The fuels on the various areas comprising a forest-protection district may thus be typed and classified. Just as cars are assigned horsepowers, fuels are classified both as to the rate at which a fire will travel through them, termed "rate of spread," and the difficulty of control, called "resistance to control.'

Rating numbers for various fuels are now being determined under various weather conditions and charted for future practical use. Much progress has already been made in determining ratings not only in Wisconsin, but also in many other forest areas. The different fuels have generally been roughly classified, both as to rate of spread and resistance to control, under the following headings: (1) Extreme, (2) High, (3) Moderate, and (4) Low.

However, while discussing the problem of fuel-type classification, it must not be forgotten that the condition of the fuels is most important. When the annual vegetation, such as grass, brush, ferns, etc., is green, it absorbs the heat of the fire and slows down its spread which speeds up control. The condition of the fuels as to relative dryness is, of course, most important—which leads directly to the problem of weather in its daily and seasonal fluctuations and abnormal variations.

Weather observation stations are maintained at the 10 district ranger headquarters and at some of the subdistrict stations, and all cooperate with the United States Weather Bureau. Readings are taken on Weather Bureau instruments three times daily and telegraphed to Chicago. Each morning during the fire season a specialized forecast is received from the Chicago office and relayed over State telephone lines to the various district forest rangers. This enables them to rate the probable fire danger in advance on the basis of the forecast of the weather elements which will be in effect.

The most important of these elements is rainfall. How long has it been since a certain amount of rain fell? On the average, evaporation will take place at a specified rate during certain seasons of the year. All forest fuels are hygroscopic, which means that they have the power of holding water within themselves in proportion to the percentage of saturation of the atmosphere. When the relative humidity (percentage of saturation) of the air goes up, the fuels take on moisture; when it goes down, they give off moisture. This power is called "hygroscopic regain" and depends to a certain extent on the temperature. The higher the temperature, the less power the fuels have to retain moisture and vice versa.

Now, it has been found that the rate at which fires burn depends upon the moisture content of the fuels, other factors being equal. When the relative humidity of the atmosphere approaches 100 percent, the moisture content of the fuels approaches 25 percent of their oven-dry weight and they do not burn readily. When the relative humidity approaches 20 percent, the fuel-moisture content approaches 5 percent and fuels are extremely inflammable. By combining relative humidity readings, obtained by a simple operation, with the length of time since a certain amount of rain has fallen, it is possible to approximate closely the moisture content of the fuels and thus gage their inflammability.

In addition to determining the amount of moisture which fuels contain, the relative humidity has other important influences on fire behavior. The smaller the amount of moisture in the air, the more oxygen there will be in a given volume. Slight as this difference may be, it has its effect, especially when a good wind is blowing. Furthermore, the lower the humidity, the faster is the heat generated by the fire enabled to drive off the remaining moisture in the fuels. More heat is thus available to be carried to adjoining fuels.

Wind is even more important than relative humidity, and its effects have been well worked out so that they can be stated in numbers. Given the fuel type, the length of time since a certain amount of rain, the condition of annual vegetation, the relative humidity, and the wind velocity at any certain time, it is possible to obtain a fair approximation of the rate at which fires will spread and the resistance they will exert to control. The device which is used to compound these factors to give a measure of the total fire danger, is called a fire-danger meter. Unfortunately, winds are often variable and extreme topography influences drafts so that such estimates can never be exact in a specific area when wind-velocity readings are taken some distance away. However, in general, such calculations can be highly useful in estimating the number of men and amount of equipment necessary to control the fires in a large area.

As a final figure, if the probable number of fires each day is multiplied by the rate at which they will spread, it is necessary only to divide by the rate at which one man can control fire to know the number of men necessary to have available. It is not quite so simple, of course, because of equipment and other factors, but in general that is the method. On that basis the fire-control army is expanded and on the same basis it is demobilized as the danger subsides.

THE "BLOCK DATA" FIRE PLAN

M. C. Howard

Forest Supervisor, George Washington National Forest, Region 8, United States Forest Service

Use is being made of a rectangular system of fire-control units in mountainous terrain on several eastern forests. The author from the forest adjoining the Monongahela, about which Hopkins writes in this issue of Fire Control Notes, deals with private cooperators in the "blocks." It is a system of dividing a forest—or any area—into rectangular blocks, each of which is considered as a unit for purposes of listing or tabulating the organization, tools, food, and other fire-control equipment available in that unit.

Fire plans take many forms and shapes, some suitable for field use and others of atlas or office size. The so-called *Block-data system* is not original with the George Washington, but it has been adapted with admirable results. It is a system of dividing a forest or any area into rectangular blocks, each of which is a unit for the purpose of listing the organization, tools, food, and other fire-control equipment available in that unit.

The block-data system provides a field record that can be aded to and revised currently, piecemeal, or periodically. It is a digest of the information a ranger, dispatcher, or detailed forest officer must have at his fingertips if he is too handle a fire situation with assurance and dispatch. Carried always by the ranger it becomes a directory of the district personnel and a check list of fire-preparedness jobs.

The following sample records indicate the data maintained for a given block which, on the George Washington, is 5 minutes of latitude and an equal distance in longitude, approximately 25 square miles. If need be, the block is further subdivided and each division is identified by a letter:

Detection

Block 0–14

A and B--Elliott Knob Tower, Staunton 186–F–13, or radio.

A---------For scouting and/or observation from home:

D. F. Shinaberry, Deerfield, Staunton 186–F–23. Has good view.

J. H. Rivercomb, Staunton 186–F–6. Fair view.

B---------J. L. Robertson, Fordwick, Craigsville 4932. Has fire finder.

See numerous stations listed in "Supplemental Telephone Directory." (By way of explanation, a card has been posted at many telephone stations along the main highways. Each telephone is assigned a number which is carried on the card and on the map. Where visibility is good and cooperation can be arranged a small fire finder is also erected.

Suppression

Area	Name	Telephone	Number of Men	Tools for—	Transportation	Food supplies
FIRST LINE OF DEFENSE						
A	F. B. Rowe	Staunton 186–F–12	6	6	Sedan	Hoy's store.
	D. F. Shinaberry	Staunton 186–F–23	6	6	½-ton	Do.
	Edd Graham	Staunton 186–F–3	10	6	1½-ton	Hamilton's store.
	F. S. Crew	Call Tower	10	24	Fire truck	Do.
B	H. L. Lockridge	Through Elliott Knob.	6	6	½-ton	Craigsville grocery.
	E. N. Via	Messenger from W. L. Staples, Craigsville 3841.	6	6	½-ton	Do.
	A. D. Graham	Through Mill Mountain.	6	6	1½-ton	Do.
SECOND LINE OF DEFENSE						
A and B.	CCC NF–25	Hot Springs 8–L–1	100	100	CCC	Army.
	Lehigh Portland Cement Co.				Craigsville Motor Co.	
	Mr. R. Forbes	Craigsville 3511	30	6		Craigsville grocery.
	Craigsville High School.	Craigsville 3216	20		C. Motor Co	Do.
	Mr. A. C. Small					
THIRD LINE OF DEFENSE						
A and B.	CCC NF–2	Bwtr. 39–F–12	100	100	CCC	Army.
	Clear through ranger.	Bwtr. 100				
	Churchville High School.	Messenger through Staunton 61–F–11 or 20–W–1.	20		R. G. Stone, Staunton 34–F–10.	Monger's store.
	Mr. C. R. Hale	H. C. Stark, Staunton 34–F–22.				
	Goshen High School	Messenger from Craigsville 3642.	20		C. C. Brown, Craigsville 4392.	Corner store.
	Mr. C. P. Short				R. Field, Craigsville 3643.	

Cover and Hazard Conditions

Area B has bad fire history. Numerous small brush burning and hunters' fires.

Areas predominanely hardwood and southern pine reproduction.

Remarks

Ration list posted in following stores:

Name	*Place*	*Telephone No.*
Hoy's Store	Deerfield	Staunton 186–F–5.
Hamilton's Store	Deerfield	Staunton 27–F–4.
Craigsville Grocery	Craigsville	Craigsville 2411.
Monger's Store	Churchville	Staunton 34–F–5.
Corner Store	Goshen	Craigsville 1642.
Staunton Wholesale Grocery	Staunton	Staunton 407.
Mr. R. C. Payne		Staunton 1704 after hours.

FIRE AND INSECTS IN THE DOUGLAS-FIR REGION

R. L. Furniss

Bureau of Entomology and Plant Quarantine

It has been observed that burned areas in some forest types create favorable conditions for encouraging insect attacks to the point where more damage is caused by the insects than by the fire itself. The relationship between fire and insects in the Douglas-fir type is here vividly portrayed.

Many persons who have seen groups of fine Douglas-firs suddenly turn red and die as a result of insect attacks have pondered upon the cause and cure. Some, considering the understory trees and other vegetation that have developed since concerted efforts have been made to keep fire out of the woods, have concluded that in such cover is a likely place for pests of all kinds to thrive. It is evident to anyone who will observe that there are all kinds of leaping and crawling insects everywhere upon the forest floor. What then would be more logical than that this multitude of insects should periodically come forth and find the forest trees to their liking? If that is what takes place, the solution seems simple and direct. Burn the brush!

Before proceeding with this wholesale control project, it is well to stop and consider what may logically be expected from such a course. No doubt many insects of one kind or another would perish in the flames, but would they be the right ones? Only a very few of the thousands of different kinds of beetles, bugs, flies, and slugs found in our fields and forests ever do man any measurable harm. Still fewer kill forest trees. Of these, only one is of any considerable importance in killing Douglas-fir in western Oregon. It is a small, reddish-brown, hard-shelled beetle about 1/4 inch long. It is known as the Douglas-fir beetle (*Dendroctonus pseudotsugae* Hopk.). It is the insect to be destroyed, if possible.

The habits of the Douglas-fir beetle are well known as a result of detailed studies carried on over a number of years by the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine. The studies reveal that the beetle spends practically all its life beneath the bark of the host tree. The life cycle requires one year. Each spring a new brood emerges from trees attacked the preceding spring. The beetles immediately fly to other trees and, working in pairs, begin a concentrated attack upon the chosen trees. Each pair bores through the bark to the surface of the wood, where a vertical egg gallery several inches long is constructed. Along the sides of the egg gallery the female deposits a number of eggs. The eggs soon hatch into small white grubs, or larvae, which bore out at right angles to the egg gallery, forming on the inner bark and on the wood surface a characteristic double fan-shaped design that can be seen by removing a section of bark from an infested tree. The larvae increase in size until they are about one-fourth inch long. The fully grown larvae construct small cells in the bark, in which they transform first into a transition or pupal stage and then into new adults. After spending the winter in the bark, the adults emerge to complete the life cycle. The attacked trees are killed by the girdling effect of the numerous egg galleries and larval mines.

The Douglas-fir beetle is a native insect associated with Douglas-fir throughout its natural range. There is every reason to believe that this beetle was killing trees long before the first logger laid ax to the tall timber in the Pacific Northwest. East of the Cascade-Sierra Nevada Range it is an aggressive tree killer. In the Douglas-fir region of western Oregon and Washington it normally attacks and breeds in injured, weakened, or fire-killed trees, although it also readily attacks trees felled in logging operations. At times, even in this region, it attacks and kills numerous healthy trees. Such killing can usually be traced to a build-up of beetle population in logging slash, in extensive windthrows, and in drought-weakened or fire-killed trees.

An outstanding example of the damage that the Douglas-fir beetle will occasionally cause as a result of fire is furnished by events following the great Tillamook fire of 1933. The countless dead and scorched trees resulting from that fire provided a vast rearing ground for the Douglas-fir beetle. These burned trees, being dead or nearly so, offered no resistance to the beetle attacks and yet provided a superabundance of nutritious food. Responding to these ideal conditions, the beetles multiplied prodigiously. Within a year after the first trees were attacked a vast population had developed. When these beetles emerged, the burned trees were no longer attractive to them. Consequently they attacked healthy green trees that normally would have resisted attack, and killed many large groups of trees near the burn. In the years 1935 and 1936 a total of approximately 200,000,000 board feet of green timber was killed in this manner. The epidemic soon subsided, however, because of the natural resistance of green trees to Douglas-fir beetle attack, but by then much damage had been done.

With the habits of the Douglas-fir beetle and the type of damage that it causes in mind, it is possible to evaluate the probable effects of burning the brush as a control measure on this, the most important insect enemy of Douglas-fir in western Oregon. First, it is evident that the time spent outside the host tree is so brief that timing the fire to catch the beetles on the wing or at rest in the woods would be a most difficult undertaking. Furthermore, not all the beetles emerge at one time, making it necessary to burn and reburn many times to kill them all. Destruction of the brush would not of itself be an effective control measure because the beetles are not attracted to and do not breed in reproduction or any species other than Douglas-fir.

In other words, the breeding-ground theory as applied to the undergrowth is a fallacy. In order to kill the beetles beneath the bark of standing infested trees it would be necessary to scorch them so heavily and so far into the tops that many of the unattacked green trees nearby would be killed by the fire. Aside from the loss of the trees this would be very undesirable, for, as already pointed out, fire-killed and fire-scorched trees provide one of the best breeding grounds for the Douglas-fir beetle. From all this it is obvious that allowing fire to run through the woods, far from being an effective insect-contro measure, would actually result in an increase in numbers of the primary culprit.

In conclusion, it can be stated that Douglas-fir in western Oregon is normally resistant to insect attacks. Occasionally as a result of unusual circumstances, an outbreak of the Douglas-fir beetle may develop and for a year or two cause extensive damage. The best way to prevent a large part of these outbreaks is to prevent the large forest fires that provide much of the breeding material necessary for the beetles to attain sufficient numbers to attack and kill green trees.

Slash Disposal and Forest Management After Clear Cutting in the Douglas-Fir Region.—A recent bulletin by Munger and Matthews reports upon studies of this important subject in a manner that should make this circular useful beyond the region treated. Particularly noteworthy are methods used in appraising hazard on burned and unburned cutover areas as the basis for comparison of conditions 1, 5, 10, 15, and more years after logging and the emphasis that is placed upon prompt reforestation as the most effective means of obtaining a normal hazard after timber harvest. It also discusses slash disposal laws and practices, effects of slash disposal, principles of slash burning, essential steps in protecting logged-off lands from fire, and incidental commercial uses of cut-over land. This publication can be obtained from the Superintendent of Documents, Washington, D. C., by asking for U. S. Department of Agriculture Circular 586; price 10 cents.—Pacific Northwest Forest and Range Experiment Station.

THE BEAR VALLEY HIGH-HAZARD PLAN

(Continued from p. 196)

a campfire foreman, who takes charge of handling company manpower and heavy equipment on fires. The Forest Service is supplying one patrolman equipped similarly to the Hines-financed patrols. Radio equipment for these patrols is of the SX, SV, and TH types with SX and SV radios mounted in the pick-up cabs for constant communication when necessary.

REDUCING MAN-CAUSED FIRES

(Continued from p. 197)

however, it seems to be one of the most beneficial. Although the 1940 fire season was the first in which such a guard was used, it is interesting to note that the number of man-caused fires was less than for any of the 9 preceding years. While one season's results do not give a reliable indication of progress it seems likely that use of a fire-prevention guard over a period of years will lower the average number of man-caused fires.

UNCONTROLLED BLUEBERRY BURNING IS UNJUSTIFIED

SCOTT PAULEY

Forest Ranger, Wisconsin Conservation Department

Adequate fire protection in an area must take into consideration the necessity of educating the local people in the proper use of fire in connection with berrying activities.

Since the time of the first white settlement in Wisconsin it has been the general assumption that fire is a necessary method of quick, cheap land clearing. In the early days there was little attempt at control of these land-clearing fires and they often spread for miles beyond the limits of the cleared area.

Gradually the attitude developed that such fires should be controlled, and with the establishment of the forest-protection districts it was necessary to obtain permits to burn within their boundaries. People were encouraged to burn during the periods of the year when the hazard was lowest and the danger of damage least—during the winter and early spring when brush is damp and peat soils wet or frozen. The increased effort at control has resulted in a reduction of 50 percent in the number of forest fires caused by land clearing in the last 12 years. Still it remains an unsolved problem, for more than 25 percent of Wisconsin's forest fires were caused by land clearing in 1939 and 28 percent in 1940. It must be conceded, for the present at least, that fire is still the chief method of land clearing in Wisconsin and, if practiced with common sense, its merits probably entitle its continued use in certain areas.

Along with the concept that fire is the cheapest and most effective land-clearing agent, has developed the idea that its use increases the yield of certain berry-producing plants and some wild forage crops. This assumption has developed to a point where fire is used, in some instances, primarily for this purpose and not incidentally for a land-clearing undertaking.

The Michigan Forest Fire Experiment Station, located at Roscommon, has experimented with controlled fire treatment of blueberry areas since 1930. Until 1936 the experiments were confined to relatively small areas, but in 1938 the project was extended to large areas in the Upper Peninsula.

No official report has been made as yet on any of the experiments but certain conclusions of practical interest in forest-fire control may be safely predicted at this time. Mr. Gilbert Stewart, director of the station at Roscommon, said in a letter to the author:

"Fire itself simply acts as a pruning agent, removing all woody growth and competing vegetation and puts each individual blueberry plant in the proper pruned condition to yield large quantities of fruit. Fruit usually is borne the second year following fire. It is imperative, however, that injury to plant roots be avoided. Many of the best blueberry areas are lowlands where the roots are contained in organic soil. If fires are permitted to run across such areas and ground fires develop which consume the plant roots, large areas of blueberry land are ruined and may revert to sedges and grass and heavy growth of sprout aspen. Injury to root systems on high land is less likely, but must be avoided at all times. Even after an area is properly burned over and the effects from the standpoint of pruning are benficial, it does not follow that large quantities of fruit will be borne.

"Adverse weather conditions may completely offset the beneficial effects of controlled burning. Entire crops will be destroyed if frost occurs after the plants have blossomed. Too little mositure during the spring and summer will not permit full-bodied berries to develop, and dry-weather conditions during the season when berries are ripening cause the crop to dry up and fall. It follows then that, in addition to a beneficial burning program, weather conditions must be favorable to guarantee the crop. Fire itself cannot guarantee a crop but when properly done simply places plants in proper condition to bear heavily, provided these other factors are favorable."

It is thus apparent that controlled burning can be beneficial in the production of blueberries if the number of factors listed are sympathetic following the burning. This conclusion in itself is of some significance since it lends credence to the generally accepted theory that fire will increase the yield of blueberries. It does not, however, mean that burning, whether controlled or not, is the economical method of treating any area where blueberries grow. It is obvious that an area must be devoted to the growing of blueberries, to the exclusion of everything else, if fire is to be used to any advantage.

The fact that, aside from the beneficial pruning action, fire removes the competing vegetation means that the seedlings and saplings of the future forest or woodlot are removed and that eventually the area treated with fire will be completely denuded of all forest growth.

It should also not be overlooked that deleterious effects to the soil must naturally follow. The periodic removal of living and dead associates of the blueberry bushes in the form of smoke removes forever the source of organic material so essential to the maintenance of soil fertility. It might be assumed that eventually soil fertility on the area might be so reduced that blueberry production itself might suffer from lack of essential soil nutrients. If that point were reached, the blueberry bushes themselves might not survive, and the last living source of vegetative protection to the soil would be removed. In most areas, especially in hilly blueberry country, such treatment of the soil normally results in an erosion problem.

Perhaps the chief objection to the use of fire as a means of increasing blueberry production is that in most instances such fires are of incendiary origin and no effort whatever is made to control them. It would appear that if the beneficial effect of fire in the treatment of blueberry areas is to be realized it must be controlled with the greatest of caution and be limited to areas where blueberry production only has proved to be the most economical method of land use.

COOPERATIVE PROTECTION AREAS IN WISCONSIN

L. E. Brackett

Cooperative Forest Ranger, Wisconsin Conservation Department

While 13,000,000 acres of Wisconsin forests are protected by organized fire-control forces in 10 districts, many agricultural areas containing large acreages of forests are not so protected.

In a forest-protection district organization the detection and suppression of forest fires is the business of first importance to the forest rangers. In the cooperative areas the control of fires, as well as their prevention and detection, is the responsibility of the chairman of the town board. (See Sec. 26.13 (1) Wisconsin Statutes.) Generally this man is a farmer to whom personal farming duties and other interests are of primary importance. During days of fire hazard he is busy in his fields or perhaps with other duties of his town office. Prompt action, comparable to that in the forest-protection districts, cannot be expected under the present set-up. Good cooperation and action can be expected, however, as soon as the town chairman knows that a fire is burning in his town.

Section 26.13 (3) Wisconsin Statutes provides that the town chairmen post their towns against burning during hazardous periods. Many have been reluctant to do so until they actually have had a fire, and many have not been posting at all. In some cases, the feeling has been that the citizens of the town would oppose such action and would retaliate at the polls.

The forest-protection division, realizing the importance of prevention and diligence during a severe hazard such as existed in 1936, delegated cooperators to go into outside areas to remind the town chairmen of their responsibilities and to suggest that they post their towns. As a result of such personal contacts and the educational work of the rangers the attitude of the chairmen is changing and the feeling against posting is gradually being overcome.

Through a slight increase in the 1937–38 budget, it was possible for the conservation department to extend a form of cooperative protection to all or parts of 35 counties. The towns within these counties were grouped into four large areas outside the forest-protection districts, and a full-time forest ranger was assigned to each area. This program was started in the fall of 1937. The rangers are carrying on a program of fire prevention and education in the cooperative areas and are responsible to the supervisor of the forest-protection area designated. The men contact the town chairmen at least once a year and work with the local responsible officer in an advisory capacity in fire suppression and are helpful in all matters relating to the fire-control program. They also attend as many county board meetings as possible.

Reports received from the cooperative areas give the following information on fires that have occurred:

Year	Number of fires	Acres burned	Damage in dollars
1939	118	7,310	$15,867
1940	143	10,897	23,078

In many cases the forest ranger has had to sell the town fire wardens on the idea of forest protection. Through their efforts also the majority of towns within the cooperative areas have been encouraged to declare a closed season on burning before the fire hazard becomes acute. Many insurance companies, banks, and Government agencies that have taken over farms and have found out about the cooperative protection are now demanding that the town declare a closed season on burning during hazardous times. People living in the cooperative areas who wish to do some burning also are learning to get in touch with their town chairmen before setting fires.

The educational and prevention program was enchanced through the purchase, by the department, of four moving-picture projectors and a complement of visual education material. Movies have been shown to and educational talks given before 25,858 school children and 5,050 miscellaneous club members, and conservation films have been shown to 10,250 4–H Club members. Such contacts are destined to influence the coming generation.

Many of the counties in the cooperative areas have bought fire-fighting equipment. Some towns have bought pack cans. Some counties are considering building fire towers to tie in with the tower system in the forest-protection districts. This would be a great advantage to the towns as it would aid detection and speed up action. On the other hand, counties in which severe fire hazards will exist in a dry year do not appear much concerned about equipment. Undoubtedly, they will be should serious fires break out in these counties, as they have in the past, and the poor towns submit large suppression bills to the county boards for payment.

Forest-area supervisors apparently had much the same conditions to contend with in the early development of the forest-protection districts as are now being met in the cooperative protection areas. Town chairmen at that time were the town fire wardens. Burning had been done without restriction for many years. When one forest-area supervisor tried to convince the community that continuous burning of the land was injurious to agriculture, he was told by a farmer that lands in Iowa were selling for $200 per acre because they were burned every spring and if he burned his land the soil would be the same as that in Iowa. If the ranger discovered a fire, he would contact the town chairman, as is now done in the cooperative area, and ask him to have the fire suppressed. Invariably the reply was that it was not doing any harm. Later when the fire got away, the "organized" remark was that it was out of control and nothing could be done.

Protection in the cooperative areas is a big undertaking, and demands much work in public relations and education. So far only the surface has been scratched.

IS THE HUNTER A SPECIAL FIRE RISK?

J. E. Hanson

Forest Ranger, Wisconsin Conservation Department

Following several years' experience as a forest ranger, it has been my observation that whenever a fire hazard exists hunters are a special risk.

During the past several fall seasons hunters have been directly responsible for many fires, principally smoker fires and campfires. Probably 50 percent of the hunters smoke, and some of them are careless and throw burning cigarette and cigar butts, pipe heels, or matches into forest fuels. It is usually cold during hunting seasons, especially in the early morning and the late afternoon, and hunters often build campfires to keep warm. Some hunters are careless and build their fires in dry, dense growths of vegetation and other hazardous materials; others leave camp without extinguishing their fires. Such practices cause forest fires, and oftentimes in inaccessible areas, because hunters roam far from roads and places of habitation.

A few years ago, while on patrol duty in a hazardous section during duck season, I saw a hunter leave a blind near a small lake, pick up his decoys, and start for home. In checking over the recently occupied blind I found a lighted cigar burning in dry grass. After extinguishing the burning material and returning to my office I looked up the automobile license number, located the owner, and discussed with him the possible results of his carelessness.

During the 1939 deer season the forest-fire hazard was high, but conditions would not have been serious had not the presence of hunters in the woods raised the fire risk. It was necessary for the protection organization to be ready to answer fire calls at all times, and fighting fires in the forest was dangerous because of the high-caliber rifles used by the hunters.

Each spring and fall, when the fire hazard is usually high, sportsmen hold field trials for hunting dogs at the bird sanctuary grounds near Solon Springs in the heart of the sand belt and jack pine area of Douglas County. Most of the sportsmen are from other States and therefore may not be as forest-fire conscious as people who live in Wisconsin. Several small patrol crews, equipped with fire-fighting tools, follow the crowds during the field trials. All persons are warned of the fire danger and all smokers cautioned to be careful with smoking materials. They are also instructed to suppress any fire which may start. Undoubtedly these precautionary measures have prevented the starting of many fires.

Hunters are not responsible, of course, for all forest fires caused by carelessly discarded "smokes" or neglected campfires, but all hunters should be careful with fire.

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INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Legends for illustrations should be typed on a strip of paper attached to illustrations with rubber cement. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing illustrations, place between cardboards held together with rubber bands. Paper clips should never be used.

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustration. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired. Do not submit copyrighted pictures, or photographs from commercial photographers on which a credit line is required.

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VOL. 6 JANUARY 1942 NO. 1

FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and technique may flow to and from every worker in the field of forest fire control.

Volume 6 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

FIRE CONTROL NOTES is issued quarterly by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

Address DIVISION OF FIRE CONTROL
Forest Service, Washington, D. C.

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Contents

EMERGENCY FIRE PLAN FOR THE EASTERN SHORE OF MARYLAND

(A suggestion for national defense planning)

S. H. Marsh

Eastern Region, Forest Service

After the blow-up of April 20–24, 1941, there was a review of some of the larger fires in Region 7 by the Division of State and Private Forestry to find out what made the big fires big and ascertain what might have been done that was not done to prevent them or confine them to smaller areas.

A review of a fire on the Eastern Shore of Maryland that burned about 2,400 acres, including about ⅔ of the Allegheny Experiment Station's forest of 900 acres, proved most interesting and instructive and led to the formulation of a plan to prevent sweeping fires that may be applicable to extensive areas along the Atlantic Seaboard and perhaps some other parts of this and other regions.

In tracing the course of the fire on an aerial photo, it was noted that after burning some 1,200 acres in an area surrounded for the most part by impassable barriers, it swept through a narrow strip of woods about ¼ of a mile wide into another timbered area where it ravaged 1,200 acres more before it finally was brought under control by the aid of a shower. This vivid indication of a lost opportunity led to speculation as to what would have been necessary in manpower and equipment to keep the fire from using this avenue of escape from one area to another and what might be done by advance planning to prevent similar occurrences in the future.

The photographic index, the only aerial map available, was then studied more carefully. Although a casual glance discloses only a mixed pattern of farm, swamp, and forest land, a closer examination shows that the area breaks down into numerous large bodies of forest land, for the most part insulated against each other by areas of cultivated land, swamps, or rivers, that form absolute barriers beyond which a forest fire could not go if it were permitted to run its course unimpeded. There are breaks or gaps in these barriers that will have to be plugged if they are to hold a fire, but roughly 95 to 99 percent of the barrier is there, waiting to be used. A case study was then made of the Delmarva Protection Unit of the Eastern Shore District to determine the location and extent of these divisions, the degree of insulation, and what can be done to plug such gaps as occur in the existing barriers.

Where a choice in barriers was possible as was often the case, preference was given to areas of open land traversed by roads, in order to make the gaps more accessible to the heavy equipment such as is commonly used by the volunteer fire departments on the Eastern Shore.

After roughing out the larger natural divisions of the Delmarva unit, the photos were studied to determine if these divisions could be further broken down into blocks likewise surrounded by good if not impassable barriers. Again this was found to be possible, although more gaps per mile of line were encountered than in the larger divisions. In the block as in the division lines, the boundaries were drawn to take advantage insofar as possible of barriers traversed by roads.

A field check then was made to determine (1) the adequacy of the barriers selected and in some cases ascertain which of two tentative barriers most nearly approached the absolute, (2) the character of the gaps in the barrier and possibilities of defending them, (3) the amount and kind of equipment required, (4) the manpower needed to do the job, and (5) improvements, i. e., fire-hazard reduction along roads, waterholes, etc., required to make the lines tenable.

Strategy then was taken into consideration bearing in mind that manpower probably will not be as abundant as in years past and the necessity of conserving and stretching it as far as possible and likewise taking advantage of all fire-fighting facilities available.

The general procedure decided upon is, briefly, as follows:

1. When a fire is reported in a certain block, dispatch one or more crews to the fire, with instructions to hit it on the nose or flank it into a barrier, whichever procedure promises to hold it to the smaller area. Simultaneously dispatch volunteer fire departments with equipment previously decided upon to prearranged stations in the gaps on the lee side of the fire, so that if it goes wild it cannot get through into another block. Should it run through a block line in spite of the gap tenders, then they will drop back to the next block line between them and the division boundary or to the division boundary itself, beyond which it cannot pass (unless there has been some very faulty planning).

District Forester Rothrock, of the Eastern Shore, is investigating the possibility of using the aerial photographs in the tower and the dispatcher's office, instead of a map. From the mosaic, strategy can be determined at a glance and dispatching, at least in the initial stages, can be simplified to the extent that it can be done by a clerk who is totally unfamiliar with the ground.

To insure that the initial action on a fire is simplified so that it becomes almost automatic, a form for each division and block was prepared which shows along with other pertinent data of value in prevention action to be taken and by whom, and with what equipment. When completed, these forms comprise the suppression chapter of the fire plan.

With the use of the photographs dependence upon towers to report progress and help mold strategy which at best they can only guess at will be greatly reduced. The good old custom of hitting a fire on the nose would be abrogated in any instance where less acreage would be lost by running the fire into a barrier by an attack on the flank, and incidentally, considerable amounts of money likewise might be saved thereby.

In short, the operation of this plan will:

1. Simplify and expedite dispatching by making it automatic, at least in the initial stages.

2. Reduce burned area by hastening and facilitating dispatching.

3. Save suppression money by preventing the milling and loss of time resulting from faulty planning and lack of adequate supervision.

4. Eliminate a lot of alibis that superiors are asked to believe about the strange and weird behavior of forest fires.

5. Provide for the maximum use of cooperating volunteer fire departments and their heavy equipment and result in assignment to them of jobs they and their equipment are best prepared to handle, thereby making full use of equipment not ordinarily available for forest-fire control.

6. Encourage the warden and his crew since they will know that all foreseeable contingencies have been provided for and that they are backed up at the gaps if the attack on the nose or flank proves futile.

The plan presupposes some very definite advance planning, but the consolation of knowing when bad fire comes along that the prescription for it is in the bag, should be ample inducement to do a little planning.

While labeled "emergency plan" the blocks may also be subdivided as desired to meet the normal conditions. The forms give much of the information needed to work up a prevention program, which is basic to any fire-control program.

It appears to have a very definite place in national-defense planning since a definite and comprehensive plan can be worked out quickly from aerial photographs and the amount and kind of equipment and manpower available can be easily and quickly checked against the jobs to be done. Likewise it will give point to CCC fire-control planning since the kind and location of projects needed will be definitely known.

Volunteer fire departments have a variety of equipment ranging from light forest-fire trucks in a few cases to heavy and expensive trucks that cannot be expected to operate off of hard roads. The heavy equipment which ordinarily is useless in the woods can be assigned to watch the gaps on a hard road, thus opening up a new source of equipment that in the past has not been available.

Reports are current in many States that the draft and the numerous defense agencies are drawing upon manpower to such an extent that by the fall of 1941 there will be a serious shortage in fire fighters. Many States have reported that this shortage was becoming evident in the spring of 1941 and that in some cases it was even impossible to keep the towers manned with experienced observers. Unless such labor and equipment as may be available is used in a planwise fashion, and in the most economical way, the shortage may become critical.

WHAT'S WRONG WITH FIRE PREVENTION?

H. J. Turney

District Ranger, Prescott National Forest

Since the early days the Forest Service has carried on an intensive fire-prevention campaign. It has been effective. In Prescott, for example, when National Fire Prevention Week comes around most of the people think of forest-fire prevention rather than of preventing fires in their homes. School children make up posters and all of these are on forest-fire prevention. The merchants always ask for our fire signs for window displays. In talking to the public, both people living on or near a national forest and those from a distance, the subject of forest fires always enters into the conversation. People generally have the impression that all a ranger does is fight fires. In view of such evidence there is no doubt that the general public is fire conscious.

Yet, there continue to be man-caused fires. The surprising thing is that most of them are started by local people—people to whom fire prevention has been preached for years.

In 1939 a picnic fire which had been put out to the best of the picnickers' knowledge started a forest fire. The needles had been scraped away and the fire had been built in the cleared place. Before leaving, the picnickers carried clean sand from a wash 50 feet away and the fire was carefully covered. Yet this fire crept out because the duff had not been removed when the place was cleared for the fire. In 1940, another picnic fire got away under very similar circumstances.

The evidence on both those fires showed clearly that the parties responsible had done everything they knew how to do to prevent starting a fire. The action, however, showed a lack of complete knowledge of what to do or just what was inflammable material.

Those fires made me wonder whether the general public knew how to prevent fires. Last June, I put in a window exhibit in which "WHAT TO DO TO PREVENT STARTING A FOREST FIRE" was stressed. The reaction of the public was good and numerous favorable comments were heard. Those of a young doctor who was reared in Prescott summed them all up. He said, "I've heard all my life to prevent forest fires but this is the first time I've been shown what to do."

That incident suggests that our prevention campaign had made the public fire conscious but has failed to educate them in just what to do to prevent fires. The campaign can be compared to a four-step training project in which the first step has been taken and a desire has been created to prevent fires. And then the other three steps have been almost forgotten. The only definite information which has been given out is "The Six Rules to Prevent Forest Fires" and these only occasionally in prevention literature. Never in an address, newspaper article, or other prevention material which reaches the general public, have I seen or heard definite information on what to do to prevent starting a fire.

I am reminded of the first time I was on a national forest. I was on my way by horse to take a fire-guard job. After I entered the forest, the trail I was following had a fire sign almost every mile and I read all of them. I kept on smoking as I rode along and it was only through the grace of God that I didn't set the woods on fire. There were many "PREVENT FOREST FIRES" signs, but nothing telling me how to prevent them.

I believe that if all field men would stress "what to do" in their contacts with the public a lot of fires would be prevented. One of my lookouts, who has a number of visitors to his tower, told me of his experience which may be helpful to others. He said, "If I bring fire prevention up first, a visitor seldom says anything, but if I let him bring it up first, I can discuss it with him and get a lot across because we're talking about the other fellow." So much for the approach. But even if field men do all they can, it is physically impossible on a heavily used district for the ranger and his guards to contact every visitor.

Would it not be more helpful if those making radio talks and other addresses or preparing written articles for publications stated just what to do to prevent starting forest fires instead of just using the over-worked statement "Prevent Forest Fires."

Couldn't posters be made to illustrate the following:

1. How to build a safe fire and how to put it out.
2. That tobacco should be thrown on bare ground and stepped on to be extinguished.
3. How to break a match in two, with notation to the effect, "You may burn your fingers the first time you try this, but that is better than setting the forest on fire." ("Break your match in two" doesn't mean anything unless the trainee does some thinking.)

Most fires are not started through willful carelessness. If the public can be educated in how to prevent starting fires, when they see "PREVENT FOREST FIRES" they will know what it means.

The first step has been taken very effectively. Let's take the other three.

FIRE PREVENTION IN THE EASTERN REGION "HOT SPOT"

George B. P. Mullin

District Ranger, Jefferson National Forest, Eastern Region

The Clinch District of the Jefferson National Forest is in the "ho spot" of the eastern region of the United States. Comprising million acres this problem area lies in southwest Virginia, eastern Kentucky, and southern West Virginia.

In 1936, the first land for national-forest purposes was acquired on the Clinch Ranger District, in the soft coal area. The populatio of native rural dwellers is dense. The year of 1936 marked a seaso of heavy fire damage in the area. Prior to the 1937 fire season, a intensive campaign was carried on in which an earnest attempt wa made to contact and catalog each family outside incorporated towns To the local residents were explained the benefits of protecting th natural resources of timber, wildlife, and water from destructiv action of forest fires.

The response in 1937 was remarkable, even considering that it wa a year of relatively low fire danger. In 1938, the prevention contact were made again and, in the meantime, the ranger enforced th requirement for campfire and berry-picking permits. In 1938, th respect for fire prevention was noticeably less evident. The numbe of fires on the Clinch District was on the increase. In 1939, th Clinch District, with about 18 percent of the total area within th protection boundary of the forest, had 33 percent of the fires. I 1940, Wise County, with 5 percent of the area of national-forest lan had 18 percent of the fires on the national forest. The evidence wa sufficient to prove that fire-prevention efforts through moving pictu showings, personal contacts, press releases, and a vigorous enforce ment of the State and Federal fire laws were inadequate to produ acceptable fire-occurrence standards.

As a result of the Elkins, West Virginia, fire-prevention conferenc in August 1940 the Jefferson National Forest was assigned the exper ment of trying out an adaptation of the fire-prevention school contes successfully staged by Supervisor Conarro of the Mississippi Nation Forest in Louisiana. The western third of Wise County, with 1 rural grade schools having approximately 2,000 pupils in attendanc was selected as an experimental area. The area consists largely privately-owned land and small farms up to the edge of the foreste area. The population of this area contributed to the fire proble within the national-forest protection area, and it was considered th the number of schools to be contacted would make a full-time j for one man for the duration of the program.

The assistance and cooperation of the County Superintendent Schools were secured in conducting four periods of instruction each of the 16 schools on preventing smoker, camper, and brus burner fires and in making contacts to get fire-prevention pledges signed. The objective was to instruct each pupil *how* to prevent such fires, so that he in turn would be able to teach adults how to smoke safely and to burn brush without causing a forest fire.

The forest guard assigned to the job was a local man experienced in fire-prevention work, a good instructor, who had the ability to get people to cooperate. Three to four schools per day were instructed until each had received four ¾-hour periods of instruction. He drew upon his own experience to illustrate the destructiveness of forest fires. He told of young birds perishing in their nests, of baby squirrels being killed by the cruel flames, and showed how stupid and uncalled for most such fires are.

Pledges similar to the one shown, which lists a set of simple precautionary measures necessary to avoid smoker, camper, and brush-burner fires, were prepared. During the first two weeks of March the children contacted people in their school areas and brought in as many signed pledges as they could obtain. The section of the pledge which listed the prevention rules was left with the signer, and the stub with his signature was retained for counting. A value of five points was assigned to camper and smoker pledges and ten points to brush-burner pledges.

BRUSH-BURNER PLEDGE

Date ________, 1941
Signed ________
Pledge taken by:
Name ________
School ________

PLEDGE

I promise to observe the following rules while burning brush:

1. I will notify the nearest fire warden or lookout before starting a fire.
2. I will not burn before 4:00 p. m.
3. I will have sufficient help and tools to control any fire started.
4. I will rake a fire line around the area to be burned.
5. I will not leave fire until it is out.
6. I will burn in small piles and begin burning at the top of the hill.

Date ________ Signed ________
Pledge taken by ________ School ________

The final score of each school was based on the number and value of pledges obtained and the average attendance of the school during that period. A deduction of 25 points was made from the score of any school if a camper, smoker, or brush-burner fire occurred in the school area between March 15 and April 30 if the person causing the fire had not been contacted by a pupil.

Prizes were subscribed from local civic clubs, fish and game clubs, and coal operators in the area. Contributions of materials and stories carried by local newspapers also helped to build widespread interest in the program. The prizes were as follows: First prize $25 cash, an American flag, and a 40-foot flagpole; second prize $15 cash and an American flag; third prize $10 cash. A framed certificate signed

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by the superintendent of schools, the State forester, and the forest supervisor was presented to each school in the contest. Exercises for the presentation of prizes were held at the three prize-winning schools, with participation by members of the State forester's staff, the board of education and the forest supervisor's staff.

Eleven thousand pledges were signed during the 2-week period, an average of five and one-half per pupil. The total number of fires in the area, including both State and national-forest fires, was 57 in 1941 compared with 58 during the spring fire season of 1940. The percentage of national-forest fires in Wise County dropped from 18 in 1940 to 13½ during the first half of 1941.

It is too early to evaluate the permanence of this prevention effort. Some incidental subsequent check-ups have indicated that the boys and girls retained the *how* of preventing fires. This was a community project; it was the school children'se plan for saving the forests from injury. Unmistakably, the boys and girls penetrated the inner consciousness of their elders, for there was much evidence that the pledges were taken seriously by those signing them.

Although some time will be required to judge the full effectiveness of our prevention program, it is apparent that the procedure outlined is effective in getting people to substitute new habits of carefulness for old habits of careless indifference. These questions arise: How long will thoughtful considration survive old habits and inertia? When should the performance be repeated? How many times must it be repeated to get satisfactory permanent results?

The school prevention program furnished a gage of the effectiveness of the former prevention work. In a school prevention contest conducted on the Holston District, in an area which had been under administration many years and in which it was thought that local sentiment was in favor of fire prevention, many adults refused to sign any pledge of cooperation. Actually, exterior evidence was deceiving, and there was a deep undercurrent of antagonism to fire prevention. Apparently, these individuals went along because the ranger seemed to be a pretty good sort of fellow. Only the exceptional available employee has real ability as an instructor. Our experience to date, indicates that lesson plans must be carefully prepared. Interest and effectiveness could be stepped up through the use of Kodachrome slides. These might, for example, show in several steps how to make and extinguish a campfire safely. The lesson plans in this way could be made almost foolproof. Projection equipment using a wet storage battery is available. A school program such as ours, covering a relatively small area, requires 6 weeks' full time of one man. This is a relatively heavy burden on a ranger district, especially since part of the time, at least, is in the busy fire season.

Figured on the basis of the cost of each contact, the program was a great success; that is, 11,000 personal contacts were made by the efforts of one man in 6 weeks.

The amount of ceremony and flag raising, and this also goes for the cost of the prizes, should be held to a minimum. In the Wise County contests the prizes were probably too costly and the awarding of certificates to each school was also relatively expensive and not entirely necessary.

AN INTENSIFIED FIRE-PREVENTION PROGRAM

A. B. Larson,

Fire Prevention Specialist, Angeles National Forest, California Region

Many persons who feel that the phrase "fire prevention" has been so overworked as to have lost its appeal to the public will find a new approach to those who use the forests in the plan outlined herein. The programs discussed in this article illustrate accomplishments which can be obtained by a full-time prevention specialist working in cooperation with several local organizations.

New ways of accomplishing an old objective—fire prevention—were tried in the 1941 fire season of Angeles National Forest.

It is much too early to boast of the results, but there seems to be little doubt that a far greater number of Southern Californians have had their attention focused on the problem of forest protection than ever before.

The campaign received its initial impetus from the Southern California Conservation Association, and that organization's backing has been an important factor throughout.

The following outline presents the varius phases of the Angeles effort:

Conventional Methods.—During the week preceding Labor Day the editorial cooperation of Los Angeles' metropolitan papers was solicited and 100 percent response resulted. Likewise, many of the newspapers in the county's smaller cities gave similar support. Two Los Angeles papers carried effective cartoons dealing with forest-fire prevention. It may be said in this connection that editorials probably do not reach the persons most likely to be careless with fire, but nonetheless such aid is valuable in that it appeals to community leaders whose cooperation is always important.

Through the generosity of Fox-West Coast Theaters, 150-foot trailers counseling care with fire and cigarettes in national forests were shown in more than 900 theaters throughout the State. Approximately 2,500,000 persons were reached by this means.

Talks dealing with the current fire hazard were delivered before numerous Los Angeles organizations by William V. Mendenhall, supervisor of Angeles Forest; DeWitt Nelson, supervisor of San Bernardino Forest; George H. Cecil, executive-secretary of the Southern California Conservation Association, and other persons acquainted with the problem.

Mr. Cecil's association concentrated particularly upon industrial house organs and the publications sent by public utilities to their hundreds of thousands of consumers. He induced such concerns as the Southern California Edison Company to enclose slips in payroll envelopes admonishing employees to refrain from carelessness with fire and cigarettes in forest areas.

Furthermore, Mr. Cecil provided radio stations with week end weather reports which included timely fire-prevention publicity.

Through the medium of lectures, slides, and silent and sound pictures presented to 469 groups of persons, such fire-prevention agencies at the Forest Service, the County Forester, and the Los Angeles Fire Department have made direct appeals for cooperation to nearly 80,000 people during 1941.

The James Montgomery Flagg poster "Yours in Trust" was distributed to scores of industrial plants for display on bulletin boards and to barber shops. Boy Scouts in several cities in the metropolitan area had the posters exhibited in the windows of many business houses.

To reenforce the publicity program, five additional fire-prevention employees were hired to serve as moving patrols in Angeles Forest. It was their task to contact forest users and watch for infractions of smoking and campfire rules. Extra men were also assigned to act as registrars to meet the public at forest entrances during week ends of heaviest use.

"Don't be a Flipper!"—This theme for a special poster that strikes a new note in Forest Service advertising resulted from a speech by DeWitt Nelson, supervisor of San Bernardino National Forest. Nelson declared in his talk that Southern California forests were as inflammable as a hula dancer's skirt. George H. Cecil, executive-secretary of the Southern California Conservation Association, had this remark converted into an attention-getting cartoon by R. H. Scribner. Thereafter, John P. Kaye of the Angeles Forest induced American Legion Post No. 570 to finance the printing of posters bearing Scribner's grass-skirted hula girl and cigarette-flipping hand. The Los Angeles Street Railway and the Pacific Electric interurban lines carried 500 of the posters throughout the county for more than a week. Probably close to a million persons repeatedly had an opportunity during that period to read these words:

DON'T BE A FLIPPER!

Forest Cover Will Burn Like a Grass Skirt

HELP PREVENT FIRE

FOR

NATIONAL DEFENSE

Subsequently, similar posters were used by San Bernardino Forest, which had the cooperation of its local Legion posts. The same forest employed the Scribner illustrations and an expanded message in getting out an attractive hula girl folder for distribution to deer hunters.

Fire-Warning Patrols.—The extensive use of Boy Scouts to act as pickets in crowded downtown business districts throughout the county, was contemplated in this phase of the program. The effort was only partly successful, because too few boys responded to make an impressive showing. Moreover, the posters and placards in stock were inadequate for the occasion. The Flagg posters were too small, and there were too few placards of the "Stamp it Out!" variety.

It was obvious enough from the lively interest aroused by the few fire-warning patrols appearing on downtown sidewalks that the idea was sound. Therefore, it is hoped to make thorough preparation for its widespread use during the 1942 fire season. The Boy Scout organization has volunteered to man an "all-out" display in our behalf next year, promising to organize fire-warning patrols to "picket the public" (a term we refrained from using) each Friday in order that week-end forest visitors and vacationists will have a last minute reminder of the cooperation expected of them by the Forest Service.

A large number of specially-designed posters should be prepared during the winter months, and probably one of the trade schools will make the placards for nothing if materials are furnished. The plan is to have different sets of placards for each week end so public interest will not lag.

The 1941 experimental tryout of the idea, which was based on the fact that a moving sign is superior in attracting notice to one that is stationary, gained the cooperation of the police commission, which facilitated the picketing; a lumber company, which furnished 500 stakes for mounting the placards; two paper concerns, which furnished the heavy cardboard for backing the posters; and the C. C. C., whose boys put the picket signs together.

Fag Bags.—A small muslin bag, closed with a drawstring and bearing a "fire-conscious" pledge tag was originated in an effort to halt automatic smoking in the forest. All inveterate cigarette smokers know from experience that automatic smoking is the act of taking out a cigarette and lighting it without conscious thought. The purpose of the "fag bag" is to hold a smoker's package of cigarettes while he is in the forest and thus remind him constantly that he must smoke only in posted areas. The fact that he has signed the attached pledge card probably increases considerably the effectiveness of the bag in preventing thoughtless smoking.

Before the idea was put to the test Labor Day week end, it was submitted to psychologists and all agreed it should accomplish its purpose; namely, bring to the level of consciousness the habitual act of unconscious "lighting up." The psychologists advised that considerable care should be taken in presenting the bags to the public at the forest entrances. It was their suggestion that forest officers personally place smokers' cigarettes in the bags, in a good-natured and unpoliceman-like manner, at the same time offering a pen for the signing of the pledge tags. This advice was transmitted in a special memorandum to forest officers and they followed it well and with fine results.

The bags were made by the Los Angeles Girl Scouts for whom 500 yards of muslin was obtained. The Southern California Automobile Club generously furnished the pledge tags. In all, more than 10,000 fag bags were prepared for Labor Day week end, and a considerable volume of advance newspaper and radio publicity was obtained on this new approach to the long-bothersome problem of automatic smoking.

More than 97,000 persons visited Angeles Forest over the week end, and the bag supply was soon exhausted. The week end went by without a single fire in the forest's 690,000 acres. It would be impossible, of course, to allocate credit for this record, but probably part of it might properly be attributed to fag bags and the "smoke safely" stories that accompanied publicity about them.

Reports from registrars and guards who handed out the bags were very interesting, for they show that with only a few exceptions the bags were enthusiastically received. Indeed, some persons drove to forest entrances solely for the purpose of obtaining the bags, for they headed back to the city immediately after receiving the "habit-smashers."

Highways leading into the forest, above checking stations, were scanned for thrown-away bags, but none was found. It is likely the signed tags restrained the impulse of some to discard the bags.

Results of the Labor Day try-out were sufficiently encouraging to warrant plans for distributing the fag bags throughout the 1942 fire season. The Girl Scouts have given assurance that they will turn out several hundred thousand fag bags for next year. They expect to make the project their main activity during the Spring months.

How to provide additional material without expense, and at the same time widen the scope of public participation in the program, was a problem tentatively solved by a general appeal for flour, sugar, and salt sacks. An appeal was carried repeatedly by newspapers and radio stations. September 22 was designated by the Los Angeles Board of Education as Fag Bag Day in the city's 380 schools, which have 273,000 pupils. Again the Los Angeles Police Department co-operated by having their patrol cars pick up the sacks and concentrate them at their various substations where Forest Service trucks collected them. Enough material is now on hand to do part of next year's job. It is expected that additional sources of free supply will be uncovered before long.

All in all, fag bags seem to have caught the public fancy—so much so that within the first 10 days after their initial use they were made the subject of a 5-minute nation-wide broadcasts—by John B. Hughes of Mutual Broadcasting System, and by Kate Smith over Columbia.

Recently the fag-bag idea has been adopted by both San Bernardino and Cleveland National Forests. The Los Angeles Fire Department is studying the device with a view of recommending the use of similar bags to control smoking on the waterfront docks, and there is a report to the effect that the Consolidated Aircraft Company in San Diego may employ the bags in its plants.

A free lance writer furnished *Science Service* in Washington, D. C., with a brief story about the bags and the endorsement they received from Dr. Robert A. Millikan, Nobel prize winner and president of the California Institute of Technology. As a result, *Science Service* has obtained 5,500 fag bags for distribution to its subscribers throughout America.

Signals.—Fire Guard Oley F. Scott, has found that a police whistle is very useful on the fire line. He uses the whistle to recall the crew when a break-over or spot fire occurs that cannot be handled by the patrolman. Because of the noise created by a crew at work it is often difficult for them to hear an ordinary voice signal. On Scott's crew this difficulty has been eliminated by the use of the whistle.—E. W. Fobes, *district ranger, Mark Twain Forest.*

SOMETHING NEW IN PUMPS

George P. Melrose,

Assistant Chief Forester, British Columbia Forest Service

The author describes a new portable power pump which resulted from efforts to get extreme light weight coupled with dependability of operation. Although its output is much less than that of the portable pumpers used commonly in the United States, the author indicates possibilities of its employment where the larger pumps are not used.

A little water promptly and properly applied, will do more good on a fire than unlimited quantities poorly used and wasted. That "axiom" worked for years in the practical Scotch brain of Fire Inspector J. G. (Jim) MacDonald of the Vancouver Forest District, British Columbia.

Economy and mechanical engineering skill came naturally to Jim so he began to look around. He listened to hydraulic engineers with their discharge formulas, pressures and heads; he listened to mechanical engineers talking R. P. M.'s and brake horsepower; he listened to many a firefighter with his demand for more power, more pressure, and more water.

But Jim has fought fire for 30 years, has seen oceans of water pumped by high-pressure pumpers, and he still felt that there was great waste in power, weight, and cost in many cases where only a little water was needed quickly.

His experience also ran to pump troubles—to worn-out engines, conrods through the casings, flywheels twisted off, and the many other breakdowns that occur in high-speed engines run at top rating.

Jim decided he wanted an ultra-lightweight unit, operating at moderate speeds, delivering a fair stream of water and complete in one pack. After a couple of years experimenting, discarding, redesigning, and trying in the field he has now produced a pumping unit that has the earmarks of a highly useful tool. It is complete to suction and discharge hose, nozzle, gasoline, and universal tool in one 60-pound pack. Here are the specifications:

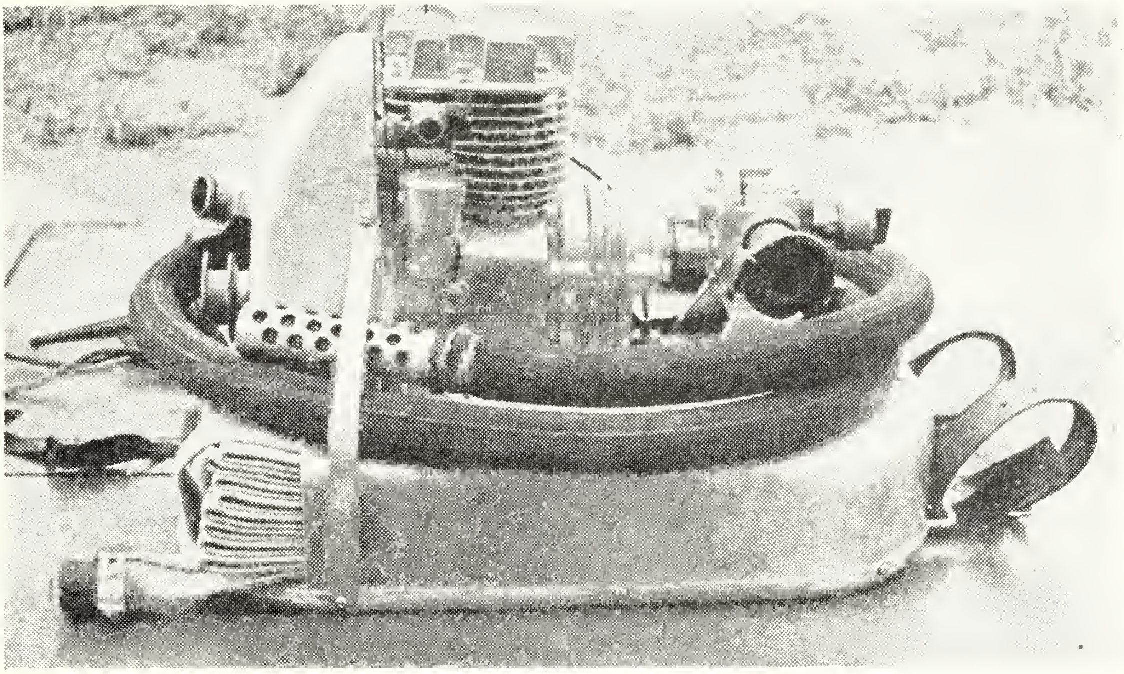
Length over all 18 inches.
Width over all 15 inches.
Height over all 13 inches.
Weight, complete with 100 feet of 1-inch linen hose—60-61 pounds.
Motor—1 h. p., air-cooled, 4-cycle Lauson, governor controlled to 2,800 r. p. m.
Pump—1-inch geared.
Coupling—3:2 reduction gear in air-cooled housing.
Base—Aluminum, shaped to fit back; pack straps attached.
Gas-tank—in base; capacity 3 pints, sufficient for 4 hours' operation.
Hose, discharge—1-inch linen; 100 feet carried in base.
Hose, suction—1-inch rubber garden hose with aluminum strainer.
Nozzle—$\frac{5}{16}$ inch.

The revolutionary part of the pump is not the size or weight but the gear-reduction coupling. It was this coupling that permitted the use of such a small motor and low speeds. It operates a pump

Portable pump and hose as carried on back.

that, directly connected, requires a 3–3½ h. p. motor and operates efficiently below its maximum rating.

The pump will not eliminate any of the various excellent pumps now on the market. They have their place most decidedly in the protection picture, but where men are scarce and the country is rugged, where water is needed quickly at strategic places and possibly the supply is small, this unit will give value. One man can pack and operate it. The reliable little engine plugs along without attention. If a change of hose is needed or another length needs to be added, the stream is stopped by simply lifting the suction hose out of the supply without danger of burning out the motor or delay in restarting.



Portable pump and hose.

Delivery of water in the experimental model is about 10 gallons per minute at 65 pounds pressure through a 5/16-inch nozzle. A 63-foot stream through a ¼-inch nozzle is obtained through 1,000 feet of 1½-inch linen hose with an elevation of about 25 feet.

Those are the only figures Jim MacDonald will quote on performance. He is content with the facts that he gets a fair stream and can now quote experience of rangers and other fire fighters who have used experimental models and found that this little gadget is useful in many spots where other pumps would not or could not be used.

And finally—economy. The units are cheap to build compared to present standard pumpers. The comparison must, of course, be local, but experience indicates a proportion of at least 2 to 1 and maybe 3 to 1.

The British Columbia Forest Service has now had a dozen units built for field use next year. It is possible that it can be improved, but only use on the fire line will tell.

425851—41——3

A FIRE-DISPATCHING GUIDE FOR USE IN THE LAKE STATES

J. A. Mitchell

Lake States Forest Experiment Station

While judgment cannot be dispensed with in fire dispatching, information as to normal manpower requirements is useful as a guide. The device described is an attempt to supply this information in convenient form for field use.

The Lake States fire-dispatching guide is designed to indicate the manpower normally required to control forest fires in northern Minnesota, Wisconsin, and Michigan within the time allowed by local Forest Service standards. That is within 5 hours in the case of "low" rate-of-spread fuels, 4 hours in the case of "moderate" rate-of-spread fuels, 3 hours for "high," and 2 hours for "extreme." Essentially the device is a slide rule with scales for each of the factors considered which, when combined, indicate the average number of men required to control fires with hand tools under the conditions set up.

The factors considered are (1) Danger or burning conditions as indicated by the Lake States fire-danger meter, (2) wind velocity, (3) travel time, and (4) fuel-type class based on rate of spread and resistance to control.

To use the meter both slides are grasped at (A) and pulled out until the end of the long slide coincides with the current "Wind velocity" on the wind scale opposite the degree of "Danger" prevailing. Next, the short slide (B) is set for "Rate of spread" class on the scale opposite the "Travel time" called for. The "Number of men" required is then indicated on the top scale by the arrow for the appropriate "Resistance to control."

For example, if the meter is set for a class 5 day, a 10-mile wind, 1-hour travel time, and high rate-of-spread fuel, the average number of men needed, in the case of moderate resistance to control, is 14 as indicated by the arrow marked "Moderate," while "Low" resistance to control calls for 7 men, "High" 28, and "Extreme" 56.

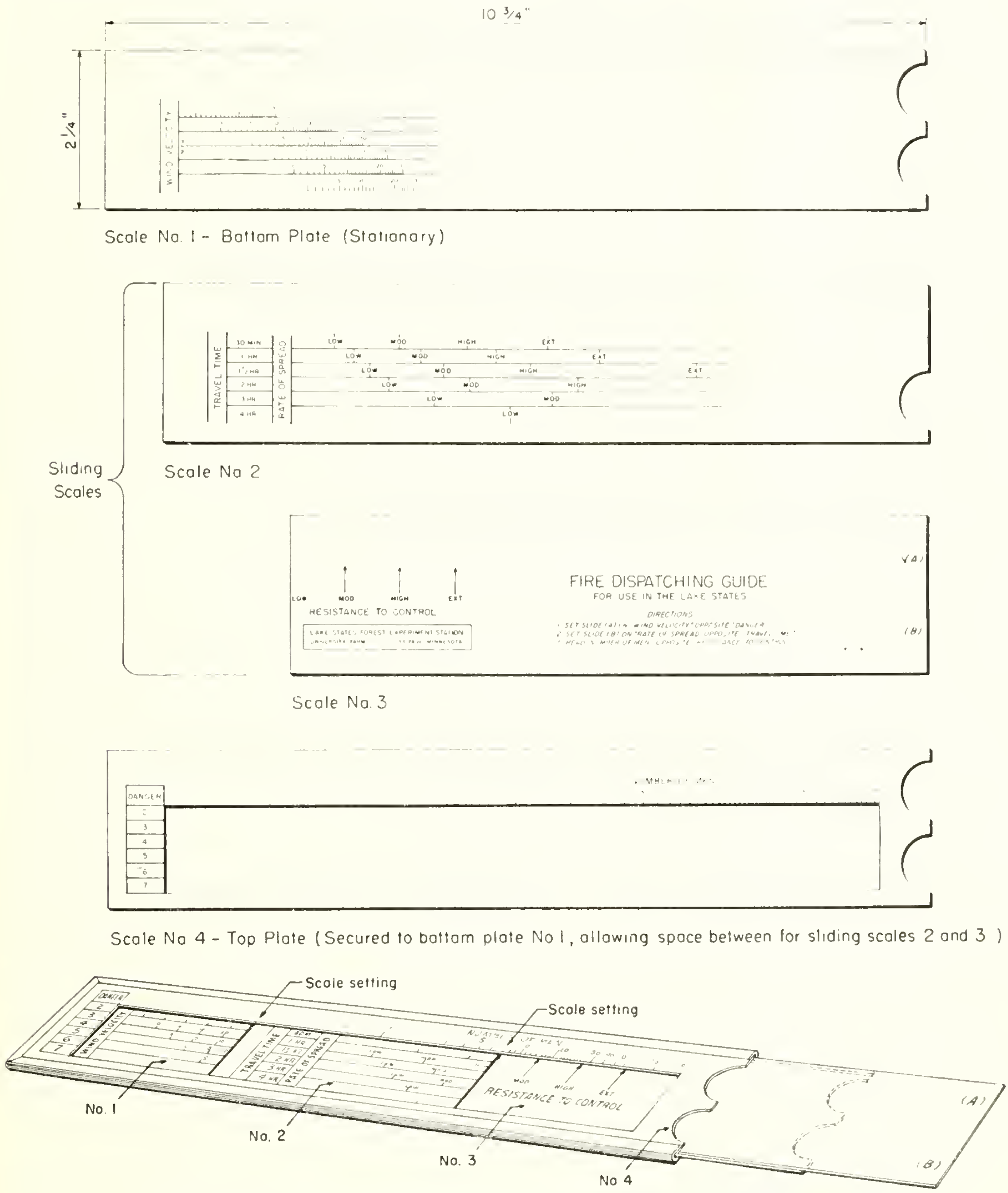
The fuel-type classes used are those adopted by the Forest Service in region 9, which classifies fuels on the basis of their average rate of spread and resistance to control on class 5 days with a 4- to 7-m. p. h. wind. Rate of spread is defined as the increase in the perimeter of a fire in chains per hour and resistance to control, as the ratio of final perimeter to man-hours required for control (exclusive of mop-up and patrol). On this basis the average rate of spread and resistance to control for the fuel type classes recognized are: Rate of spread—"Low," 8 chains per hour; "Moderate," 16; "High," 32; "Extreme," 64. Resistance to control—"Low," 8 chains per man-hour; "Moderate," 4, "High," 2, and "Extreme," 1.

In practice, rate of spread and resistance to control are determined by reference to a map showing the fuel type class prevailing on the area in question. In the same way travel time is usually determined by reference to a map showing the time required to reach any point on the protection area from the nearest established base.

The computation of manpower is based on the formula

$$N = R/2C + RT_1/T_2C$$

in which $R/2C$ equals the number of men required to offset the increase in the perimeter of the fire after attack begins and RT_1/T_2C the num-



Fire-dispatching guide as constructed and assembled.

ber required to control the fire burning on arrival, N being the total number of men required, R the rate of spread in chains per hour, C resistance to control in chains per man-hour, T_1 the elapsed time from origin to arrival, and T_2 elapsed time from arrival to control.

In calibrating the meter, elapsed time from origin to arrival (T_1) is assumed to be travel time plus ½ hour. If known to be more or less, the difference can be allowed for by using a correspondingly longer or shorter travel time in setting up conditions on the meter.

Since empirical values are used in its calibration the meter is not recommended for use outside of the Lake States. The formula used in computing manpower and the method of integrating the various factors, however, are applicable generally.

No dispatching table or meter should be followed blindly as local conditions often call for special consideration. In such cases there is no substitute for experience and good judgment. All a dispatching guide can do is to indicate normal requirements as a check on judgment.

In practice the tendency is to overman fires when conditions are favorable and to under man them when conditions are critical. This results in a waste of effort on small fires and allows bad fires to get away. There may be some excuse for overmanning small fires in the interest of safety but undermanning bad fires is serious. The trouble appears to be a lack of appreciation of the rapid increase in rate of spread with wind velocity in the higher danger classes, particularly when high rate-of-spread fuels are involved. The importance of adequate first attack cannot be overemphasized if area burned is to be kept small. The fire-dispatching guide serves to call attention to conditions which require increased strength of attack.

More About Burros.—The suggestions made by J. H. Sizer about burros (Fire Control Notes, July 1941, paragraph 5, page 142, "Fire Control Work in Isolated Sections") seem very impracticable, judging from our experience with burros in these mountains a few years back. Perhaps, however, Sizer has a different kind of burros than we had, or some burro tenders who know a lot more about such animals than do ours.

Burros may be all right in a fairly level country, where you can herd them around, but ours were decidedly poor animals to try to lead around very much, being slow and stubborn. When you turn them loose and expect one to follow the others, you are again disappointed in being able to get them to travel at more than a snail's pace. If you then try to herd them along to get more speed out of them, they crowd each other off the trail and roll half of the string down the mountainside. You then spend the balance of the day, or night, packing the equipment back onto the trail (the part worth packing back) and getting the rolled burros back, if you don't have to dispose of them for injuries. They are tough though and can stand a lot of rolling.

The burros can be subsisted cheaply and will stick around camps quite well for a short time if a constant check is made on them and they are fed something at camp. Otherwise, they wander farther and farther away and eventually will wind up back at the ranger station, or other main base camp, or home range. Each camp has to be protected by a good pole fence or barricade of some kind unless a watchman is left in camp to keep the burros out during the absence of the crew.—Lester D. Robinson, *district ranger, St. Regis District, Cabinet National Forest.*

MAPPING ACTIVITIES OF THE WISCONSIN CONSERVATION DEPARTMENT

John W. Ockerman,

Principal Topographer, Forest Protection Division, Wisconsin Conservation Department

Maps and the theories and practices underlying their construction are often not understood even by those who use them. The author mixes together a little history, a little theory, and a little practice in such a manner as to dispel some of the mysterious aura surrounding maps.

A map is not just an abstract plan of a portion of the earth's surface but in reality is a piece of equipment. In the case of the forest-protection division, it is an important part of the fire-control equipment. It does its part in locating the fire, in the rapidity with which the men get to the fire, in the location of water supplies, and in the general plan of attack.

But in addition to being purely utilitarian the map is an important adjunct to recreation. It helps in the planning of trips, whether on land or water, and adds enjoyment to the vacation by revealing new places to explore. The map helps the air traveler and orients the continually changing panorama of lakes and woods so that he may fly safely.

Before we plunge into the actual business of map making, let's look backward into the history of mapping. A review of deficiencies and idiosyncrasies of the earlier maps will tend to give added weight to the qualities of our present maps and a greater appreciation of the maps now available.

The first prerequisite of a map is that it have a definite scale so that distances can be denoted. Actually measurements on the ground were made as early as 1300 B. C. in the survey of the Nile land, but the standards of measurement were extremely confused up to the eighteenth century. For example, in 1781 the map of France had 20 different scales shown on it. In 1789 the map of England showed 3 miles, the long, the mean, and the short mile.

The second need for a map is direction. Distance without direction is meaningless. Prior to the advent of the compass, maps were based on religious or geometric principles and consequently were pictures rather than maps as we now think of maps. The reverence for the east was pronounced, and east dominated the maps even after the compass made its appearance. We still say "orient" a map, but we orient it to north instead of east now.

To put a map together it is necessary to have a plan or projection by which the data can be assembled. A projection may be defined as a systematic drawing or meridians and parallels on a plane surface. Though projections were devised by Ptolemy, none was used until the eighteenth century. We now have our prime meridian running through Greenwich, England, but in the earlier maps using projections, the prime meridian was put in many places with resulting confusion.

As can be seen, mapping is a relatively new science. Certain phases of it are extremely new, and advances are continually being made in both the technique of mapping and the finished product.

The map section at the forest-protection headquarters at Tomahawk, Wisc., is actively engaged in the preparation of several types of maps, the most important being the forest-protection maps. Since one of the principal uses of these maps is to locate fires by intersection, accuracy is of prime importance. To accomplish this it is necessary to have an accurate base, precise control, and as good cultural data as possible.

For constructing the base the polyconic projection has been selected. This projection is well adapted to Wisconsin and facilitates the use of data from the United States Geological Survey and the United States Coast and Geodetic Survey. The maps are constructed on drawing paper, mounted on either side of a sheet of aluminum. This base minimizes the distortion due to shrinking or stretching of the paper and gives a very permanent master copy. The base map is drawn on a scale of 8/10 inch per mile and is called a quadrangle. It is 30 minutes of latitude and 30 minutes of longitude on a side, which translated into miles is approximately 25 miles east and west and 35 miles north and south. These quadrangles are so drawn that several can be assembled to form whatever size area is desired.

After the polyconic base has been constructed, the control points are then accurately placed on the outline. These control points consist of fire towers, United States Coast and Geodetic triangulation stations, water tanks, and other tall structures for which there is a precise location. In 1934 the United States Geological Survey triangulated all the fire towers in Wisconsin and furnished us with their precise positions in latitude and longitude as well as distance between adjacent towers. From this data it is possible to plot the position of the towers very accurately on the maps. The tower control is supplemented with other triangulation stations which are parts of several major control networks in Wisconsin. All of these towers and stations have been tied into the Government land survey, and it is possible to build the land survey lines around these control points quite accurately. Whenever possible, surveys of Government agencies are used in laying out the land lines.

The final stage in the construction of the quadrangle is filling in the cultural data. During the last few years the entire State has been photographed from the air, and it is from these pictures that the lakes, streams, roads, trails, railroads, etc., are taken. These pictures, of which there is a complete set at the office of the Highway Commission in Madison, were taken at approximately 15,000 feet altitude with a single lens camera. The original pictures are 7 by 9 inches in size and are on the scale of 1/20,000 or about 3¼ inches per mile. At the time the pictures were being taken many land corners were marked with cheesecloth crosses so that they could be located and identified on the pictures. This was extremely important in areas where there were few roads and little cleared land that might help to identify the land lines and corners.

By the use of a suspended pantograph, on which the slight variations in scale can be corrected, the information from the pictures is reduced to 2 inches per mile, and compiled in township form on what is called a topographic base map. On these bases are shown the original meander lines and Government lots, present lake outlines and stream courses, roads, trails, fire lanes, towers, telephone lines, and all information pertinent to fire-control work. These maps are sent out in preliminary form to the respective district rangers for field check as to road types, names of lakes and streams, and any additions or corrections to get the map as complete and correct as possible. When these have been returned and corrections have made on the original tracing, sets of these maps are issued to the districts to be used for compiling varied data such as tree plantings, hazard zones, burned areas, etc., as well as new information on roads, towers, etc., and for future correcting of the quadrangle map. It is from these corrected topographic base maps that the cultural data for the quadrangle is secured, and it is transposed or pantographed onto the quadrangle map.

When the quadrangle map has been completed, it is photographically reproduced to scale and printed on a uniform type of paper so that several can be matched and mounted for the large wall maps or dispachers' maps. In the case of the latter, 6-inch protractors are overprinted in red ink at each tower position, the zero of the protractor being oriented to true north, as are the protractors in each of the fire towers.

The district maps are issued on the scale of ½ inch per mile and are made by assembling as many quadrangles and parts of quadrangles as lie within the district boundaries. When the maps have been put together and a border and legend has been constructed, the composite is photographed down in scale from 8/10 to ½ inch per mile. In addition to the black and white maps, a portion of the district maps are issued with red tower protractors superimposed over each tower.

In addition to the forest-protection quadrangles, topographic base maps and district maps, there are several other types of maps produced by or issued from the map section at Tomahawk.

Ground-water survey maps are similar to the topographic base maps in scale and make-up, but in addition to cultural data they show the ground-water conditions. After a careful study of the township has been made to determine the location and amounts of ground water, and test wells have been sunk, this information is incorporated in a ground-water survey map. These maps are useful tools in fighting fires in areas of little or no surface water.

Lake survey maps, showing the depths, weed beds, bottom materials, etc., prepared under the supervision of the biology division, are issued from the Tomahawk office.

In addition to miscellaneous maps and plats of surveys, such as fire lanes, ranger station sites, state properties, etc., many building plans have been prepared at this office, ranging from small tower cabins to large ranger stations and garages, and many drawings of equipment have likewise been prepared and issued at this headquarters.

A SIERRA RATION AND EQUIPMENT OUTFIT

Ralph L. Cunningham and Wesley W. Spinney

Sierra National Forest

The Sierra National Forest (California) is divided roughly north and south by the San Joaquin River which runs west and southerly toward the main valley. The canyon formed by this river in the Sierra is steep, rugged, inaccessible.

The forest cover is highly inflammable. In the southern end of the canyon it consists largely of scrub oak, grass, and brush. The middle and upper portions break away into ponderosa pine and sugar pine with some fir and cedar in the upper reaches.

Whenever a fire starts in the canyon area, it usually covers considerable acreage and is very costly to control. Because of the prevailing high-velocity SW. winds, sometimes reaching 30 to 35 miles per hour, fires travel up the canyon rapidly during the day. The topography and lack of roads in the area make travel to a fire slow. Precipitous canyon walls and lack of transportation facilities also make it impossible to put fire camps in close proximity to the fire. Consequently, line crews are obliged to do considerable walking, which cuts deeply into the daily line production. Some of the canyon country is too dangerous for CCC crews.

In searching for means of eliminating the use of CCC crews and of reducing excessive walking, the personnel of the Sierra decided upon a modification of the 40-man suppression crew used in Region 6 (Described in Fire Control Notes, April 1940, The 40-man Crew—A Report on the Activities of the Experimental 40-man Fire-Suppression Crew). Fortunately local Indians, loggers, and residents who are familiar with the country and who depend upon a certain amount of income from fire fighting each year are available for use in organizing fire crews. Local experience has indicated that large crews are not necessary down deep in the canyons, but that small compact units located at strategic places will suffice in a good many cases.

With the local situation and problems in mind and looking ahead to future canyon fires, "blitz-blaze" ration and equipment outfits were made up. They were so planned that a man might subsist alone for at least 72 hours if he were left on patrol work or the outfits might be combined into ten 12-man set-ups in case a temporary camp were established. Since each outfit is self-sufficient, the size of the crew can be enlarged simply by adding another man and pack.

Each outfit complete weighs in the neighborhood of 40 pounds and can be handled by the average man, while in good shape, going into the fire. If necessary, the packs and equipment can be brought out by stock or by a fresh crew after the fire had been controlled.

One man in each group of 12 carries a supplemental cooking outfit. Contents and weights of different items in the Sierra outfits follow:

1. Individual crew member pack:

Article	Amount	Weight in ounces	Article	Amount	Weight in ounces
Roast beef ... cans	3	36	Peaches, sliced ... cans	2	16
Butter ... can	1	13	Milk, evaporated ... can	1	14½
Date-nut bread ... do	1	8	Spaghetti ... do	1	15¾
Raisins ... package	1	15	Pork and beans ... do	1	30
Prunes ... do	1	16	Canteen with cup and cover ... quart	1	16
Macaroni ... do	1	16	Army mess kit with knife, fork, and spoon ... can	1	16
Sausage, breakfast ... cans	2	21	Army blanket, W. O. D.	1	48
Cheese ... can	1	7¾	Zweiback ... package	1	6
Bread, brown ... cans	2	32	Granulated sugar ... do	1	16
Coffee ... can	1	32	Headlamp, new 4-cell type	1	48
Potatoes, peeled whole, new ... can	1	20	Salt and pepper (mixed) shaker	1	8
Rice ... package	1	16	Knapsack	1	16
Soap, Lava hand ... bar	1	6	F. M. B. file 8-inch	1	01
Soup ... can	1	10½	Matches, paper	1	1
Tomato juice ... do	1	15	Socks, towel, tooth brush, etc.	...	16
Jam ... do	1	24			
Grapefruit ... do	1	8			

Total weight knapsack and contents	pounds	34.4
Average weight of fire tools	do	6.6
Total weight of outfit	do	41.0

2. Items in cook's knapsack:

Article	Amount	Weight in ounces	Article	Amount	Weight in ounces
Blanket, W. O. D.	1	48	Tea, black	1	8
5-gallon can, square	1	40	Dipper, tin	1	4
Dish towels	3	16	Fry pans, folding	2	48
Spoons, table	5	16	Soap, laundry	1	12
Knife, butcher	1		Dry soup, mixture	2	16
Cheese	1	32	Army meat, can with knife, fork, and spoon	1	16
Matches, penny size	2	2	Canteen, 1-quart, with cup and cover	1	16
Coffee	1	8	Nails, assorted	...	16
Roast beef	3	36	Soap, bar Lava, hand	1	6
Date-nut bread	1	8	First-aid kit	1	16
Sandwich spread ... quart	1	32	Salt pills (100) ... bottle	1	10
Butter, canned	1	13	Gasoline lantern with extra mantles	1	80
Milk, tall, evaporated	2	29	Knapsack	1	16
Pepper (can)	1	2			
Pickles, dill	1	26			
Flour	2	80			

Total weight, 40¾ pounds.

Small articles are rolled in three 10-pound cloth sacks—sacks to be used to carry lunches if necessary, or as towels otherwise.

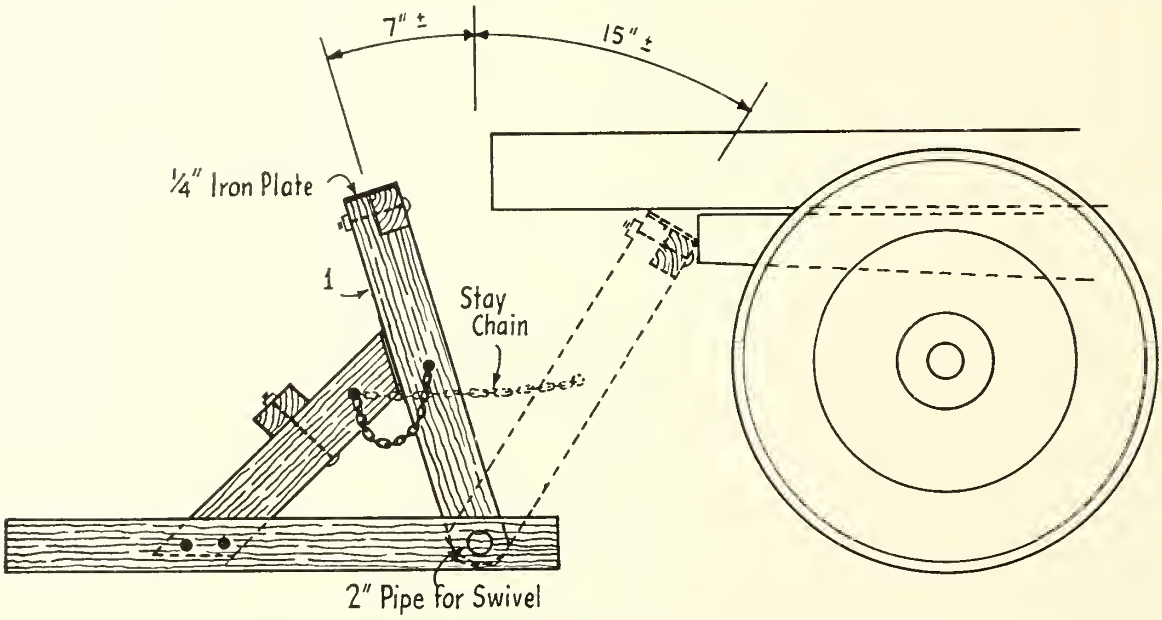
One W. O. D. blanket is sufficient for most mid-Sierra summer nights. However, if the shift system is used, each man will have access to an extra blanket.

Although the outfits described may not be perfect in food and calory content, they should enable the crews to get by in good shape for at least 3 days. They were made up of standard R–5 equipment and of supplies on hand insofar as was possible. Nonperishable items, such as canned meat and butter, were purchased specifically for such use. The plan would be to supplement the rations and supplies with a radio set, light batteries, fresh meat, bread, water if necessary, and sharp tools delivered either by pack train or by plane when possible.

The man in charge of each crew must be trained in the use of the ration and supply outfits. When the crew is grouped together, he must see that the food is pooled in order to prevent waste and spoilage. He must also "rough out" menus in order to make the rations last.

It must be remembered that the "blitz-blaze" outfits have been made up for use in cases of emergency, in a hazardous area where a few men can do the job, and where decreased walking time and increased line production are necessary for prompt control of fires. Their value and practicability are yet to be tested by actual use on the fire front.

Relieving Weight From Overloaded Truck Springs.—Shown on the accompanying sketch is a design for relieving weight from overloaded springs on trucks where it is necessary to keep the truck loaded for any length of time. This model was designed and built by mechanic Herman Isbell at Camp F-12, Stearns, Ky., for use in relieving springs on a fire truck that is constantly loaded.



Apparatus to relieve weight from truck springs.

The material consists of 3- by 4-inch piece of oak or equivalent wood and a 2- or 3-inch pipe for swivel or axle. The distance and arch can be varied to suit height of truck frame. If necessary, a chock block for the truck can be added. Note that the vertical piece (1) should be low enough that the truck can maneuver on and off jack under its own power.—*Cumberland National Forest.*

COMPARISON OF 1-, 2-, 4-, 6-, AND 8-MINUTE WIND-VELOCITY MEASUREMENTS

William G. Morris

Pacific Northwest Forest and Range Experiment Station

Wind velocity for fire-danger rating is often estimated for a given period of the day by making brief measurements with a wind gage at certain observation times. One type of gage in widespread use is designed for a 1-minute count of the revolutions to obtain the wind velocity, and another type is designed for a 2-minute count. It is frequently suggested that a period several times as long should be used so as to average the irregular effects of gusts. The following article gives results of a study to determine the relative desirability of different velocity measurements ranging from 1 to 8 minutes in length.

Wind velocity is an important factor in rating forest-fire danger in R-6. In present practice it is measured by a 2-minute observation at 8 a. m., noon, and 4:30 p. m. Either the noon or afternoon measurement is usually used with the current fuel-moisture measurement to determine the rating of fire-weather conditions.

The rating of fire weather is intended to represent conditions during a considerable proportion of the afternoon and not just the conditions at exactly noon or 4:30. It would be more desirable to have a continuous record of wind velocity and fuel moisture, but available recording instruments are too expensive. A greater frequency of 2-minute observations also would be desirable, but other duties of the observers prevent this at many of the observing stations.

It is known that fuel moisture usually changes rather gradually and steadily in a certain pattern during the afternoon but wind velocity may fluctuate greatly from minute to minute or hour to hour. The study to be described as made, therefore, to obtain an estimate of the reliability of short observations of wind velocity when used to represent prevailing conditions for the afternoon during a period that was chosen arbitrarily to be $2\frac{1}{2}$ hours in length.

The general method of study was to measure wind velocity for each minute during an 8-minute period. The 8-minute periods of measurement were repeated 10 times during each afternoon and were begun at 15-minute intervals. A Friez aneomometer with three $2\frac{7}{8}$-inch cups and with buzzer contacts every $\frac{1}{60}$ mile were used. The observations were taken on 5 days on a mountain top when the wind velocity averaged from 7 to 11.5 miles per hour for the afternoon period sampled, on 3 days on the mountain top when the wind velocity averaged from 3.5 to 5 miles per hour, and on 10 days in a 1-mile-wide valley when the wind velocity averaged from 2.8 to 4.4 miles per hour.

The measurements for each minute in the 8-minute period were later grouped to form observation periods of differing length. Thus 1-minute, 2-minute, 4-minute, 6-minute, and 8-minute periods of observation were obtained for comparison. The fifth minute in the series of 8 was used in each case as the 1-minute measurement period. The fourth and fifth minutes were used as the 2-minute measurement period. The third, fourth, fifth, and sixth minutes were used as the 4-minute period. The second to seventh minutes were used as the 6-minute period. Thus each long period included each shorter period.

The manner in which the observations differed from each other owing to variations in wind velocity between different hours of the afternoon, different periods within the hours, and different lengths of observation was studied by methods of statistical analysis. These methods were used also to obtain estimates of the comparative reliability of single observations differing in length and used to represent the average velocity for a 2½-hour period.

The fact that all observations were taken at regular intervals of 15 minutes instead of at random casts a certain degree of doubt on the interpretation of statistical measures designed for use with random distributions. If the wind should show a tendency to rise and fall in 15-minute cycles the results of random sampling methods of analysis certainly could not be correctly interpreted for the data collected in this study.

The velocities observed during the first, fifth, and eighth minutes of each 8-minute period were analyzed to determine if there was any tendency for 15-minute cycles to occur and none was found. Continuous automatic recordings of wind velocity at the valley station during two summers have been inspected and no regular pattern of wind velocity variation during the afternoon could be found. The writer feels safe, therefore, in using methods designed for random sampling to estimate from the present data the reliability of 1-minute, 2-minute, 4-minute, etc. measurements.

The wind velocities for afternoons of low average velocity and for relatively high average velocity showed that these two groups should be studied separately. The data taken on afternoons of low velocity on the mountain top and on afternoons of low velocity in the valley did not differ and were grouped for analysis. Thus the results will be discussed separately for afternoons on which the wind velocity averaged from 7.0 to 11.5 miles per hour on the mountain and for afternoons on which it averaged from 2.8 to 5 miles per hour at the valley and mountain-top station.

Following are some of the probable limits of accuracy to be expected when the average velocity for a 2½-hour period is estimated from measurements of short duration:

Afternoons on which the velocity averagee 2.8 to 5 miles per hour

	Length of measurement period—minutes				
	8	6	4	2	1
Expected maximum error in miles per hour for 1 measurement [1]	1.8	2.1	2.1	2.7	2.9
Number of measurements needed to obtain an average having a maximum error of 3 miles per hour.[1]	Less than 1.				

Afternoons on which the velociuy averaged 7.0 to 11.5 miles per hour

	8	6	4	2	1
Expected maximum error in miles per hour for 1 measurement [1]	4.8	4.8	5.0	6.2	7.2
Number of measurements needed to obtain an average having a maximum error of 3 miles per hour [1]	2.5	2.6	2.8	4.8	5.8

[1] In 95 percent of infinite cases. From 1.96 X S. D.

These data show: (1) Short-period measurements of wind velocity used as estimates of the average velocity for a $2\frac{1}{2}$-hour period had a much greater error in terms of miles per hour for average velocities of about 7 to 11 miles per hour than for average velocities of about 3 to 5 miles per hour. (2) With either wind-velocity class the accuracy of estimating a $2\frac{1}{2}$-hour average from brief measurements increased as the length of measurements increased, but the increase in accuracy was small for measurements longer than 4 minutes.

From another analysis it was found that in most cases there is more difference in velocity between the first, fifth, and eighth minutes within the same 8-minute period than there is between different 8-minute periods spaced 15 minutes apart. This shows that the use of a measurement period several minutes in length will add more to the accuracy of estimating the average $2\frac{1}{2}$-hour velocity than will several short measurements 15 minutes apart.

It was found that on certain days there was a significant difference in average velocity between the first and second $1\frac{1}{4}$ hours in the $2\frac{1}{2}$-hour period when compared to the difference among the velocities recorded every 15 minutes. On most of the days this difference between $1\frac{1}{4}$-hour periods was not significant. Definite conclusions concerning the chance that the first and second $1\frac{1}{4}$ hours will differ in average velocity cannot be drawn from the available data because a sufficient number of days were not sampled.

The fluctuation of wind velocity during a $2\frac{1}{2}$-hour period in the afternoon in some localities might be greater or smaller than found in this study and correspondingly the expected maximum error of one measurement and the number of measurements needed for an average of given accuracy would be greater or smaller. But experience in recording the duration of gusts makes it appear probable that the comparative desirability of measurements 1, 2, 4, 6, or 8 minutes in length to represent the average for a $2\frac{1}{2}$-hour period in the afternoon in most places will be approximately the same as found in this study. These results may be used at least as a guide in other localities to determine the length of wind-measurement period that should be used until more intensive studies can be made. Additional studies for velocities over 12 miles per hour are especially needed.

The following conclusions and recommendations have been drawn from the study: (1) An observation period at least 4 minutes long should be used in estimating afternoon wind velocities of about 3 to 12 miles per hour. This may be done with wind gages designed for 1-minute observations by counting the contacts for 4 minutes and dividing the total by 4. Similarly, for gages designed for 2-minute observations count the contacts for 4 minutes and divide by 2. (2) If a $2\frac{1}{2}$-hour average velocity is to be estimated from short observations, and if the velocity is between about 7 and 12 miles per hour, it is highly desirable to obtain several measurements scattered through the $2\frac{1}{2}$-hour period. Three such measurements each 4 minutes in length will be necessary if an average with a maximum error of about 3 miles per hour is desired. (3) If a $2\frac{1}{2}$-hour average velocity in the range of velocities less than 7 miles per hour is to be estimated one measurement 4 minutes in length will be sufficient for many purposes, because it can be expected to fall within about 2 miles per hour of the $2\frac{1}{2}$-hour average.

A GOOD SUPPRESSION RECORD

C. R. Byers

Assistant Supervisor, Lolo National Forest, Region 1, U. S. Forest Service

Steve Doyle, CCC foreman, Camp F–42 on the Lolo National Forest in region 1, was stationed at Fort Missoula Spike Camp during the 1940 fire season. He had charge of a crew of 15 men who were maintained and trained as a fire-fighting unit. The regular course of fire training was given, plus continued special training.

Part of the training was given while burning firebreaks around Fort Missoula and Waterworks Hill in grass types. The special training continued in the use of the Bosworth trencher, the step-up method, the one-lick method, direct attack, and other methods on early small fires. Every advantage was taken of the opportunity, for training both off and on the early season fire job.

The crew was on 12 fires during the summer, ranging in size from a ½-acre fire to the Jones Creek fire of more than 4,000 acres on the Lewis and Clark National Forest.

On the Post Office Creek fire in the Lochsa Canyon, the crew drove to Jerry Johnson Lookout which required approximately 8 hours' travel time from Missoula. After arriving at Jerry Johnson the crew hiked down to the fire, a distance of approximately 5 miles and arrived on the fire line at 10:15 p. m. The 15 men completed 75 chains of fire line by 10 o'clock the next morning. That is at the rate of 0.42 chains per man-hour, not allowing any time out for rest or lunch. The resistance varied from medium to heavy-medium. The line constructed all held.

A functional-unit organization was used on the Post Office Creek fire. First came five ax men, then two saw crews, then a five-man trench and swamper crew, and one water buck. If the ax and saw gangs got too far ahead of the trenching crew, they worked back and helped swamp out and trench. The crew was kept in as compact a unit as possible, yet providing adequate spacing to meet the needs of the job for safety.

During the summer, Foreman Doyle's crew lost only 1½ chains of trench (caused by a burning log rolling across the line). They traveled 1,800 miles by truck and more than 100 miles on foot.

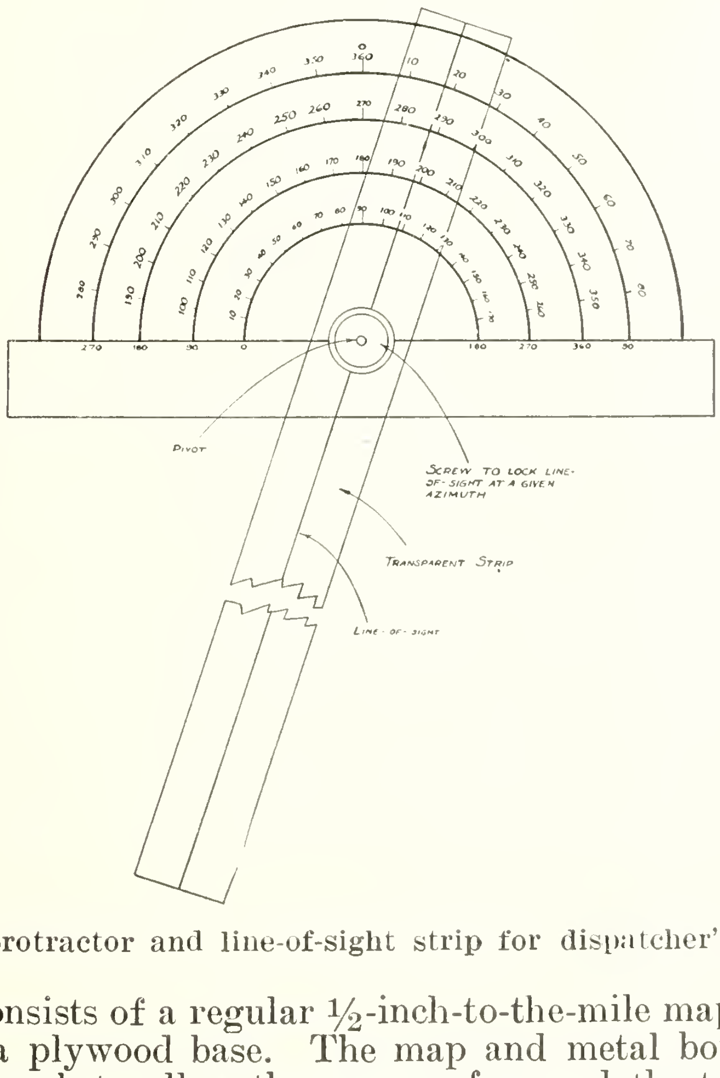
No doubt there have been many other crews similarly trained which have functioned with comparable success. Nevertheless, a comparison of the record of this compact, well-trained crew with the average performance of a few years ago, and even with recent records of what has happened on fires where unskilled men have been used, appears to prove that more and better training will pay big dividends.

A TYPE OF MAPBOARD AND PROTRACTORS FOR DISPATCHER USE IN LOCATING FIRES

Lawrence W. Zach

School of Forestry, Oregon State College

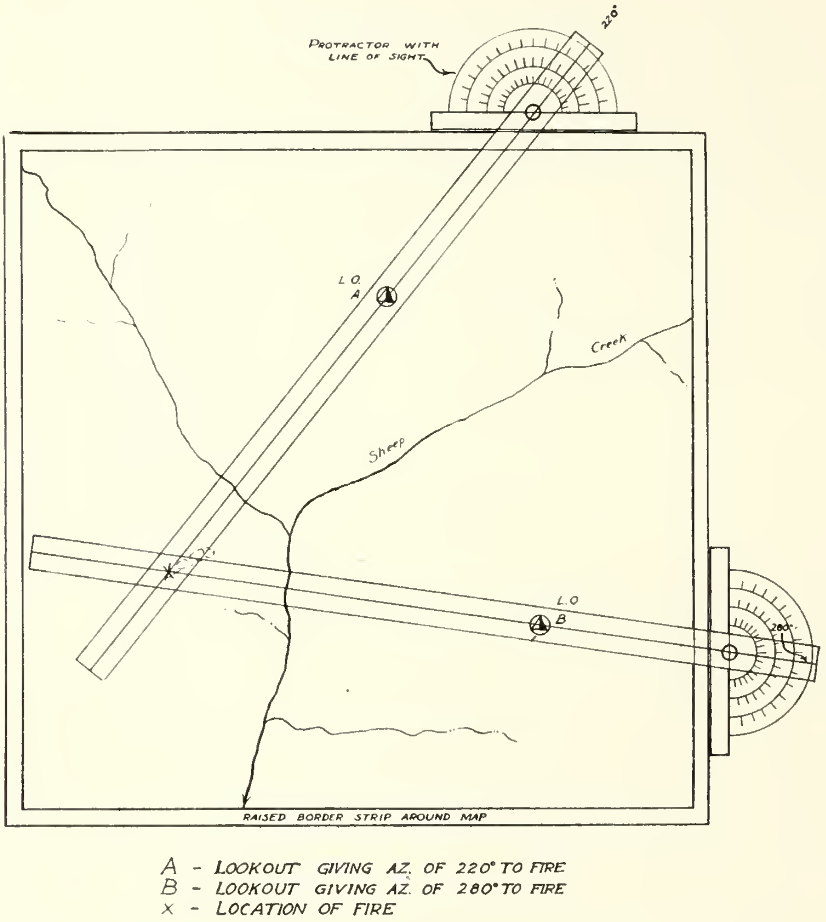
Accompanying diagrams show the type of mapboard used in dispatching on the Coeur d'Alene District of the Coeur d'Alene National Forest at Coeur d'Alene, Idaho. This system of map and protractors was designed and developed by W. W. Larsen, district ranger, and H. Flodberg, alternate ranger, about 5 years ago. They have used this board and protractors every season since their development, and they report the board superior to any device previously used.



Detail of protractor and line-of-sight strip for dispatcher's mapboard.

The map consists of a regular ½-inch-to-the-mile map of the forest mounted on a plywood base. The map and metal bordering strips are raised enough to allow the map surface and the top of the protractors to be flush; this allows the lines of sight on the transparent strips to lie flat in contact with the map. These lines of sight are drawn on transparent celluloid strips which fasten to the protractors as shown in the diagrams. The map and surrounding strips are oriented to lie in the cardinal directions. Screws through the metal border strips and base allow the map and strips to be properly oriented, using slotted holes.

The protractors are divided for azimuths, as shown by the protractor diagram. This allows the lookout's azimuth to be set off on the protractor and the line of sight to be fixed securely by the screw on the protractor. The protractor is then moved along the proper side of the board by the dispatcher until the line of sight



Dispatcher's mapboard with protractor.

crosses the lookout location from which the reading was reported. The second protractor is similarly used to set off an azimuth from any other peak reporting the fire and the location of the fire is then indicated by the crossing of the lines on the transparent strips.

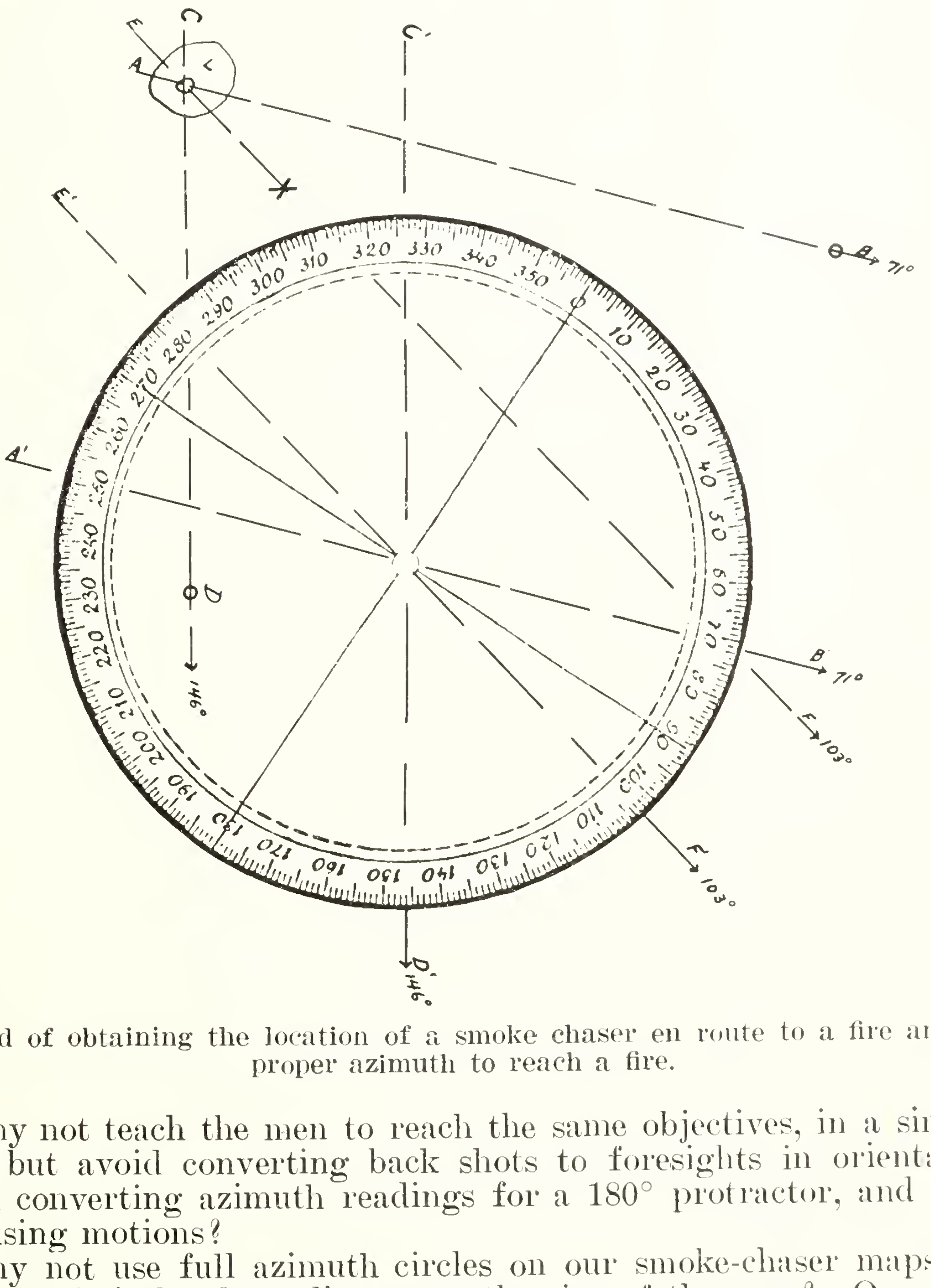
Larsen and Flodberg report that this mapboard with the protractors is unsurpassed for speed, accuracy, clearness of vision, and ease of operation. No lines need be drawn, and no confusing set of azimuth circles and strings clutter up the mapboard; the entire face of the map is entirely visible at all times.

A PARALLEL RULE FOR SMOKE CHASERS

F. E. Williams

Assistant District Ranger, Nezperce National Forest, Northern Region

The compass and protractor have been stressed in guard schools as means of orientation and of drafting courses to fires. The value of such training cannot be overemphasized. However, I have observed that the compass-and-protractor method has not been, shall we say, "comprehensible" to all of the guards. Why? It may be our fault as trainers, but, nevertheless, it is not used to the extent desired.



Method of obtaining the location of a smoke chaser en route to a fire and the proper azimuth to reach a fire.

Why not teach the men to reach the same objectives, in a simpler way, but avoid converting back shots to foresights in orientation, avoid converting azimuth readings for a 180° protractor, and other confusing motions?

Why not use full azimuth circles on our smoke-chaser maps, the number of circles depending upon the size of the map? One circle will do for a small map, and more for larger maps. A parallel rule may be made out of a piece of plastacele (my sample is 4 x 9 inches), with parallel lines ⅛ inch apart etched in the plastacele, the lines running the long way of the plastacele. The advantages of the solid piece over an adjustable rule are obvious. This rule may be used on either a solid piece, rolled map, or a cut and folded map. For a folded map the line is marked at the edge of the piece map with the azimuth circle, then extended directly opposite to the edge of the next piece. The parallel rule is again laid on the original line and a parallel line is used from the edge of the second piece. The parallel rule will roll up with a rolled map, and may be placed flat with a fold-up map.

The diagram illustrates use of the parallel rule with an azimuth circle on the map that the smoke chaser carries with him in the field. The azimuth circle is stamped by means of a rubber stamp at a convenient point on the map where the center opening will be clearly visible. Its purpose is to enable the smoke chaser to draw lines on the map at certain azimuth readings, the parallel rule enabling him to carry the lines through specific points on the map.

A smoke chaser en route to a fire at X, a known location on the map, finds an opening (irregular area L) in heavy timber. He knows the fire is in heavy timber and wishes to locate himself and draft a course to fire X. His compass reads 71° on point B, and 146° on point D, both of which he can identify on the map. He places his parallel rule across the azimuth circle on 71°, line A^1B^1, and finds a parallel line running through point B, line AB; then he knows he is somewhere on that line. He likewise finds line C^1D^1 and from it the parallel line CD. The intersection of lines AB and CD indicates his own position O on the map. He then draws a line between points O and X and with his parallel rule finds the reading of line O^1X^1 is 103°. He now proceeds to his fire on a compass reading of 103°. Note, no readings were converted to back sights; only foresights were needed.

If the fire is on the right side of the oriented location, read the right side of the azimuth circle; if on the left side, read the left side of the azimuth circle.

USE OF TYPE SV RADIO INSTALLED IN AUTOMOTIVE EQUIPMENT

E. W. Woods

District Ranger, Clark National Forest
North Central Region

During the spring fire season of 1940–41, two type SV radios were installed in trucks used as initial attack units on fires out of the Fredericktown Ranger Station. One of these was put in a 1940 model Chevrolet ½-ton pickup and the other in a ¾-ton International fire truck.

In order to conserve all of the space possible, a special case was built to hold only the radio chassis and speaker. The glove compartment on both trucks was removed and the radio was installed in its place. The case containing the radio was held in place by means of two galvanized metal strips which fastened with the same screws that originally held the glove compartment. The dimensions of the case were 16x6x4¾ inches. The construction was of plywood reinforced with metal corners and edges.

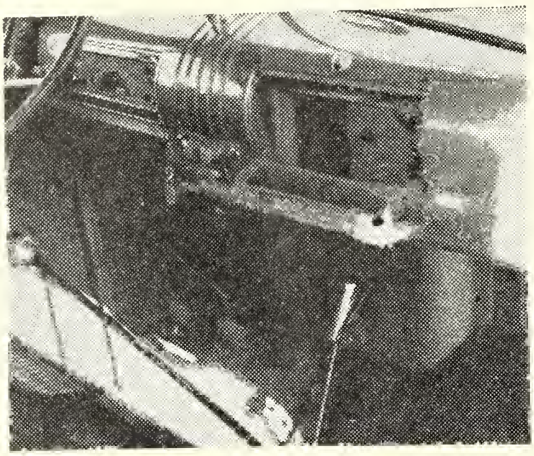
A 5-foot, 5-conductor battery cord was substituted for the one regularly supplied with the set; this allowed the batteries to be carried under the seat in a specially built wooden box. The battery cable was run under the floor mat and up the inside of the dash to the radio. It was found that the super heavy-duty B-batteries could be used, which resulted in a long period of service without replacement and also a saving in cost over a period of time. Regular 1½-volt telephone dry cells were used for A-batteries.

An ordinary telescoping, 7-foot whip aerial was used for the antenna. This was fastened to the right side of the cowl and connected to the set by a short lead-in.

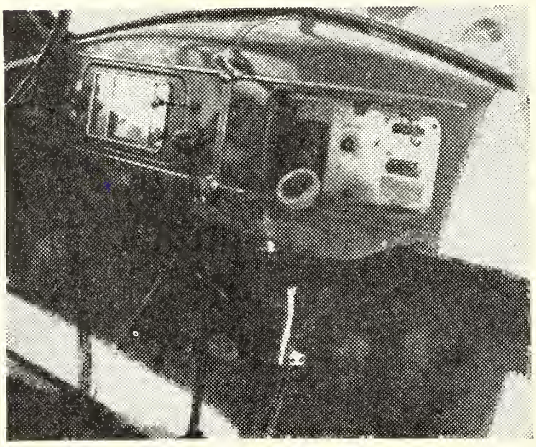
One of these sets has been in operation 7 months and the other 6 months, and neither has ever given a moment's trouble. One truck has traveled over 8,000 miles since the radio was installed and the other about 4,000. Most of the travel has been over very rough roads and under all sorts of conditions. There seems to have been no failure from excessive vibration. The sets did not seem to pick up any excessive engine noise, as conversations are carried on very satisfactorily while the truck is traveling along the road.

It was found that communication was generally possible with either the ranger station or some lookout tower from any point on the district. The sets were especially useful in communication with airplanes. On several occasions two-way conversation was maintained between the plane and the initial attack crew in one of the radio-equipped trucks. Officers in the plane were thus enabled to direct the crew to the fire with a minimum of travel and also inform the fire foreman of the fire's behavior, hot places, danger spots, and in other words, have the fire scouted for him when he arrived. The arrangement also has great possibilities in apprehending fire setters, for the plane pilot can occasionally keep the incendiarist in sight and inform the fire crew of his movements.

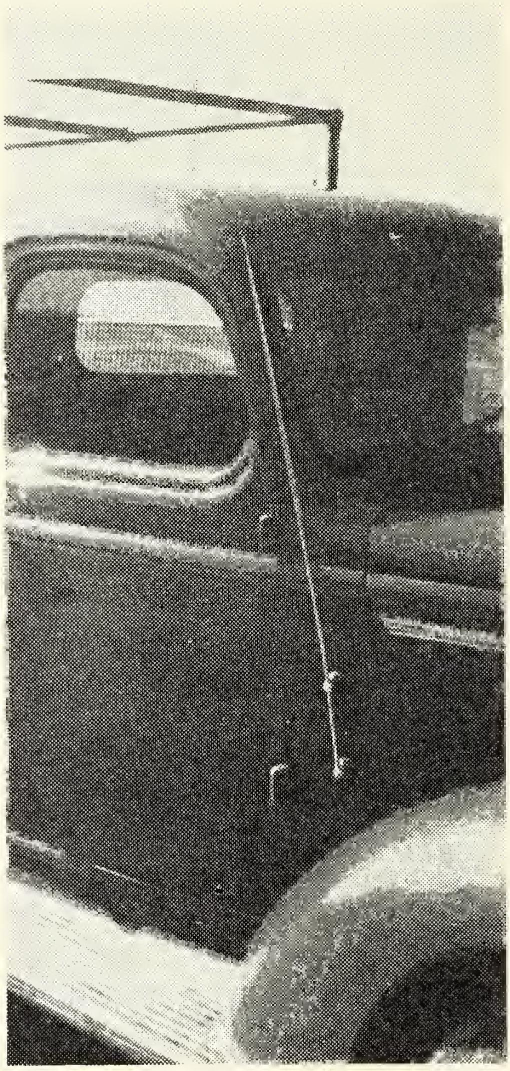
One of the foremen, during the fire season, rigged up a steel fly rod as an aerial on his truck and connected it to an SV set carried on the seat beside him. This worked very well and on two different



SV radio installed in Chevrolet pick-up.



SV radio in International ¾-ton truck.



Aerial for SV radio in Chevrolet pick-up.

occasions was used to receive directions from the airplane on how to get into a fire that was burning in country new to the fire boss.

The installation of two-way radio equipment in our fire trucks has apparently very materially contributed to a decided drop in the size of the average fire on this district. It has also greatly increased the effectiveness of the use of plane by making possible direct communication with the crew going to the fire.

RADIO COMMUNICATION ON THE WASHAKIE NATIONAL FOREST

Roy L. Williams

Forest Supervisor, Washakie National Forest, Region 2, United States Forest Service

Forty-five percent of the Washakie National Forest is wilderness area and much of the remainder carrier lodgepole slash from tie sales. The short-term force of the forest consists of one lookout and one recreation guard. On an area such as this, the use of radio can go far in providing communication flexibility in the back country. What was unusual yesterday is commonplace today.

During the last 3 years, short-wave radios have been used on the Washakie National Forest to enable district rangers to spend a maximum of time in the field, eliminating the necessity of standing by at headquarters during periods of high hazard. Communication has been maintained throughout the fire season over a network of seven stations, which are centered around the Warm Springs Lookout Station. The lookout serves as chief radio operator and the station is connected by telephone with all ranger stations and the supervisor's headquarters.

One of the later sets, SPF 783, is in use at Warm Springs and gave satisfactory service during the entire 1940 season. Daily contacts were maintained with the supervisor's office in Lander, a distance of 80 miles, and with the Wapiti CCC camp on the Shoshone Forest, a distance of 60 miles.

During the peak of the fire season, an SP set was installed at a secondary lookout on Indian Point and hourly contacts were made with Warm Springs. Another SP set was installed at the timber sale ranger's headquarters and scheduled contacts were made daily with the lookout.

Trail crews on both the Absaroka and Wind River Districts were furnished with SP sets and contacts were made morning and night with these crews, except during period when the fire-danger readings were in the high class, when more frequent contacts were made.

The Washakie Forest is very rough with practically no roads. Range administration is the principal activity during the field season, making it necessary for rangers to spend a large percentage of time on long pack trips. Two rangers were equipped with SPF sets and made regular contacts with the lookout station in the morning and at night. During periods of high hazard, noon contacts were made. Such contacts gave the rangers a feeling of security and enabled them to continue trips in the field.

The new SPF sets are very satisfactory and can be sujected to very rough use. They were carried on pack horses throughout the season, and when set up gave no trouble. Contacts were established on schedule except on a few occasions when some of the tubes shook out of the sockets. Also it was found necessary to carry an extra set of batteries with each set.

The greatest difficulty experienced with these sets on field trips was with the long antenna. In timbered areas, it could usually be hung from trees but this took time both in setting up and dismantling, a job which the field men disliked to do, especially at lunch time. Many noon contacts were passed up last year because of the time required to hang up the 150-foot antenna. Where camps were made above timber line, it was difficult to find antenna locations. One end of the antenna was generally attached to a rock in such situations and the other to a peg in the ground. Contacts were established in this manner but not always satisfactorily. It is possible that some form of fishpole antenna might be developed which, when not in use and for packing, could be telescoped together; and when in use could be stuck into the ground and connected to the set.

Experience over the 3-year period has clearly demonstrated that the use of radios by field men is practicable on the Washakie and, in fact, is necessary. The rangers have become so dependent upon radios that it is now almost impossible to carry on the work in the field without such equipment. The fact that the Warm Springs Lookout Station is centrally located for a dispatcher set-up adds considerably to the efficiency of the radio-communication system and also has made it unnecessary to employ special dispatchers to handle the radio-communications program.

The Washakie Forest expects to continue and enlarge the radio system and provide trail crews, emergency guards, and other short-term men with additional sets as rapidly as funds permit so that they can carry on and broaden their usual duties during the field season without interruption to stand by during periods of high hazard.

A PUSH BUTTON TUNING PORTABLE RADIO

RADIO EQUIPMENT BULLETIN

The type SX radiophone is a stabilized unit having extreme flexibility in application. The type SX is a portable radiophone with

Type SX radiophone, model A.

self-contained batteries, applicable to uses of scouts, smokechasers, and others requiring extreme portability. The addition of the type

SXA radiophone attachment, which incorporates a loudspeaker, adapts the unit to semiportable service in lookouts, ranger stations, and wherever standby operation is needed. The type SX in the portable form supersedes the type S, and with the attachment supersedes the type SV.

The type SX transmits and receives voice only. The portable unit weighs about 10 pounds, and has a rated working range of about 50 miles over *optical paths*. However, with low antennas and over level terrain, this may be reduced to 3 or 4 miles. A panel switch permits selection of any of three transmitting frequencies, any or all of which may be crystal controlled. The receiver is substantially nonradiating.

The provision for selecting any of three crystal-controlled frequencies adapts the unit for operation in fixed-frequency networks, and permits ready transfer from one network to another. The procedure for establishing communication is far simpler than for types S and SV. A panel pushbutton provides means for setting the receiver on any of the three transmitter frequencies.

Where strictly portable operation is contemplated, the radiophone is normally used without the attachment. The type SXA radiophone attachment is desirable where standby service is needed, since its amplifier and loudspeaker relieve the operator of the necessity of wearing headphones. No additional wiring or mechanical change is required to install the attachment. It is merely necessary to remove the microphone and battery-cable plugs from the radiopohone and insert them into receptacles on the attachment. Short stub cords on the attachment are then plugged into the radiophone receptacles.

A kitbox is normally supplied when the attachment is ordered with the radiophone. This has compartments for storing the radiophone, radiophone attachment, heavy-duty batteries, heavy-duty battery cable, type J antenna, and halyards.

Orders for the type SX should state the desired transmitter frequencies, and which of these are to be crystal controlled. When ordered without the attachment, the type SX radiophone will be supplied with portable batteries, but without the kitbox, unless otherwise specified. Where the companion type SXA attachment is also ordered, the kitbox will be furnished, together with the type J antenna, halyards, and the heavy-duty battery cable. Heavy-duty batteries are not normally supplied, since they add weight to the shipment and are usually available locally.

A MORE "EATABLE" EMERGENCY RATION

M. A. Benedict

Forest Supervisor, Sierra National Forest,
Region 5, U. S. Forest Service

The emergency fire rations used in region 5 have "refueled" many weary fire fighters, but there has been little praise for their "eatability." However, it took a bear that broke into the Sierra Forest's guard station at Placer to convince the Sierra force that a change of diet was needed.

The bear ripped open all sorts of canned foods, beans, and flour, but carefully avoided the roast beef, hash, and brown bread in the emergency ration sacks. The only possible conclusion was that what a bear wouldn't eat wasn't just the right dish for a man. So, thanks to Old Bruin, fire fighters on the Sierra are looking forward to a new menu in their 1941 ration sacks.

A 1-man, 1-day ration has been made up as follows:

Item	*Weight in ounces*	*Cost on bid*
Luncheon meat	12	$0.196
Date-nut bread	16	.188
Grapefruit juice	8	.036
Sliced peaches	9	.045
Beans	16	.074
Raisins	15	.054
Tomato juice	10	.041
Shoestring potatoes	4	.081
		.715
Freight		.015
Total cost per 1-man, 1-day ration		.760

Total gross weight, 7½ pounds.

Also, a 1-man, 1-meal ration has been developed:

Item	*Weight in ounces*	*Cost on bid*
Vienna sausage	4	$0.071
Date-nut bread	8	.094
Tomato juice	10	.041
Grapefruit juice	8	.036
Beans	8	.037
		.279
Freight		.011
Cost of a 10-pound misprint sugar sack		.020
Cost per 1-man, 1-meal ration		.310

Total gross weight, 3½ pounds.

EARLY AIRPLANE SUPPLY IN REGION 6

Glenn E. Mitchell

Wildlife Management, North Pacific Region

The use of airplanes as standard equipment for fighting forest fires has gone a long way since 1926. When one sees the special packaging of "chute loads" and "parachute smoke jumpers" fully equipped to attack remote fires, the contrast is amazing.

Back in 1926 on the Chelan, an airplane of the old Army DeHaviland type was used for reconnaissance. After the Boulder Creek fire was controlled, as I started out to headquarters, some of the boys said, "Be sure to send a plane over with our mail." The cook added, "You had better add a few pounds of butter, too." The mail and butter were dropped by putting them in a large white sugar sack, tied at the end to give as much air resistance as possible. The report was that they got both mail and butter in good shape.

In 1932 the Siskiyou had a large number of lightning and incendiary fires. Five class C's were going at once. The forest was about the most inaccessible in the region at that time, and one fire, the "Red Mountain," was difficult to reach. It was only 12 miles from the end of the road to the top of Red Mountain, but the topography and ground cover is such that distance is a poor indicator of travel time; a pack train required 2 hard days to make a round trip.

Radios were not so good those days as they are now and communication was slow and discouraging. The regional office secured the services of an autogiro in Seattle and sent it down to Grants Pass for reconnaissance. The fires were all near the ocean so the home port was established at Crescent City. Occasionally fog obscured the beach and once the "giro" started for Grants Pass, 90 miles away, to refuel. The pilot was alone and not knowing the country landed where no one ever had before, in an isolated field, deep in a canyon 18 or 20 miles from Grants Pass and 12 miles from a road. The rancher had a little gasoline for use in lamps which was sufficient to take the pilot to Grants Pass. The pilot asked the general direction. Though he never admitted it, he was probably lost as well as short of fuel.

Word came out from Red Mountain that the crew needed lunch foods. We decided to use the "giro." Meats, jam, and bread were tied in large burlap sacks with as much slack as possible, putting probably 25 or 30 pounds in each sack. When we were over the fire camp, the pilot by reducing the speed of the engine, would allow the "giro" to settle down close to the ground and we would heave out the sacks. Two or three such loads were all the pilot would take at a trip. One of the interesting things we belatedly learned on that job was that solid loaves of bread would shatter so they could not be sliced, but that sliced loaves were seldom damaged. Occasionally a can was broken, but we purposely dropped the sacks on thickets of knobcone pine to break the fall as much as possible.

The supplying of lunch foods by "giro" made it possible to support a larger crew than could have been maintained with the available pack train. It also indicated early the possibilities of such methods of supply.

Another interesting incident occurred when we were out over the ocean. The ship gave an unusual jerk and I thought the pilot was trying to attract my attention as I was in the forward seat. Immediately he started for land and signaled O. K. We landed in a hay field and found a guy wire used to space the fins of the "giro" had broken. When the repairs had been made we took off without any difficulty and returned to the base.

The "giro" was limited as to load and range but it was excellent for detailed vision of the ground as it would hover over a spot for several seconds and it was possible to converse with the men on the ground by short messages.

It was interesting to me to compare the 1932 plane service with that of 1938 on the same forest. During the latter season we were supplying all equipment and rations, including water, to four camps of more than 50 men each and part of the equipment to four more camps. The terrain was exceedingly rough and the dropper could have used a bomb sight to good advantage. Some of the camps were so located that a miss of 100 yards would result in a complete loss, but only a few chute loads were lost on that account. Once a chute load dropped in the fire close to the line. Supplies were so badly needed that two men rushed in to save the food but were successful in salvaging only a part of it.

In those days we dared not think of dropping men on fires. Brains and courage, however, can do much to shape nature to the needs of man.

AIRPLANES VERSUS PACKHORSES

JACK B. HOGAN

Wallowa National Forest, Region 6, U. S. Forest Service

The following contribution to airplane experience bears on the questions raised in the April 1941 issue of FIRE CONTROL NOTES. Securing and analyzing data on all phases of the subject will aid in determining under what conditions airplanes may best be used in fire control.

The Wallowa National Forest has been one of the experimental grounds for dropping supplies and equipment to fire camps from airplanes. Additional experience in this phase of fire suppression was gained during the 1940 season on the Cook Creek fire. Caused by an abandoned campfire this class C fire burned 22 acres. It was located in the bottom of a deep draw along the edge of a stringer of timber leading to the head of the draw, paralleled by slopes covered with bunchgrass, cheatgrass, and various species of brush.

The part of the forest in which Cook Creek fire occurred is approximately 8 miles airline from the location of the Rogersburg fire of 1939, which started in the State of Washington and burned south into Oregon to within a mile of the Wallowa Forest boundary, covering more than 11,000 acres. The area adjacent to the location of the Cook Creek fire is similar to much of that burned over in the Rogersburg blaze.

The horizontal distance from the nearest road to the Cook Creek fire location is about 1¾ miles. The difference in elevation between these points is more than 2,500 feet and the topography is extremely rough. From 2 to 2½ hours were required for a packhorse trip from the base camp on the road to the camp on the fire line.

The base camp was located approximately 50 miles from the Enterprise fire warehouse (Enterprise is the supervisor's headquarters), a distance requiring 2 to 2½ hours' driving time by truck.

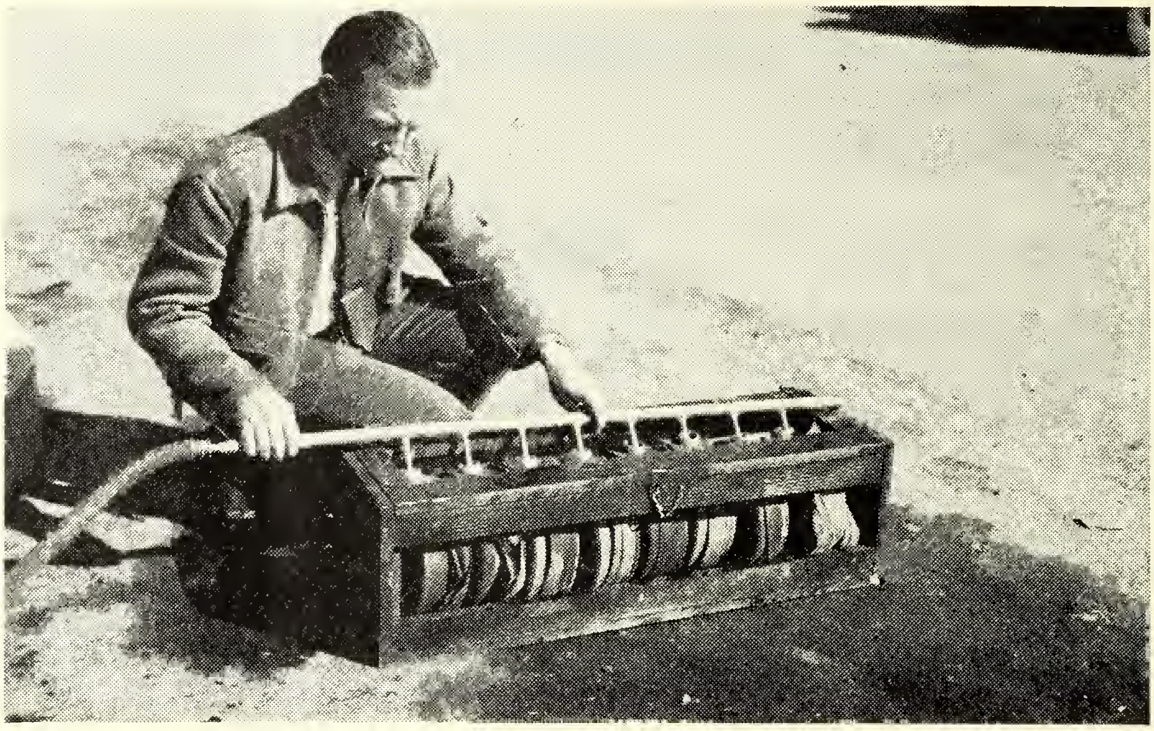
Accurate time records were not kept for packing horses or for packaging, preparing for dropping, and loading supplies and equipment transported by airplane. However, statements of forest officers concerned indicate the time required for preparing and loading was about the same for each operation.

The landing field at Enterprise is 2 miles from the Forest Service warehouse. A Travelair plane, operated by Zimmerly Brothers Air Transport of Lewiston, Idaho, with a capacity of 800 pounds in addition to pilot and dropper, made repeated trips from the Enterprise landing field to the fire and return in 1 hour. For delivery of supplies and equipment from the Enterprise warehouse to the fire, including unloading time, approximately 45 minutes was required by airplane and about 5 hours by pack horse.

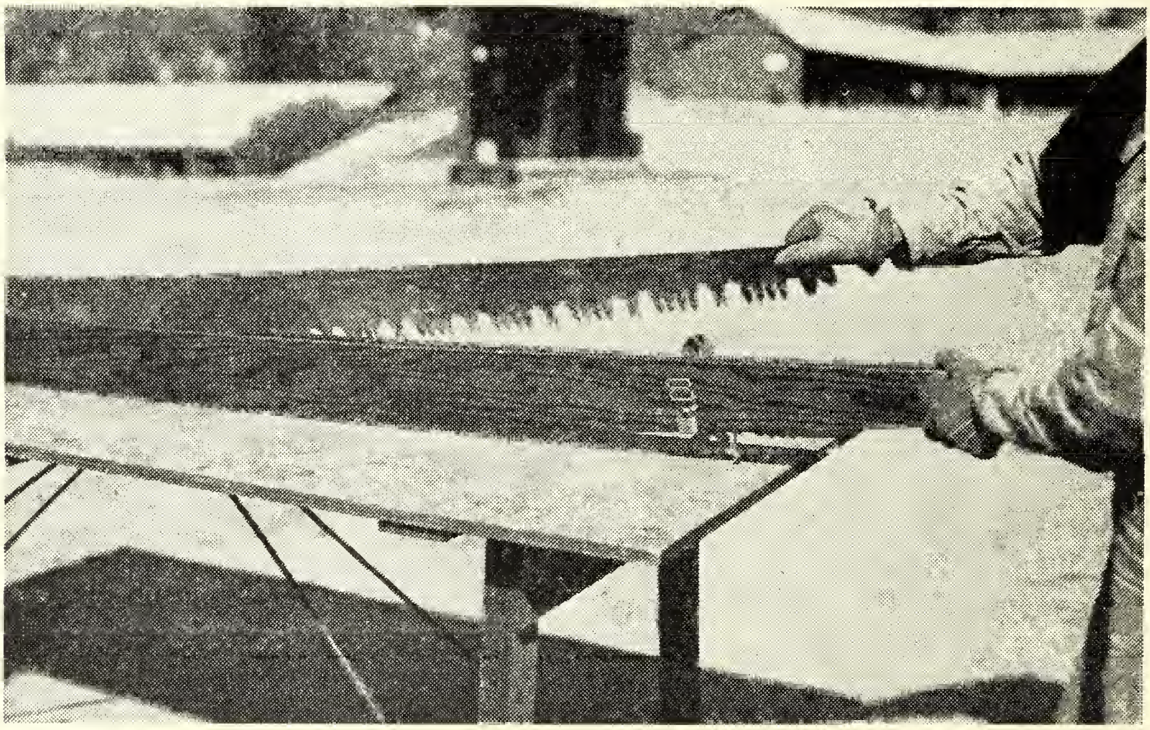
The cost per pound for delivery of supplies and equipment to the Cook Creek fire was 5.4 cents by airplane and 2 cents by pack animal. The objective of fire control requires that immediate and thorough action be taken to control fires, mop them up to the point of safety, and then extinguish them wholly or in part in accordance with fire-fighting standards. If airplane transportation is available, its use seems justified on fires in inaccessible locations comparable to that of the Cook Creek fire, and such transportation should be used for supplies and equipment needed until mopping up to the point of safety is completed.

The fact that the Cook Creek fire was confined to 22 acres indicates the effectiveness of the action taken. The favorable outcome may have resulted from the initial attack by four Forest Service employees and nine cowboys, mop-up work done by the 40-man CCC crew, or "an act of God." Probably all the "actions" described, combined with the delivery of food and equipment by airplane, were responsible. Incidentally the campers, who left the campfire burning, were apprehended and satisfactory law-enforcement action was obtained.

Equipment Hints.—Pictures have recently been received of two devices developed on the Sierra National Forest of the California Region which have interest beyond that forest. The canteens of suppression crews are carried in racks of 8. Filling them daily from one faucet apparently proved time consuming so a pipe was rigged with garden hose threads on one end and with 8 outlets welded to the pipe. The 8 canteens can be filled as quickly as one could be previously. No valve is shown in the picture but one could be used if desired.



Multiple spout filler for canteens.



Wooden saw guard.

The other illustration shows a saw guard devised to replace the rubber guards which are no longer being purchased because of the need for rubber in national defense. The saw guard is made of three pieces of plywood by bolting together the two sides and the separator and riveting a web strap with a buckle at each end.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

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VOL. 6 APRIL 1942 NO. 2

FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and technique may flow to and from every worker in the field of forest fire control.

Volume 6 Number 2

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

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The value of this publication will be determined by what Federal, State, and other public Agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

Address DIVISION OF FIRE CONTROL
Forest Service, Washington, D. C.

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THE PRIEST RIVER FIRE MEETING

Kenneth P. Davis

Senior Silviculturist, Forest Management Research, U. S. Forest Service

Research and administrative men in Forest Service fire control met to appraise their technical problems at the Priest River Experimental Forest, Idaho, December 2–6, 1941. Twenty-seven men attended throughout the meeting. From Research were 9 men from the 6 stations carrying on fire research, plus 3 from the Washington office. Administration had 13 men from Regions 1 to 9, and 2 from the Washington office. In addition, Regional Foresters Watts and Kelley sat in on part of the meeting, doing their best, as Watts said, "to add to a healthy state of confusion."

The last general investigative meeting was in 1936, and substantial progress in fire control has been made since. According to Headley's recent report, the annual average acreage of lands within the national forests burned per million acres has dropped from 2,421 in 1930–34 to 1,418 in 1935–39, and the trend is still downward. The once seemingly far distant goal of one-tenth of 1 percent burned annually is rapidly being approached; in fact, it has been exceeded on some forests.

Research has progressed correspondingly. In the last 5 years, fire danger meters have developed from a somewhat newfangled device to a mainstay of the fire-control organization in most regions. Discussion of fire meters now centers around what kind of a meter and how to build a better one rather than why a meter. Thorough studies of visibility have helped round out a working knowledge of fire detection; a good start has been made on more fundamental studies of fire behavior to give the fire dispatcher and boss a better guide for action; and much progress has been made in determining fire effects to give a basis for controlled use and evaluation of damage. A region-by-region analysis of investigative needs in fire control was completed early in 1941. The time was ripe for a constructive over-all appraisal of the direction, emphasis, and organization of the fire-research program and the formulation insofar as feasible and desirable of a coordinated national program.

At the meeting fire-investigative needs were divided into 5 topics: Fire economics, prevention, effects and use, behavior, and organization and management. A committee for each topic was appointed in advance and made responsible for a well-rounded presentation and summary of the sense of the meeting. Each topic was opened by 3 to 4 more or less set papers by committee members and followed by open discussion, with the committee acting as an "Information Please" panel. Following topic presentations and discussions, the respective committees went into a huddle and produced recommendations for a final round of general consideration and summary.

The interest in and emphasis on the economics of fire control were high lights of the meeting. It was generally agreed that much hard-headed appraisal and study were needed of values at stake and liable to damage in relation to protection costs, to guide fire-control effort effectively and indicate its proper intensity.

Some background may help in orienting the present situation. Economic problems in fire control have long been recognized. But in the past, with control rather obviously inadequate, there was no great need for thoroughgoing economic analysis. The ratio of benefit to cost was strongly favorable. This perhaps explains in part why Sparhawk's comprehensive analysis of liability ratings nearly 20 years ago [1] and other past studies and proposed programs for economic research have not been aggressively followed. A contributing factor was lack of statistics on which to base sound analysis.

The situation now is somewhat different. Specifically considering the national forests, a degree of control is now being achieved on some areas—but not all—that even 10 years ago seemed a far-off dream. Retraction of CCC and other emergency aids responsible for much of this advance in control effectiveness has developed keen pressure to define how much protection is justifiable and how much it costs. Intermixed with this is increasing consciousness of the economic ramifications of timber losses and of the existence of many forest values other than timber. These factors have combined to make questions of achieving proper balance and intensity in fire control of immediate importance. So, while interest in fire economics is not new, there is evidence of considerable more wallop behind it to do something.

The committee recommended as a first step that investigative work be started at the national level to identify and develop methods of measuring the direct and indirect effects of fire on all forest resources in terms of dollars, so far as possible, but not overlooking values not now measurable in dollars. Also, to determine the cost of various intensities of protection and the probabilities of losses, and on the basis of this information to indicate justifiable expenditures for fire control. A big job and, it was soberly realized, one that would take continuing effort. Case studies could probably be employed that would yield useful answers to particular problems and also contribute toward a body of information generally applicable. Wide regional differences in economic problems were recognized and regional studies were encouraged, though it was believed they should be supervised at the national level to promote reasonable uniformity and avoid unnecessary duplication. A two-man project was recommended as a minimum beginning.

Another recommended extension into a new field of research was in fire prevention. Long recognized and wrestled with as a serious problem, it has not received much systematic research attention. For fire prevention effort to be effective, the underlying reasons why and how people start fires must be known, and convincing counter reasons must be advanced and put in such terms and form that they will reach

[1] Sparhawk, W. N. The Use of Liability Ratings in Planning Forest Fire Protection. Jour. Agr. Research 30 (8) : 693–762, 1925.

(Continued on page 84)

REVIEW OF PROBLEMS AND ACCOMPLISHMENTS IN FIRE CONTROL AND FIRE RESEARCH

H. T. Gisborne

Senior Silviculturist, Forest Protection Research, Northern Rocky Mountain Experiment Station

This topic was assigned to the author at the recent fire research meeting at Priest River Experimental Forest, Idaho. When asked to permit publication of his paper in Fire Control Notes, he replied that he had no notion that his paper was an historical opus of any kind. "It was prepared to be read to an in-Service, friendly group * * *. It was intended to be a mustard-plaster, counter-irritant, spiced-up cocktail." It doubtless brought the meeting up on its mental toes right at the start. But, in addition, it is a valuable beginning of a facinating and important chronicle—the saga of fire control for the last 35 years.

As the author expects, there will be disagreement with regard to some of his "milestones of progress." If, however, his stimulating article impels other men to submit article making corrections or additions, or questioning his emphasis on some "milestones," the foundation will be laid for a history of an amazing development in the conservation of natural resources of the United States. A perspective derived from some knowledge of our "milestones" is indispensable to our thinking now and in future years.

Selecting a Point of View

Whoever laid out the program for this meeting utilized one device which is recognized by philosophers and successful writers as essential to the productive development of discussion. At Spokane, a month ago, Dr. Carl F. Taeusch, of the Bureau of Agricultural Economics, told us that for common understanding of any problem it is essential that we first establish the "framework of ideas within which we are trying to work out the problem." Walter B. Pitkin stresses the same point when he says: "The next task is to take some position toward the subject you propose to discuss * * *. When you take a position toward a field of fact or fantasy, you do something strangely like the choosing of a vantage point from which you view a valley * * *. Point of view and perspective determine the special arrangement and design of the entire panorama. Any valley may be seen from a thousand outlooks. Always the same valley, it presents itself in a thousand manners according to the outlook."

Our present program makers obviously agreed with these authorities when they set up Topic 1 as a review of problems and accomplishments in fire control and fire research. They recognized the need of getting together and being sure that we are all looking at the same valley, not mistaking some of the minor gulches for the main valley, before we plunge into the examination of specific phases of the problem, each of which is minor to the whole. They apparently agreed with Dr. Morris L. Cooke who states, under the title of "On Total Conservation": "Increasingly in human affairs—material, intellectual, and even spiritual—the effort is made to see things whole."

Personally, I welcome the oportunity to tackle this topic because I am convinced that failure in recent years to look at the whole problem first, and its parts second, has caused a large part of what we now call the fire problem. For the past 20 to 25 years, we have been so engrossed with certain exceptionally pressing phases of the fire problem that at times we have almost lost our perspective. I believe that I can demonstrate this to you. In the process I hope that I can establish a common vantage point and thereby reveal the true size and complex topography of our "valley."

To do this, I propose to go back to the beginning of Nation-wide fire control and come down the 35-year road, citing what I have selected as the outstanding accomplishments. In this selection I have had the help of Major Kelley, Axel Lindh, C. K. McHarg, Roy Phillips, W. W. White, and Clarence Sutliff. I take full responsibility, however, for all omissions of events which you may think should have been included in this historical series.

One basic presupposition seems to be essential, and to demand full agreement and understanding before we proceed. This is the premise that all of our experiment station divisions of fire research have just one justification for existence, just one function, just one objective. That is: To aid the present and future administrators of fire control, Federal, State, and private. We are not doing research for research's sake. We have a definite, decidedly practical goal, and it is still the basic, over-all goal that Graves stated in 1910: "The first measure necessary for the successful practice of forestry is protection from forest fires." Fire research is therefore intended to serve as directly as possible the fire-control men who must first be successful before any of the other arts or artists of forestry can function with safety.

There is one other and perhaps even more basis presupposition that should be raised here. I do not expect that we could get unanimous agreement on it, but it is a condition or factor which certainly should influence your reaction to my selections of the significant facts in the history of fire control. Furthermore, it is a basic factor in determining your reaction to much of the discussion of project program that will follow. It is, in my opinion, the biggest, the most overshadowing, the most all-permeating feature of our fire problem. It is, briefly: Does fire control have to be able to demonstrate with data that its expenditures, in toto or in part, will pay dividends in dollars of increased revenue?

Mileposts of Progress

In venturing to select and designate certain events as mileposts of progress, I realize now, better than I did when I started, the difficulty of the task. Probably no one will agree with all of my selections. But in this game it is dealer's choice and anyone can deal who is willing to write. My own major criterion has been whether or not the event was of national and lasting significance in fire control, Federal, State, or private. In some cases I have used the first proposal or broaching of an idea if it "took." In some cases the original idea failed to take, or to become nationally effective, until clarified, amplified, or given the right push by some individual. In those cases I used the push that put it over. In a few cases there has been real progress along broad lines, but I have not been able to name the event or date it. I have also probably overlooked some deserving events.

I have tried here to distingish three types of events: (1) Progress toward better objectives in fire control, (2) better methods used in pursuing the objectives, and (3) better finances permitting the use of better methods. My reasons for selecting these particular events are as follows:

1904. The creation of a widespread framework of forest reserves in 1904, 1905, 1906, and 1907.

Here was the real beginning of all future Nation-wide problems in fire-control objectives, methods, and finance. All previous problems had been relatively local. All State and private major problems of fire control have likewise appeared since the Federal Government began to practice forestry on a national scale. Hence, although Sargent compiled the first fire statistics in 1880, the active history of fire control seems to me to commence in 1904.

1905. In 1905 there was born the first cooperative agreement and work plan between private and State timber protective agencies. This move proved to be so profitable and so beneficial that the formal cooperative protection movement spread rapidly, first throughout the Northwest and subsequently throughout the Nation. This first cooperative association greatly improved both the objectives and the costs of State and private protection. It was so beneficial that similar "cooperation" has even been forced by law in many States, beginning with the Oregon compulsory patrol law of 1913.

1906. The Use Book for 1906 was a definite milepost in bringing all of our major problems of objectives, methods, and finance into focus in terms of the job ahead. These problems are all evident in one short sentence in that book. "At the beginning of the summer season, or before March 15, each supervisor will recommend to the forester the number of men needed adequately to protect his reserve, the rate each should be paid, and the number of months each should serve." There, in one pregnant sentence, are all of our problems—beginning, ending, and degree of fire danger, manpower placement, what constitutes "adequate" protection, the problem of temporary employees, and finances—the wherewithal with which to do everything. Even Mr. Headley's pet problem was there, in the next sentence, reading: "After consideration of these recommendations the forester will fix the number for the full summer force of each reserve, and this allotment will be final." As Gowen and Headley will probably be willing to testify, the forester's office is still "considering" these recommendations and still trying to make allotments that will be "final." Hence, I believe that "The Use Book" of 1906 constitutes a distinct milestone along the road of fire control.

1909. The formation in 1909 of the Northwest Forest Protection and Conservation Association was more of a national milestone of progress than many of you may think. This organization soon became the Western Forestry and Conservation Association and under the exceptionally aggressive leadership of E. T. Allen, the steady guiding hand of C. S. Chapman, and the farsightedness of Geo. S. Long, it had a Nation-wide influence for more than 25 years. It was especially helpful on Federal appropriations for fire control, fire research, and fire-weather forecasting. It exerted and still exerts an extremely beneficial influence on many State legislatures for the improvement of fire laws, brush disposal requirements, and other objectives. It has contributed steadily to the improvement of methods of fire control, especially on State and private land, through its several editions of the seven chapters of "The Western Fire Fighters' Manual." This text on fire control is probably used in every forestry school in the country. If not, it should be.

1910 (*a*). A milepost contributed by a Chief Forester of the United State. If any man here has not read Forest Service Bulletin No. 82, "Protection of Forests From Fire" by H. S. Graves, he should take time—make time—to do it. There you will find such a keen and clear analysis of the fire problem that, although it was published in 1910, many of its statements have not yet been improved upon.

For instance, if you think that methods of fighting fire, crew organization problems, skill in sizing up and attacking fires, are recent discoveries or new problems, listen this: "The following are of first importance: (1) Quick arrival at the fire; (2) an adequate force; (3) proper equipment; (4) a thorough organization of the fighting crew; and (5) skill in attacking and fighting fires." What factors have we added to that list in the past 30 years since Graves saw these phases of the problem and described them so clearly? While many old-timers have probably now forgotten this bulletin, many later events indicate that such subsequent progress began right here.

1910 (*b*). I may be wrong in erecting a milepost of progress to the great Idaho fires of 1910, but I am told that before they occurred public interest in forestry and the Forest Service was almost non-existent. The dramatic incidents and loss of lives in those fires made newspaper headlines all over the country and "the people" were awakened to two things. First, that timber wealth was burning up; second, that there was a Federal organization trying its best to protect that wealth. These fires probably were the greatest object lesson in forestry that ever occurred, anywhere. A marked upswing in public interest and in funds for fire control was evident immediately after the 1910 fires.

1911 (*a*). The first forest-fire deficiency appropriation in 1911 was certainly a milepost of progress. Some of you may not know that in 1910 several supervisors in Region 1 furloughed all of their unmarried rangers for one month in order to acquire the funds to pay fire-fighting bills of the previous summer.

This situation shows clearly the distinctivness of finances as a separate phase of the fire problem, and reveals the great and serious weakness in that phase existing up through 1910. The provision in 1911 of EFFF, emergency fire-fighting funds, more commonly known as FF, remedied this weakness.

Most unfortunately somebody made this godsend of 1911 into a Damocles sword and has been dangling it over our heads ever since. Looking back at its origin it does not seem conceivable that Congress could possibly return to the fire-financing methods of 1910, forcing furloughs to pay fire-fighting bills.

1911 (*b*). While the Weeks Law of 1911 was primarily aimed at the acquisition and protection of the headwaters of navigable streams, and hence was a milepost in objectives, it also appropriated Federal funds for the first time for fire control in cooperation with the States. It was therefore the forerunner of the monumental and highly effective Clarke-McNary Act that followed 13 years later. All the old-timers tell me that the Weeks Law was a distinct milepost of progress.

1912 (*a*). "The National Forest Manual," issued in some six or more sections, 1911 to 1913, contained in the volume on "Protection" the first detailed break-down of the fire problem which I have been able to find. There is not time here even to list all the features separately recognized. "The Fire Plan" was named, however, and this was clearly the forerunner of DuBois' "Systematics for California," which followed 2 years later, and for Hornby's highly detailed integrations which followed 12 years after that.

Firebreaks were given great emphasis; in fact, here seems to have been the origin of a fire-phobia which 30 years have not entirely eliminated. Permanent lookouts were indicated as possibly desirable as follows: "Main lookouts are those from which an exceptionally large territory can be seen and where *it might pay* to keep a permanent lookout." The same year that this Manual was distributed, Forest Service Bulletin No. 113 appeared with photographs of permanent lookout towers and houses already in actual use on what was then the Arkansas National Forest.

This Manual of 1912 also took one definite step ahead in objectives when the statement was included: "Practically all of the resources of the national forests are subject to severe injury, or even to entire destruction by fire. Besides the direct damage which fire may do to merchantable timber, to the forage crop, and to watershed cover * * *." For the first time that I can find, "the forage crop" is included in addition to commercial timber and the old stand-by—watershed cover. Here for the first time was an objective definitely broader than "timber alone for dollars alone."

Here also was the real origin of fire prevention research, in the statement: "Since the best way to stop fires is to prevent them, a fire plan must include a careful study of prevention methods." Note that they said, "Prevention methods." I believe you will all agree that we were a long, long time getting past the mere listing of prevention cases and concentrating on the study of prevention methods. There is a vast difference.

Here I would like to digress for one-half minute on the subject of cases versus methods. I have attended quite a few fire meetings, and at most of them I have been struck by the time spent in attempting to solve cases, with so little effort intentionally directed to draw from those cases either methods or principles. A lot of us here today were present at the Washington fire meeting in January and February 1939. My notes for one national meeting contain this statement: "If there has been a single feature of this meeting that has been conspicuous by its absence, it is the phrase: '*There* is a good method, there is a good principle, which all regions should be able to follow or apply.' " Twenty years ago Howard Flint wrote, in a comment on Sparhawk's liability rating: "Why not stick to a *method* that is fundamentally sound, using figures that are admittedly arbitrary?" I think that Flint hit the nail on the head. I certainly believe that we, here at Priest River in 1941, should keep our eyes open for methods and avoid quibbling over the split-hair accuracy of minor figures or cases that are, perhaps, being used in an unsound method.

1912 (*b*). Daniel W. Adams' "Methods and Apparatus for the Prevention and Control of Forest Fires," Bulletin No. 113, published in 1912, is so clearly the forerunner of both the Fire Control Equipment Handbook and the various fireman's guides and fire-suppression handbooks, that were to follow 20 years later, that it certainly rates a monument. Yet I will venture the guess that not more than two men here ever heard of D. W. Adams or have any recollection of this bulletin. But if you doubt that this was a "first" and should be recognized as such, look at the drawing, in figure 8, showing where to locate a fire line on a ridge and compare it with the drawing for problem 6, page 21, in the Region 5 Fire Control Handbook issued in 1937; or problem 1, page 88, of the Region 1 Fireman's Guide issued in 1940; or Bob Monro's figure 4 in his article (Fire Suppression) in the October 1940 Fire Control Notes. That old drawing of 1912 shows not only the best fireline location but also the wind current involved, just as well as many of the similar attempts 28 years later.

As for equipment, if you think the Los Padres shield for a flame thrower, illustrated in the July 1941 issue of Fire Control Notes,[1] is something new, take a look at figure 2 of plate III of Bulletin 113 published 29 years earlier. For chemicals on the fire line see figure 2 of that same bulletin. For a quick get-away with water tanks on a pack horse, see figure 3 of plate IV. For railroad tank cars, see figures 3, 4, and 5. For something really new, see the logging system suited to better fire control, outlined by figures 6 and 7.

Incidentally, this pioneer work in fire control in Arkansas seems to have borne fruit. Dean Walter Mulford recently stated that "Arkansas, which has 15 million acres of active forest lands, is probably the foremost State in the United States as regards forestry matters." I believe that we here should salute D. W. Adams and the Arkansas National Forests. They were so far ahead of us in some respects that we haven't caught up yet, but if we are not careful we may include in our research program a project or two aimed at features of the fire problem that were pretty well thought out as much as 30 years ago.

1914. 1914, Region 5 tried to scoop the country and keep all good things to themselves, but they were unsuccessful. Coert DuBois' publication, "Systematic Fire Protection in the California Forests," an unnumbered item is not labeled as either bulletin or circular and is marked, "Not for public distribution," was very definitely a milepost in progressive thinking on a national scale, even though the Californians did try to keep it exclusively to themselves. I read that bulletin from cover to cover several times when I was a lookout in 1915. It was all new to me then. Every time I read it now I still find something that is new and useful.

If you will read DuBois you will find that he actually pointed the way for nearly everything that Hornby and I ever did, when he said:

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[1] A Portable Flame Thrower, by Neil L. Perkins.

"A way must be devised of reducing all of these factors (inflammability, season, risk, controllability, liability, and safety) to concrete terms, so that any forest area, after careful study, can be given a rating which will convey to our minds something in the nature of an exact measure of its total fire danger." The expression "class 5.8 danger in a high-high fuel type" does that for Region 1 men today, for any instant and spot, with one exception—"liability" or values are out. Hornby wanted to include those in his "total danger rating" and they were in his first formula, but the 10 a. m. policy came along about then and under it "values are out." So Hornby left them out, to all ostensible purposes, although he fully agreed with DuBois.

Someday we will go the rest of the way for Coert DuBois and put those "liabilities" or values back into the prominent place they deserve, but there is one small matter which must be settled first, the subject of "objectives in fire control." When we clarify that the road will be open again.

1916. It may have been a coincidence, but if so it was a monumental one, when in 1916 Silcox first proposed the one-tenth of 1 percent objective of fire control and about the same time Headley proposed the "least cost plus damage" or "economic" objective. To me, the flat "tenth of 1 percent" was an expedient, but a little bit more sound than the 10 a. m. policy which was to come 19 years later. To me, Headley's theory was and is fundamentally the soundest ever proposed. It has its difficulties, but if we can ever do with it, as DuBois said we must do with danger ratings, "devise a way of reducing all of these factors to concrete terms," we can make that economic theory work. When we do that we will have *applied economics.*

1919. Although there is some evidence to indicate that the Canadians were ahead of us in the use of airplanes in fire control, this phase was not reached until 1924 or 1925. Long before that Howard Flint was investigating lighter-than-air craft and by 1920 the United States Army had become interested. The latter is witnessed by Erle Kauffman who, in an article in the April 1930 issue of American Forests, quotes an army officer as follows: "The day will come when large numbers of men and equipment will be carried by airship to the scene of a forest fire, both men and equipment dropped by parachute, while the airship will rain down fire extinguishing chemicals from above." From this use of the term "airship" it appears that the Army officer was, like Flint, thinking primarily of dirigibles.

The earliest printed record of Flint's interest, which I can find, is in an issue of the Forest Patrolman (Western Forestry and Conservation Association), which quotes Major Kelley, then fire inspector out of the Washington office, as follows: "H. R. Flint, fire chief in District 1, holds credit as the first forest officer to recognize the possibility of real value in the dirigible as a vehicle for transporting fire crews and supplies, and as a means of effective patrol and detection service. In the fall of 1919 Flint corresponded with a concern in the East about the use of a "lighter-than-air machine." Flint, himself, in the December 7, 1931, issue of the Northern Region News, says that airplanes were first used on fire-control work in this region in 1925. Possibly other regions antedated this.

There are three features of this development well worth noting. First, the long, slow, uphill drag indicated by part of Flint's "News" note: "In the seven seasons since that time, backed up by a little real support, a great deal of discouragement, and some ridicule, I have seen the airplane slowly taking a definite place in our work. It has come to stay." Second, an entirely unforeseen value of this new departure almost usurped the place of the original idea. Photographic mapping, pioneered in 1925 by Flint, Jim Yule, and T. W. Norcross, almost stole the show and for several years was more significant nationally than was the fire-control idea. Third, whereas Flint's original idea was aviation by use of blimps, that has not yet come to pass. But the blimp idea obviously led to airplanes, and it is not at all inconceivable that the latest development in airplane use—parachuting men and supplies—may later lead back to the blimps.

1920. I believe that all fire chiefs, fire bosses, and rangers will agree that when Orin Bradeen began in 1920 to centralize the purchasing, packaging, and delivery of fire-fighting food, tools, and other equipment he removed one of the greatest headaches of previous fire control and made the future job both more efficient and less costly. Bradeen erected a milepost from which we have forged ahead, still under his leadership, probably to as near perfection as in any phase of our problem.

1921. Radio, like airplanes, also opened a new epoch and while the Radio Laboratory of the Forest Service has made steady progress, credit for the milepost should go to R. B. Adams who first made radio actually work on a going fire in 1921 and to Dwight Beatty, who, 6 or 7 years later, produced the first truly Forest Service sending and receiving set.

1922. Sometime in the early 1920's, a new idea began to be practiced which has since swept the country and become standard practice in all Forest Service regions. This is organized training. While it began as general administrative training, the value of this procedure in fire control was soon appreciated, and fire-training schools and correspondence courses are now recognized as indispensable to the attainment of adequate fire control. The one man who deserves all the credit for this milepost of progress is Peter Keplinger. His full contribution amounted to much more than the first idea, for he, like Bradeen, stayed with it and developed the method, showing all of us how to use it.

1923 (*a*). Up to 1923 I cannot find a single event produced by research that should be called a milepost of national progress in fire control. Clapp's first working plan for fire research, written about 1916, and the research work of Sparhawk, Show, Larsen, Hofmann, and Osborne from 1916 onward would rate a tremendous monument in the history of fire research alone, but fire research is only one means to an end and here we are discussing all means of progress toward the big END.

Publication of the relative humidity theory in 1923 by J. V. Hofmann and W. B. Osborne seems to me to be the first contribution by research which was of Nation-wide signifiance. The "relative humidity" idea literally and actually swept the country. For a while it appeared to be the total and final answer to the 1916 Working Plan request for "some simple, single index" of fire danger. For certain fuels and fuel types it is still the simplest and best.

There is one feature of this milepost which should be of special interest to this Priest River assembly of fire-control and fire-research men. While "J. V." (Hoffmann) was an experiment station director engaged in full-time research, "Bush" Osborne was chief of fire control in this region, and an administrator. But there was no "fence" here between research and administration, and this happy combination of a researcher and an administrator proved to be highly efficient. Bevier Show, then a full-time researcher, and Ed Kotok, fire chief, like Osborne, had also joined forces about that same time, and the world knows how productive that was.

To me the milepost to relative humidity in 1923 is therefore a monument not only to the first simple index of fire danger, but it is also a symbol of the great value of combining the efforts of the man experienced in practical problems and the man trained in the methods of solving problems. It is a known fact that nearly all kinds of engines operate best with a balance wheel or governor.

1923 (*b*). When Show and Kotok, in 1923, distinguished between the "economic" and the "minimum damage" theories, I believe that they erected a milepost which should have accelerated future progress more than many of their later contributions. Unfortunately, that particular feature of their "analytical study" did not "take" in the sense of inoculating us against the danger in the economic theory.

By their own words, on page 59 of Circular 243, Show and Kotok demonstrate that even while proposing the minimum damage theory, they also favored the hypothesis of least cost plus damage. For they state, in their summary: "Successful protection is reached at the point where the cost of prevention, suppression, and damage is a minimum." Hence, "minimum damage' 'was offered not in contradiction of the records from all over the country, Sparhawk was not attempting to clearly evident when they state. on page 4, that their main objection to the economic theory is that it will not work when too much emphasis is given to holding down the costs of prevention and presuppression.

1924 (*a*). The Clarke-McNary Act of 1924 hardly needs any justification as a milepost of national progress. It recognized for the first time the Federal interest, hence responsibility, in fire control on private as well as State forest lands, and it provided those highly essential funds, without which the best ideas and interests lie dormant.

The Clarke-McNary Law did one other thing that is significant. It revived a phrase from the Use Book of 1906— "to adequately protect." That was the stated objective of fire control on the national forests in 1906. It is repeated as the objective of Federal, State, and private cooperative fire protection under the Clarke-McNary Law in 1924. Here are some simple words coming down through history. But, I ask you in 1941: "What do those words mean?" "To adequately protect?" "Provide adequate protection?" Do we even yet, in 1941, know just what those words mean? I am quite sure that *we do not know what we are talking about when we put these words into our Federal laws and fire-control manuals.*

1924 (*b*). The first written agreements between the Weather Bureau and the Forest Service providing for "fire-weather warnings" were dated August 11, 1916, and March 12, 1917. They provided for measurements of only wind velocity form the forest stations, although the forecast was to cover other meteorological elements. As late as 1923, however, these forecasts, when furnished, were of such doubtful value that I cannot rate either or both of the old first agreements as a milepost of progress.

In about 1924, however, a meeting of Weather Bureau and forest protective agencies was called by the Western Forestry and Conservation Association. At Portland, Oreg., and at the Wind River Experiment Station methods of measurement and types of forecasts were thoroughly discussed. Out of this came the first congressional appropriation of funds specifically for fire-weather forecasting. I believe that that meeting in 1924 rates the milepost.

1925. Everyone here is aware of the vital and extremely practical problem of allotting fire-control funds. Regional fire chiefs probably appreciate it most keenly. It cuts them most. Headley and Gowen undoubtedly know more about it than anyone else in the world. How many of you knew that Sparhawk worked on this particular problem from 1915 to 1921 and wrote a bulletin on it, that was published in 1925? [2]

In his tremendous compilation and analysis of Forest Service fire records from all over the country, Sparhawk was not attempting to tell Operation or anyone how much money should be allotted that year or the next year to each region, forest, and ranger district. He was hunting for a method by which that could be done. He says so, very specifically, in the third sentence of his report.

But even more than this, Sparhawk was hunting for an over-all justification for fire-control expenses. He was trying to answer that extremely basic question: "What is the cost of adequate protection?" In the light of our admitted ignorance today, just pause a moment to consider Sparhawk's task: "What is the cost we can justify to do a job which we cannot define, using many elements which cannot be measured?" Then look at the miserable, incomplete, inaccurate fire reports which he had to work with! No; Bill Sparhawk was not born too soon, and he was not tackling an impossible task. It is not his fault that we are not all thoroughly familiar with his report. It is ours. We have so lost touch with our own literature and so lost our perspective of the basic features of our job, that we now piddle around with fire danger meters and argue whether we should use 5 classes or 7 classes or 100 classes, while Bill Sparhawk's clear vision of the really basic problem gathers dust on our bookselves.

As evidence of Sparhawk's attitude toward the economic theory, you will find as figure 1 in his report a diagram illustrating the effect of the law of diminishing returns. This last summer Mr. Headley was carrying around and distributing to all willing listeners a very similar diagram. From 1925 to 1941 is 16 years. This feature of the problem must be something.

As another bit of evidence of Sparhawk's vision and the effect of his work on later efforts, you will find in his report published in 1925 and in a memorandum written after he had completed the manuscript in March 1922, the words, "hour control." Show and Kotok

[2] The Use of Liability Ratings in Planning Forest Fire Protection. Jour. Agr. Research 30 (8) : 693–762, 1925.

picked up this ball and kept it moving in their 1930 "Determination of Hour Control," but they rather dragged their feet on the subject of the justifiable cost of any particular hour control. What is the operational function of hour control anyway? It is to get adequate protection. And what is "adequate protection"? Does anyone know? Don't we need to know?

Sparhawk knew that we have to know, for on page 694 of his report he listed, for the first time to my knowledge, all the kinds of values of forest resources which justify protection. No one has since added *anything* to that list of timber, including mature timber, young growth, the forest capital, and soil productivity; forage for livestock; regulation of stream flow and the prevention of erosion and floods; game resources; recreational use; improvements; and other occupancy values. That list is a true masterpiece of perception. Note, for instance, the inclusion of "the forest capital." When the silviculturists get a working circle into managed age classes, it is obvious that fire wiping out one or two particular classes would do damage far exceeding the maturity value of those particular trees discounted to date. The whole working circle would be thrown seriously out of orderly future progression, and there is a form of loss that is still far ahead of us in 1941. Sparhawk saw it, and named it, in 1925! Research program makers of 1941 can well go back and begin at the 1925 milepost in many respects.

1926. This milepost, "A National Program of Forest Research," by Earle H. Clapp, is too well known and so well appreciated that it needs no explanation. There are certain features of the forest protection section, however, which I should like to emphasize.

First, protection from fire, fungi, and insects are grouped and tied together so closely here that every time I read these three sections over again I wonder why the Forest Service has a solitary division of fire control when the job, on the ground, could be so much more efficiently handled by a division of forest protection. Here may lie one of the most effective methods of solving the problem of the temporary employee or—keeping a trained organization.

Second, in 1925 Sparhawk came out and named all of the many reasons for fire control, of which commercial timber was only one. A year later, Mr. Clapp implied, by his words "forest management" and "to grow timber," that timber alone for dollars alone is our major and perhaps sole justification.

Third, that Mr. Clapp subscribed to the economic theory is shown by his statement: "Possibly they (foresters) should also be able to set limits beyond which expenditures for protection are not justifiable, that is, the determination of that point where the law of diminishing returns becomes effective." In his next sentence he opened the door to the ultimate answer when he said: "But if used at all, these limits should be set upon very comprehensive rather than narrow considerations." As will be brought out later, the dollar value of destructible resources is not the sole criterion of damage and a much more comprehensive basis, as Mr. Clapp called it, is absolutely essential.

Fourth, under "Protection Standards," Mr. Clapp stated 15 years ago: "Satisfactory timber crops cannot be grown unless certain definite standards or objectives of protection are attained." And he continued: "Those standards must be definitely determined." And: "This is a task best attempted by research methods."

Let's keep this milepost in mind when we get to our 1941 research program.

1928 (*a*). The McSweeney-McNary Act of 1928 is perhaps merely a result of the 1926 national program, but it is well to point out one difference. The "program" was an idea, a plan for a "functional operation." It could not function, however, without finances. The McSweeney-McNary Act liberated these essential dollars, like putting water into an irrigation ditch.

A lot of fine work had gone into building the ditch and laying out the orchard, but until some water was turned into the ditch the orchard could be neither planted nor irrigated. The McSweeney-McNary Act did that.

Here, again, when we come to our fire-research program, let's remember our history. We here at Priest River are merely extending that same ditch and laying out some more orchard. And that's all. The other half of the job still remains to be done. Somebody has the specific job of diverting water into our ditch. Whose job is that anyway? Unless that job is specifically assigned, and a McSweeney-McNary Act puts golden water into our ditch, our job here at Priest River will join Sparhawk's fine work on the bookshelves.

1928 (*b*). Another milestone of progress was erected in 1928, or thereabouts, which should be credited specifically to the Chief of our Division of Engineering, T. W. Norcross. The Norcross-Grefe report was not published until 1931, but apparently, "Transportation Planning" was well under way as early as 1928.

When Norcross saw the opportunity, planned a systematic attack, and rang the bell with his "Transportation Planning Methods," he gave all future forest researchers and administrators a well designed tool. In my opinion that is a major contribution.

1930 (*a*). Although Sparhawk may have originated the "hour control" idea in fire control in the early 1920's, and Norcross was designing transportation planning to meet hour-control standards in the middle twenties, still there is no doubt that Show and Kotok made a milestone of that concept when, in 1930, they published Technical Bulletin No. 209, "The Determination of Hour Control for Adequate Fire Protection in the Major Cover Types of the California Pine Region." This popularized the idea and the term sufficiently to produce action in many parts of the country.

In this bulletin, Show and Kotok also added to all previous concepts of "adequate protection" when they went one step beyond Silcox by setting "an annual average of 0.2 percent for the commercial and potential timber types and at 0.5 percent for the nontimbered types" as the criteria of adequate protection in their region. Here was recognition of a "variable standard" varying according to economic demands. There were many other outstanding features of this particular publication, but none, to my mind, either in this bulletin or in their earlier "Role of Fire" and "Cover Type" bulletins, which so strongly influenced national ideas and action as this variable standard.

1930 (*b*). The milepost erected by the District Foresters' Washington meeting in 1930 seems actually to have been primarily and largely a Nation-wide application of the "variable standard" originated by Show and Kotok.

In view of all previous statements of objectives of fire control, it is well to note here how the district foresters affirmed the past basis of damage as a criterion, as follows: "Damage from fires to forest values varies considerably in the different forest types and the objectives in fire control must be based mainly upon consideration of these variations in damage." The fire control committee, of which Kotok was chairman, then listed (1) timber, (2) site, (3) reestablishment process, and (4) future fire danger, as the four main features of damage. Forage, recreation, and game are ignored, as well as that feature which Show and Kotok were to inject later; i. e., "downstream financial interests."

It is evident that although the objectives were incompletely stated, still there was no doubt that damage was the sound basis. Every milepost in objectives from 1906 up to, but not including, 1935 will be found to be in agreement on that point.

1933. The advent of the CCC's in 1933 appears to me to have been a milepost first in finance and second in methods. Money and labor were here made available to carry out Norcross' transportation plans, Show and Kotok's standards of speed and attack, and build more airplane landing fields for Howard Flint. Cooperation between Federal, State, and private agencies also was pushed ahead in a significant surge. Coincident were funds for greatly expanded research of certain types and better facilities.

But the CCC's brought a surge in methods too, for with that volume and type of labor came both the opportunity and the absolute need of training fire-fighting crews. The man-passing-man, the sector method, the one-lick, and the 40-man shock crew methods of large fire suppression all seem to have been accelerated by the advent of the CCC's.

New ideas not only grow best and can be tested best when you have money and men, but sometimes they are then forced on you. A similar period seems highly probable after the end of the present war. If Hornby's experience is any index of what that means to fire-research men, I hope that we can have our research well under way and not be forced into the 12-hour day and the 8-day week which he worked for 3 years while pressed by availability of CCC money and men.

1934. I have been advised by some of the consultants who helped me prepare this list of mileposts, that fire danger meters should be included. Because of my personal interest in those particular devices, I am automatically disqualified from judging that point. I therefore leave them out.

1935. The so-called "Forester's policy of control by 10 a. m." undoubtedly rates either a milepost or a tombstone on our 35-year road of progress. If and when that policy becomes clearly recognized as a temporary expedient, I believe that it will rate a milepost. If, however, it has become or ever does become the death knell of all previous objectives based on damage, then it rates a tombstone executed in the blackest of black granite. It has already cost us 6 years of attention to variable damage as an objective, but it seems to have

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achieved something else which may have been, at the time, worth more than the little thought which might have been given to damage.

It is futile to open a discussion of that policy here and now. It has such a direct bearing, however, on any fire-research program which we may recommend that the import of its impact deserves serious thought.

First, the 10 a. m. policy, if fully enforced, actually sweeps into the discard all previous standards and objectives of fire control. It specifies the same standard of protection for commercial timber, reproduction, forage, water control, recreation, and wildlife. It demands the same speed of control for timber and sagebrush, goat rocks, and valley bottom site I, white pine plantation and decadent hemlock or hair-on-a-dog-back lodgepole. The letter of May 25, 1935, says: "In these respects it treats all areas on an equal basis."

Second, actually the 10 a. m. policy is not fully enforced. The framers themselves never intended that it should be. It therefore says one thing but means another. It is a monumental piece (not masterpiece) of self-deception. Instead of facing facts, it confuses them. It renders systematic fire-control planning impossible because it says that IF you cannot control the fire by 10 a. m. tomorrow by use of all available resources, you can plan on control by 10 a. m. the next day. If that fails, then you may plan for 10 a. m. the third day. Et cetera, until the rain falls! Which 10 a. m. is the fire-control planner to use? The first for commercial timber and forage, the second for old burn and goat rocks, the third, fourth, or fifth for wildlife forage? Only the first, because "In these respects it treats all areas on an equal basis."

Third, to this amateur historian it appears that the 10 a. m. policy actually had the same objective as the Show and Kotok minimum damage theory of 1923; to wit: Stronger prevention and presuppression action so as to catch fires small rather than stronger suppression action aimed primarily at keeping 10,000-acre fires from becoming 20,000—or 30,000-acre burns. There is a vital and basic difference here which will come out in our discussion of the economics of fire control. But if the main idea of the 10 a. m. policy was to catch fires while small, the use of a time criterion—the 10 a. m. tomorrow—would seem to be open to further investigation. For fires can be caught small and cheaply WITHOUT controlling them by 10 a. m. tomorrow. If one function of research is to assemble and array all the significant facts, it seems more than possible that research might contribute something here.

1936. Hornby's methodical treatment of all the significant features of fire control, especially his weighting of each factor and final integration of all of them, has been approved as a milepost by all of the consultants who have aided me in selecting the events that marked progress. While not new, in that fire-control men have always planned, Hornby systematized that planning, made it so methodical, and incorporated so many new features that all future fire-control planners were greatly aided. That is a milepost of progress.

There is one feature of Hornby's work to which I should like to call your attention. I do not believe that his work has very often been viewed from this angle. When Sparhawk set out to "provide a basis for the proper distribution of protection funds between the different units of the organization"; when he named presence or absence of the causative agencies, cover type, climate and weather, topography, and five factors of controllability as the significant items to measure and integrate, what was he doing that Hornby did not do? Nothing! They were both aiming at the same target. Actually, Sparhawk did little more than set up the target. The records he had to use were so poor that he really had no ammunition. Hornby had far better records and he shot with those as well as with the keen eye of an experienced forest administrator. But he was actually shooting at Sparhawk's target: The proper distribution of protection facilities, hence funds, between different units of the organization.

Both Sparhawk and Hornby likewise turned to the physical conditions on the ground and said to the writers of the Use Book of 1906: "These are the factors that should be considered by each supervisor and by the forester before fixing 'the number for the full summer force of each reserve' and before deciding that 'this allotment will be final.' " They both approached the problem by beginning with the physical conditions on the ground: Sparkhawk said "causative agencies," Hornby said "occurrence rate"; Sparhawk said "cover type, topography, and controllability;" Hornby said "fuel types"; Sparhawk said "climate and weather," Hornby said "measured fire danger," etc., etc. In other words, they both approached their problem from the standpoint of the physical conditions on the ground. They both had the same objective: The proper distribution of protection facilities, but no one gave either man a satisfactory definition of "proper."

The results of many a research project have been determined, and still are determined, before the detailed research begins. The all-powerful determinant is the "approach." Start the problem of distributing facilities or funds on the basis of results attained with past facilities and funds, and you will very probably end up altogether differently than if you approach the same problem from its true beginning—the physical conditions on the ground. Graves named them in 1910, DuBois repeated them in 1914, Sparhawk reasserted them in 1925, Hornby refined them in 1936. Who will be next? And when?

1938. From Hornby's milepost in 1936 to date I cannot find a single event in objectives, methods, or finance that has proved to be of national significance in fire control. I believe that there are three reasons for this. First, in any field of human endeavor, whether it be forest-fire control or the effort to produce a temperature of absolute zero, the nearer you approach your goal the harder it is to take the next step ahead. Second, progress requires men and time to work, and these require funds. Since 1936 funds for all kinds of Forest Service work have been steadily reduced. While we have had additional "relief labor," intellectual progress in objectives and methods of fire control have not been and never will be assisted by ERA and WPA labor. Third, it is difficult to judge the most recent past. Perhaps there have been some steps proposed or taken during the last 5 years which will show up later as milestones of progress.

One recent step, which I believe will be recognized later as a milepost, was taken in Region 1 in 1938 when Sutliff proposed, and Shoemaker and Kelley approved, a uniform, standard relation between current fire danger and the percentage of manpower on duty. Before that, in 1936, for example, when class 4 fire danger prevailed on the Kaniksu Forest that supervisor would have only 23 percent of his total fire force on duty, while under the same class 4 danger the Bitterroot would have 44 percent of its men in place. The spread was even greater when danger became worse and class 5 was reported. Then the Cabinet Forest would have only 41 percent of its force on duty while the Coeur d'Alene would have 81 percent. These are extreme cases. The point is that manpower had not yet been tied to measured fire danger consistently on all forests.[3]

By 1938, however, Sutliff, Crocker, and Hand had 3 or 4 years of records to scrutinize and they did that and more, too. They analyzed. They concluded that if Hornby's principles of planning had been properly applied so that the total manpower on each forest had been properly adjusted to all the significant factors—area protected, causative agencies, fuel types, detection coverage, smoke-chaser coverage, crew attack, etc.—then when class 4 danger occurred on a forest that supervisor should put on the same *percentage* of his total manpower as any other forest experiencing the same danger.

The chart called table X–1–c in the Region 1 fire plan, which has been used in this region since 1938, is the final result of this analysis. While Sutliff himself admits that efficiency can be improved by certain small changes in the shape of this curve, this standard relation for 10 forests in Region 1 has for 4 years done for current fire danger exactly what Hornby's systematic planning did for average bad danger. Hornby's method says that when the permanent factors of danger are thus and so, the following list of stations and facilities must be *available* for occupancy and use. Sutliff's table X–1–c says that when the variable factors of danger are thus and so, the following percentage of those stations will be occupied. Two, clear-cut, logical steps, both essential to adequate fire control at least possible cost.

To my knowledge this standardization of fire control practices on several national forests was first achieved by Sutliff's table X–1–c in 1938. In 1958, when all forests have planned alike, when all are provided with facilities according to uniform consideration of the same factors, and all are manned alike according to uniformly measured danger, Sutliff's method of correlating manpower and fire danger may be judged as a milepost of progress. The possibility is sufficiently great to justify the shadow or outline of this most recent milepost.

While this concludes the list of definite and datable events which I rate, now, as milestones of progress, there has been one other type of progress which must not be ignored. This type is difficult to name and impossible to date. It is illustrated by Kelley's "Fire Code" for the Eastern Forest Region issued in 1926, and by Head-

[3] The writer has subsequently been informed that H. M. Shank had established a standard relationship and was using it on Region 4 forests previous to 1938. H. T. G.

ley's "Fire Control as an Executive Problem," mimeographed in 1928. It is illustrated by the drive to "calculate the probabilities" contained in the forester's 10 a. m. policy of 1935 (which is the best part of that policy). It is the concept that fire control is a tremendously complicated job, but one which is susceptible to orderly dispatch if the man uses his head, looks at all the factors and facilities, forms correct conclusions, and then takes action. To me it seems that this particular phase of the fire problem began when the forest reserves were created in 1904, has become increasingly important since then, and will never end. Progress has been steady, but I cannot name any particular event that stands out like a national milepost.

I am purposefully not saying anything about "regulation" as a milepost in the progress of fire control, although that idea, and especially the recent action concerning it, are certain to exert a tremendous effect in the future.

Conclusion

If this summary of some of the history of fire control appears to be primarily an attempt to pass judgment on history, then I have failed in my main purpose. My real purpose was to collect, select, and relate enough of the major events of fire control during the past 35 years so that we would have a reasonably dependable background or stage for this Priest River meeting. It may be significant that 19 of the mileposts mark progress in methods, 14 are achievements in understanding our own objectives, while only 10 major steps are evident in finances. One might question whether this shows knowledge ahead of practice, or finance retarding application.

I have tried also to assemble the "framework of ideas" within which we are trying to work out our problem, to see the problem as a whole in the light of past accomplishments. My viewpoint or "position toward this field of facts," as Pitkin calls it, is naturally influenced and perhaps controlled by my own personal experiences to date. I cannot help that, but I admit that mine is not the only viewpoint. Others undoubtedly see this field of fact from a different viewpoint. I know that I would benefit by having them do for me this same job that I have tried to do for them: review the field and tell me how it looks to them. We have done altogether too little of that in the past 20 years, and our failure has consituted a serious weakness in our work. I am convinced that many of our present disagreements would disappear if we could get together and look together at the whole valley from each of the several admittedly different vista points. And I am convinced that we here at Priest River cannot expect to lay out a sound fire research program unless we keep in mind the major events which constitute the history of our particular line of work.

SCIENCE SERVICE FEATURES PREVENTION PROJECTS

In November, Science Service, the "Institution for the Popularization of Science," Washington, D. C., sent to the subscribers of its "THINGS of science" educational service all the material items incorporated in the "fag bag" and "superstition" fire prevention projects, and features these Forest Service undertakings as "the most widespread experiment in applied psychology ever conducted in the interest of all the American people."

"THINGS of science" lists among its 5,500 subscribers mainly educators, students, and laymen with a particular interest in science, and is sponsored and distributed by subscription but without profit by Science Service in much the same way as is the SCIENCE NEWS LETTER with which many readers of Fire Control Notes are familiar.

The purpose of "THINGS of service" is to teach by circularizing disassociated individuals with actual "things" having to do with various scientific subjects—things which can be felt and seen—thereby making the projects more near, real, and understandable.

Packets are made up and distributed as the projects present themselves and the materials become available—on as near a regular monthly schedule as possible. Each packet of "things" is called a "unit" and is accompanied by a popularized letter of explanation. The letter names and gives the necessary background of the particular project involved; names, describes, and explains the use of each "thing" or item included; and usually, but not always, suggests methods of teaching or experiments for testing the effectiveness of the material.

In the case of the "Fire Psychology Unit," as the November fire prevention "THINGS of science" packet was called, the letter itself, which follows, is self-explanatory.

Fire Psychology Unit

This fire psychology unit consists of one cloth bag with tag and enclosed note, a button badge, three posters, two museum-type display cards and these sheets of information.

These are the materials for the most widespread experiment in applied psychology ever conducted in the interest of all the American people.

Pin the button badge on your coat lapel and you immediately take an active part in this Nation-wide experiment designed to save the Nation from the annual tragedy of more than 50,000 man-set forest fires on protected lands which destroy acre upon acre of valuable timber and millions of living creatures.

Forest fire fighters have an old saying that you must "Fight fire with fire." They set a back-fire, using the "scorched earth" defense against the spreading invasion of this universal foe.

Psychologists are following just about the same technique when they circulate buttons with the slogan "It's BAD LUCK to start a forest fire."

For superstition, folkways, and something deep-rooted in the customs of the people that is almost akin to fire-worship are believed to have their part in causing men to burn the woods each year.

Nine out of ten of the great forest fires of the Southland, which run free over miles of woods, are set by human hands—most of them deliberately.

The people in that region will tell you that the woods are burned to kill snakes, to keep down the ticks, to destroy boll weevils. But the answer lies much deeper.

The Button

With the button which you have in this unit of THINGS, the hope is to deliberately start a superstition to fight the superstitions of fire setters.

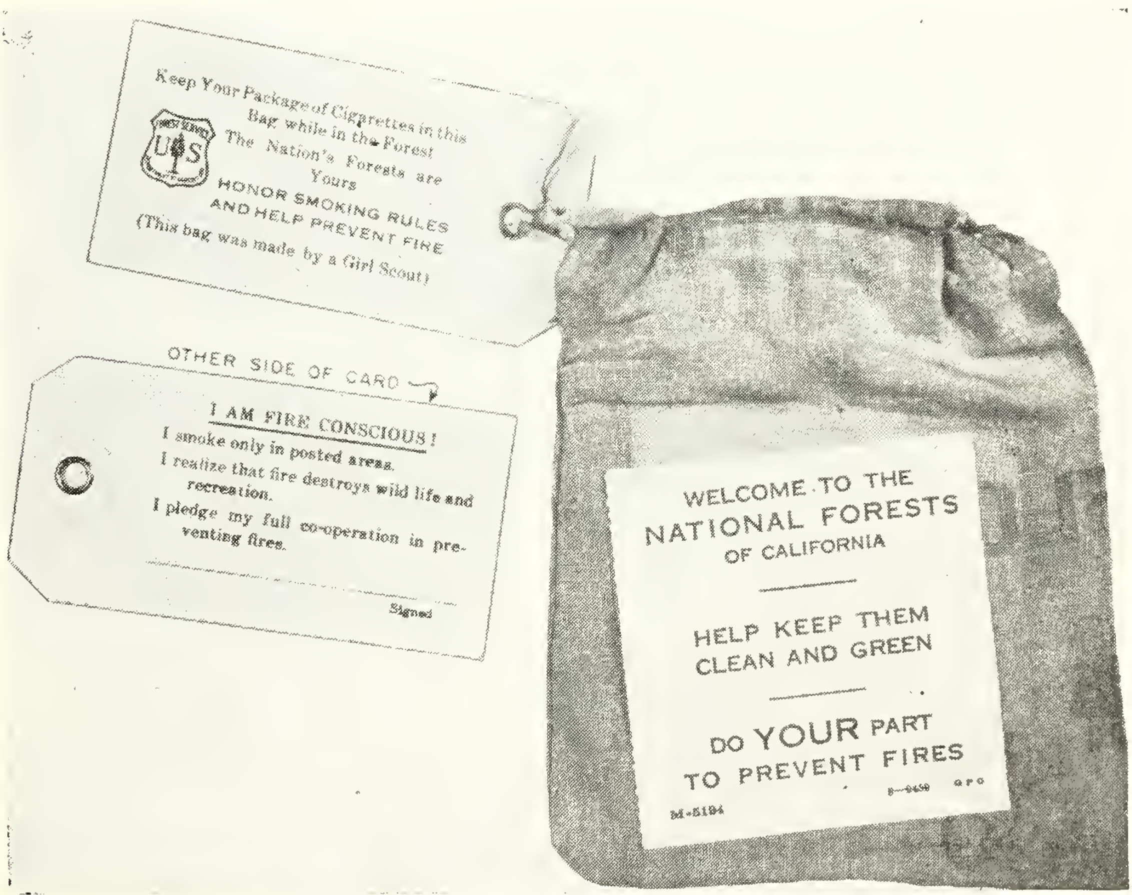
Such a plan has a precedent in the very well known three-on-a-match superstition. Many people who pass along the saying that it is "bad luck to light three cigarettes on one match" do not realize that this bit of folklore is camparatively modern. A credible story of its origin is that it dates back no further than the trench warfare of the first world war. At night up in the front lines, if you held a lighted match long enough to light three cigarettes, it was also long enough for the enemy to take his aim and fire. It was very bad luck indeed.

Whether the superstition was started deliberately for the protection of the doughboys, or whether it spread naturally, based on observation of what happened to the holder of a match kept flaming, it served effectively the same sort of purpose that Uncle Sam's forest fire-fighting forces hope to achieve in their fire-fighting psychological experiment.

Drawback to the experiment is that superstitions—whether they serve a useful purpose or not—are evil things. They can never serve as an adequate substitute for sound knowledge and enlightenment. Psychologists would be the first to assure you of that. But these men who know the workings of the human mind realize that superstitions do have an appeal that is almost universal. They are easily remembered. They work.

The Fag Bag

The cloth bag in this unit of THINGS is also being used in the great fire-fighting experiment in applied psychology. But this psychological tool is intended to make people think. Its purpose is to break up the mechanical, automatic behavior of long habit.



Fag bag F-416478

When a smoker enters a national forest, he will receive one of the fag bags with a pledge card attached. Not only does the smoker sign the pledge to be "fire conscious," but he puts his package of cigarettes into the bag and pulls up the drawstring.

Then when he reaches for a smoke, he cannot light up thoughtlessly. The flame-red bag and its drawstring are reminders of the hazard of a careless smoke, a dropped match, a discarded glowing stub.

Psychological value of the reminder is in the timing. It comes at exactly the right moment to be most effective.

The fag bag also serves indirectly to educate the public in regard to fire dangers, through the children. The bag you have in this unit of THINGS was made by a Girl Scout. Girl Scouts made all the other fag bags used in this great fire-fighting experiment. The material for your fag bag was collected by California school children who held a "Fag Bag Day." On that day they gathered in all the sugar, salt, and flour sacks they could collect for this purpose.

You, too, can contribute by sending any such cloth sacks you may have to the nearest United States Forest Service office. It tells how on the letter to you from William V. Mendenhall, forest supervisor of the Angeles National Forest, that you will find tucked into your fag bag.

The school children who gathered the sugar sacks, the Girl Scouts who made them into fag bags, and the smokers who use them to keep cigarettes in are all made fire conscious by this experiment.

The Posters

In making use of very modern psychological devices for changing the habits of careless smokers in the forests and of men and women who have learned to follow ignorantly the generations-old tradition of burning the woods, Uncle Sam's forest fire fighters are not neglecting the older psychology of advertising.

Effective teaching through "eye appeal" is demonstrated by the posters in this unit of THINGS. Notice that each contains a dramatic painting by the well-loved illustrator, James Montgomery Flagg. Each contains a brief, compelling slogan—"Forest Defense Is National Defense," "Yours in Trust," "Your Forest—Your Fault—Your Loss." Each carries the same easily learned lesson on fire prevention in the form of nine short rules.

The Forest Service welcomes the cooperation of many organizations, companies, and agencies in their campaign of fire prevention. Psychologists know that the most effective way to learn a lesson is to take part in teaching it. One of these posters you have was carried as a full-page illustration in the American Weekly. Another poster, not in your collection, was carried in the advertising of the Texas Oil Co.

The National Fire Protection Association, various religious and fraternal organizations, the American Legion, the Boy Scouts, the Post Office Department, and the Western Union and Postal Telegraph companies are among the organizations that have joined in distributing and posting these educational posters. They are placed in post offices, schools, hotel lobbies, meeting places, and show windows.

Experiments

1. You can try this experiment on one person—perhaps yourself—but it will be more fun and more interesting scientifically if you use a group as your subjects. Have each individual follow this procedure: First, he should read the button and wear it for, say, 10 minutes. Then he should copy and sign the pledge card on the fag bag. Then he should read and study the slogan and fire-prevention rules on one of the posters. Allow about 5 minutes for this. Now take away all the materials and have him write: (1) The pledge, (2) the slogan on the button, (3) the slogan on the poster, (4) a description of the picture on the poster, and (5) as many of the fire-prevention rules on the poster as he can remember. Vary the order of the material studied and the recall for the different persons you test. This is to avoid "loading" the experiment in favor of the material studied first or last or that which it is attempted to recall first.

(Continued on page 69)

RANDOM NEWS NOTES FROM THE FOREST SERVICE RADIO LABORATORY

H. K. Lawson

Associate Radio Engineer, Region 6, U. S. Forest Service

The Radio Laboratory has a variety of new equipment and improvements to report which should be of interest to those associated with protection and suppression communication.

The type SX radiophone, superseding the type S, has been completed and 290 sets have been produced and are being distributed to the field. The type SX transmitter, being crystal-controlled, opens the way to improved reliability in ultra-high frequency communication networks and makes possible the successful inclusion of automatic relay equipment in such networks. The type SX can be operated on any one of three crystal-controlled frequencies merely by turning a switch on the panel of the set. The inclusion of three transmitting frequencies permits setting up one channel for local district communication, one for adjacent district or forest or regional fire communication, and one for automatic relay contact, or in any other combination desired.

An attachment, which has been designated as type SXA, provides loudspeaker stand-by service. Where it is desired to use the SX as a station or lookout-communication unit, the attachment can be plugged into the SX and a loudspeaker is then available for stand-by or for off-schedule calls.

This combination of SX and SXA provides the same service facilities as the type SV radiophone which has been discontinued. No tools are required to separate the two units and the SX can be prepared for strictly portable service in less than a half minute. In portable form the SX weighs 10 pounds.

When an SX is ordered with SXA attachment the two units are supplied in a wood kitbox. The box has storage space for heavy-duty batteries necessary for stand-by service and is equipped with heavy-duty battery cable and semipermanent type antenna.

The subject of automatic radio relaying and the purpose and possibilities of such systems was discussed under Random News Notes from the Forest Service Radio Laboratory in the October 1939 and January 1940 issues of Fire Control Notes. Two field installations were put in service in Region 5 during the past season. One relay, an A. C. operated unit, was installed on Mount Diablo, Calif., and was commissioned to provide direct communication between the fire weather office at Mills Field, San Francisco, and reporting stations on 7 different forests. The shortest path between relay and field station was approximately 75 miles and the longest about 210 miles. Aside from an hourly shifting in signal level ranging from weak to moderately strong on the 210-mile path and on one circuit of about 165 miles the performance of this installation has been extremely gratifying.

A dry-battery operated relay installed on Grey Butte, Shasta National Forest, has further proved the possibilities of the general application of radio relaying. Tests just concluded indicate that a new circuit and system of control, devised since the Grey Butte installation, has completely eliminated the problem of normal battery voltage drop during use. It is hoped that a representative number of these relays will be put into service during 1942 to acquaint the field with the enlarged communication possibilities resulting from inclusion of this new equipment.

A new ultra-high frequency antenna for tower and other permanent antenna installations has been designed and tested. The new antenna to be known as the type PD will produce almost a 2-to-1 increase in equipment performance as compared to the type J described in the Radio Handbook. Detailed drawings of this antenna have been processed and distributed to holders of the Radio Handbook.

A development of which the laboratory group is justly proud is the new type KU–R ultra high frequency mobile radio receiver. Intensive use of 2-way ultra-high frequency communication in cars and trucks has awaited development of a receiver that would discriminate against traffic-ignition interference while providing high sensitivity for weak signals.

The much-publicized system of Frequency modulation (FM) provides this noise-free service, but there are two very important facts that rule out its application to Forest Service problems. First, the Forest Service already has approximately 2,000 ultra-high frequency radiophones, all amplitude modulated (AM) and all serving a useful purpose in communication. It would be impossible to justify a complete change-over to the new system merely to provide a more ideal mobile communication system where, incidentally, the only major improvement in service would result. Second, frequency modulation technique has not advanced sufficiently far to date to permit the production of portable units that can compete with equipment such as the SX in size, weight, and over-all low power consumption.

The new type KU–R receiver so effectively minimizes ignition interference that we can now say that reliable equipment is available for all normal forestry mobile communication problems where ultra-high frequency is desired. Provision is made in the receiver to permit tuning to any frequency in the range of 30.5 to 40 megacycles as well as for crystal-controlled spot-frequency stand-by operation. Crystal-controlled spot-frequency stand-by assures that the receiver will always be on the principal operating channel without necessity of intermittent correction of the tuning dial.

Two types of ultra-high-frequency mobile transmitters are available. One, known as the type KU–T, operates on a single frequency only and has a power output of approximately 8 watts. The other transmitter, known as the type KU–T2, is a two-frequency unit having a power output of approximately 4½ watts. Either of the two frequencies in the KU–T2 are instantly available by manipulation of a single panel control. The two-frequency unit will undoubtedly find wide application in communication systems involving automatic relays where only frequency can be used for relaying and the other for local network operation.

Since we have mentioned two transmitters, one having a power output 1.77 times that of the other, it seems that this is an excellent opportunity to correct a general misunderstanding as to the effect of doubling the power of a transmitter. For the case at hand, if we assume that a certain arbitrary strength of signal is received at a distance of 31 miles from the 4½-watt transmitter then the 8-watt transmitter will deliver the same strength of signal at only 34 miles—not 55 miles as is often assumed on the basis of a multiplying factor of 1.77 times. This comparison assumes only that the antenna heights remain the same and that there is no radical change in topography in the two cases. The distances indicated in the example are not the maximum working range of the KZ series of transmitters, but serve merely to indicate the comparative coverage to be expected from the 4½- and 8-watt units.

SCIENCE SERVICE FEATURES PREVENTION PROJECTS

(Continued from page 66)

Notice which sort of material is remembered correctly by the greatest number. Can you tell why?

2. Invent a psychological device using the same principle as that of the fag bag to break a bad habit in your own home or community. Remember that timeliness is a key to the effectiveness of this habit-breaker. Here are some suggestions to start your thinking: Want to stop leaving lights burning when you go out of a room?—A light-weight card without sharp corners suspended in the doorway where it must bump your face as you leave the room might be effective reminder until you form the habit of reaching for the switch. Want to form the habit of studying?—Arrange the lighting in your room so that when you push your light switch only your desk and an open book on it is illuminated. (This is not recommended illumination for reading, only as a forceful reminder of your work.) Is scattering of litter on the streets a problem in your town?—Where would you place trash receptacles?—How would you mark them?—Is jay-walking a menace to traffic?—How and where would you warn pedestrians of this danger?

3. If you like a quiz, here is a question to try on your friends: Which of the following are superstitions?—(1) when you see smoke from a woods, you should make a wish, (2) you should break a burnt match twice before you throw it away, (3) a campfire should be built in a hole, (4) woods should always be burned in the autumn to clear the ground—Answer: (1) and (4). Which are useful rules?—Answer: (2) and (3).

A NEW TYPE OF FIRE EQUIPMENT IN MICHIGAN

GILBERT STEWART

Roscommon Experiment Station, Michigan Department of Conservation

When using water in fire suppression, hand-operated pack-sack water pumps carried by individual men permit extreme mobility, quick attack, and ease of operation, but necessary refiles involve delay. Tank equipment with guaranteed delivery of larger volumes of water is less mobile and slower in attack. The author describes a new water tank-pump-trailer assembly used in Michigan which was designed to include the favorable qualities of both hand pumps and tank equipment.

For the past decade, specialized classes of mechanical equipment have been adapted to every possible phase of forest-fire suppression. In order to increase combat power of fire organizations, manual methods of attack have been supplemented by mechanical means wherever they have been applicable. There are very definite reasons for this. After fire starts, the amount of physical work which must be done, within a short time, is tremenduous. It becomes necessary to stop running fronts, and the entire fire area must be confined as quickly as possible. To do this, barriers must be constructed, immense quantities of fuel may have to be moved, and backfires may have to be set and held at correct places and at proper times. After these tasks are accomplished, there still remains the important work of mop-up and patrol.

All forest-fire agencies have to be organized and equipped to meet these hazardous conditions which constitute the extreme. Under such circumstances, the usefulness of proper machines is very great. Manpower can be conserved, organization simplified, greater flexibility in the assignment of forces realized, and the power of each individual increased, simply because much of the arduous work can be assigned to mechanical equipment.

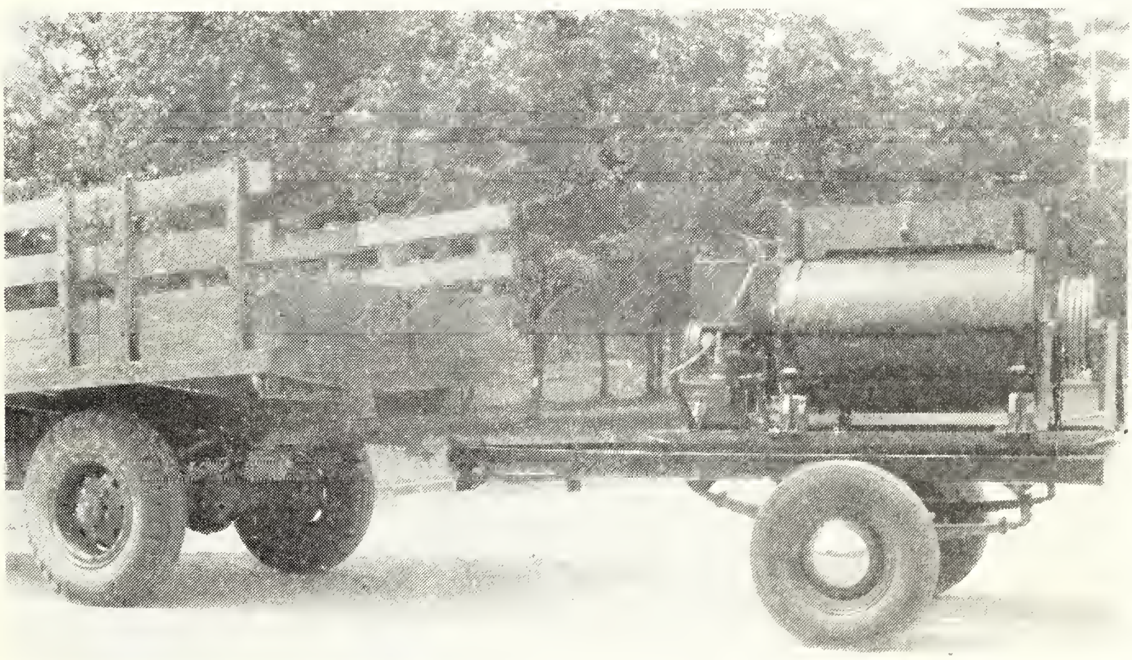
Disastrous results may develop, however, if mechanical equipment is improperly assigned or if incorrect types are employed. It therefore becomes necessary to provide organizations with a variety of equipment. In Michigan, the assignment of mechanical equipment has become extensive, and within the past year, specialized types of tank units have been perfected for issue to the field personnel of the Department of Conservation. Up to the present time, tank equipment has not been widely used, because correct types have not been developed to meet the requirements of Michigon forest conditions.

The New Equipment

The term "booster unit" has been applied to tank equipment for a long time. Such machines have been used in forest regions for a number of years, especially in certain portions of the West where no other type of power equipment found ready acceptance. In most cases, these have been special tank units transported by trucks completely equipped for that particular purpose. Sole dependence could not be placed on machines of this kind for average duty in Michigan because great areas of hazardous character cannot be reached by truck. Additional means of transportation must be provided, which implies trailer mounting suitable for attachment to any truck, pick-up truck, car, or tractor.

A type of tank equipment has been developed at the Michigan Forest Fire Experiment Station which fulfills the requirements of field assignment in this region. Experience had proved that water-pumping equipment could be used with great success in Michigan, where water normally is readily accessible. However, pumping units were restricted to hand-operated pack-sack pumps to do heavy-duty stationary machines. The pack-sack pumps, carried readily by one man, permitted extreme mobility, rapidity of attack, and ease of operation. The working time is relatively short, however, and frequent refills are absolutely necessary to maintain high efficiency on running fire. Power-pumping equipment guarantees the delivery of large volumes of water at any desired point; but fast attack is not usually possible, and there is absolutely no mobility while in use, except as hose line can be shifted.

Analysis of field requirements indicated that a third class of machine was greatly needed. The chief requirements were extreme mobility, long working time, moderate capacity, and the reliability of power delivery of water under high pressure. A unit of this kind would incorporate all the advantages of back pumps in terms of mobility and greatly increase the quantity of water carried in one mobile outfit. The weight and bulk involved, however, would take the machine completely out of the class of manually operated equipments consist of a tank assembly, complete with self-contained power pump would guarantee all the advantages of mechanical pumping without robbing the unit of mobility or restricting it to stationary duty.



MICHIGAN DEPARTMENT OF CONSERVATION

Water tank and pump assembly mounting on special trailer pulled by truck.

The machine which has been built in accordance with the requirements consist of a tank assembly, complete with self-contained power pump, tool box, and hose reel. The entire outfit is attached to a sled-like base, and the assembly is one complete unit; all pipe lines and hose lines are permanent and ready for instant use. Inasmuch as the unit is completely self-contained, it may be transported by any truck, pick-up truck, or trailer, which eliminates the necessity for a special truck.

MICHIGAN DEPARTMENT OF CONSERVATION

Water-tank machine, pulled by tractor, in operation on fire line.

A special trailer is a standard part of the outfit, but its use is optional. Trailer transportation, however, permits extreme flexibility in field assignment, and tractors may transport the outfit over rugged terrain and into isolated places where truck transportation would be impossible. Practically all portions of fire fronts may be reached with tractor-trailer transportation.

Actually, the assembly of self-contained tank units is not particularly new. The specialized design and the features which have been incorporated in the new equipment, however, make it particularly adaptable for woods work. The entire unit is 6½ feet long, 30 inches wide, and 40 inches high. The tank capacity is 110 gallons. The complete pumping unit is manufactured by the Novo Engine Co., and its capacity is 5 gallons per minute with a pressure range up to 300 pounds. Power is provided by a 2-horsepower motor, and 2 pumps are driven by it. In addition to the reciprocating pressure pump, an auxiliary centrifugal pump is used for purposes of filling the tank only. These 2 pumps are used at different times: the pressure pump is employed for fire fighting only, and the centrifugal pump for refilling the tank. A selective clutch permits disengagement of the auxiliary pump—but the latter is primed by the pressure pump by a special arrangement of hose lines and valves connecting them.

Starting with a full tank, the average working time is about 1 hour 20 minutes. In actual service, water is seldom discharged continuously. This necessitates the installation of a bypass on the pressure pump, which permits water to pass from the pump back into the tank or intake line when the nozzle is closed and eliminates the necessity of stopping both pump and motor when water is not to be discharged.

Ordinary high-pressure hose may be used, size ½ inch and 75 feet long. A special nozzle gun completes the hose assembly. This is a spray gun with a shut-off valve in the handle, by means of which the discharge or stoppage of water is under the immediate control of the operator. The bypass and nozzle gun are features which greatly increase the convenience, usefulness, and efficiency of the entire outfit. Without them, water would be continuously discharged with great waste, unless the pumping unit were stopped very frequently. As it is, the unit can be transported along a fire front with the motor and pump in operation and water discharged only when necessary.

Convenience in operation is provided by a fully equipped tool and accessory box mounted permanently over the tank, so arranged that every spare part and tool has one particular space. A full kit of necessary tools is included, together with a variety of spare nozzles, spray head with a selection of disks, gaskets, foot valve, spare fuel, and oil. Full instructions for operation and care are framed in the lid.

All tractors, trucks, and cars used by the department are equipped with standard interchangeable trailer hitches so that transportation is guaranteed by all of these classes of equipment.

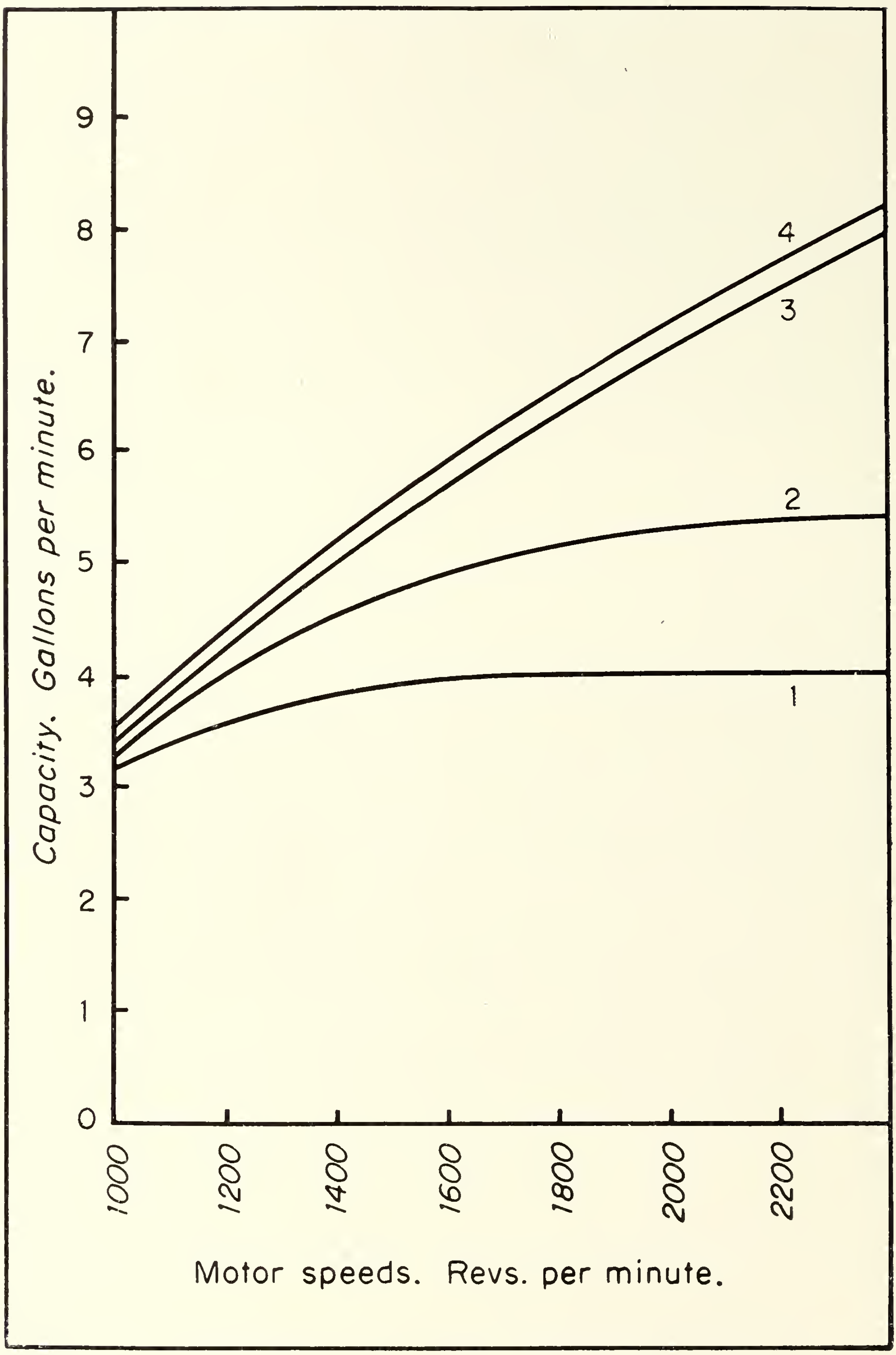
Performance Ratings

Carefully controlled tests conducted at the Experiment Station have determined the capabilities of the pumping unit with which these machines are outfitted. Tables 1 to 4 contain the data assembled from these rating tests.

TABLE 1.—*Performance rating of the Novo pressure pump, Model AU—Capacities developed when operated over a full range of speeds, and when using different sizes of nozzle equipment*

Motor speed (revolutions per minute)	Size of nozzles				Motor speed (revolutions per minute)	Size of nozzles			
	3/32 inch	1/8 inch	3/16 inch	1/4 inch		3/32 inch	1/8 inch	3/16 inch	1/4 inch
	Gallons per minute	*Gallons per minute*	*Gallons per minute*	*Gallons per minute*		*Gallons per minute*	*Gallons per minute*	*Gallons per minute*	*Gallons per minute*
1,000	3.2	3.3	3.43	3.5	1,800	4.0	5.2	6.4	6.58
1,100	3.4	3.75	3.86	3.95	1,900	4.0	5.25	6.7	6.88
1,200	3.6	4.1	4.3	4.38	2,000	4.0	5.3	6.95	7.15
1,300	3.75	4.4	4.7	4.8	2,100	4.0	5.33	7.25	7.42
1,400	3.85	4.65	5.05	5.18	2,200	4.0	5.35	7.5	7.68
1,500	3.9	4.83	5.42	5.58	2,300	4.0	5.38	7.75	7.9
1,600	3.96	5.0	5.75	5.92	2,400	4.0	5.4	7.95	8.1
1,700	4.0	5.1	6.1	6.28					

Governed motor speed is 1,200 revolutions per minute. The pump operates at one-tenth of the speed of the motor.



Capacities obtainable with the Novo pressure pump, Model AU, when equipped for booster duty. Curve 1, 3/32-inch nozzle; curve 2, 1/8-inch nozzle; curve 3, 3/16-inch nozzle; curve 4, 1/4-inch nozzle.

TABLE 2.—*Performance rating of the Novo pressure pump, Model AU—Pump pressures developed when the unit is operated over a full range of speeds, and when using different sizes of nozzle equipment*

Motor speeds (revolutions per minute)	Sizes of nozzles				Motor speeds (revolutions per minute)	Sizes of nozzles			
	3/32 inch	1/8 inch	3/16 inch	1/4 inch		3/32 inch	1/8 inch	3/16 inch	1/4 inch
	Pump pressure—Pounds per square inch					Pump pressure—Pounds per square inch			
1,000	250	175	60	50	1,800	300	300	195	150
1,100	275	217	78	62	1,900	300	399	211	163
1,200	300	246	96	75	2,000	300	300	226	175
1,300	300	275	113	87	2,100	300	300	241	187
1,400	300	300	131	100	2,200	300	300	256	200
1,500	300	300	147	112	2,300	300	300	271	212
1,600	300	300	163	125	2,400	300	300	285	224
1,700	300	300	180	138					

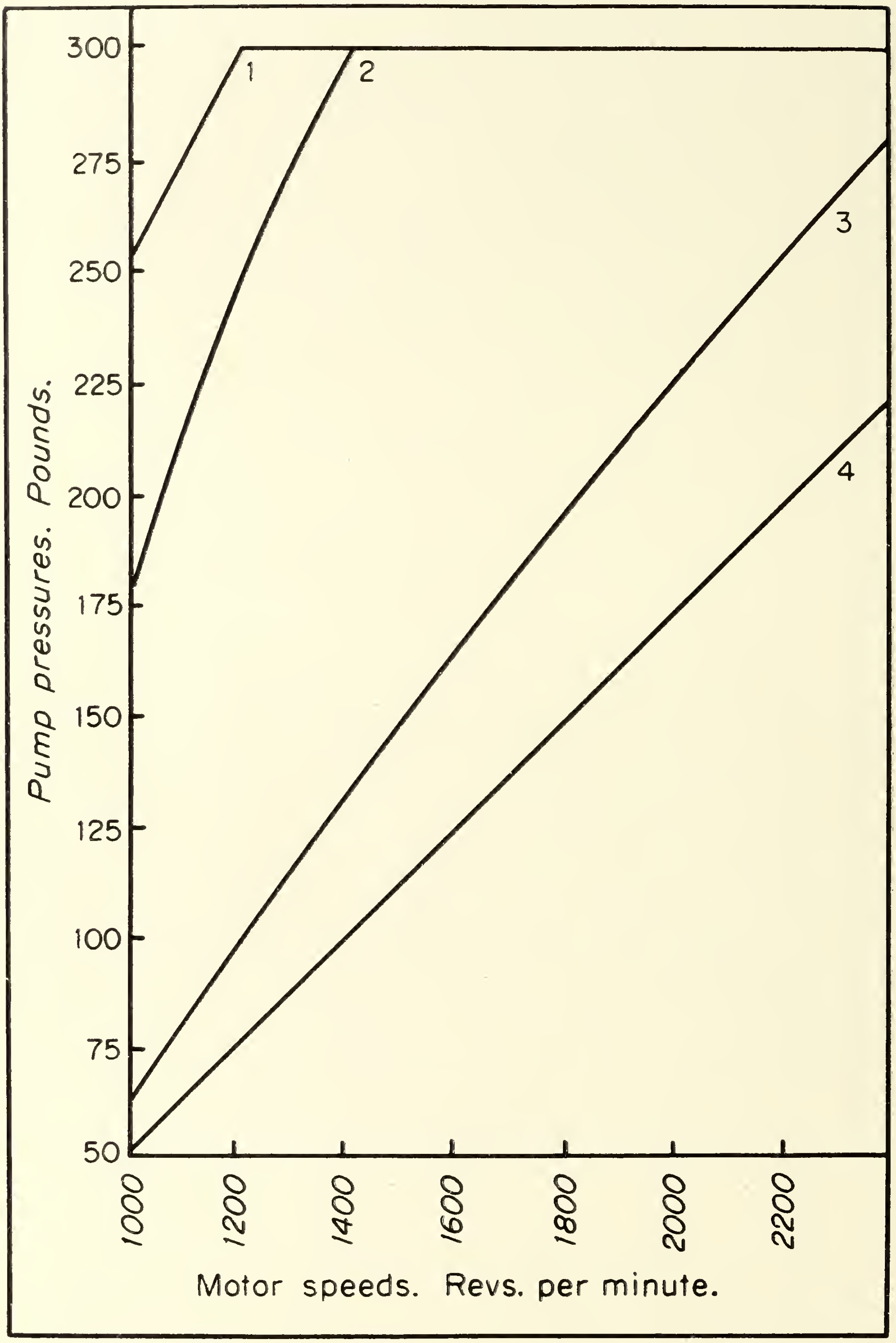
The bypass valve on this particular unit was set at 300 pounds. Normal setting is 275 pounds. Pressures higher than the valve setting are impossible to develop. Water passing through the bypass valve returns to the intake line. Governed motor speed is 1,200 revolutions per minute.

TABLE 3.—*Performance rating of the Novo pressure pump, Model AU—Remaining nozzle pressure available for fire suppression, when the pump is operated over a full range of speeds, and when using different sizes of nozzle equipment*

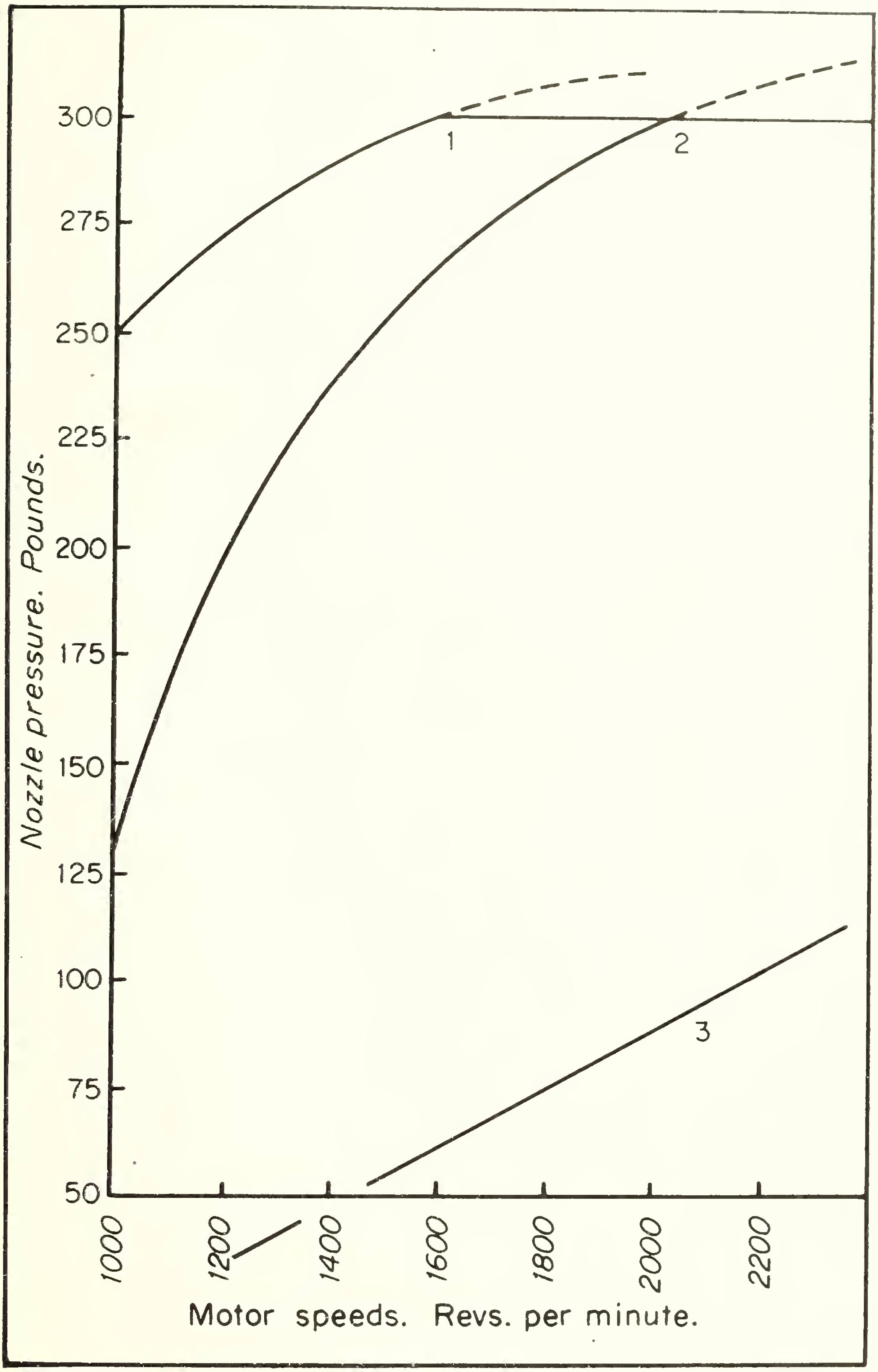
Motor speeds (revolutions per minute)	Size of nozzles				Motor speeds (revolutions per minute)	Sizes of nozzles			
	3/32 inch	1/8 inch	3/16 inch	1/4 inch		3/32 inch	1/8 inch	3/16 inch	1/4 inch
	Nozzle pressure—Pounds per square inch					Nozzle pressure—Pounds per square inch			
1,000	250	130	21	1	1,800	300	287	75	7
1,100	265	165	28	1	1,900	300	294	83	8
1,200	274	195	35	2	2,000	300	300	90	9
1,300	283	217	41	3	2,100	300	300	96	10
1,400	290	237	48	4	2,200	300	300	103	11
1,500	295	255	55	4	2,300	300	300	110	12
1,600	300	268	63	5	2,400	300	300	116	13
1,700	300	280	69	6					

TABLE 4.—*Road test under actual field conditions, showing the performance of the machine in terms of road mileage with constant water delivery; working time; capacities and pressures developed with standard types of hose equipment and when the motor is operated at the proper governed speed of 1,200 revolutions per minute*

Nozzle type	Size of orifice	Capacity	Pump pressure	Road mileage	Working time	Car speed	Remarks
	Inch	*Gallons per minute*	*Pounds*	*Miles*	*Minutes*	*Miles per hour*	
Spray disk	3 1/32	1.42	300	4.6	69½	3–4	3-way spray head.
Do	7/64	3.75	300	1.8	27½	3–4	Single spray disk.
Straight	7/64	4.25	275	1.8	26¼	3–4	Good stream; grass, brush.
Do	3/32	3.6	300	1.9	32⅔	3–4	Do.
Do	1/8	4.1	246	1.45	27½	3–4	Fair stream; grass, brush.
Do	5/32	4.3	150	1.8	24½	4–5	Too little pressure.
Do	3/16	4.7	100	1.6	23⅗	3–4	Do.



Pump pressures obtainable with the Novo pressure pump, Model AU, when equipped for booster duty—Curve 1, 3/32-inch nozzle; curve 2, 1/8-inch nozzle; curve 3, 3/16-inch nozzle; curve 4, 1/4-inch nozzle.



Remaining nozzle pressures available for fire suppression with the Novo pressure pump, Model AU—Curve 1, 3/32-inch nozzle; curve 2, 1/8-inch nozzle; curve 3, 3/16-inch nozzle.

It is obvious that a selection of nozzle equipment is available, and a choice can be made depending on the requirements of the work to be done. Those requirements cannot be established by rule; efficient use of the outfit depends largely upon the experience and training of the fire officers using it. However, some generalization is permissible. Spray nozzles can be used very successfully with high pressures; they are effective on grass fires and other light types of fuel where close approach is permissible. Dense, foglike jets are produced, especially by the multiple-head nozzles, which appear to have a deadening effect far out of proportion to the quantity of water discharged. In all probability a smothering effect is produced, in addition to the drowning action of the water itself.

Sharp, cutting streams are produced by the standard straight nozzles. They are effective at distances up to 30 feet and are used with good results on hot types of fuel which do not permit close approach. Because of the high pressures developed, they derive much of their effectiveness from striking force, in addition to the wetting and cooling action of the water itself. In suppressing fire, given quantities of water are always more efficient when delivered at high pressure, which is especially desirable in small-capacity power pumps. Pressures of less than 150 pounds should not be used for booster duty; pressures of 200 to 250 pounds produce really effective results, and nozzle equipment must be selected accordingly.

Organization and Field Assignment

The real value of new developments in mechanical equipment is never measured solely by laboratory rating tests. Success or failure is determined by actual use in fire suppression. Many different classes of machines have proved successful simply because they have eliminated tremendous amounts of physical labor. Devices which simplify and make organization flexible are extremely useful, particularly when manpower is scarce. Small booster units because of their performance, promise to be especially successful in Michigan. Considering the fact that each unit has a tank capacity of 110 gallons, they are equal to 22 men equipped with pack-sack pumps as far as actual quantity of water is concerned. When transported by truck or trailer, they are exceedingly mobile, and guarantee fast attack and considerable combat power while fires are small. Even on large fires which grow beyond their capacity, these small outfits fill important places in the organization. Under present-day conditions, many fires occur by roadsides or are stopped at roadsides, and one booster unit can undertake the fast patrol of miles of such fire front, thereby freeing many men for assignment along other portions where automotive travel is difficult or impossible. Backfires, or burning-out fires, are usually set at some barrier such as roadside or firebreak, and this work proceeds with great rapidity with the aid of booster equipment.

Irrespective of roads, few places are too isolated to be reached by booster equipment hauled on trailers behind tractors. In fact, this type of assignment promises to increase the usefulness of tractors on fire location.

MICHIGAN DEPARTMENT OF CONSERVATION

Water-tank machine pulled by tractor cross-country through forest en route to fire.

It frequently happens that tractors are removed from duty after adequate fire lines have been constructed, because they are one-purpose machines and no additional work can be done with them. If booster equipment is available, however, tractors can be assigned to patrol duty along all fronts, and the tank unit can be trailed to any desired location for holding backfires and mopping-up portions of fire line that have been successfully held. In this particular phase of work, tank units will probably never completely replace well organized foot crews, but their value can hardly be overestimated in increased combat strength and flexibility of organization that may be gained through their use. Their aid in mop-up and patrol is effective on any fire, especially when crews are exhausted from previous work. Present-day assignment of tractor equipment is for the single purpose of fire line construction. As sufficient tank equipment becomes available, its use will be extended; transportation of booster equipment on trailers by tractors will be considered a function of these machines, equally as important as the drawing of plows.

Disadvantages of Tank Equipment

Certain field conditions tend to reduce greatly the usefulness of booster machines. Of necessity, they must possess considerable bulk and weight. Absence of passable roads, thick cover, rough terrain, and scarcity of surface water for refills are factors which place booster machines at a disadvantage. Like all power equipment, they are not adaptable everywhere, and in localities where adverse conditions exist, considerable care must be exercised in their assignment. Fire organizations, therefore, must be familiar with the situation throughout each district and govern the assignment of tank equipment accordingly. This must be done with all other classes of power equipment, however, and entails no redrafting of fire plans.

Probable Use of Tank Equipment

Throughout most of the forested areas of Michigan, many miles of roads and firebreaks have been constructed during the past 5 years. Moreover hundreds of miles of sand trails have been used for years by fire organizations. These conditions favor the extensive use of tank units because large areas of wild land can be reached by them. They may be dispatched speedily with a crew of 2 men in charge, and permit fast attack on roadside fires with the water carrying capacity equivalent to that of 22 men. In view of the progress being made in the use of cheap chemicals, it is probable that booster units will be the means of handling them on fire location. Whether or not full dependence will be placed on small units of 110 to 150 gallons capacity cannot be predicted. Water is so useful on fire location that larger units are almost sure to be employed, in which case tank capacities will range up to 500 gallons, with pump capacities of 10 gallons per minute.

Conclusions

Based on experience with booster units dating from 1932, certain conclusions are permissible.

1. Forest conditions throughout Michigan favor the use of tank units. Many areas, such as the surface rock localties around Alpena, will not permit the use of any other kind of power equipment.
2. Extreme mobility is of great importance; outfits of 110-gallon capacity permit transportation by light truck or trailer, or behind any car or tractor.
3. Trailer mounting is essential; it avoids tying up special truck equipment solely as tank trucks; hence a large number of cars or tractors may provide transportation when equipped with interchangeable trailer couplers.
4. Flexibility of organization is guaranteed through the use of booster units because duties such as patrol and mop-up can be alloted to them, thereby freeing men for assignment at other places.
5. Power of attack is increased. The tank capacity of 110-gallon units equals the quantity of water carried by 22 men with back pumps.
6. Use of booster units increases the usefulness of tractor equipment. After fire lines are constructed, trailer-mounted tank units may be hauled by tractors along all portions of a fire front.
7. Booster units offer the best chance for extensive use of chemicals in the future. Use of chemicals is not yet justified, but if they are ever employed, liquid chemicals will require self-contained tank units to handle them.

REDUCING FIRE SUPPRESSION COSTS WITH RADIO COMMUNICATION

WALDO M. SANDS
Project Superintendent CCC Camp Wellston, F–68, Michigan

Reduction of fire suppression costs has been the goal for many years of all personnel connected with fire-fighting organizations. Increased fire costs generally result from:

1. Poor organization.
2. Lack of proper communication, resulting in:
   (*a*) Inability of initial attack crew to get into immediate contact with the towerman or dispatcher.
   (*b*) Overmanning of fires through sending relief crews by dispatcher or towerman, because of lack of immediate contact with first crew on fire.
   (*c*) Sending crews from camp or other main stations, thus adding to transportation costs and risking increased burned area through loss of time in travel, when crews in immediate vicinity, if they had been equipped with mobile stand-by communication, such as a portable radio set, could have been sent while fire was small.

The use of radio both in fire detection and suppression during the summer of 1941 by Camp Wellston fire crews proved it to be the most efficient and economical means of communication used to date for fire suppression. This was demonstrated on two fires, on which the burned area and costs could have reached major proportions had dependence been placed on telephone lines for communication.

Pickerel Lake Fire

The Pickerel Lake Fire in sec. 8, T. 20 N., R. 15 W., on July 29, was one of the fires on which the effectiveness and economy of radio were demonstrated. The fire occurred on a low hazard (2) day when the dispatcher and towerman were not on duty. Starting sometime in the morning, the fire burned slowly until shortly after noon, when, whipped up by a sudden high wind, it was discovered by a local man, who reported it to Camp Wellston at 3:11 p. m. The superintendent immediately sent a small crew to the fire with a competent foreman and instructed the switchboard operator at the Wellston Guard Station to stand-by the radio there, and to mount the Udell Lookout towerman and have him stand-by his radio.

Upon arrival at the fire with a few additional men, the superintendent made a rapid survey of the fire, which had started along an east and west road in an old field furrowed and planted to jack pine in 1939. The area at the point of origin of the fire was covered by a rank growth of sedge and junegrasses. The fire, although checked by the furrows, spread rapidly into a heavy overstory of natural jack pine and oak, saplings and poles. The wind was in the southwest and blowing at the rate of 9 miles per hour. Bordering the burn to the north was an area of slash from the previous winter's TSI operations, toward which the fire was spreading and which it reached before it was controlled.

It was decided that the crew on the fire could control it, and communication was established immediately with the Udell Lookout towerman, using the radio set mounted on the stand-by fire truck. This radio set, incidentally, is part of the fire equipment of Camp Wellston's stand-by unit during the fire season. Needed crew reinforcements for relief and mop-up work were called out, food and water ordered for the fire fighters, and directions given as to the fastest and shortest route to the fire.

The radios on the truck and in the tower were type T radiophone transmitter-receiver, ultra-high frequency sets, operating in a range of 30,000 to 40,000 kilocycles. Messages were relayed by the towerman to the Wellston dispatcher's radio, which is a type U, ultra-high frequency, transmitter-receiver radiophone. Relaying was necessary because of the range of hills between fire location and dispatcher, which made direct communication difficult.

Lack of the radio would have required traveling 10 miles to a telephone line to establish communication with the tower and camp, using additional truck mileage, and losing valuable time when minutes could have meant the loss of a planted area of 210 acres and other timber. Immediate contact with the towerman also made it unnecessary to dispatch additional reinforcements as is customary when communication is delayed and the volume of smoke indicates the fire is not suppressed, which would have caused a large and unnecessary man-day cost. Direct communication with the towerman forestalled an error in judgment in deciding what was the smallest crew possible for control of the fire, as reinforcements could be called out quickly if an emergency arose.

Because of the direction of the wind, the fire burned itself out partially against a fire lane on the east side of the burned area, but had the wind blown from a southeasterly direction, the fire could not have been controlled with the first crew on the scene of action. Any delay which would have prevented establishing prompt communication with the towerman and camp would have meant disaster and the probable loss of several hundred acres of planted and natural-growth area. The saving effected on this fire, shown below, is representative of the many fires on which radio communication has been used successfully.

Increased costs for this fire, had telephone communication been used, were estimated as follows:

Distance to and from telephone line—24 miles with pick-up, at $0.045 per mile	$1.08
Enrollee and superintendent's time lost (1 hour)	1.30
Crew man-days saved on reinforcements—15, at $1.50	22.50
Two trucks at 35 miles each—70 miles, at $0.065 per mile	4.55
Two foremen (time lost—3 hours)—6 hours, at $0.62 per hour	3.72
Total	33.15
Potential damage, assuming fire had not been controlled by first crew and a ½ hour delay had occurred before communication could be established, would have been 210 acres of planted area and 350 acres of oak and jack pine natural reproduction burned, at an estimated value of	3,270.00
Total damage sustained through fire (actual)	291.00
Difference between actual and potential damage	2,979.00

Maple Street Fire

The Maple Street Fire, sec. 14, T. 20 N., R. 17 W., in the Grant Extension, was another example on which radio communication was an indispensable and cost-reducing factor. This fire was reported at 1:53 p. m., August 5, 1941, to the district ranger at Manistee, who left with 5 men to locate it. On arrival at the reported location, no fire or smoke were visible. Because of the flat terrain and heavy growth of timber on all sides, locating the fire by search would have been extremely difficult. The ranger immediately contacted the towerman at Grant tower with a type A set mounted in the dashboard of the ¾ ton International, pump-type pick-up. By establishing his location with the towerman through description of the ground and landmarks, he determined the cross-shot was in error, and was able to correct himself as to the true direction of the fire and eventually reached the burning area at 2:30 p. m. The fire, ¾ of a mile off the main road and almost in the center of a section, was difficult to find. It had started at the edge of an alder and marsh-grass swamp and was burning its way deeper into the swamp. Wind velocity was 15 miles per hour, danger class 5. Rate of spread was 3 feet per minute, but gaining rapidly, because of wind velocity and additional heat from increasing spread of burned area. Area increased 7 acres from time of attack until controlled.

There was no telephone line closer from Manistee, 9 miles away. The delay caused by returning to Manistee or to the tower to try to relocate the fire, based on fire conditions, fuel, type of fire and rate of speed, would have allowed the fire to triple in area, and a larger number of man-days and more supervision would have been required to control it. In addition, the time lost looking for the smoke would have further increased the number of man-days and tended to give the fire time to burn and perhaps reach major proportions.

Analysis of the probable increased costs of this fire, if radio communication had not been available follows:

Probable time lost in looking for fire and establishing telephone communication—5 men and ranger—2 hours	$3.70
Increased area over total burned, because of time between discovery and attack—27 acres—increase in damage	21.60
Probable increase in reinforcements in excess of needs because of failure to locate fire—25 men and foreman	7.24
Truck mileage in excess of needs—60 miles at $0.065 per mile	3.90
Total increased costs	36.44

It is admitted that in both fires we have set up hypothetical cases based on the burning conditions and fire behavior, but it is believed these figures bring out the fact that regardless of the problematical side of the picture, certain definite costs were reduced because of the quick contact established with the towers. Cost reductions were caused by:

1. Less transportation.
2. Use of minimum number of effective man-days for fire sup-suppression.
3. Less time lost in locating fire.

4. Fewer crew reinforcements.
5. Smaller burned area loss.
6. Added protection in case of emergency (intangible cost); i. e., such as sudden shift in wind direction.

THE PRIEST RIVER MEETING

(Continued from page 46)

and influence the right people. Recent advances in applied psychology and in methods of sampling and studying mass opinion seem to offer effective tools that research could investigate and develop to aid administration in increasing the effectiveness of fire-prevention work.

Emphasis in the fields of effects and behavior was toward getting a more complete basic knowledge. Significant was the recommendation of the committee accepted at the meeting that "* * * fire-danger-rating research be temporarily suspended as soon as current work reaches a reasonable stopping point. It is recognized that existing fire-danger-rating systems only partially satisfy the needs of fire control, but pending the more precise definition of the elements of fire behavior, it is believed that more rapid progress in this field will be made by the study of these elements than by further direct study of danger at this time."

The fire-control organization and management committee was handed a very broad assignment and responded in kind. Their job was to examine research needs in problems of detection planning, communications, transportation, fire-suppression organization, and tactics, all having a direct tie-in with control by the administrative organizations. It is here that the big money is spent and even a relatively small percentage increase in efficiency means a sizeable gain. The committee recognized a definite need for objective study in the general field of fire-control management and outlined a comprehensive program of needed work divided between the research and administrative organizations.

A strong point of the meeting was the closeness with which research and administrative men work together. In all discussions full consideration was given research needs for the protection of State and private forest areas as well as those on the national forests. The fine facilities at the Priest River Experimental Forest and the smooth handling of arrangements by the Northern Rocky Mountain Station contributed much to the success of the meeting. As a wind-up, the Southerners were treated to a good Western snowstorm.

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INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Legends for illustrations should be typed on a strip of paper attached to illustrations with rubber cement. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing illustrations, place between cardboards held together with rubber bands. Paper clips should never be used.

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustration. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired. Do not submit copyrighted pictures, or photographs from commercial photographers on which a credit line is required.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproduction. Please therefore submit well-drawn tracings instead of prints.

The approximate position that illustrations bear to the printed text should be indicated in the manuscript. This position is usually following the first reference to the illustration.

VOL. 6 JULY 1942 NO. 3

FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and technique may flow to and from every worker in the field of forest fire control.

Volume 6 Number 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

*

FIRE CONTROL NOTES is issued quarterly by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

The value of this publication will be determined by what Federal, State, and other public Agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

Address Division of Fire Control
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CONTENTS

Much as we regret it, this will be the last issue of Fire Control Notes during the war. However, if you have any suggestions that might be helpful to others engaged in fire control activities, and will send them to the Forest Service, Washington, D. C., such data as seem to warrant it will be passed along to those most likely to be interested by including in administrative memoranda or by other means.

Erratum.—In the article by H. T. Gisborne, "Review of Problems and Accomplishments in Fire Control and Fire Research," Fire Control Notes for April, 1942, line 31, page 55 should read—"economic theory, but merely as a moderator of evener. This is * * *"

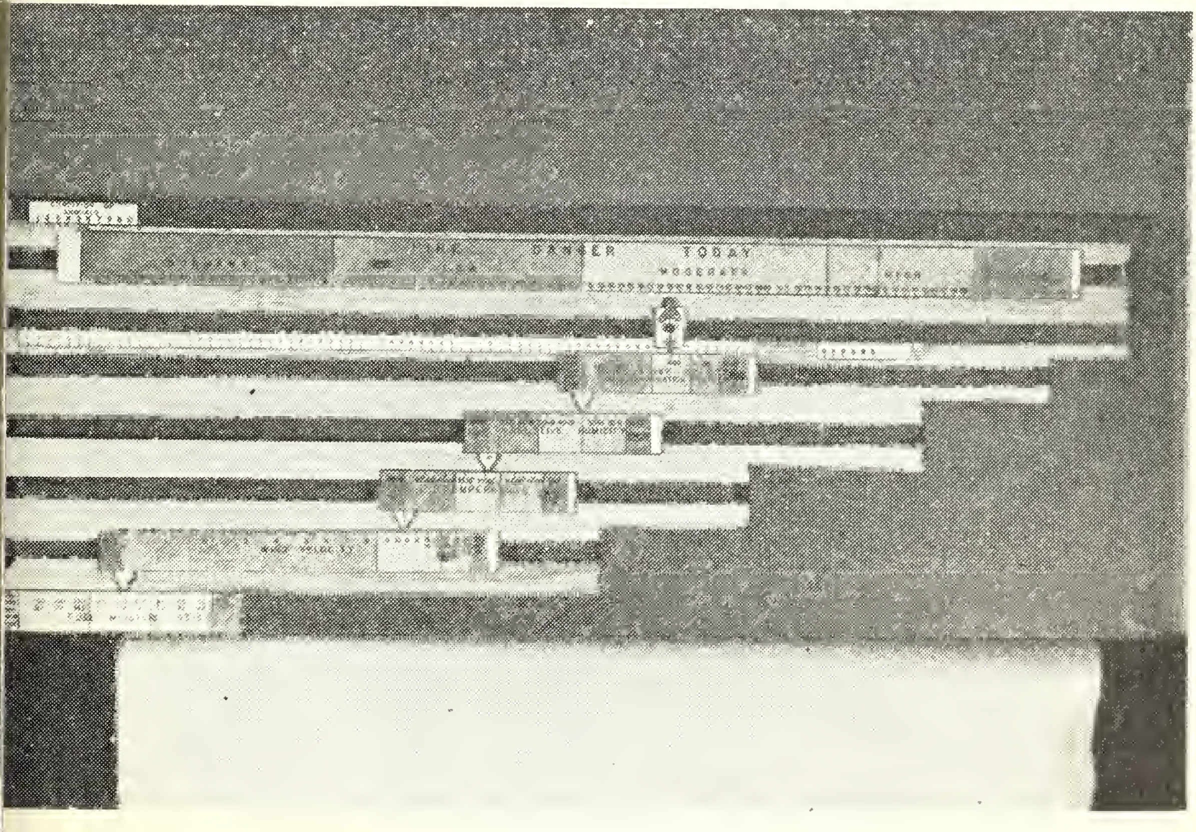
STREAMLINING THE R-2 FIRE-DANGER METER

PAUL P. McCORD

1ssistant Supervisor, Pike National Forest, Region 2, U. S. Forest Service

"I wish we had our fire-danger meter so arranged that when all the omponent factor scales have been set the fire danger would be auto- natically shown." Thus spoke Mr. A. A. Brown of the Regional Office at the time of an inspection trip on the Pike last fall. Follow- ng some humor about connecting the scales to rheostats and other lectrical gadgets, Messrs. Brown, Dakan (Project Superintendent, '–60 CCC camp), and I did some serious thinking about the matter vithout serving at any definite conclusion as to how it could be done. 'or a couple of months I amused myself at odd moments thinking hrough the possibilities of solving the problem by designing a meter hat would be simple and cheap to construct, stand up well under use, iave a certain amount of eye appeal and eliminate necessity for off ide calculations either mental or scribbled.

Finally these ideas crystallized and the preliminary model shown in he accompanying photograph was constructed. As can be seen, he FIRE DANGER TODAY is indicated by the upper scale which ontains 100 points. Below this, in turn, are scales for CUMULA- 'IVE EFFECTS, RELATIVE HUMIDITY, TEMPERATURE, VIND VELOCITY, and FUEL MOISTURE STICK.



R–2 fire-danger meter.

(Continued on page 91)

FIRES IN ALASKA

J. N. Hessel

Information and Education, U. S. Forest Service, Washington, D. C.

When the heat's on in the timber and above the jangling of the telephone or the cracking of the flames you hear in strident, stentorian tones something like this: "I'm gonna quit this business and find me a place somewhere in the middle of a swamp"—you can figure you're in the presence of an experienced fire fighter and that everything is being well taken care of. The more stentorian and profane this proclamation, the more experienced the fire fighter is likely to be.

Top-notch forest-fire fighters go around making this fervent announcement all summer and brood about it all winter. None, or at least very few of them, ever actually do any thing about it. This also is typical.

And another item these heroes of the hot spots hold largely in common in this connection has to do with Alaska. In their most morose moments, Alaska is the land generally regarded as the utopian escape from all fire-control worries and troubles—a land where the need for fire control and the problems thereof drop to an irreducible minimum—a land where the forester can proceed with his anointed silvicultural endeavors unmolested and forget about forest fires once and forever.

Granted the opportunity of an extensive Alaskan junket with Dr. Dow V. Barter of the University of Michigan, and his student assistant Fred Walker, last summer, I set this matter down as one for special investigation.

Via the Alaska Steamship Line's S. S. *Alaska*, after stops at Metlakatla, Ketchikan, Juneau, Cordova, Valdez, and half a dozen isolated salmon canneries, we eventually arrived in Resurrection Bay and disembarked at Seward.

Anyone can see that the relationship between fish and fire, except for the alliteration of the two words, is almost purely antithetical. And after 8 days on the S. S. *Alaska*, during which I had talked fish, smelled fish, seen fish, eaten fish, and otherwise become so full of fish as to believe nothing else in Alaska commanded any attention, it was natural that on arrival in Seward the business of fire was farthermost from my investigative apparatus. The only connection was a nausea for fish the same as I had felt for fire in other times and climes.

On turning up at the Forest Service headquarters of the Kenai Division of the Chugach National Forest in the Federal Building in Seward, searching for one Emil "Whitey" Norgorden in charge, I was therefore due for a shock.

Ranger Norgorden, I was informed by office manager Joe Werner, was at Kenai Lake where he had been and where he would remain for the duration of the *fire season*. It was then late July, and as nearly as I could gather this meant from early June to early September depending on the time of spring break-up and fall rains, just as in the Northern Rockies and Pacific Northwest.

Although an occasional fire is started by brush-burning homesteaders, by prospectors, or by sportsmen who travel far to enjoy the famed hunting and fishing of the Kenai country, the chief hazard—believe it or not—is a railroad. Also, believe it or not, it's a Government-owned railroad.

This railroad extends from Seward to Fairbanks, and the trains which run at odd, infrequent, and indeterminate intervals have at one time or another started whopping big fires practically from one end of the route to the other. One of the features of the line is the famous screw trestle which gets the road out of the valley and over the mountain in a hurry. This is a renowned scenic thriller for the sightseer, but to the Kenai ranger it's a pain in the neck.

The matter of screens on the locomotive smokestacks has never been satisfactorily settled. During the burning season a speeder patrol

F–94157

Forest fire along Iditarod River, Alaska.

after every train making the haul over the mountain is considered essential.

We traveled over the Alaska Railroad to Anchorage. In an office in the Anchorage Federal Building I found W. N. "Bill" McDonald and Roger R. Robinson representing the Department of Interior's Alaska Fire Control Commission. Bill, an old-time Alaskan, put in many years as a member of the Region 10 Forest Service organization, previous to taking over in Anchorage. Robinson, a graduate forester from New York State College, also previously served with the Forest Service in West Virginia, Colorado, and Alaska.

"Folks in the States have no idea of the fire job there is to do up here," they told me. "Here's Alaska with an area of 546,000 square miles, about a fifth the size of the 48 states. And outside the twenty-five-million-odd acres in the Tongass and Chugach National Forests, we're responsible for protecting the whole of it. We get a total appropriation of between 30 and 40 thousand dollars—sometimes not that much. You can see what we're up against."

"Yeah," I replied, "but I've flown over much of the country and there must be a whale of a hunk you don't have to worry about. And besides, I can't see much need for spending a lot of money protecting any of it. As far as I can see all the good and accessible timber is along the coast in the national forests. What do we lose if this back country does burn over?"

"Look," said Bill, "you like to hunt migrating birds don't you? Well, this is where your migratory birds come from. They nest up here and when those nesting grounds burn over as they do, the answer is obvious—fewer birds."

F–17989

Old burn in hemlock and spruce, Skagway Valley, Alaska.

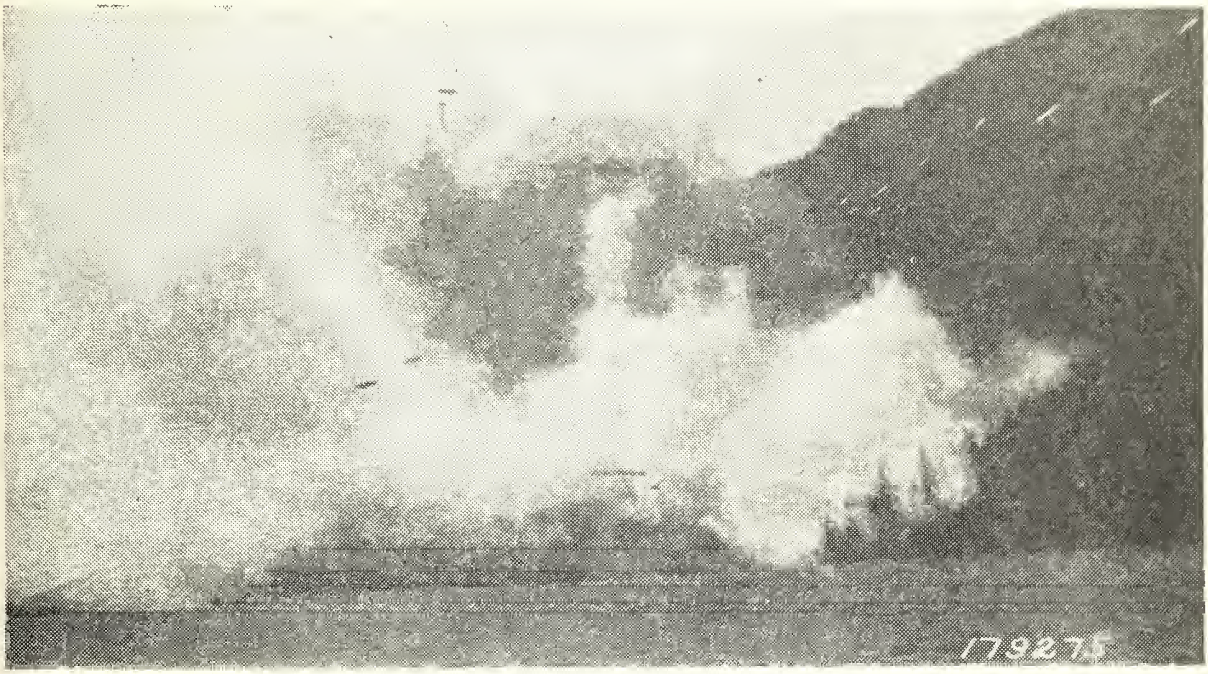
"Sure," Robinson backed him up. "You've flown over a big area an you've seen a lot of rock and muskeg country that we don't have t worry about, it's true. But there's more of it you haven't been over You haven't been up in the interior around Fairbanks. There's som good timber up there too, and timber means a lot to the isolated peopl mining and trapping and developing that area.

"Then take the case of the reindeer range. Reindeer are might important up here for meat and hides for the Eskimos and whit population too. They're suitable for export, and the day may com when there'll be enough of them to make an important industry. Bu that'll never happen if we continue to let the range burn. A goo stand of reindeer moss doesn't spring up over night. It's slow grow ing—a good thick growth takes years. But she burns just like gras once she gets started."

"Yeah," wound up Bill, "and don't think fires don't get started an don't burn. They start in the spring and burn all summer. Cove thousands of acres every year. And we can't even spot 'em. We've got to depend on reports from prospectors or whoever happens to be in the country to know about 'em. Sometimes they burn for weeks before any word ever gets out to us.

"The only way we can get to 'em is by plane and we've got no planes. Once we get to 'em they're too big to handle with the few men we can hire to fight 'em. With our little money all we can do is hammer away at prevention.

"You go back to the States and tell 'em we've got a fire control problem up here that's a dinger. Tell 'em we've got to have more money, more equipment and specialized equipment, more manpower. Especially tell the sportsmen—they've got an immediate interest."



F-179275

Forest fire on Chugach National Forest, Alaska.

So it went. I heard about fires and saw evidences of past fires in Alaska. And on the way outside in middle September I had an opportunity to actually fight two fires where you'd least expect to find them—in the heavy rain forests along the southeastern coast.

After a day's run in the Ranger 8, one of the fleet of Forest Service boats, we were cruising in to a late anchorage in one of the countless small coves. Fred and I were in the galley cleaning up the evening meal dishes, and Fred was looking out of the shore-side porthole.

"Hey," he said suddenly, "look across there—there's a fire."

Taking a look I could make out a dim illumination. "Maybe it's just a beacon of some kind," I said. "I'll go up in the wheelhouse and take a squint through the glasses."

Up in the wheelhouse Skipper George Reynolds and Harry Sperling of the Juneau office had already spotted the light.

"It might be a gas boat on fire close to the shore," said Harry.

"Too high," said George.

"How about a settler's cabin?" I asked.

"Nobody along this part of the coast that I know of," replied George.

We were nearer now and daylight was growing very dim. Flames suddenly broke out brightly and raced up almost to the top of the shore line trees. "Just like fire going up into the crowns of a piece of timber," I thought. And then it dawned on me.

"That's what it is," I said. It's a fire in the timber."

Both George and Harry laughed. "You're in Alaska now, fella," said Harry. "It's a little different up here than down in western Montana."

Not long after, however, they incredulously came to agree with my opinion. Anchoring a safe distance offshore we put the dingy over and with pump, hose, shovels, Pulaski tools, and axes rowed in to a landing. Pushing through a dense growth of shore grass, head high and reeking wet, we emerged suddenly at the edge of the conflagration.

Under the thick canopy of great spruce trees the fire had caught the dry matting of needles and spread over about a tenth of an acre. The shooting flames we had seen was a run of fire up through the branches. With the exception of this one catch, which had been of brief duration, the crowns were apparently impervious. At the base of one of the trees were what we took to be the remains of a campfire—apparently how and where the blaze started.

Setting up the pump and coupling together enough hose to reach all parts of the fire required but a few moments. Among other things loaded into the dingy on leaving the boat, George had included one of the steel folding chairs, out of the galley. This, when set upon the beach, served as an elevated stand for the gas tank, gravity feeding the pump. Because of the corrosive effect of salt water, pumps when not in use are kept thoroughly capped and filled with oil.

Within less than an hour all visible sparks had been doused with brind from the Pacific. Mopping-up was left for the morning. Since the fire had obviously been smouldering for several days before actually breaking out in the open, it had become deeply established under roots and rocks, which called for considerable digging and hacking.

Additional atmosphere and interest was furnished the evening's engagement by a school of whales frolicking just offshore. Over the hum of the pump motor the spouting of these animals sounded like an engineer letting steam out of a locomotive. This type of cheering from the sidelines, I am told, is a fire-fighting feature infrequently encountered and exclusively Alaskan.

Hardly had we again got under way after dispatching this fire than another was sighted. Except that it was smaller and of more recent origin, this second fire in all respects was identical with the first. About 2 hours was all that was required to drown and dig it out completely. A driftwood board set up at one end of the beach near the fire had been shattered with bullets. At the opposite end of the beach we found a number of empty .30–06 cartridges, establishing this as a hunter's fire almost unquestionably.

I am not generally credited as a scientist nor do I by any manner of means represent myself to be one. That my investigative technique in this instance might have been faulty and incomplete is quite likely. But to me the dictum is clear: Fire fighting is a disease as unshakable as a bad habit.

Two fires in two days in the heart of Alaska's swamp utopia leaves nothing more to be answered. Recognizing my fate I resign myself to fire fighting unconditionally and regardless, wherever I may be.

STREAMLINING THE R-2 FIRE-DANGER METER

(Continued from page 85)

In operation the pointer above the FUEL MOISTURE STICK scale is set at the FUEL MOISTURE STICK reading and so on until the RELATIVE HUMIDITY reading has been set. Just above the CUMULATIVE EFFECTS scale is a fixed scale and by noting the figure opposite the zero point, the daily cumulative effect can be read. (Unfortunately part of the scale just to the right of the CUMULATIVE EFFECTS scale was lost before the photograph was taken.) Here enters the only mental calculation necessary—the daily cumulative effect is added to the CUMULATIVE EFFECTS figure for the previous day and the pointer above the scale is set and the FIRE DANGER TODAY is read direct. It will be noted that a CONDITION OF ANNUALS scale appears above the left end of the FIRE DANGER TODAY scale. By setting the zero point on the latter opposite the current deduction figure, the deduction is automatically made.

It is felt that this new design is an improvement over the present one, but actual use will be needed to demonstrate this.

458654—42——2

BOY SCOUTS AND AMERICAN FORESTS

Capt. E. C. Mills

National Director, Health and Safety Service, Boy Scouts of America

The playgrounds and workshops of Scouting are the forests, fields, mountains, and waterways of America. Nature forms the back drop against which the great outdoor program of the Boy Scouts of America has been built.

An inseparable part of that program is training in citizenship and the traits of character essential to maintaining the "American way" of life.

"And just what," may be asked, "does such training have to do with preventing forest fires, or putting them out, or of replacing the losses with young trees?"

Before attempting to answer that question, your attention is called to a statement quoted from Scouting's Health and Safety Magazine of August 1939:

> The Boy Scouts of America is interested in the protection of American forests and homes from fire for a number of excellent reasons, chief of which is that it is an American institution dedicated to character development and the training of young men for citizenship. It believes that an educated and trained citizenry conserves its national resources and protects its people. By the same token, it believes that destruction caused by carelessness indicates weaknesses not conducive to strong character building and that the causes of such destruction can be removed through better understanding, training, and the assumption of personal responsibility.
>
> As an organization it has a moral and economic obligation for the magnificient gifts of thousands of citizens which have made it possible for Scout Councils to lease or own more than 160,000 acres of wild land for Scout camps well equipped with facilities for the use of American boys. The value of the properties owned by various councils is close to $10,000,000. The man-made equipment on these sites can be replaced, but the timber and wildlife cannot, except through nature's efforts and then only after many years—if at all.
>
> Is the future of your council's camp property protected as well as is possible, or will its usefulness and the happiness of this and future generations of Scouts be dissipated in wood smoke?

Today more than 1,150,000 boys are registered members, 923,000 of these being Scouts—boys over 12 years of age—divided among 42,000 troops. The adult leader of each troop is the scoutmaster who has one or more adult assistants. The camping program is of great importance to every troop. Between 350,000 and 500.000 Scouts spend one or more weeks at camp each year. Many troops carry on their overnight and week end camping activities throughout the year, weather permitting, and some regardless of weather.

Because the use of fire for cooking, heat, and ceremonies is very important in a camping program, a great deal of training in fire making, use, and extinguishing is necessary. It must be carried on almost constantly by leaders, who, in turn, must have training. Courses for leaders are conducted throughout the year by the 542 Scout Councils into which the country is divided.

Scouting has a special award plan for advanced study in more than 100 different subjects. This is known as the Merit Badge system. One of these merit badges is for "Firemanship." Requirement No. 2 of the 6 which must be passed to win this badge has to do with forest-fire prevention. It reads:

> Demonstrate or submit sketches illustrating two of the following:
> *a.* Proper building of campfire with relation to inflammable material both around and under place where fire is laid.
> *b.* How to extinguish a campfire.
> *c.* Three practical methods of forest-fire prevention.
> *d.* Three simple methods of forest-fire fighting where elaborate equipment is not available.

Boy Scout National Training School students in "one-lick" method forest-fire drill.

In another requirement is found the following:

> Demonstrate (*a*) How to light and discard a match safely.
> In the past seven years 206,800 Scouts have won this merit badge. Another merit badge of particular importance in the protection of forests and wildlife is "Conservation."

This excellent course has to do with conserving wildlife of forest and stream. In studying it, Scouts learn better to appreciate and protect animal life, and this means giving thoughtful consideration to their environment. They soon learn that adequate ground cover means protection for animals and water in rivers and lakes, and that fire destroys it. The necessity of saving timber and replacing that which has been destroyed becomes immediately apparent.

It would be impossible and of little value to attempt even to estimate the number of acres of seedlings that have been planted by Scouts since the organization's inception in 1911. Planting is a part of the program for every Scout Council. Every Scout is a tree planter and consequently a potential conservationist.

Another very valuable source of training for Scouts and their leaders has been the cooperative relationships with National and State forest authorities.

Scouting believes in the principle of "learning by doing." Giving service is a great educational medium, and Scouts have given service of many kinds, ranging from posting fire prevention signs, distributing pamphlets, notices, and "fag bags," and carrying warning posters in public places, to serving as fire watchers, guards, and fire fighters.

During the past 3 years the relations of the Scouts with the Division of Fire Control of the U. S. Forest Service have been very close, and it is felt that as a result the education of Scouts and their value to their country have been greatly extended. This expansion began with a series of conferences between Roy Headley, chief of the division, and members of his staff and officials of the Boy Scouts of America. These discussions resulted in the publication and wide distribution and use of an article on the "one-lick method of forest fire fighting," written by Mr. Headley; the extensive showing of the motion picture on the same subject; the securing of Forest Service personnel to give technical training in methods; the correction of potentially dangerous conditions existing at Scout camps; the placing of Forest Service members on Scout Council health and safety committees; and the training of Scout executives in methods at the National Training School at Schiff Scout Reservation.

Schiff Scout Reservation at Mendham, N. J., is the National Training School of the Boy Scouts of America. Many training courses are carried on there for leaders, in addition to those for Scout executives. These include, among others, camping, emergency service, health and safety, and aquatics. Each group is shown the "one-lick method" film, and in many instances the men are taken into the woods, equipped with proper tools, and put through the "one-lick" drill.

Since Scouting was developed in our country 31 years ago, Scouts and Scout leaders have been working energetically to prevent and halt the ravages of fire. Tales of effective and oftentimes heroic action in fire fighting are a part of Scouting's traditions. Scouting is an American institution that constantly strives to improve on past results by learning to do things more effectively. Complacency is the enemy of progress. The Boy Scouts of America has never been a complacent organization. IT CAN DO BETTER. IT WILL DO BETTER.

HAVE WE GONE FAR ENOUGH IN THE USE OF AIRPLANES?

James Bosworth

Assistant Supervisor, St. Joe National Forest, Region 1, U. S. Forest Service

The airplane-parachute method of transporting firemen for attack on forest fires was suggested by Forest Service employees as early as 1934, possibly earlier. It has been put to practical test on limited national-forest areas with encouraging results. (Fire Control Notes, April 1940, Technical Report on the Parachute-jumping Experiment, and October 1940, Wings and Parachutes over the National Forests.) The author now advocates an "all out" application of the method on a full national-forest basis, indicating savings in personnel, improvements, and transportation costs, reduction in damage values, and savings in time, which he believes to be possible. In view of the enormous increase in air-mindedness which has grown with the national emergency, the author's plan may rank with other progressive items which may persist to the benefit of society because of untrammeled thinking and courage exercised now by their sponsors.

Parachute smoke jumping, although still somewhat in the experimental state, has proved according to all reports, that such a method of attack on small fires is practical.

Airplane transportation has been developed to such an extent that this mode of travel is about as safe as automobile travel.

Freight transportation by plane is coming into use throughout the country and we have proved to our own satisfaction in the Forest Service that dropping supplies from a plane by the use of parachutes is also practical, if we have the funds to buy adequate parachutes and other equipment.

With these factors in mind, I propose that we select one forest in Region 1 and go "all out" with an experiment in the use of planes and parachutes for carrying on all work connected with fire control. In other words, the forest organization would be so planned that it would operate and function, so far as possible, by the use of planes and parachute jumpers.

Such a forest should be one where the main activity is fire control, where national-forest land or land under paid protection is more or less blocked up, where a flying base could be located within or close to the area, and preferably close to a large town or city.

Under such a plan, detection would be obtained by airplanes patrolling in the forest in a gridiron fashion on strips 12 miles apart, making from 1 to 8 trips per day, depending on the fire danger. Each plane would carry 2 smoke jumpers, 1 observer, 1 pilot, radio, and other equipment.

In comparing detection by air patrol with our regular lookout system, I believe that a plane flying 100 miles an hour, with 4 men watching a strip of land 12 miles wide would give as good, if not better, detection than our present look-out system, since the observers in a plane would have the advantage of seeing 25 percent more area than is seen by our regular season force. This is on the basis that the observers from a plane could see 95 percent of the area, while our regular season force has a "seen" area coverage of about 70 percent.

The fire-discovery time, however, would be somewhat increased because of the small number of trips per day during low fire danger and the fact that patrol flights would be made only in daylight. The St. Joe records show that in 1940, 18 percent of the fires were discovered between 9 p. m. and 4 a. m. compared with 10 percent in 1941. Personally, this does not worry me for the reason that a great many of these fires are not actually worked on until daylight hours. Furthermore, there are only a very few nights during which a fire will travel to any extent.

During daylight hours it would probably be desirable to arrange the flights so that the last one would be just before dark and the first one just after daylight. It may also be possible to patrol at night, but these are points which would have to be worked out later.

When a fire is discovered on a flight, the plane would go to it immediately and unload the jumpers. In this way, travel and hunting time would be reduced to about 30 minutes or less, compared with the average on the St. Joe Forest of 2 hours 58 minutes in 1940 and 2 hours 31 minutes in 1941, based on 150 and 69 fire reports, respectively—a factor which I believe will more than offset the slower discovery time.

The hazards in parachute jumping may appear to be much higher than for a ground organization, although reports show that so far the only lost-time accidents sustained by our smoke jumpers were two sprained ankles. The indications are that the accident rate is not any higher than would normally be expected in our smoke-chaser travel.

I am not qualified to judge the type of plane best suited for the purpose, but it appears to me that a twin-motored plane would be the safest and most suitable. If this type of plane had been used in the past in our flying, some the serious and near-serious accidents that we have had could probably have been avoided.

One of the most difficult things to work out might be to obtain sufficient parachute smoke jumpers and keep within the fire-control allotments. My solution for this would be:

1. A crew of at least 15 men trained and qualified as smoke jumpers and observers to be held at the flying base to man the patrol flights.

2. At least 10 men to be trained in smoke jumping and employed in accessible crews located on the forest. These men would be paid while training and given a $30 per month bonus to act as smoke jumpers when called.

3. To have the adjacent forests cooperate by furnishing two smoke jumpers each who would be available on short notice near landing fields. These men to be trained and given a subsidy of $30 per month.

4. The air base for the forest should be located at or near the largest city, where it would be possible to obtain up to 40 or 50 men

(volunteers) who could meet the standard requirements, to be trained in jumping and fire suppression and given, for example, $25 per jump and $1 per hour for working time when called. These men could be employed by private concerns at various jobs in the city and arrangements made with their employers to release them when needed. This would be the force from which our overload of fires would be handled.

I believe it would be possible in a town of 5,000 or more to stimulate enough interest in parachute jumping so that men could be obtained under such arrangements. It might be possible, also, to interest the Army to the extent of having them finance the training in connection with the war program, since the candidates might be available as parachute troops.

With such an organization, it should be possible to man up to 40 fires in 1 day. Since this would not catch the peak load on most of the heavy-fire forests, it would be necessary to rely on trail- and road-maintenance men, other crews, and help from other forests as we do now.

In discussing an aerial organization, other members of the Forest Service seem to feel that the peak load of fires on a forest would break down such an organization. Personally, I can't see it, since the regular schedule flights would be made to obtain location even though it was impossible to send smoke jumpers to fires at the time they were discovered. Detection and location would be more regular and at least as accurate as it is now and no more difficulty would be encountered in dispatching men to unmanned fires than exists under our present management.

A break-down is also predicted during smoky weather. Some of the men seem to feel that it would be impossible to see small fires from a plane, but it is my theory that smoke usually lies just over the mountain in a blanket of various thicknesses, and a look-out—in order to see a fire—must look through the smoke blanket horizontally, while an observer flying overhead would look through the smoke blanket vertically or at an angle and would have better visibility. At least the look-out is up against the same visibility conditions as the observer in a plane.

With an "all out" aerial organization on a forest, it would be necessary to make a number of changes since there would be no protection force. The amount of work on a back district would not justify a year-long ranger, and a 6-months alternate could be used to handle public administration, supervise trail-maintenance crews, take care of weather reports, and pick up the parachute jumpers. These men would form part of the fire-overhead organization and should be trained and capable of taking over the fire-boss job on medium-sized fires.

All telephone-maintenance funds except those needed to maintain the main-line circuits could be transferred for aerial use.

Pack stock could be reduced to the actual number needed to handle the progressive trail-maintenance crews during the fire season.

Smoke-chaser and suppression equipment could be concentrated at flying base and reduced considerably.

Elaborate ranger station set-ups, look-out houses, towers, and other fire-control structures could be practically eliminated.

A large reduction could be made in travel time and transportation.

In order to show the possibilities of the experiment, I am proposing, and to clarify it, I will work out roughly a plan for the St. Joe Forest, not that the St. Joe should necessarily be the one to practice on, but because I have some facts and figures to work with. The St. Joe lacks landing fields and the flying base would have to be located near Moscow, Idaho, which would require deadhead travel. Two districts have numerous activities other than fire, and the land under paid protection is not as compact as it should be.

To start with, I have prepared a tabulation showing fire danger each day for the past five seasons and the average number of days for each class of fire danger in order to determine about how many trips over the forest would be needed during an average season. I then assumed that when the fire danger is 2.4 or less no patrol would be needed. From 2.6 to 3.0, inclusive, 1 patrol trip per day; 3.2 to 3.6 inclusive, 2 patrol trips per day and so on until the danger reached class 5+ when 8 patrol trips per day would be flown.

Using 12-mile strips with base at Moscow, Idaho, the round trip distance will be 270 miles. This has been increased 30 miles per trip to take care of extra miles needed to look over suspicious or false smokes and extra trips.

Since the primary job of the rangers on the Avery, Roundtop, Red Ives, and Calder districts is fire control, rangers would be eliminated and replaced with 6- or 7-month alternates. The Palouse and Clarkia districts, because of the numerous other activities would have yearlong rangers and 6-month public contact men. Road maintenance would be supervised from the supervisor's office.

Blister rust control crews would also be handled from the supervisor's office as they are now.

Pack and saddle stock could be reduced 60 percent by handling trail maintenance under the progressive system during fire season.

The clerical force could be reduced 20 percent because of the decreased number of employees, less purchasing, vouchering, and other miscellaneous details.

Equipment could be reduced and concentrated with a saving estimated at about $2,000.

There have been 77 look-out houses and towers constructed on the St. Joe; 30 more are needed to meet the fire plan. Under average season conditions, a total of 107, at an average cost of about $1,500 each, including visibility clearing, amounts to $160,500—assuming a life of 30 years, a maintenance cost of $20 per year each and interest at 5 percent, the annual cost amounts to $15,515.

By replacing the four yearlong rangers with temporary men and practically all the protection force, the headquarters improvement could be almost entirely eliminated on four districts and reduced 60 percent on the other two.

A conservative figure for the cost of a ranger station set-up is about $30,000. On this basis, the total would amount to $156,000. Assuming a life of 40 years, maintenance at $1,600 on all and interest at 5 percent, the annual savings would be $13,300.

An analysis recently made on the forest showed that during the past 12-month period, rangers, alternates, contact men and supervisor's staff spent a total of 2⅓ years driving a car. With a reduced force and travel made on the regular patrol flights, travel time and travel costs could probably be reduced 75 percent.

Summary of Estimated Savings

4 yearlong rangers and expense	$10,900
Reduction in pack stock	3,000
Saving in clerical help	2,000
Saving on equipment	2,000
Elimination of look-out houses and towers	15,515
Reduction in headquarters, improvements	13,300
Saving on telephone maintenance	2,000
Total	48,715

Cost of Proposed Aerial Fire Control Organization

1 yearlong forest officer in charge	$2,700
1 dispatcher, 6 months @ $175	1,050
15 smoke jumpers at base	8,750
10 smoke jumpers, trained and subsidized (on forest)	3,000
8 smoke jumpers, trained and subsidized (on adjacent forests)	2,400
40 volunteers, training, etc	8,000
Annual equipment costs	2,000
4 ranger alternates, 6 months @ $175	[1] 3,150
2 contact men, 5 months @ $166	1,660
Travel and expense	2,000
843 flying hours @ $25 per hour	21,075
	55,785

[1] Paid 25 percent from trail- and road-maintenance funds.

The average annual presuppression expenditures during the past 5 years, including FF E. P., have amounted to $56,900. Thus there would be a slight difference in favor of an aerial organization, but there still remains $48,715 accumulated in other savings based on a long period of time.

In arriving at a cost of $25 per hour for plane service, I assumed that since we are able to obtain planes at $35 under bid now with a limited number of flying hours, we should, by increasing the number of hours, be able to get a cheaper rate and eliminate the stand-by service, if any.

In an average or bad fire season, at least three planes would be required to handle the increased number of trips per day.

I realize that I am proposing a radical plan, that it sounds fantastic, and that most of it is based on theory, but I really believe we have enough sound facts to justify some pretty serious thinking along this line.

We have fire plans in Region 1 that have been estimated to cost $250,000 and so far as I can see they are just as fantastic as the plan I

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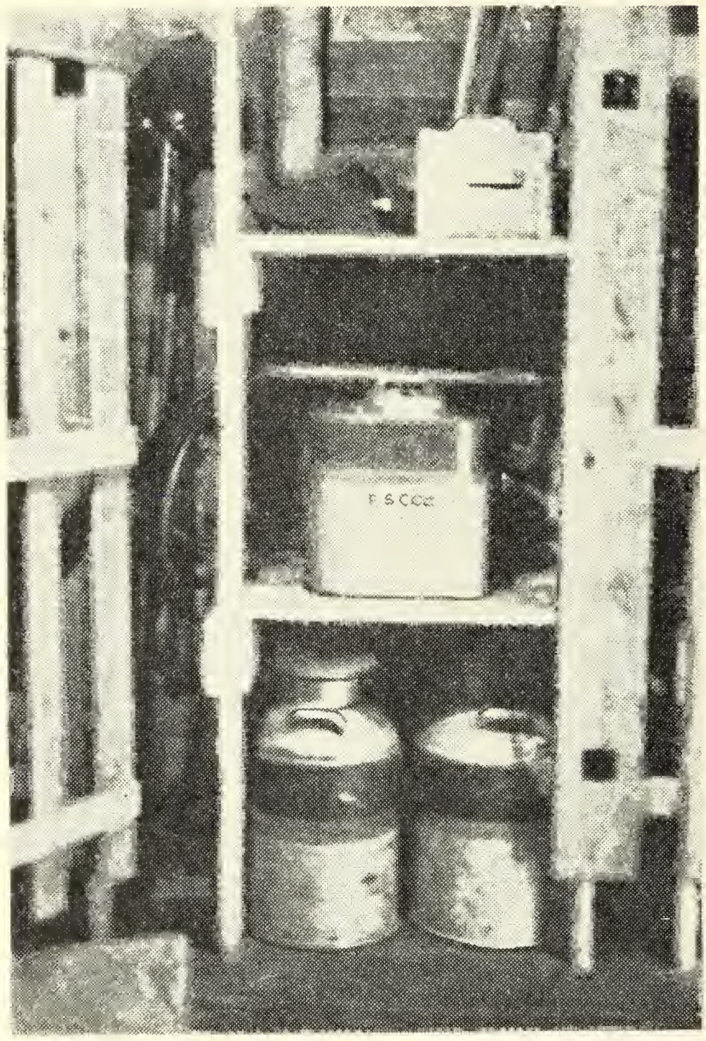
TRUCK TOOL BOX AND STALLS SOLVE FIRE-TOOL CACHE PROBLEMS

WALDO M. SANDS, *Project Superintendent, Camp Wellston, F–68, Manistee National Forest, Region 9, U. S. Forest Service*

At Camp Wellston, on the Manistee National Forest, a new system has been adopted for making up fire-tool caches in preparing stand-by trucks for immediate action and use as first attack and reinforcement units on fire calls.

Trucks at this camp are equipped with a combination tool box and truck seat, which is designed to accommodate all tools, water cans, and back-pack pumps. The closed covers of the boxes make safe and comfortable riding seats for enrollee workers and fire fighters.

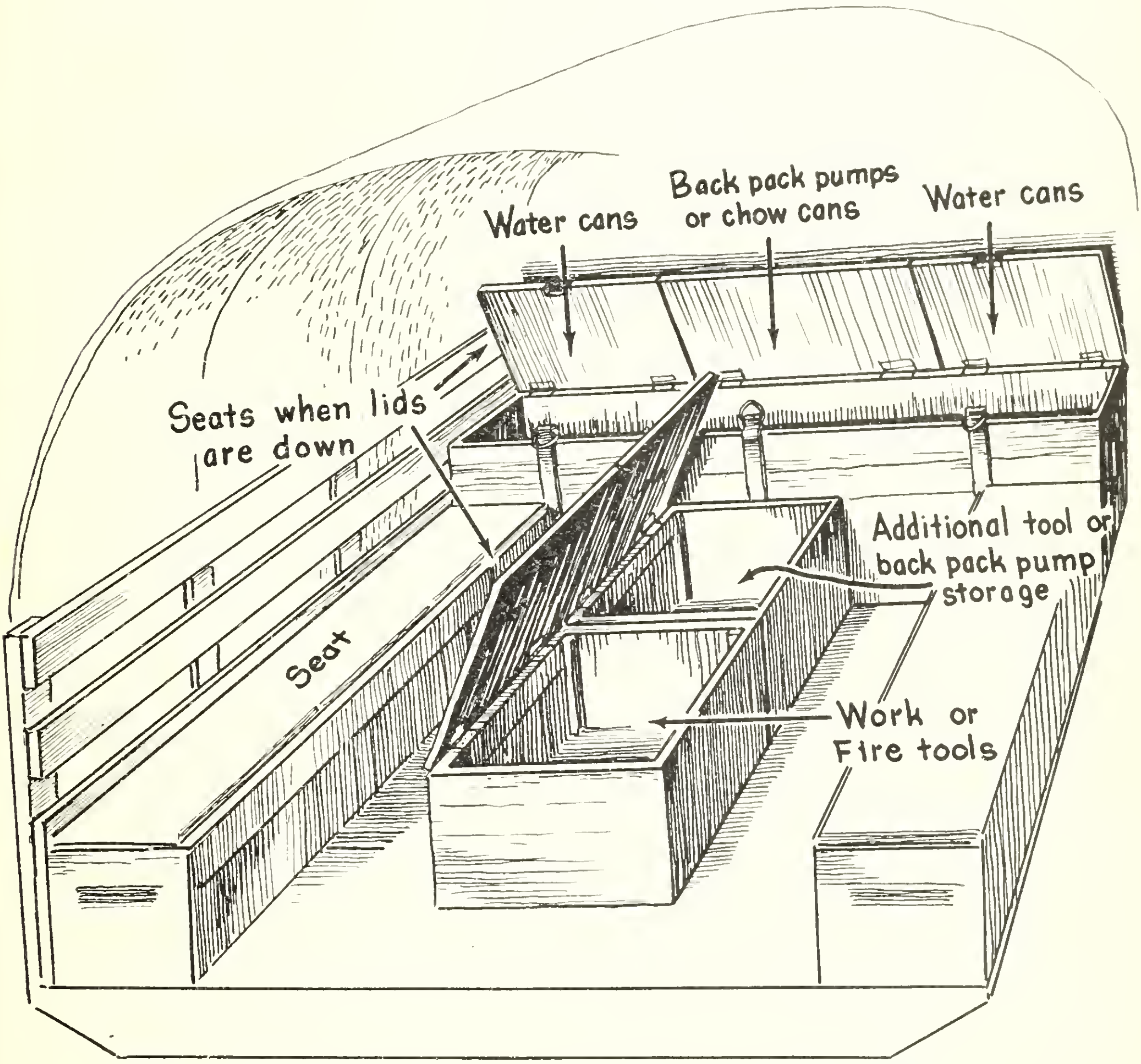


Typical stall in fire-cache building containing fire equipment ready for transfer to fire trucks.

Complications and safety measures have prohibited the efficient use of devices for attaching or anchoring both tool boxes and seats and fire-tool cache boxes on stake trucks. To simplify matters and to save time and labor in removing crew seats, and in loading fire-cache boxes and fastening them down, it was decided to organize and store the contents of all 5- and 10-man caches in separate stalls in the fire-cache building, thus permitting the equipment to be transferred from these stalls to the truck tool boxes very easily when needed. One man can now do the loading, as compared with 4 or 5 formerly needed to remove the heavy seats and install the equally heavy fire-tool boxes.

In the former use of separate fire-tool boxes, only one 10-man unit could be loaded and fastened down, thus limiting the size of the crew and seating capacity, with no provision for safe, comfortable riding of the men and equipment; also, it is doubtful that the heavy cache boxes would withstand the strain of being tossed around in case of accident, as it is necessary to place them in position on the truck floor and fasten them down with the same fasteners that are used to hold the regular crew seats.

Normally a stand-by fire truck loaded with a 15-man fire-tool cache is maintained and stationed at Camp Wellston throughout the fire season. When this truck is dispatched to a fire, it is a comparatively simple job to back up another truck in front of the equipment stall in the fire-cache building, break the seal on the 5- or 10-man fire-tool cache stall, or even two or three stalls, and transfer the equipment to the combination crew seat and tool box on the truck.



Tool boxes installed in truck body, with lids open.

Increasing the carrying capacity of each individual truck reduces transportation and other important costs, principally through the reduction in the number of trucks sent to a fire, thus allowing the extra trucks to be equipped and used on emergency stand-by and elsewhere. Also, with the present war emergency, more economical use of trucks is desirable.

This method of loading and transporting fire-cache tools during the 1941 fire season was satisfactory and efficient. No difficulty was experienced in maintaining equipment after a fire, as the equipment was inspected, reconditioned, and placed in its proper place in a numbered and sealed stall until needed again. Another advantage was use of the wall space for the cache stalls, which were divided into an upper and lower compartment for various sized tools. The floor was clear of miscellaneous items and each stall was accessible for each inspection checking and inventory.

Advantages of the cache-stall system over the fire tool-box system are as follows:

1. Facilitates loading and unloading operations.
   a. Reduces accidents caused in handling heavy fire tools and back-pack pump boxes.
2. One tool box is used for two purposes.
3. Permits secure attachment of tool box and seats to truck bed.
4. Minimizes risk, and has added safety features in case of accident.
   a. Provides safe and comfortable means of riding.
5. Speeds dispatch, and permits more men and equipment to go to a fire in a single truck.
6. Reduces transportation and many other important costs in fire control and suppression work, by reducing number of trucks required.
7. Increases general utility of storage building by providing more available floor space.

HAVE WE GONE FAR ENOUGH IN THE USE OF AIRPLANES?

(Continued from page 99)

propose here. As an example: Last year we started out with a loss of about 45 percent of our old experienced men. We managed to fill these vacancies, trained the men and another 40 or 50 of our best men, and wound up the season short-handed and with a number of inferior fire-goers. Fortunately, we had one of the easiest fire seasons most of us old-timers have ever seen.

Suppose next year we have a fire season that demands a class 5 5 organization. Our fire plan shows that we need 177 detectors and fire-goers and 40 overhead. That's 112 more men than we had last year. If we couldn't get them last year with 600 B. R. C. men to pick from, what are the prospects? If, in the next year or two, we should get a season rated 6.7 danger class, the quarter-million-dollar fire plan would show the St. Joe needing 342 fire-goers and 41 overhead, plus an enormous amount of equipment and supplies which we would be unable to obtain.

FIGHTING PRAIRIE FIRES IN THE NEBRASKA SAND HILLS

Donald W. Smith

District Forest Ranger, Nebraska National Forest, Region 2 U. S. Forest Service

From articles appearing in the July and October issues of the 1940 Fire Control Notes, it is apparent that other forests and foresters have grass-fire problems and are working on applicable suppression techniques. Most fires on the Nebraska National Forest are grass fires, and 39 years of study and fire fighting by past and present personnel have developed several worth-while practices.

The so-called Austin rotary organization or "spinning firemen" technique, wherein fire fighters move along a line of fire in a rotating circle, has been in use in this vicinity for a number of years. Many local ranchers through years of experience in fighting prairie fires had developed the art of sand throwing to a high degree, and when working on fires in small groups, they frequently fell into a revolving circle as they worked along the line. Both the sand-throwing practice and the type of crew organization were picked up from them and developed into a planned method of fire fighting with the advent of CCC crews on the Nebraska. Our method is similar to that described in earlier (Fire Control Notes) articles in all but one respect. We start out with larger crews, as many as 12 men, in order that extra men will be available for patrol and mop-up along extinguished fire line. By advancing extra men in the crew and dropping them as needed, they can be located by the man in charge of the suppression crew. At the same time, these men assist in control work as they move around the fire into position.

The job of throwing sand along a line of fire is an art in itself and is quite different from an ordinary shoveling job. A short, D-handled, round-pointed shovel is preferred. Among local ranchers, the technique of throwing sand for maximum effect varies a great deal with the individual. Most of them can wield a D-handled shovel equally well either right- or left-handed regardless of whether the fire perimeter is to their right or to their left, and can reverse their hold to avoid undue strain. For maximum force in a narrow radius the best working position is different than for maximum scatter over a wide arc. For CCC use the techniques involved are taught as a standard set of motions. Flames along 10 to 12 feet of the perimeter of a running fire can be knocked down by a single shovelful of sand properly thrown.

Backfiring, or the burning of barrier strips ahead of a fire, is, of course, a most important method, too, in combating fast running, dry grass fires. We use a simple and inexpensive kerosene torch for this purpose. It consists of ⅜-inch tubing fastened to a small gate valve on a 1-quart can. The tube is nearly filled with a cotton wicking and the can is filled with kerosene through a cap on the opposite end from the tube. The valve is opened so that kerosene soaks the wicking and slowly drips. With this simple torch, a man can set grass fire as fast as he can walk.

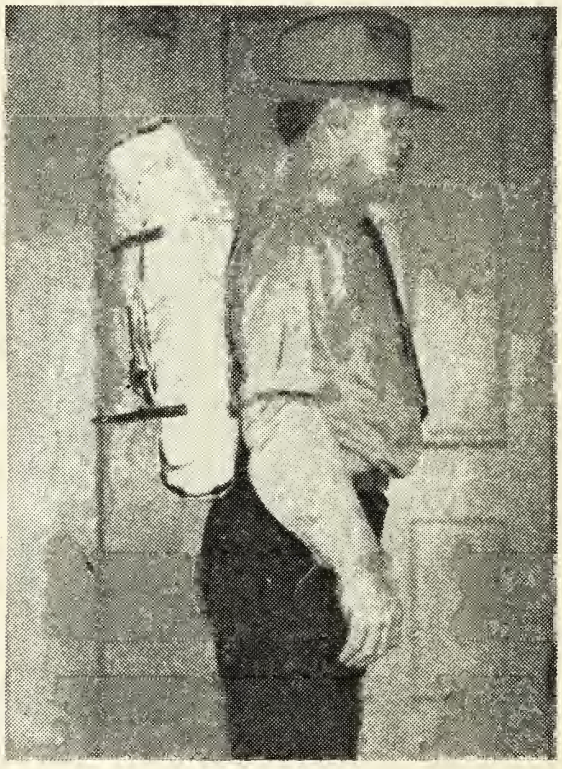
THE ROUTT PUMP ACCESSORY PACK

Samuel W. Orr

Forest Ranger, Routt National Forest, Region 2, U. S. Forest Service

For some time it has been felt that a back pack was needed in which to transport the essential tools and accessories necessary to place in operation the type Y Pacific Marine pump used on this forest.

First experiments along this line were undertaken in 1940. About a year ago, in 1941, a model pack was made of scrap material picked up around headquarters. The results were encouraging, so a request was made for funds with which to make a serviceable pack. These funds being granted, the pack illustrated in the accompanying photographs was made up.



Fire-pump accessories assembled, ready for packing. Canvas container packed with fire-pump accessories.

The illustrations describe the pack better than words can do, except for a few details which are not apparent from the photographs. The body of the pack is made of 15-ounce canvas, carrying straps are of 4-inch pack-cinch material, and all leather used is grade A. The two heavy pieces attached to the back of the pack are of the heaviest leather obtainable locally. The weight of the pack without the contents is 4½ pounds and with the contents it weighs 40 pounds. The outside dimensions when packed are 4 by 15 by 22 inches. Contents of the pack are as follows:

50 feet 1½-inch linen hose.
1 1½-inch nozzle with 2 extra tips.
1 8-foot suction hose.
1 suction strainer.
1 6-inch stillson wrench.
1 6-inch crescent wrench.
1 spaner wrench.
1 magneto wrench.

1 pair slip joint pliers.
1 pair large pliers.
1 emergency ration.
1 first-aid kit.
1 canvas bucket.
1 piece sash cord, 12 feet long.
1 headlight with 3 batteries.
1 starting rope for engine.
2 extra spark plugs.
3 extra headlight batteries.
1 screw driver.
1 coil stovepipe wire.
1 engine record book.
6 rubber hose washers.
1 6-inch machinist punch.
1 packing gland wrench.
1 spark-plug gauge.
1 check and relief valve.
¼ pound rags.
1 can cup grease.
1 pencil.
1 box pencil leads.
1 notebook.
1 set instructions.
1 2½-gallon water bag.

In making up the pack, straps and buckles were used rather than snaps and rings, as was suggested, because the pack must be cinched up tight in order to carry well, and this could not be done with snaps and rings. Also snaps have a tendency to break easily. At different times during the process of construction the addition of a tump line, belt, and breast strap was suggested. All of these suggestions were rejected for one reason or another. However, if any of these features are needed they can be added at small cost.

The addition of a small hand ax to the pack seems desirable. Often an ax can be used to advantage in placing the pump, or while traveling through the brush to the site of the fire. I would recommend a single-bitted hatchet similar to that turned out under the "Marble" trade-name. This hatchet should be carried on the outside of the pack in loops where it would be easily accessible without opening the pack. Probably the best place for it would be on the side of the pack behind the left shoulder. In this position, it would be a simple matter for a man to reach over his left shoulder with his right hand and withdraw the hatchet and go to work. A single-bited hatchet is recommended because it could be used as a hammer and thus the extra weight of a hammer in the pack would be eliminated. The 50 feet of hose is included to be used at the working end of the hose line. How often it has happened that the first 100 feet of hose has come back from a fire full of holes, usually because the hose has been dragged over the ground by the nozzle man. Since the working end of the hose line must be moved around more or less, it seemed more economical to wear out a 50-foot length rather than a 100-foot length. This hose also acts as a cushion to keep the hard objects in the pack away from a man's back.

In arranging the pack, various methods were tried with the idea of securing a well-balanced pack. The method finally selected provided that all the heavier objects should be placed in the center of and towards the top of the pack. This method of packing resulted in throwing the center of gravity well up on a man's back at just the proper point for easy carrying.

The items included in the pack are those which we feel are needed immediately, to get the pump working and to keep it working until additional equipment can be brought up. However, the contents can be varied to suit local conditions. It should be borne in mind, though,

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RECREATION GROUPS ON THE FIRE FRONT

Robert S. Monahan

Information and Education, Washington Office U. S. Forest Service

Recreation visitors are traditionally classed as fire risks. Does not our present extensive system of recreation improvements stem back to the belief that such visitors were two-legged firebrands who must be corralled in fireproofed areas?

Responsible leaders of outdoor organizations have always been sensitive to this blanket indictment. They seem to have recognized 1942 as the year when they can demonstrate the fire-consciousness of their followers not only by an effective prevention campaign but also by what is even more timely—an organized fire-fighting auxiliary.

Reports originating from all over the country emphasize the sincere desire of recreation groups to bolster regular suppression personnel. The Pacific Camping Association at its annual meeting studied suggestions for training fire suppression squads from camps of older groups.

In a special appeal to its 300,000 subscribers, the editors of Outdoor Life declared:

> The Forest Service still has trained and experienced leaders and modern equipment, but it is dangerously short of manpower. * * * Sportsmen's organizations and individual sportsmen who are willing to give their efforts and some of their spare time to helping to protect our national forests against fire during the war are asked to write to the supervisor of their nearest national forest. * * * If you can't do your bit on the firing line, do it on the fire line!

The Portland Oregonian struck a responsive chord when Bob Webb, a staff writer, challenged his outdoor colleagues:

> You have long felt a debt of gratitude toward the Government that opened these areas for your recreation and toward the men who have protected the forests against their greatest enemy—fire! You can repay that debt by joining the newest of the important home defense units, the Forest Service reserves.

Fred H. McNeil, one-time forest guard and now night editor of the Oregon Journal, addressed a stirring appeal, We Can Help Some More, to the Ski Bulletin, official publication of the National Ski Association. Writing as the first vice president of that far-flung organization, McNeil concluded his plea:

> The foresters have done much for mountain sports, winter or summer. They have come to our assistance so often in the extremity of a tournament crisis or in helping us get established in new skiing centers. So now, in a dire time, we can aid them.

Skiers are particularly well adapted to fire fighting. At the drop of a hat they are on their way whether it's a report of "new powder on Baldy" or "forest fire up Sandy." The average skier's outfit is a veritable depot of outdoor necessities. His womenfolk are a hardy, resourceful crew. And in the summer, unlike many other potential fire fighters, his muscles and lungs conditioned from a long winter season of vigorous exercise, are ready for action.

Officials of ski tournaments, familiar with adjusting split-second differences in competitors' times and spelling the names of Scandinavian contestants, should have little difficulty in preparing time reports. With uncanny sense of grade and personal knowledge of mountain terrain, cross-country skiers should be well qualified as smoke chasers. In fact, there is a place to utilize the varied capabilities of experienced skiers in every forest-fire organization plan.

These spontaneous offers from recreation groups have received the equally sincere acceptance of forest-protection agencies. Fire plans have been revised to give such volunteers the opportunity they deserve. But to be truly effective when initial enthusiasm may have waned, such cooperative understandings must be based on strong organization, positive commitments, and dependable obligations.

As Roy Headley put it, "I am confident that the readiness of cooperators to cooperate will not outrun Forest Service readiness to welcome, organize, train, and utilize their help."

THE ROUTT PUMP ACCESSORY PACK

(Continued from page 105)

that every piece of equipment added increases the weight of the pack, and weight is what we have tried to cut down. It is possible to reduce the present weight of the pack a pound or so by combining some of the tools contained in it into one tool, such as the 6-inch crescent and 6-inch stillson wrenches, the spanner wrench, the packing gland wrench, etc. The pack might be improved by using narrower material for the shoulder straps. It has been suggested that the edges of the straps as they now are might have a tendency to rub a man's shoulders. I have used 4-inch material, but 3-inch would probably be better.

All points of the pack which are subject to severe strain are double-sewed with harness thread and, in addition, are riveted with copper harness rivets. The heavy pieces of leather on the back of the pack, referred to elsewhere, were placed there to act as stiffeners and to hold the pack to shape.

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THE CYPHER HAND-OPERATED PICK-UP FIRE PUMPER

Ralph D. Cypher

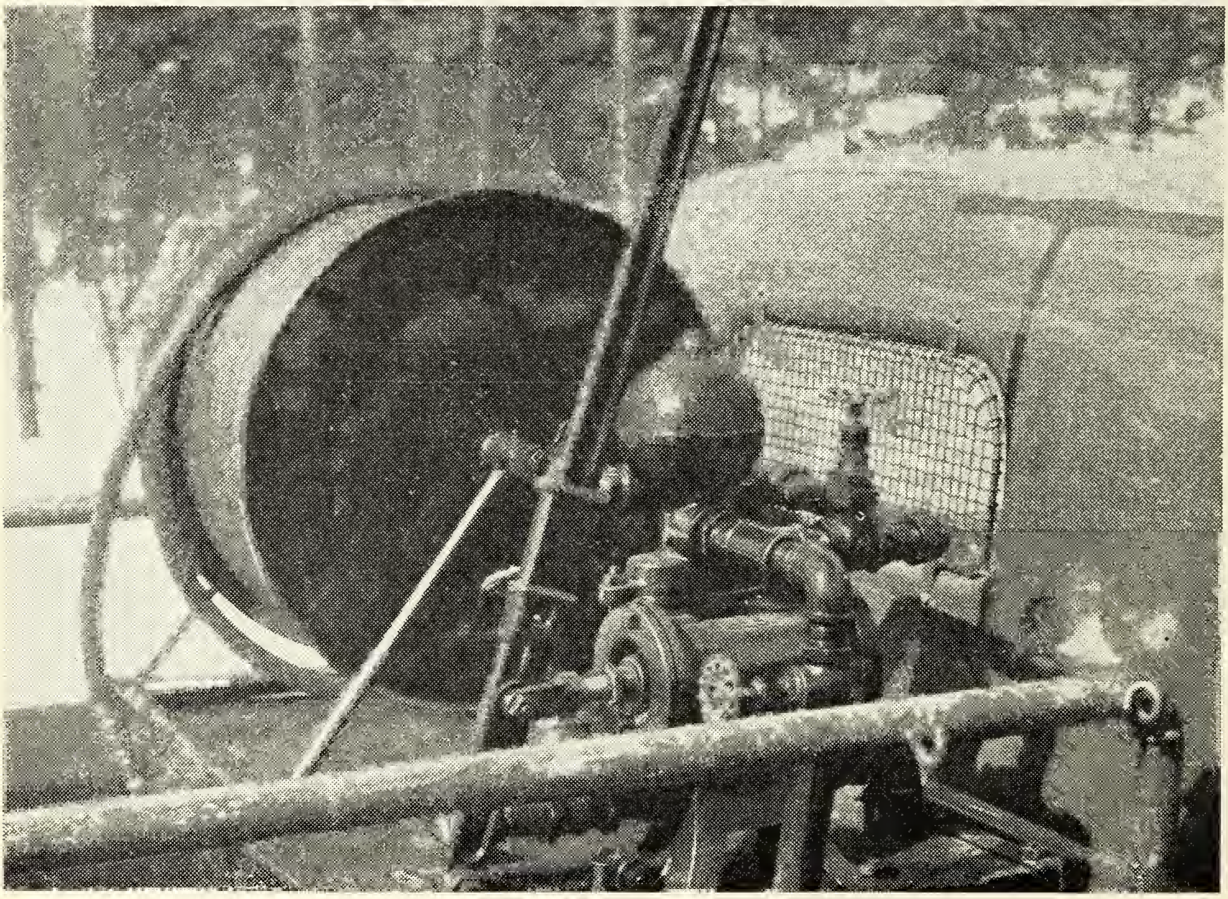
Project Superintendent CCC Camp, Sheridan F–24, Harney National Forest, Region 2, U. S. Forest Service

After observing the embarrassment of inexperienced operators attempting to start various types of temperamental power pumps and the numerous fires on which it has been impracticable to get pumpers on first attack, the idea of a small hand-operated pump that could be mounted on a pick-up and moved easily from pick-up to pick-up was considered. With this idea in mind experiments were started.

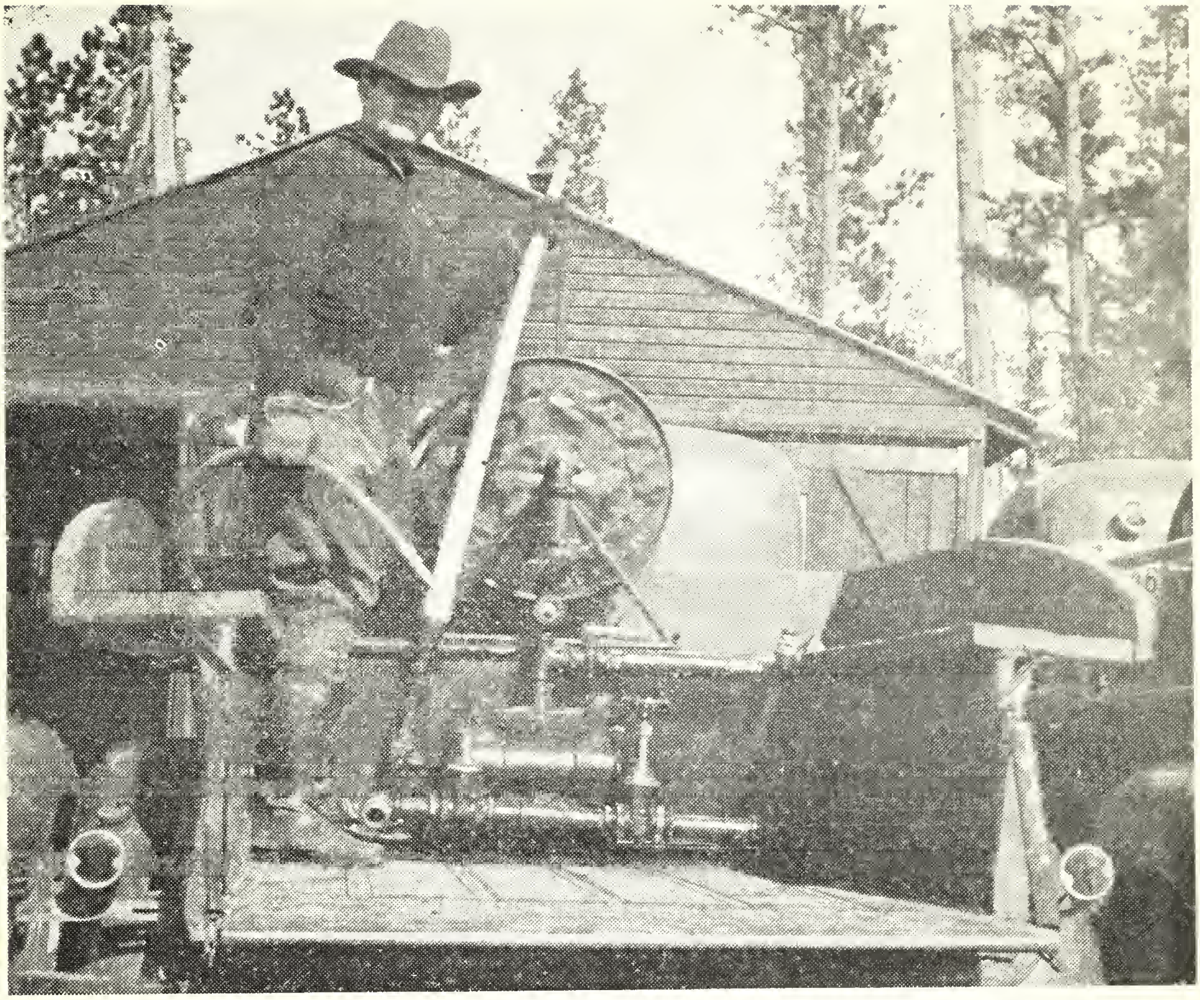
The first pumper built and still in use was made with an ordinary thresher pump mounted on a tank of 90-gallon capacity.

This outfit worked very successfully on first attack on small fires. Usually in the Harney Forest, it is possible to drive directly to the fire and in controlling lightning strikes and fires resulting from such strikes, the pick-up pumper is very valuable. It is easily operated by one man on the pump and one on the hose.

During the winter of 1941–42, two more units were constructed at a cost of less than $50 per unit. Pressure pumps of similar design to the thresher pump, but more easily operated and more efficient, were used.



Portable hand-operated water pump constructed from a used threshing machine unit.



Portable hand-operated water pump of later model.

Tanks of various capacity and shapes, partly for experimental reasons and partly because of necessity, have been used in connection with these pumps. At present, tanks of 90-, 85-, and 80-gallon capacities are in use.

A live reel, constructed from the ends of an oil barrel and a grease drum mounted on a frame of ½-inch welded pipe, carries 200 feet of 1-inch hose. This length of hose seems to fit the local situation in the most practical manner, although more or less may be used.

The tank may be filled by the pump from any source of water, such as a pond or creek, and each unit carries 20 feet of 1½-inch hose for this purpose. The tanks in use can be filled in about 3 minutes and the water supply will last from 20 to 30 minutes where a ¼-inch nozzle is used.

The entire outfit when loaded weighs less than 1,000 pounds and can be taken anywhere a pick-up truck will go. The hand pumper is not designed to compete with motor-driven pumps now in use. Its primary purpose is to fill a need for a light first-attack unit that is cheap, easily built, and operable by anyone regardless of experience, and that will deliver an amount of water sufficient for normal first-attack purposes.

EXPERIMENTS WITH FIBROUS WATER HOSE

Glenn C. Charlton

District Ranger, Williamette National Forest, Region 6, U. S. Forest Service

In this article the author described a fibrous water hose of very light weight and low cost, easy to extend over forest terrain, and of sufficient strength to deliver water by gravity flow over long distances in quantities practicable for use in controlling and mopping-up forest fire areas.

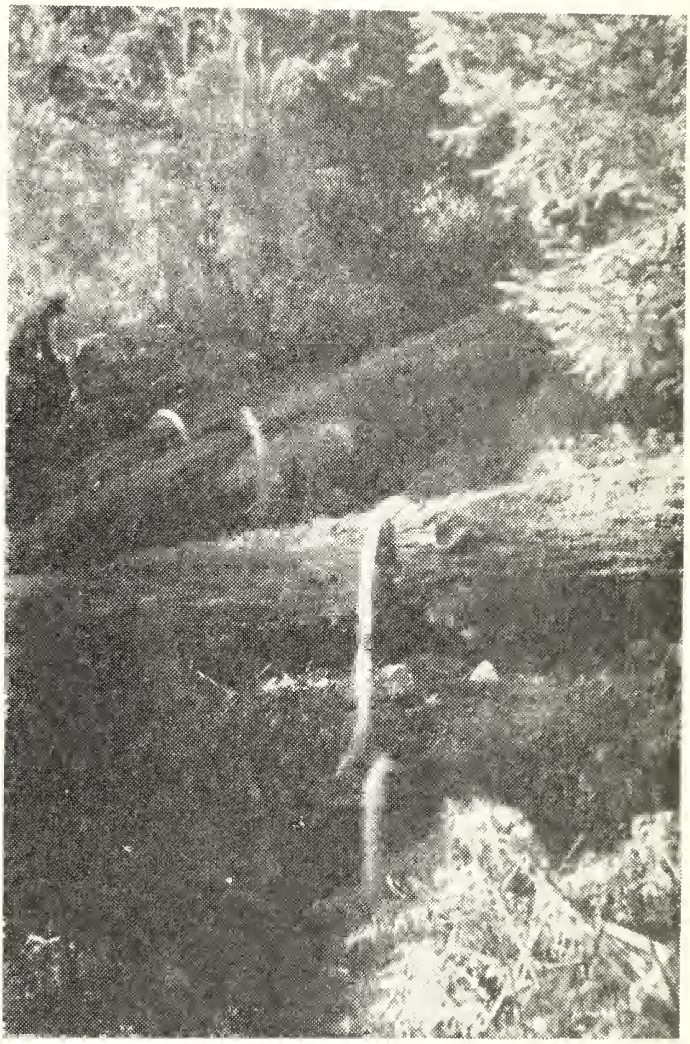
The purpose of the experiments described was to develop a light hose for conveying water by gravity to points where it can be used in fire-suppression work. In order to be practical, the hose must be strong enough to withstand the pressure developed when it is run over uneven ground and across shallow depressions or over logs and other obstacles normally encountered when laying out a gravity system; light enough to enable one man to carry several thousand feet over rugged mountain terrain; durable enough to outlast the life of an ordinary fire; and so packaged that it can be laid out at a high rate of speed.

The Visking Corporation, of Chicago, has developed a casing under the trade-name "Fibrous Sausage Casing," which they use as a covering for all kinds of sausages. It is a transparent casing made from sheets of fibrous and chemical cellulose glued together with a waterproof glue. To date, it is manufactured in 3 sizes, approximately 1½ inches, 2 inches, and 2½ inches in diameter. All sizes are made from the same weight and grade of paper. The casing comes in random lengths that vary from 50 to 500 feet. The company has stated that they can develop a process that would produce 500-foot lengths and by gluing these together, they could give us a continuous casing of any length desired. The 1½-inch casing weighs 11 pounds per 1,000 feet, or 58 pounds per mile. The 1½-inch cotton-jacketed rubber-lined hose commonly used weighs 320 pounds per 1,000 feet, or 1,689 pounds per mile.

The fibrous casing costs $0.00648 per foot or $34.21 per mile. The cotton-jacketed rubber-lined hose costs about $0.202 per foot or about $1,066.56 per mile.

The experiments with the hose began with the pressure testing of some 5-foot sample lengths furnished by the manufacturer. The test on the 1½-inch casing showed that it had a breaking strength of about 12 pounds per square inch. The breaking strength of the two larger sizes was much lower, and further experiments were not carried on with them. The next step was to purchase 500 feet of the casing and lay it out under actual field conditions. The site selected made it possible to secure a 60-foot fall in 400 feet. The ground cover consisted of slashing left from a cutting of cedar poles, which which the limbs had been lopped but the slash had not been burned, and which offered unusual opportunity for puncturing the hose. Logs and other obstacles were crossed where encountered, and no special attention was paid to where the hose fell on the ground. At the end of the 400-foot length, the hose was strung uphill 100 feet for a total vertical raise of 26 feet. All the water that could be forced into the hose through a regular sump bag was then turned in. The hose was checked daily for 3 days and every week thereafter for 4 weeks. At the end of 21 days, there was no apparent deterioriation, but on the twenty-eighth day it had ruptured at the low point. The break was repaired, but numerous small holes were found throughout the entire section that was under pressure, and new ruptures occurred when an attempt was made to raise the water to the original height of 26 feet.

Additional hose was purchased and numerous tests were made during the summer to determine its breaking strength. It was found that rupture occurred when an elevation of 28 to 29 feet above the low point was reached. When the hose was stretched between two logs, the weight of the water, combined with the internal pressure, lowered the breaking pressure in proportion to the distance the hose was suspended above the ground. Very little trouble was experienced with puncture from sharp sticks or rock, and with ordinary care this trouble can be practically eliminated. When the hose was strung over very uneven ground across logs and other obstacles, it was necessary to leave about 1 foot of slack for every 4 feet of horizontal distance in order to compensate for the extra length required when the water-filled hose sank into all the depressions. On fairly smooth slopes it is not necessary to leave additional slack.



Fibrous water hose line laid over logs.

A final test was made in the fall of 1941 with casing that had been in storage for 4 months to determine the loss of strength from deterioration and the effect of friction on 800 feet of hose, and to measure the volume of water in gallons per minute that could be forced through the hose under certain conditions. The test was made on ground where conditions were more severe than will ordinarily be encountered when the hose is used on fire.

The route followed by the hose line was divided into stations and the distance and difference in elevation were determined for each station.

Distance between hose line stations and difference in elevation

From station	To station	Distance [1]	Difference in elevation	From station	To station	Distance [1]	Difference in elevation
		Feet	*Feet*			*Feet*	*Feet*
A	B	79	−40.0	F	G	66	−15.0
B	C	66	−22.8	G	H	132	+4.0
C	D	59	−0.7	H	I	50	+2.6
D	E	50	+16.5	I	J	50	+24.0
E	F	53	−1.5				

[1] The distance between stations represents the shortest distance between them, not the actual length of hose used.

The difference in elevation between the outlet and intake was 32.9 feet, and between the low point and the outlet 30.6 feet. The latter difference is about 2 feet more than that which was used in former tests and indicates that the hose had not deteriorated in the 4 months it was in storage. Friction was also too low to make a noticeable difference as the hose ran flat down the hill to a point approximately level with the outlet. After the hose was tested for breaking strength it was leveled off so the outlet was 26 feet above the low point, and all the water that the sump would hold was turned in. The sump bag was suspended so there was a 2-foot head of water above the actual intake of the hose. The rate of flow was checked at the outlet several times and found to be 17.6 gallons per minute.

As the hose is received in random lengths and also because it is sometimes necessary to repair a break, a light coupling made of 12-gauge sheet metal was designed. It consists of a straight tube slightly smaller in diameter than the hose and has two corrugations on each end. A Y connection was also designed so that water could be diverted in two directions if necessary. The amount of water in each branch can be regulated by tying a string around the hose about 1 foot from the connections and tightening the string until the desired flow is obtained. The hose is fastened to the connections by slipping the ends over the tube and tying with a small but strong cord. A suitable reel for stringing the hose can be made similar to the reel used for stringing emergency telephone wire. A more suitable reel, however, is one made similar to the front forks on a bicycle with a handhold fastened on top. This type of reel gives the man stringing the hose a better chance to place it in the best locations and makes it easier to put it under logs or over the top of other obstacles. Since the 1,000-foot rolls weigh 11 pounds and are only 12 inches in diameter a large or strong reel is not required.

The storage of the hose does not require special facilities. Instructions from the company are to store in a cool place where it does not get wet but at the same time does not dry out. Storage in a basement away from steam pipes is considered satisfactory. Hose used on fire can be drained, rolled, and moved to a new location a number of times provided that the periods between use are not more than a day or two. It does, however, deteriorate rapidly when subject to wet and dry conditions, and salvage is not recommended when the date for future use is uncertain.

An inquiry sent the Visking Corporation in regard to the development of a stronger casing resulted in the manufacture of a slightly smaller and heavier casing. This casing withstood the pressure of a vertical column of water 39 feet high. It will weigh about one-third more, but since only 100 feet were manufactured its cost could not be determined. The Visking Corporation feels that an order of 100,000 feet would be necessary in order to justify tooling-up to make the heavier casing.

Fibrous water hose, gravity intake, and connections.

The hose does not have sufficient strength to permit use on any kind of pump system. For gravity systems it can be used to replace the regular hose wherever the outlet is not more than 28 feet vertical above low point. If pressure is needed the light hose can be run into a sump, and a power pumper with a short length of regular hose used. It can also be used to carry water to a location above the point of use and connected to the regular hose for developing pressure for gravity mop-up. Its use to carry water close to the point where mop-up is being done with pump cans will often eliminate the long pack necessary under present conditions. Another planned use is to have special smoke chasers carry it out to small fires in well watered country to expedite the mop-up.

The results of experiments carried on at the district ranger station during the past summer may be helpful to those planning to use the hose on fires. The materials needed are a sump bag with the male end of the connection from regular bhose fitted into the lower corner, a female connection of the type used for making emergency repair of regular hose in the field and which has a corrugated projection about 3 inches long, light sleeves, Y's, and a ball of small but strong twine.

Although one man can string the hose at a high rate of speed, two men can more than double the length strung out in any given time. The first man starts stringing the hose at the point of intake, while the second man places the sump bag and makes the necessary connec-

(Continued on page 123)

FIREBREAK PREVENTS LARGER FIRES

A. J. Wagstaff

Assistant Forest Supervisor, Uinta National Forest, Region 4, U. S. Forest Service

Steep slopes with flash fuels have been the scene of a number of large and rapidly burning fires, usually man-caused, in limited lower portions of the slope areas frequented by persons in travel and other activity. The author has indicated one effective method of isolating the greater portions of the inflammable slope areas from the limited lower danger zones and confining man-caused fires to these limited portions with resulting reduction in area burned, suppression costs, and damage.

In the spring of 1935 an addition was made to the Uinta National Forest, the new area extending from the valley floor above the cultivated fields at an elevation of approximately 5,000 feet to higher country some 3 miles distant at elevations of 8,500 to 11,000 feet. The vegetative cover consisted of a belt of cheat grass (*Bromus tectorum*) at the lower elevations, gradually merging into oak brush, with aspen and smaller patches of alpine fir and Douglas-fir at the higher elevations.

The cheat-grass belt at the base of the mountain presented a new fire problem, which was accentuated after the area was added to the forest. Watershed protection was of first importance, so the land previously grazed was given total protection, which resulted in the growth of a rank vegetation.

The cheat-grass belt remains very inflammable from the time the grass seeds start to ripen in early June until late October, depending upon the amount and frequency of precipitation. The annual normal rainfall over this area is 4.82 inches from June to October, inclusive.

There are no data available to show the number and size of fires previous to 1935, although fires were common occurrences.

Through the 5-year period of 1935 to 1939, however, 25 fires occurred on the area under discussion, which burned over 1,222 acres of important watershed land, costing $1,080 to suppress, with an estimated damage of $1,222.

During this time a CCC camp was located near the area and most of the suppression was done with CCC labor. Otherwise the suppression costs would have been much higher. Also it is reasonable to assume the CCC boys put the fires under control faster than a crew of civilians could have done, considering time in recruiting and previous training, which all resulted in smaller fires.

Under extremely dry conditions these fires spread very fast. Some of them have actually traveled ½ mile in 10 minutes. It was observed that trails and small openings in the grass, if they occurred before the fire reached the brush type, often controlled the bounds of the fires.

Most of this area is near U S 91 with its heavy travel load. Also the cities of Provo and Springville, with a population of approximately

25,000 people, are adjacent to the area. The human element of fire hazard is therefore high, and all fires have been man-caused.

It was thought that if fires could be checked before reaching the steeper part of the mountain, the large fires would be prevented. With this in mind, it was decided to build a firebreak, which was done in the early spring of 1940.

The firebreak was located as near as possible around the old Bonneville Lake terrace, which forms a small bench and makes construction less difficult. This location is generally at the foot of the steeper mountain but above the areas where the fires ordinarily start.

A caterpillar tractor with bulldozer and a grader were used, and the cost amounted to approximately $20 a mile. The width of the break is 8 to 9 feet, or just wide enough for the tractor. Ten miles of this type of break were constructed. No car travel is permitted over the break.


A section of the firebreak located at the base of the steeper part of the mountain.

Maintenance is not difficult and requires but one annual trip, before the cheat grass starts to ripen. The cost runs from $2 to $3 a mile.

While the break has been in use for only 2 years and one of these was the most favorable in precipitation known, it is believed the break was a good sound investment.

During the 2 years of operation, 10 fires have occurred, burning 24 acres with a suppression cost of $90 and a damage estimate of $50. The number of fires the past 2 years has averaged the same as the previous 5-year period, with the average acreage burned one-twentieth of the 5-year average.

The 5-year suppression cost average is slightly higher than the total construction cost of $200. The savings over suppression costs the past 2 years have paid for the break nearly twice. The damage costs are likewise low as compared with the 5-year average. A direct comparison follows:

Suppression and damage costs, compared with cost of constructing new firebreak

	Number fires	Acreage burned	Suppression costs	Damage estimates
5 years, 1935–39, inclusive	25	1,222	$1,078	$1,222
Average	5	244	215	244
2 years (after break constructed) 1940–41:				
Total	10	24	90	50
Average	5	12	45	25

(Continued on page 127)

FIRE TRUCK WITH CHAIN MESH AND ASBESTOS MAT DRAGS USED ON THE BLACKFEET INDIAN RESERVATION

Henry F. Wershing

Associate Range Examiner, Districts 3 and 4, U. S. Indian Service

A fire truck equipped with the chain mesh and asbestos mat drags has been used successfully for the past 3 years in the control of grass fires on the Blackfeet Indian Reservation. Its origin dates back many years. During the early days in the western plains the control of grass fires received very little attention except when they threatened ranch property and livestock. It was then a common practice to use two saddle horses to drag over the fire a wet blanket or other material, such as a green hide, or even a freshly killed animal split down the middle. This method has been mechanized by the use of chain mesh and asbestos mat drags attached to a truck.

Several men have had a hand in the development of the fire truck, both on and off the reservation. The specifications for the chain mesh and asbestos mat were worked out from equipment used by ranch operators in South Dakota. Similar equipment is being used by other Indian reservations in the Prairie States.

This type of equipment can be used only on areas that are relatively flat or rolling. The outfit has not been tried out on heavy sagebrush or shrub areas, but it is believed not to be practical for vegetation of such type. Its application is confined largely to areas of grassland and light shrubs in flat or rolling country. In general, the equipment can be used in areas which can be negotiated by a light truck.

U. S. INDIAN SERVICE

Truck rigged for action.

The chain mesh and asbestos mat drag is designed to accomplish two purposes: The chain mesh, the position of which is directly on top of the fuel, serves to break up the material and mix it to some extent with dry top soil; the asbestos mat, which is fastened over the chain mesh, shuts off oxygen from the burning material.

In areas of light to medium cover, one trip over the fire line is usually sufficient to extinguish the fire. Where the grass cover is heavy it may require more than one trip to extinguish the fire in the line made by the drags. However, the first trip usually deadens the fire to such an extent that it will not run for a considerable period of time. Mop-up crews are then used, if available; otherwise a second or third trip is made over the line with the truck. A certain amount of mop-up work is nearly always necessary to remove or extinguish the dry dung usually found in these areas. This may be done by spraying with water, burying, or tossing well within the burned line where it will burn out.

The original specifications for the chain mesh and asbestos mats are as follows:

1. The chain mesh shall be rectangular in shape, shall not be less than 80 by 100 inches and shall be constructed of round, welded rings made of 3-16-inch round steel stock, 1½ inches inside diameter. Every odd-numbered row of rings of the chain mesh shall form a complete chain having an odd number of rings. Every odd-numbered ring in each of these chains shall be connected with a single ring, forming the even-numbered rings of the mesh.

2. The asbestos mat shall be made of good-quality wire-inserted cloth weighing approximately 4 pounds per square yard, and shall be finished to 80 by 100 inches including all seams and hems, which shall be securely sewed and riveted. The manufacturer shall fasten the two mats together with heavy metal fasteners every 15 inches in rows 15 inches apart, and shall securely bind the chain mesh and mat together on all outside edges.

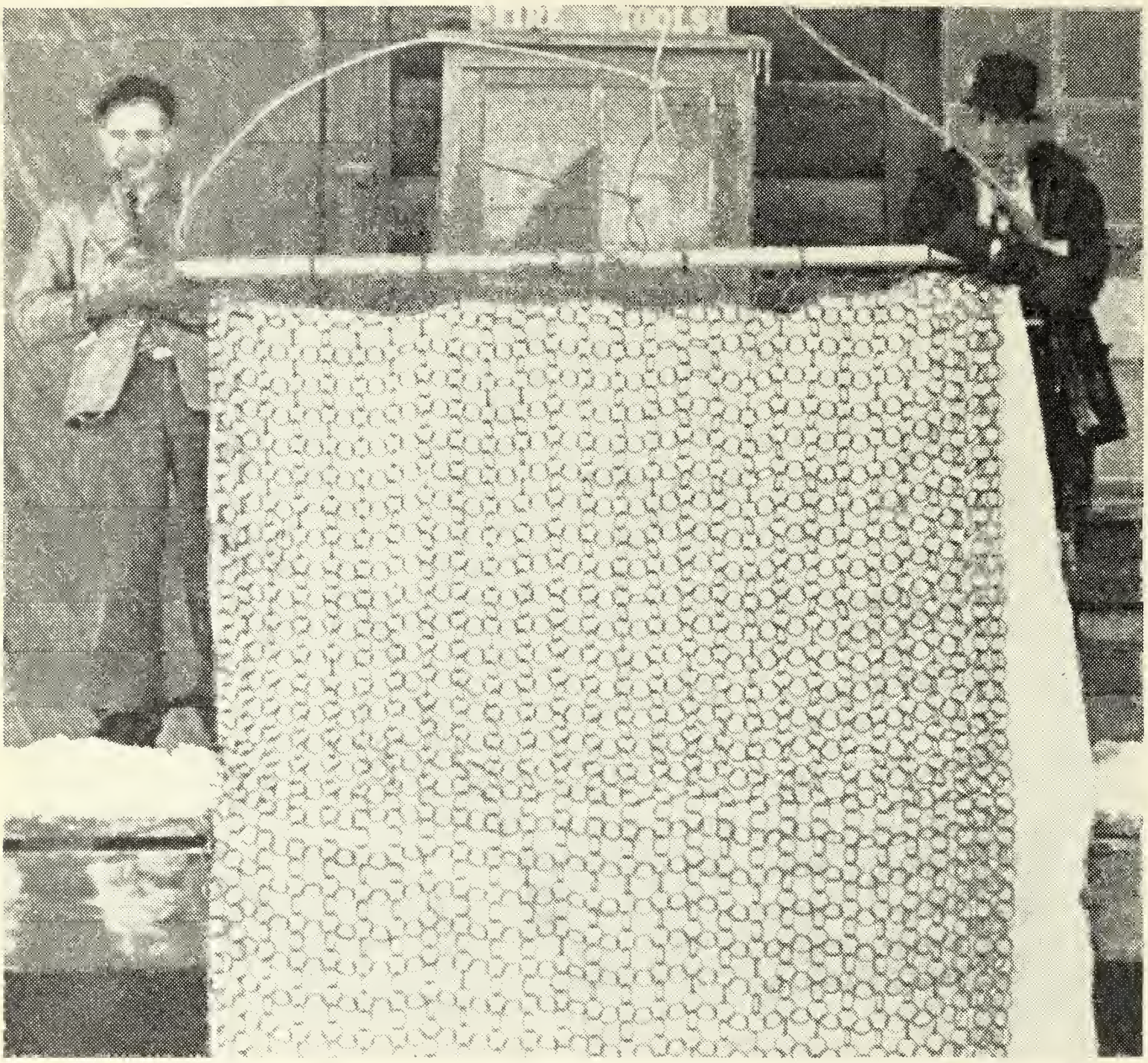
Since it is somewhat difficult to visualize the construction of the chain mesh, a detail drawing showing how the rings are put together is given in the following diagram. This diagram also gives the specifications for rigging the truck.

It will be noted that the over-all dimensions of the mats as given in the specifications differ somewhat from those given in the diagram. This difference is due largely to the fact that the mesh and mat measurements as given in the specifications, are made with the rings and asbestos stretched tight, while those in the diagram are after actual use, causing them to be loose and somewhat wrinkled.

The asbestos mats of very recent construction are equipped with snap fasteners, with which they are attached to the chain mesh instead of rivets.

The diagram and photographs give all construction features necessary to rig the truck. The mats should be attached on the driver's side so that he may watch them closely in order to prevent damage by running into obstacles and to see that they are functioning properly.

The front mat is attached to a pipe 3 inches in diameter and 10 feet long. This pipe is fastened to the heavy front bumper with steel plates welded to it and containing holes large enough to receive the pipe. A pin on either side of one of the plates is necessary to keep the pipe from slipping out. A pig-tail hook is fastened into the end of the pipe to receive the cable attached to the mat.



U. S. INDIAN SERVICE

Close-up of chain mesh and asbestos mat.

The rear pipe is set at an angle. The proper angle was determined by experimentation and may vary somewhat on other trucks. About 20° to 25° forward proved to be most satisfactory on the trucks used. The two steel plates and the method of attaching them are shown in the photographs. The left-side plate is relatively simple—a hole cut into it being large enough to accommodate the 3½-inch pipe—and is bolted to the chassis and body of the truck. The right-side plate has a band welded to it to keep the pipe from slipping through. This is all the fastening necessary to keep the rear pipe in place, as the drag of the mat keeps it from slipping forward and out. Both right and left turns can be made without difficulty.

Length of the cables which attach the mats to the projecting pipes is a matter of judgment. The shorter the cable, the steeper the angle will be between the pipe and the front of the mat. If the cable is too short there will be considerable loss of efficiency due to the mats lifting from the ground when the truck is in motion. For the front mat it has been found that the leading edge must be at least 28 inches from a perpendicular line extended from the end of the pipe to the ground. The distance on the rear mat must be somewhat greater since the pipe is much farther from the ground.

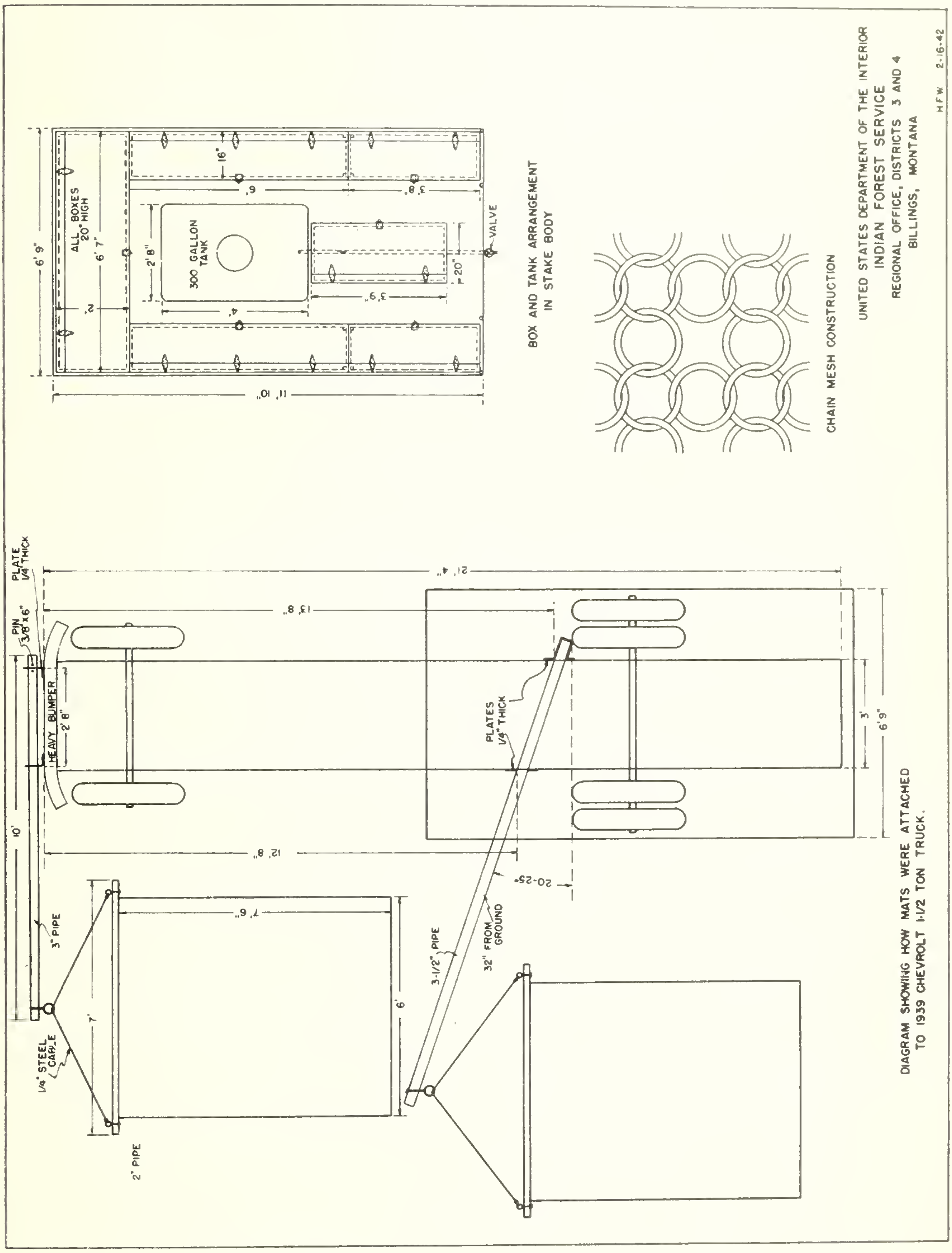


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Diagram for rigging truck.

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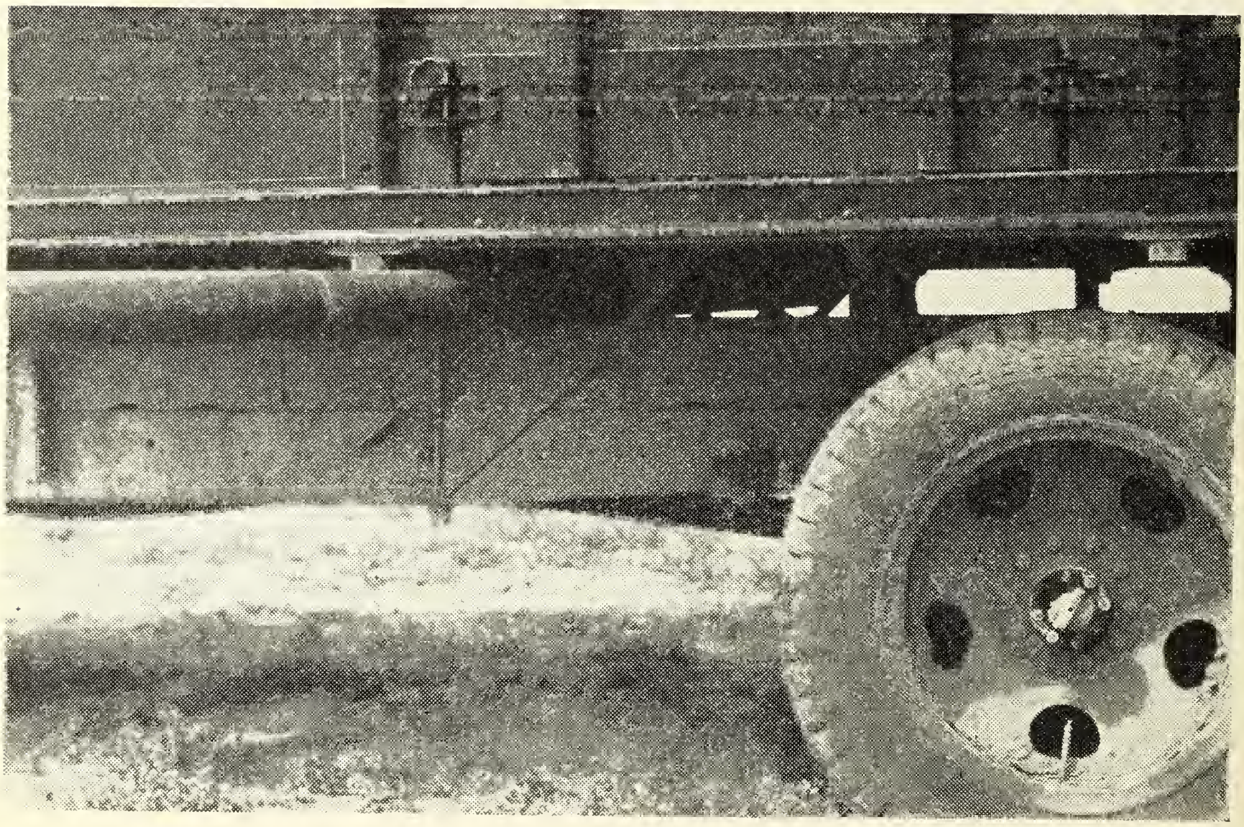
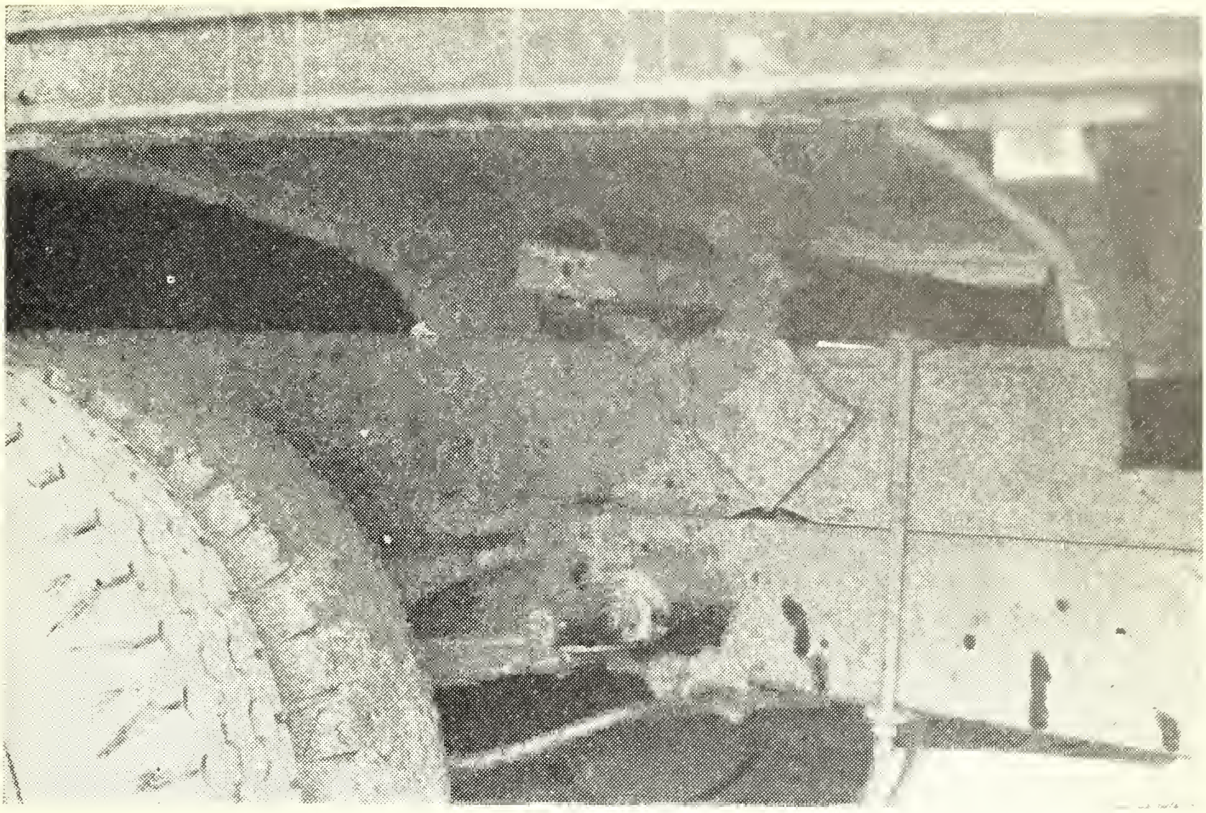
How the front assembly is attached.



U. S. INDIAN SERVICE

How left rear plate is attached.



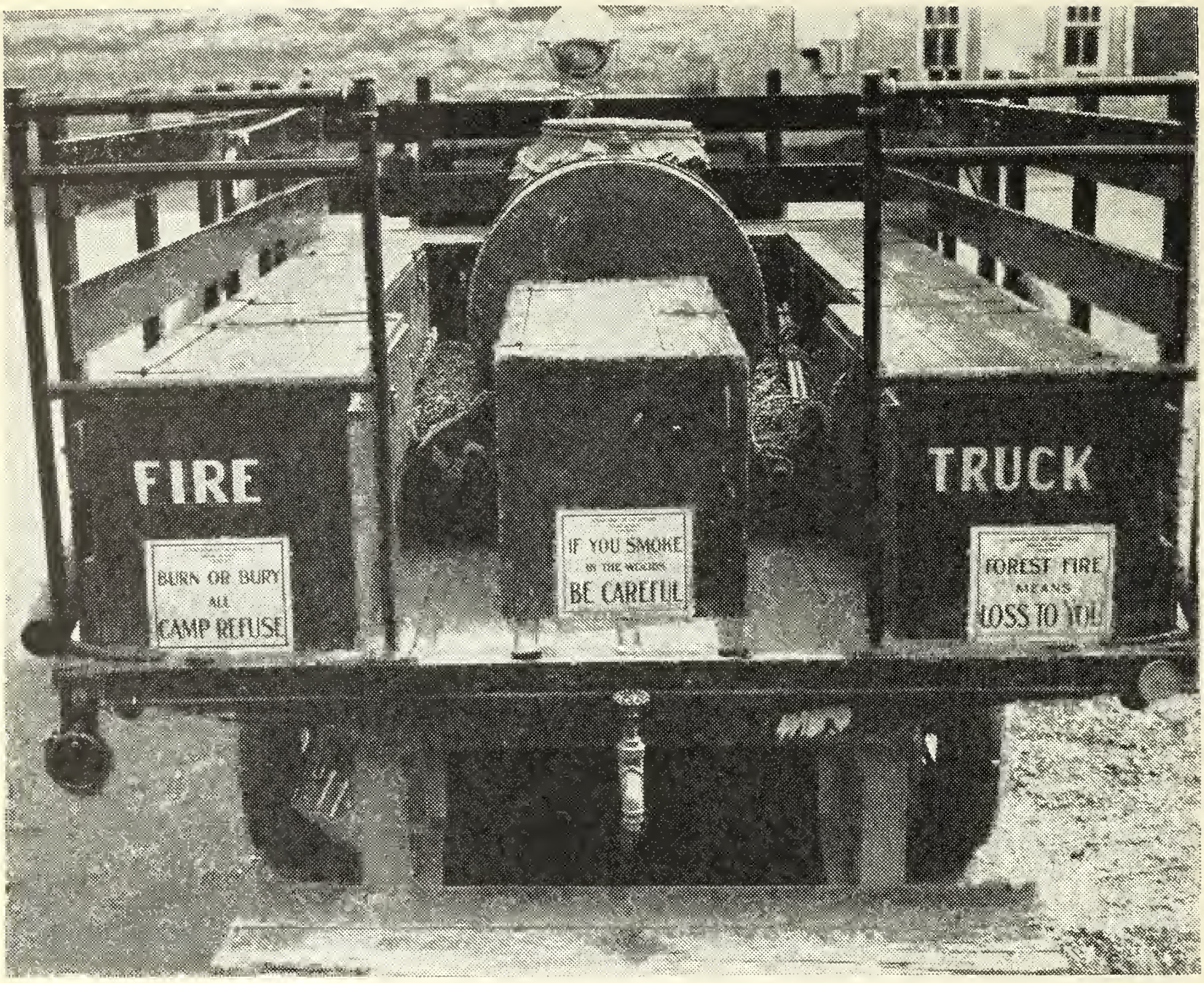
Right rear construction which keeps pipe from slipping through.

If the cables are too long there may be some difficulty in negotiating turns as the mats may be caught under the wheels of the truck. Experience has shown that there is a high proportionate loss of efficiency as the truck approaches a speed of 10 miles per hour. The arrangement on the truck causes the mats to lift from the ground at a speed of about 9 to 10 miles per hour. Best results are obtained at a speed of about 5 miles per hour, since this allows the drags to remain for a sufficient time over a given area to cool the burning material, gives the driver more time to maneuver the truck, and prevents serious damage if an obstacle is encountered.

The mats are usually dragged directly over the fire line, with the truck on the outside of the fire. However, if the ground cover is quite dry, and not too dense, a line may be dragged outside of the fire line with equally good results. A line is formed which is from 6 to 8 feet wide and is generally sufficient to stop a grass fire. Under very high wind conditions it may be necessary to drag several lines fairly close together. Occasionally it is necessary to backfire a small area which may be too rough to drive through but around which a line can be dragged. At other times a line of fire can be started with a torch, the truck being driven behind to extinguish the outside of the fire, allowing the inside to burn in toward the main front.

The truck is equipped with a large searchlight which is operated by a crew member for night work. It is useful to penetrate smoke and to allow the driver to plan his route as far in advance as possible.

The body of the truck is equipped with boxes and a tank, as shown in the diagram and photographed. The boxes were made of surfaced material a full inch in width. The hinged lids were made of heavy



U. S. INDIAN SERVICE

Tank and tool box arrangement in body of truck.

material about $1\frac{1}{8}$ inches in thickness, since they are used as seats for the crew. The tank has a capacity of about 300 gallons and is provided with a valve at the rear of the truck for filling back pumps and water bags. The opening in the top of the tank is large enough to admit a bucket and is kept closed with a piece of canvas held in place by a band made from an inner tube. The water in the tank is changed every other day to provide fresh drinking water for the crews. On long runs a bucket of water is occasionally thrown on the mats by a crew member to cool the mats, as they become quite hot from friction with the ground and the fire.

The pipes to which the mats are fastened are carried on hooks attached to the outside of the stake body of the truck. The mats are rolled, with the pipe to which they are attached on the inside, and fastened with wire. They are carried between the tank and boxes in the truck. The truck driver has been able to assemble the mats in about two minutes without help. With help, the assembling takes less time. The loading of the mats on the truck can be accomplished by one man but is somewhat difficult.

The boxes contain equipment that can be used on both prairie and timber fires. Enough equipment is carried to outfit at least 25 men. A Pacific Marine pump and about 1,200 feet of linen hose, as well as other pump accessories, are carried in the box at the front of the truck body. Other equipment is as follows:

12 fire mops (swatters).
6 bags, water, canvas, 5-gallon man-pack.
6 pumps, hand-spray, with hoses and nozzles.
1 torch, propane, with backboard.
6 flashlights, headsets.
16 shovels, lady.
16 Pulaskis.
6 axes, d. b., 3½ pound.
1 saw, C. C., 5½-foot, with handles.
10 rations, emergency, one-man, one-day.
1 lantern, gasoline.
1 gasoline, high-test (gallon).
1 kit, medicine.
1 radio, SPF.
2 buckets, canvas, folding
2 poles, antenna.
Files, stones, hammer, wedges.

The antenna poles are equipped with three rope guys and pegs so that they may be set up quickly at any place. Frequently the truck serves as one antenna pole. With two poles the radio may be set up independent of the truck. Otherwise the aerial is wrapped around the top of the stake body on the left side. The radio is carried in the cab, on the driver's seat, to cushion the jolting and prevent damage to it.

This truck is held in instant readiness for action at all times during the fire season. With the help of the truck nearly all grass fires on the Blackfeet Reservation during the past 3 years have been controlled by the "flying squad" which is loaded on the truck whenever there is a call. Under ideal conditions the truck can do the work of 50 men using hand tools.

EXPERIMENTS WITH FIBROUS WATER HOSE

(Continued from page 113)

tions. When the first man reaches the end of the first length he stops and inserts a sleeve in the second joint and continues to string out more hose. This process is continued until the desired point is reached. A little practice will enable the man stringing the hose to leave the proper amount of slack.

The second man places the sump bag and connects the hose. He regulates the flow of water to about 5 gallons per minute and follows through to the end of the first section. He straightens out bad kinks and may move the hose a foot or two for better location. He then connects the first and second joints and repeats the process. When the water reaches the desired point this man returns to the intake and gradually increases the flow of water to all that can be forced through the outlet of the sump bag. Two men should carry their own supply of hose and connections and string about 1½ miles per hour over ordinary mountain terrain.

HOW ABOUT THE ESPRIT de CORPS

E. F. Barry

Staff Assistant, Flathead National Forest, Region 1, U. S. Forest Service

This article, which relates to the method of attacking and suppressing the Honey Fire (1,092 acres, Kisatchie National Forest, Louisiana, 1938) should be read in connection with Mr. Headley's article in Fire Control Notes, vol. 3, No. 4, October 1939, pp. 40–41, Lessons from Larger Fires of 1938, under the heading "Honey Fire." Methods of attack on fires in various situations in this location have formed a controversial subject, and it is not surprising that Mr. Barry has raised some questions in this instance. Based upon all the facts now known it appears that the only method of controlling the Honey Fire at a smaller acreage would have been an immediate attack by the indirect method of backfiring. The direct attack made, failed. The action showed clearly the need for the special study in fire behavior made on this area, to supply detailed facts for training and improved action in connection with future fires. (See Fire Control Notes, vol. 5, No. 4, October 1941, pp. 161–178, An Analysis of the Honey Fire, by C. F. Olsen.)

On most fires in some regions an early direct attack can be expected to help toward the final suppression accomplishments. In this instance, where the fire in dry grass aided by the wind spread very rapidly, a direct attack by the studies crew with hand tools a few minutes ahead of the suppression crew would have been ineffective toward reducing the suppression job or the final area. Also, as is indicated in footnote 2 on the first page of Mr. Olsen's article, the studies crew upon arrival near the fire was confronted with two fences and a railroad track which prevented passage of their truck. Although Mr. Olsen's article may permit of the question as raised by Mr. Barry, it appears the discovery by the studies crew of the errors made in action methods on the Honey Fire is of greatest value and vital in future suppression work. The criticism offered by the studies personnel is wholly constructive, pointing out actual faults as they occurred, and was given only to guide our protection organizations to better accomplishment when they may be confronted again with similar fire problems. The supervisor had previously agreed that the members of the studies crew were relieved of any obligation to assist in fire suppression, it being recognized that their full attention should be given to the essential research duties on fires.

A reading of the article of C. F. Olsen, entitled "An Analysis of the Honey Fire," in the October 1941 issue of Fire Control Notes, brings to attention a situation hard to imagine. Of course, it is practically impossible for us at this remote location to visualize all the factors; nevertheless, after making generous allowances, I still experience an unpleasant jolt when I think of what happened.

There were two branches of the same department involved in the suppression of a fire, one interested in determining how the fire would behave on a bad burning day, the other charged specifically with the responsibility for stopping its spread.

The branch interested in behavior arrived at the Honey Fire first, 3 minutes after its origin according to the article. A four-man fire-behavior crew had been traveling on a paralleling highway about a mile behind a train that stopped to service a hot box. The train crew carelessly threw some burning waste into dry grass and the behavior crew happened along 3 minutes later. They found it "definitely too big for them to hold." (See footnote 2, of Mr. Olsen's article.)

The decision of the fire-behavior crew—equipped with a car having various fire-fighting tools—to refrain from an attempt to check or retard the spread of this fire when it was approximately 100 feet long is hard to understand. We would expect more from four untrained men off the street as a quality of citizenship. Forest Service guard-training instructions have emphasized for years that there is always something that even a single guard can do to retard the spread of a fire, although it may be obvious that a frontal attack is impossible. The failure to make some attempt in that direction on the part of this fire-behavior crew indicates that they did not believe in such a theory. Won't the morale and fighting spirit of our temporary guards be lessened by such an example? The public, too, may find such action, or lack thereof, confusing.

If the fire-behavior crew admitted that they were unskilled in fire fighting and limited their report to the factors of weather and rate of spread, their disregard for attempting control action could be overlooked to some extent.

The fact that suppression foremen, who apparently did their best to stop this fire, were subjected to criticism by such men indicates an oversight in personnel management that cannot help but decrease spirit and morale in a marked degree. Moreover, the fire-behavior crew has been permitted to make capital of their questionable action by printing the results of their study.

There is no quarrel with the policy of conducting fire-behavior studies, and the men assigned to that duty should not be expected to take part in the suppression work on fires that have escaped first control efforts. However, there should be no tolerance of a policy permitting an organized crew of men to travel about the country looking for fires to study unless they are willing to lend a hand in an effort to check the spread of small fires pending the arrival of regular suppression crews.

It is hoped that in the future this fact will be made clear to all, so that even though a fire cannot be entirely stopped, it may be retarded, thereby permitting arriving suppression crews to handle it more easily. That kind of action will make far better reading than the one referred to above, and the results after the fire is out will go far toward strengthening the spirit and morale of the whole organization.

REPAIRING LINEN FIRE HOSE

Anne C. Allen

Chief, Cedar Hill State Forest Fire Experiment Station,
Cedar Hill Fire Department, Cowesett, R. I.

An easy and efficient method of repairing the leaks, or "weepers," in linen fire hose has long been the aim of many departments. All forest-fire-fighting organizations have had the experience of placing in use brand-new hose and finding holes that emit streams the size of a lead pencil. These holes, caused by the knotting of the thread during manufacture are annoying, to say the least. Furthermore, lengths of hose that have been in service for a time will spring serious leaks.

With an eye to saving hose for war needs, this station began intensive research into the matter of repairing hose. Finally evolved was a method for repairing that will work, not only on linen fire hose but

Plugs used in linen hose.

on regular rubber-lined fire-department hose. The method is easy and efficient, may be employed while the hose is in use, and is low in cost.

M. L. Holst, Chief Forester for the Cedar Hill Forest Fire Experiment Station, conducted the research and tests over a period of several months and under various conditions. It was found that the most inexperienced members of the Rhode Island State Forest Fire Service crews could, by using the method, make repairs on filled hose at 150 pounds pressure, or even higher.

Back in the "gay nineties" when bicycles were the rage, a small brass plug to stop air leaks in single tube bicycle tires was invented. There were several different makes, among them the Sampson brass plugs, patented April 1898, and the Spooner brass plugs. All bicycle stores carried the plugs then and they and the large mail-order houses still carry them. These small brass plugs have now been put to a new use—that of repairing the leaks in fire hose!

The plugs come in three sizes—large, medium, and small. The two larger sizes are best for repairing fire hose.

The efficiency and durability of the plugs could be greatly increased if they could be dipped in some sort of rubber solution, which would cover the bottom and cap with a coating of rubber. It has not been possible, however, to interest anyone in manufacturing a rubber-covered plug, because of present war conditions.

FIREBREAKS PREVENT LARGER FIRES

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In other words, during the past 2 years there has been a direct saving on the area of 464 acres of burned area, $340 of suppression costs, and $438 of estimated damage.

It is not expected that this firebreak is going to stop all the fires on the area, nor has it solved all of the fire problems, but so far no fires have crossed it.

The evidence is that thus far it has been a great help in limiting the size of fires, which has resulted in smaller suppression costs and less damage. Its value will be better appraised in the future.

WHERE ARE WE GOING WITH CONFLAGRATIONS?

Lowell J. Farmer

District Ranger, Powell National Forest, Region 4, U. S. Forest Service

Looking ahead to new fire-control methods as one forest officer sees them.

It is the year 2042. Tremendous acreages of second-growth timber cover the areas that 100 years ago had scarcely known the ring of the woodsman's ax and saw. The summer is hot and dry, and every lookout is at his post, tense and waiting. An electric storm slowly darkens a vast panorama of forest land and the fireworks begin. Suddenly the headquarters radiophone booms out information on two smokes. Within 3 minutes two planes are following the radio beam to the fires. Approaching the rising smoke columns, they circle low, emitting dense billows of oxygen-eating gas that settle rapidly to the ground smothering the flames that are already getting under way. As the planes circle to return for a recharge of gas two more take their places. Two transports discharge small smoke-chasing crews by parachute and within a short time the fires are under control.

Combined research and experience in dealing with forest fires today (1942) is approaching the point where, in probably much less than 100 years conflagrations will be unknown. Developments in technique all point toward a methodical and precise handling of potentially large fires. Radio is used now in all the ways mentioned. There is every reason to believe that a direct beam to any point will be used in the future. The gas may be one we know or it may not yet have been developed.

The other angle is simply consideration of forest fires from the point of view that combustion is a chemical reaction, while we have not given suppression activities a strictly chemical approach.

Those who studied elementary chemistry learned that the requirements for combustion are:

1. Proper mixing of fuel and air in proportions which will insure complete combustion.

2. Exposure of fuel particles to oxygen throughout a period of time sufficient for their combustion.

3. Maintenance of the combustion zone at a temperature above that of the ignition zone.

Fire-danger rating charts now in wide use successfully forecast the first requirement, and we prevent the other two by removing the fuel. As far as I know, we have never attempted to handle a potentially large fire by removing the oxygen supply. Will this be the next experimental step in suppression technique?

Theoretically, as determined from a table on the combustion properties of fuels, 11.5 pounds of air are required to burn 1 pound of car-

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LIGHTNING VERSUS BOMBS

L. L. Colvill

Assistant Forest Supervisor, Siskiyou National Forest, Region 6, U. S. Forest Service

On July 13, 1941, at 10 p. m., the Bear Basin Lookout house, elevation 5,300 feet, was struck by lightning and the same strike started the Bear Basin fire.

District Ranger Quackenbush and the writer investigated the results of this strike the next day, and the following is a brief description of what we found.

The look-out building is a gabled-roof, 14 by 14 Alladin house, equipped with standard lightning protection, and with the ends facing north and south.

Apparently the lightning bolt was horizontal and struck the north end of the building at the top of the window sash and in the approximate center, and appeared to have exploded when it contacted the lightning conductor which extends across the end of the building at the top of the window frame. This end of the building was blackened for several feet in all directions. A considerable portion of the charge was carried from the building by the northwest guy line, as evidenced by the ground which was torn up for several feet where the line was anchored. At practically every point where the lightning conductor was fastened to the building, there were indications of a heavy voltage. The impact against the building was so great that it shattered one window sash, and approximately two-thirds of the window panes in the building. Much of the broken glass was pulverized and there was hardly a piece bigger than a dime. The nails in the building at the north corners were so loosened that many of them could be pulled by hand. A radio antenna wire, which extended for about 50 feet on the north side of the building and which was disconnected before the storm and left lying on top of the brush, was completely burned and the brush was scorched.

A considerable portion of the charge went through the building directly over the fire finder, striking a gasoline lantern which hung from the ceiling and shattering the globe but leaving the mantels untouched, then passed out through the window at the opposite end of the building, resulting in two holes in the top panes approximately 5 inches in diameter. The look-out and his wife were standing on opposite sides of the fire finder, and this portion of the charge going between them and slightly over their heads knocked them unconscious for approximately 1 hour.

The master switch for protection of the telephone was located on a pole approximately 10 feet from the south end of the building and directly in the line of travel of the lightning. It was struck at the point where the copper U-connectors holding the ground rod are fastened to the box. The charge was further broken at this point, and a portion went through the discharge gap in the switch with such force that it broke the bakelite base and went out over the telephone line, eliminating all traces of the line for one-fourth mile. A part of the charge was deflected down the copper ground conductor to where it connected with the No. 9 galvanized telephone ground line. This telephone ground was anchored in a spring approximately one-fourth mile distance, and the lightning eliminated all traces of this ground line for approximately 400 feet and set the brush on fire for this distance. The telephone was not damaged. No doubt the lightning conductors carried away a large volume of the charge, but the fact that the building failed to catch on fire and cremate the unconscious bodies of the look-out and his wife is miraculous.

Thirteen days later lightning again struck at Bear Basin, but this time its course was more conventional. The lightning struck a tree located several hundred feet from the building, on which the telephone line was anchored, followed the telephone line through the master switch which had not been opened, burned out the lightning protection fuse, and entered the telephone instrument and burned out the generator, thus completing the job started July 13.

WHERE ARE WE GOING WITH CONFLAGRATIONS?

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bon. Mr. Fredrick T. Morse, assistant professor of mechanical engineering at the University of Virginia, has devised the following formula to determine the number of pounds of air necessary to burn 1 pound of coal:

$$Air = 11.5C + 34.5\ (H - \frac{8}{0} + 4.35S)$$

Substituting in the formula where the symbols represent fractional portions of the elements, it should be a simple matter to determine the amount of air necessary to burn any of the forest fuel types. The reducing action might then be accomplished by any gas having sufficient weight and density to adhere to the ground level and possessing the ability to absorb enough oxygen to bring the available amount below that required. The factors of atmospheric density, pressure, temperature, and motion would all enter into the computations.

At the end of this year we will read quotations on the thousands of acres of timberlands destroyed by fire. Next year the figures will be compared with those of previous years and remarks will be cast about peak years and good years. New forest-fire films will be made. The public educational program will be expanded. New features such as "hula dancers" and "fag bags" will catch the public fancy and make them fire conscious. But we still summarize our annual fire losses in *thousands* of acres. The fag bag has served its purpose when it prevents a fire, but there will always be lightning storms and there are too many fires that get out of bounds before men can be placed on them. Let's not wait until 2042. Conflagrations can be licked and some day someone is going to figure out a way to do it.

CEMENT AS A FIRE EXTINGUISHER

Roy Cross

Kansas City Testing Laboratory

SCIENCE, January 23, 1942, contains a short article "Pitch the Best Incendiary Extinguisher," by Dr. R. R. Sayres, Director of the U. S. Bureau of Mines.

It would seem to the writer that a good deal of caution should be used in the application of pitch to extinguish fire, even though it originates from a magnesium incendiary bomb. It has been the experience of the writer with a great variety of small fires in oil, metals, and other materials, that there is nothing so satisfactory and so foolproof as portland cement as it is placed on the market. In many cases in the writer's experience it has been highly successful in extinguishing fires where water, carbon tetrachloride, foam, and similar substances have been unsuccessful. This very common material so easily available and so safe to use should be placed at points where there is danger from fires either from incendiary bombs or from normal causes.

In our own laboratory, such material is easily available in kegs and we find it far more successful than the usual fire extinguishers. Furthermore, it gives off no injurious gases and is in itself not combustible, as is the case with pitch.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Legends for illustrations should be typed on a strip of paper attached to illustrations with rubber cement. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing illustrations, place between cardboards held together with rubber bands. Paper clips should never be used.

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustration. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired. Do not submit copyrighted pictures, or photographs from commercial photographers on which a credit line is required.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproduction. Please therefore submit well-drawn tracings instead of prints.

The approximate position that illustrations bear to the printed text should be indicated in the manuscript. This position is usually following the first reference to the illustration.