

FIRE CONTROL NOTES

A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

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 techniques may be communicated to and from every worker in the field of forest fire control.

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FOREST FIRE CONTROL

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, 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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FIRE HAZARD RESULTING FROM JACK PINE SLASH¹

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INTRODUCTION

The accumulation of slash during logging operations introduces a serious problem to those concerned with fire control. Not only are fires more likely to start in slash areas but once ignited they have a greater resistance to control and often do more damage than fires burning in an uncut forest. Slash is treated in a number of ways depending usually on the cutting method. Essentially, there are two main treatments—leaving the slash on the cut-over area, or removing it by burning. Further, the manner in which the slash is left has an effect on the subsequent fire hazard.

The comparative fire hazard of areas of burned and unburned slash was investigated by Munger and Matthews (6)² and they concluded that unburned slash in western Washington and Oregon is one-third more hazardous than burned slash 10 years after logging. Cheyney (2), on the other hand, writes in the *Journal of Forestry*: "It would be a conservative statement to say that no slash is a special fire hazard in the Lake States for more than 5 years after it is cut." There appears to be no doubt, however, that an accumulation of slash in a cut-over forest will increase the fire hazard of the area for a considerable period after cutting operations have been completed. Further, it is evident that in any locality the increase of hazard brought about by the presence of slash will vary somewhat with the method of slash treatment employed, and with the number of years which have elapsed since cutting took place.

The Federal Forestry Branch, in co-operation with the Manitoba Forest Service, conducted a series of large-scale test fires in slash areas in the Sandilands Forest Reserve. The object of the study was to determine experimentally, (a) the comparative fire hazard in jack pine in similar cut-over areas where different slash treatments had been employed and, (b) the variations in hazard which occur as slash ages. The term "slash age" will be used to refer to the number of years since logging.

This study also provided an opportunity for an investigation of the effect of slash disposal methods on jack pine regeneration. The results of this investigation are described by H. J. Johnson in a current publication of the Federal Forestry Branch (4).

¹An article of this title appeared in its entirety in 1955 as Forest Research Division Technical Note 22 of the Forestry Branch of the Canada Department of Northern Affairs and National Resources, Ottawa. A somewhat shortened version is published here through the courtesy of the author and the Forestry Branch.

²Italic numbers in parentheses refer to a list of References, p. 8.

DESCRIPTION OF AREA

The Sandilands Forest Reserve lies near the southeast corner of Manitoba at the western extremity of Halliday's (3) Great Lakes-St. Lawrence Forest Region. The topography is flat and the soil is sandy. Stands of jack pine (*Pinus banksiana* Lamb.), the most important commercial species in the area, are typically very open and consequent heavy branching results in moderate to heavy slash accumulation during logging operations. High underbrush is very scattered and other vegetation is moderate with bearberry (*Arctostaphylos uva-ursi*), blueberry (*Vaccinium* spp.) and caribou moss (*Cladonia* spp.) as the main components along with a considerable amount of grass.

The area in which the study was made is adjacent to agricultural land and is subject to fires started by land clearing operations. Owing to the lack of natural water supplies and to the nature of the soil, fire suppression is best effected by hand tools and pumper-tankers.

The cutting methods which had been employed were mainly medium to heavy selection cuts and a few clear cuts.

METHOD OF STUDY

Examples of 6 different slash treatments were available in the Sandilands area, and areas representing 4 stages of slash deterioration were located. Duplicate test fire plots were placed within each slash age-class for each type of disposal method, wherever it was possible. Table 1 shows the distribution of plots which were available and on which the conclusion of this study was based. In addition to the plots listed, two control plots were located in a representative uncut jack pine stand.

The sample plots were square, 100 feet to the side. Two single firefurrows were plowed around the perimeter of each plot as a fireguard and, where slash was particularly heavy, an additional fireguard was plowed approximately 20 feet outside the first. A Manitoba Forest Service fire ranger and five or more men were present at all tests and, when the plots had been burned, hand tools and pack tanks were used to extinguish the fires.

Four-foot stakes were set at 20-foot intervals throughout the plot providing a grid which greatly facilitated the plotting of the fire perimeter as burning progressed. Just before burning, each plot was inspected and a complete plot description was recorded on specially prepared forms. Particular attention was paid to the height of the slash; ground vegetation; kind, amount, and depth of duff; and the thickness of the humus layer. The number of pieces and sizes of the heavier fuels (3 inches or more at the large end) were recorded.

Air temperature and relative humidity were measured with a sling psychrometer, and other weather conditions were noted. The wind velocity at the time of the fire was measured with a portable anemometer and its direction was estimated with the aid of a box compass. The amount of dew which formed the

TABLE 1.—*Distribution of test fire plots according to slash treatment and slash age class*

Slash treatment	Plots burned when slash age class was—			
	1-2 years	3-5 years	6-9 years	10-12 years
	Number	Number	Number	Number
Left as cut (untreated).....	2	2	2	1
Piled and left unburned.....	1	2	2	2
Piled and burned (100 percent).....	1	2	2	2
Tops only (stands with clear-boled trees)....	1	2	2	0
Lopped and scattered (maximum depth 18 inches).....	1	2	2	2
Windrows (1 chain apart, unburned) ¹	0	2	0	0

¹This treatment dropped from study because of insufficient data.

previous night was measured by the method developed by the Federal Forestry Branch (?) and recorded in the field notes.

Various sizes of branches, duff, and other fuels were sampled and their moisture content determined by laboratory methods.

Immediately after igniting each test fire, an observer and an assistant began plotting the position of the fire perimeter at 1- or 2- minute intervals depending on the rapidity of spread. Observers worked independently on the leeward and windward sides of the starting point and were able to keep accurate records of the fire's progress with the aid of stop watches and guide stakes. Notes were made also on the height of flame, vigour, smouldering, and depth of ash.

When the fire was out, further notes on the severity of the burn were made. Estimates were made of the percentage of the area left unburned as well as the percentages of each type of unburned fuel.

The careful plotting of the fire perimeter at regular intervals gave a very comprehensive picture of the fire's progress and a measure of its rate of spread. The grids were planimetered and the proportionate area burned during each 5-minute interval of the fire's progress was determined.

A numerical hazard index was computed for each test fire, using much the same method as that employed regularly by the Forestry Branch in rating small-scale test fires (5). In calculating this hazard index the factors used and the relative weights given to each were as follows: (1) rate of spread, 30 percent; (2) total area burned, 20; (3) vigour, 20; (4) height of flame, 10; (5) smouldering, 10; (6) depth of ash, 10. These factors, with the exception of vigour and smouldering, can be measured directly with the result that errors owing to personal judgment are kept to a minimum.

Following the described procedure, all test fire plots shown in table 1 were burned during the summer periods of 1949, 1951, and 1952. A fire weather station was set up in the area and the danger index was calculated daily, throughout the periods of the tests, from the Midwest Fire Danger Tables (1). All tests were made when this local danger index was in the range 7 to 12; the average for all tests was found to be 9.

Each test fire was given a hazard rating as determined by the six performance factors listed above. An adjustment of one hazard index unit was made to the rated hazard for those tests made on days when the local danger index differed from the mean by two units or more. For example, one plot was burned on a day when the local danger index was 7. To adjust for the lower fire danger conditions on this day, the rated hazard index for that test fire, calculated to be 11, was increased by one unit to 12.

It should be noted here that the local danger index refers to the average fire danger in all fuel types in the area, whereas the rated hazard index is a measure of the fire hazard as indicated by the individual test fires in the fuel concerned.

ANALYSIS OF DATA

Burned slash.—Analysis of test fire behaviour in cut-over areas where slash had been piled and burned indicated that the hazard is substantially lower than in areas where the slash had been left unburned. Further, it was found that, when slash is burned after cutting operations, the fire hazard can be expected either to be similar to that existing before the area was cut or slightly higher because of increased insolation. Other investigators have found that, under full insolation, fuel temperatures approaching 150° F. are not uncommon.

The conclusions drawn here will hold true only if the slash burning operations have been thoroughly carried out, in which case all the slash in the piles will have been destroyed. It is to be expected, however, that in some instances the original duff and litter will be left unburned between the piles.

Of the test plots burned in this group, one was not included in the analysis. The plot description indicates that there was an 85 percent coverage of jack pine duff and litter on the plot as opposed to an average of less than 10 percent on the remaining 6 plots representing this treatment. The depth of litter and humus on that was double the average of the other plots. This was, no doubt, a result of the unusually high density of the residual stand. Observations made on this plot, therefore, were excluded from the analysis on the basis that fuel conditions were not typical.

Figure 1 shows the comparative hazard to be expected with each type of slash treatment studied and with slash age. The curve for piled and burned slash (fig. 1) describes the hazard of burned slash over the years since it was cut. This curve shows that, if slash burning is done thoroughly, the hazard will be almost nonexistent immediately afterward and will increase,

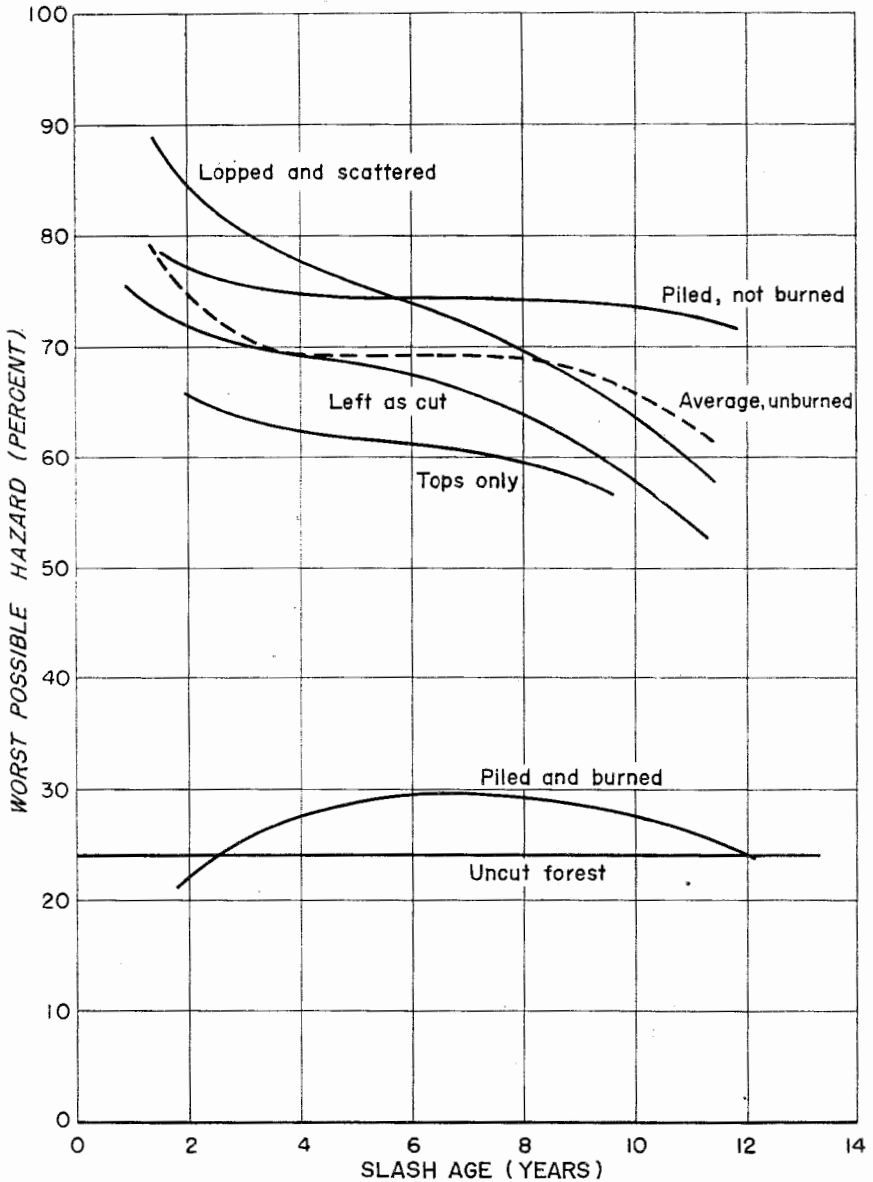


FIGURE 1.—Variation in hazard with age of slash.

within a period influenced by the density of the residual stand and the growth of new vegetation, to a value comparable to that in the uncut stand.

Unburned slash.—The analyses of tests on unburned slash showed that fire hazard will remain comparatively high; regardless of treatment, for at least 10 years after the cut. Figure 1

shows the percent of worst possible³ hazard to be expected with each disposal method. These methods are listed in decreasing hazard potential at a slash age of approximately 2 years: (1) Lopped and scattered; (2) piled and not burned; (3) left as cut; (4) tops only.

Differences in hazard owing to the use of different treatments of unburned slash, however, were found to be small and of little significance. Of somewhat greater significance is the fact that slash which has been lopped and scattered or left as cut deteriorates more rapidly over the years than that which has been piled and left. Thus the hazard existing in cut-over areas where the slash has been scattered or left strewn about, although initially high, falls off with age at a relatively rapid rate.

On areas where tops only have been left after cutting, the hazard is lower than when other treatments have been employed and the reduction in hazard over the years parallels closely that for piled slash. It should be borne in mind, however, that in the Sandilands area stands are typically open, and this type of slash consists mainly of scattered tops. Where this treatment is used in heavy stands the tops are more or less contiguous and the slash resembles that left as cut.

Of the test fires made in slash which had been piled and left, only 6 of the 7 fires were considered to be truly representative of normal conditions. A changing wind direction during the course of the burning of one plot prevented the fire from burning consistently on any one front. Also, there were more bare patches on this plot than were normally encountered on the remaining six plots. In consequence, observations made on that plot were not included in the analysis.

The average height of the piled slash was 3 feet and when the test fire was in progress, sufficient heat was produced by the burning piles of slash to promote the rapid spread of the fire between the piles. This was normally a distance of 20 feet. Under the piles, all duff and organic matter was completely burned to mineral soil, whereas between piles the burn was light. There was less falling off of hazard with slash age than occurred when the lopped-and-scattered or left-as-cut methods were employed.

In almost all areas of piled slash and tops only, there were sufficient surface fuels to allow the fire to run from pile to pile or from top to top.

CONCLUSIONS

In the region and season in which these tests were made, the burning of jack pine slash, when thoroughly carried out, will reduce the fire hazard to a level comparable to that of the uncut forest and to about one-third of that of unburned slash. Therefore, where hazard reduction is of primary importance, serious consideration should be given to slash burning after cutting

³"Worst possible" refers to the highest hazard rating based on the 0 to 16 danger index scale.

operations. This is the only commonly used slash disposal method which is effective in reducing the fire hazard.

The hazard resulting from unburned slash is comparatively high for at least 10 years after it has been cut; about 3 times as great as the hazard of the uncut forest. Some further effects regarding unburned slash were noted in this study: (a) The hazard is highest immediately following the cut when the dead foliage is still clinging to the twigs. (b) The hazard diminishes gradually as the needles dry and fall—that is, until approximately 4 years after the slash has been cut. (c) From this point until the slash is 8 or 9 years old, the hazard decreases slowly as the debris weathers and compacts. (d) After this time the slash has been reduced by weathering and other action to a point where it is overgrown by an increasing abundance of vegetation. With this increased shade, the slash receives less ventilation and solar radiation and, as a result, the rate of moisture loss is reduced, thus further lessening the hazard.

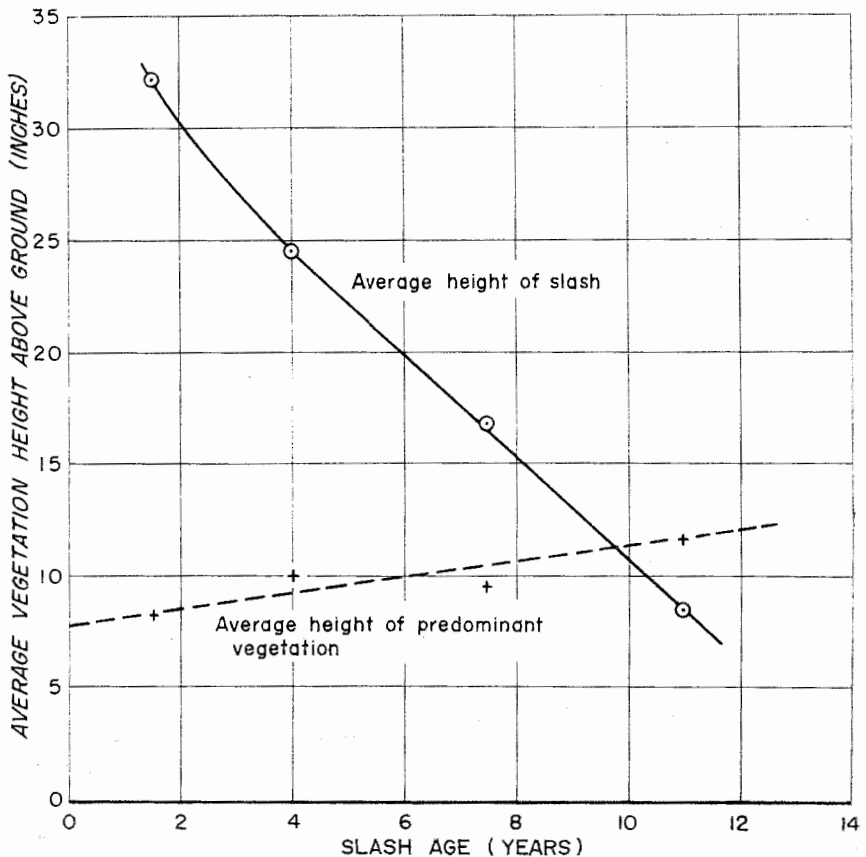


FIGURE 2.—Deterioration of unburned slash with age, and growth of ground vegetation after cut.

An illustration of this process is given in figure 2. The 2 curves show the relationship between average height of slash and height of ground vegetation during the first 12 years following the cut. From this graph it appears that green vegetation begins to overtop the slash 10 years after the cut. Figure 1 shows a general falling-off of fire hazard at approximately this same point. It may be expected that, where environmental conditions differ from those of the area under study, the rate of slash deterioration and vegetative growth may also be different.

The small differences in hazard resulting from the use of the four different treatments of unburned slash are more or less of academic interest only. The choice of one method over another will depend a great deal on the chooser's point of view. For example, it may be felt that the high initial hazard of slash which has been lopped and scattered or left strewn over an area is offset by the relatively rapid rate of hazard decrease which would obtain with increasing slash age. Others may argue that this high initial hazard is too risky to tolerate under any circumstance.

Although Johnson (4) found that the poorest regeneration resulted from piling and burning, no slash treatment studied gave a satisfactory stocking of seedlings. Thus, because it results in the lowest hazard, the piling and burning of jack pine slash should be carried out whenever it is economical to do so.

REFERENCES

- (1) BEALL, H. W.
1948. FOREST FIRE DANGER TABLES. (2d ed.) Canada Dept. North. Affairs and Natl. Resources, Forest Fire Res. Note 12. (Reprinted.)
- (2) CHEYNEY, E. G.
1939. SLASH AGAIN IN THE LAKE STATES. Jour. Forestry 37: 640-641.
- (3) HALLIDAY, W. E. D.
1937. A FOREST CLASSIFICATION FOR CANADA. Canada Dept. Resources and Devlpmt., Forestry Branch, Forest Res. Div. Bul. 89. (Reprinted.)
- (4) JOHNSON, H. J.
1955. THE EFFECT OF VARIOUS SLASH DISPOSAL METHODS ON THE REGENERATION OF CUT-OVER JACK PINE STANDS. Canada Dept. North. Affairs and Natl. Resources, Forestry Branch, Forest Res. Div. Tech. Note 23.
- (5) MACLEOD, J. C.
1948. THE EFFECT OF NIGHT WEATHER ON FOREST FIRE DANGER. Canada Dept. North. Affairs and Natl. Resources, Forestry Branch, Forest Fire Res. Note 14.
- (6) MUNGER, T. T., AND MATTHEWS, D. N.
1941. SLASH DISPOSAL AND FOREST MANAGEMENT AFTER CLEAR CUTTING IN THE DOUGLAS FIR REGION. U. S. Dept. Agr., Forest Serv. Cir. 586.
- (7) POTVIN, A.
1949. A SIMPLE METHOD OF DEW MEASUREMENT. Forestry Chron. 25(1): 52-53.

THE CHRISTMAS EVE PRESCRIBED BURN

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It was the morning before Christmas, Santa Claus was loading up and the holly and mistletoe were being hung. Gifts were being wrapped, and the weather was just right for prescribed burning on the Escambia Experimental Forest. The south Alabama woods were damp, the north wind was swaying the tree tops, and the air temperature was near freezing. This was the weather the Escambia foresters had wanted for nearly 2 months. Brown-spot needle disease had invaded several large areas of longleaf reproduction on the forest. The only practical way to save the infected seedlings was to prescribe-burn, and this was the day for the job. Seven years of study and experience went into the planning and application of the Christmas Eve burn (fig. 1).

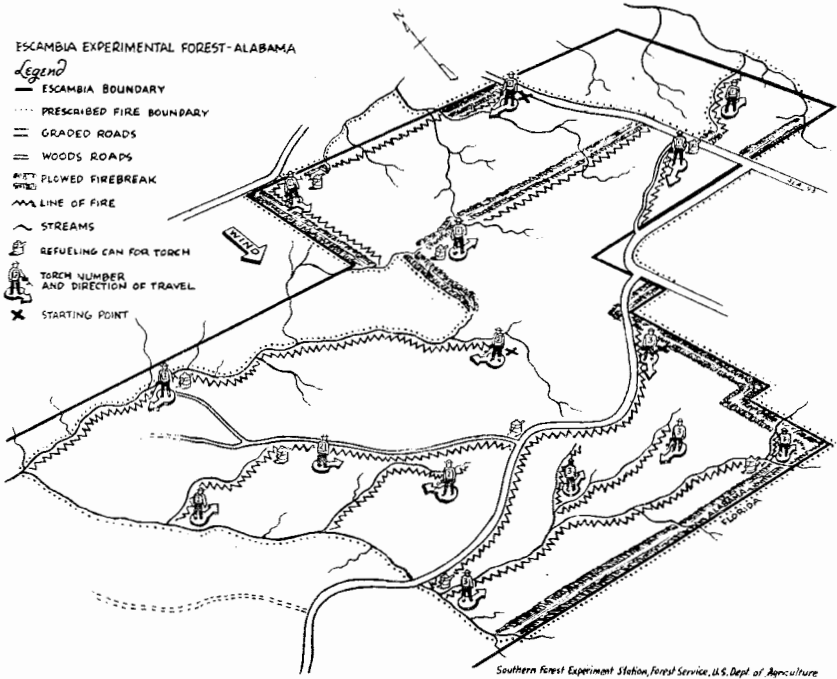


FIGURE 1.—In the Christmas Eve prescribed burn, nearly 1,400 acres of longleaf pine seedlings were rid of brown-spot disease at a cost of 6 cents an acre by 4 men working 4 hours.

¹This article first appeared in the March 1956 issue of *American Forests* and is republished here through courtesy of that periodical.

Prescribed burning is a calculated risk. The risk should be taken only after careful planning and preparation based on a thorough understanding of fire and fire behavior. The guiding principle for prescribed burning on the Escambia is **the burning yardstick**.

The **yardstick** is simple. **Benefits** from the fire must **exceed** all burning **cost plus fire damages**. Application is more complex. A five-step procedure is used: **diagnosis, prescription, preparation, treatment, and appraisal**. When properly followed this procedure removes most of the gamble, and fire becomes a useful tool in the longleaf forest.

DIAGNOSIS

First, exactly what areas on the forest contained heavy brown-spot infection? What damages could be expected from the use of prescribed fire? To find out, a survey was made. After the first killing frost in early November, the percent of brown-spot infection was estimated on a minimum of 100 longleaf seedlings on each 10- to 40-acre reproduction area.

The survey showed several hundred acres of grass-stage longleaf reproduction infected with brown spot, with the degree of infection ranging from a low of 15 percent to a high of over 35 percent. Past experiments and experience have shown that areas with 25 percent or more infection in November should be prescribe-burned during the coming winter. To prevent reinfection, the area surrounding the seedlings should also be burned where possible.

Longleaf seedlings can generally be burned safely if: (1) they are at least one-half inch in diameter at the root collar; (2) very little root is exposed; and (3) the seedlings are not in active height growth. The survey showed that if fire was applied properly, damage should be confined to a few scattered seedlings 1 to 5 feet high that were already nearly dead from brown spot.

The areas that needed burning were mapped. Then, to plan for control of the fire, information was obtained on the condition of rough, natural fire breaks, roads, and trails.

The diagnosis: Several large areas were dangerously infected. Fire was needed and could be applied without excessive damage.

PRESCRIPTION

Next was to prescribe the fire treatment for each area—the kind of fire and the weather needed.

If the areas had had a heavy rough and lots of draped fuel, a backfire would have been prescribed. Heavy roughs with draped fuel burn very hot, and unnecessary overhead scorch to standing timber would occur if headfire were used. The survey showed, however, that the areas contained a light rough—a small accumulation of pine straw and not much grass. A fast-running headfire would be safe and do a better job than a backfire.

Weather is the most important factor in prescribed burning. Cold weather and plenty of ground moisture are essential. This means burning in winter as soon as possible after 1 inch or more of rainfall. To get a fast-moving headfire, a moderate, cold north wind is needed—north wind because it is usually dependable and steady in south Alabama. To insure that all areas will be covered while ideal weather lasts, fires should be started by 10:00 a. m. and be completely under way by noon.

The prescription: A headfire on a day when ground moisture was plentiful and a moderate, steady, cold north wind was blowing. The fire to be under way before noon and to cover the areas in a few hours.

PREPARATION

Successful burning can only be done after thorough preparations for applying and controlling the fire.

In delineating each area to burn, natural firebreaks such as roads and streams were used wherever possible, to save firebreak construction. Nearby landowners were contacted. Letting neighbors know what's going on is always good public relations, and on the Christmas Eve Burn permission was needed to burn two areas into natural firebreaks outside the forest boundary. This saved more than one-half mile of firebreak construction, and eliminated two heavily infected areas adjoining the forest.

Since the prescription called for headfire and a north wind, 2 lines about 100 feet apart were plowed and burned on the south, east, and west boundaries to control the fire where natural firebreaks were not available. On the north side of the area only a single plowed line was necessary.

Next, was to be sure a headfire would be under way in all areas by noon of D-day, and that burning would be completed a few hours later. The map showed that one line of fire along the north boundary would have to travel more than a mile. This is too far. Experience has shown that one-half mile is about the maximum for the time allowed in the prescription. Otherwise, the burn may not be completed before weather conditions change. Another east-west firing line was therefore put in. Natural firebreaks could be used to fire the rest of the area.

A total of 9 miles of line had to be fired. One torch man would be able to fire about 3 miles in the allotted 2 hours between 10:00 a. m. and noon. The line was roughly divided into 3-mile sections and assigned to men designated as Torches 1, 2, and 3. Since 1-gallon fire torches hold only enough fuel for about three-fourths of a mile of line, refueling cans would be needed at intervals along the line. A small letter-size map was prepared to show each torch man (1) the line to fire, (2) the direction of travel, (3) locations of refueling cans, and (4) how to fire his part of the line. A crew of 3 torch men and 1 man supervising and patrolling the burning area was required.

By early November everything was ready except the most important item, the weather.

TREATMENT

It was the day before Christmas, Santa Claus was busy with his myriad preparations for his trip that night, but the weather was just what the doctor ordered for prescribed burning. There had been almost 3 inches of rainfall in the past 3 days. Air temperature was down to 29°F. A cold front was overhead and a moderate, steady, north wind was blowing. The Weather Bureau predicted that this condition would last for 10 to 12 hours.

Early morning telephone calls were made ordering the crew to get into their "burning" clothes. The Alabama and Florida forestry departments were notified to expect a big smoke starting at 10 o'clock. Torch fuel was distributed to the planned points along the burning lines. At 9:30 a. m. the crew met on the forest. A small test fire was set and then each torch man was briefed and given his map. At exactly 10 o'clock all three torches started firing. A few minutes after 12 noon all torches were through and well over half of the area was burned. At 2 o'clock over 90 percent of the area was burned. By 3 o'clock the crew, tired but satisfied, was back home helping Santa Claus.

APPRAISAL

What were the benefits? Longleaf experts agree that a heavy infection of brown spot can ruin a stand of seedlings. The established seedlings treated by the Christmas Eve Burn were worth at least \$4,000. It is doubtful that half of these would have survived and grown without the prescribed fire. At least \$2,000 worth of seedlings were saved.

What was the cost? The whole job, including diagnosis, prescription, preparation, treatment, and appraisal, came to less than \$100.

What were the damages? A seedling survey after the fire showed less than 1 percent loss in stocking—a value of not more than \$50. Most of the lost seedlings were stunted and heavily infected with brown spot and probably would have died anyway. Their value was more than offset by many fringe benefits, such as hardwood brush control, seedbed preparation, hazard reduction, and a large area burned to prevent reinfection of the reproduction areas.

The burning yardstick showed that the benefits of several thousand dollars in brown-spot control far exceeded the burning cost plus the minor damages of the fire.

A READY-REFERENCE RADIO DISPATCH BOARD

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State Forester, Virginia

The large number of mobile and tower radios now in service with the Virginia Division of Forestry made it necessary to find a simple record system that would expedite the clerk-dispatcher's job of keeping track of the frequent changes in location and activities of men in the field. One district forester devised such a system from a piece of acoustical tile and roofing nails, and with a minimum number of changes the unit was workable statewide.

The ready-reference board is made of $\frac{3}{4}$ -inch plywood 14 inches wide, and it is 14 inches or more in height (fig. 1), depending upon the number of radios in use. Holes are bored on $\frac{1}{2}$ -inch centers large enough to accommodate 8-penny, double-headed nails. Since the entire length of nail is not necessary, it is cut

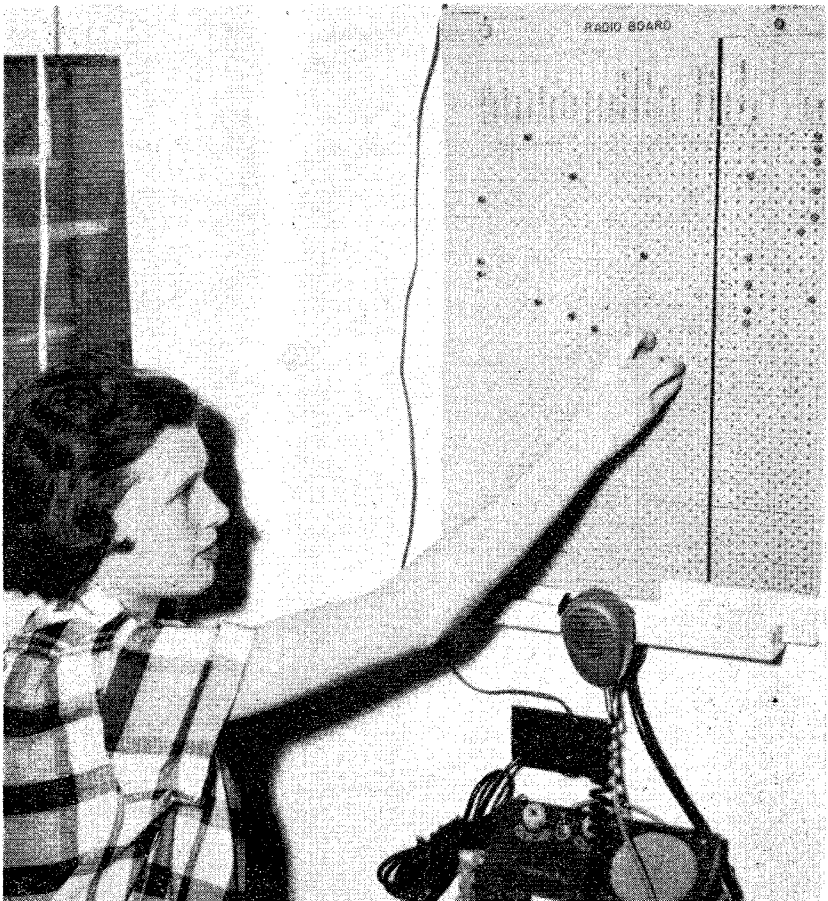


FIGURE 1.—The ready-reference radio dispatch board.

in half. A small, compartment tray, which is screwed to the bottom of the board, serves as a storage bin for the nail pegs. The nail pegs are painted red for off-air, green for on-air, and yellow for special messages. The board's vertical columns are headed by counties in the district and major jobs, and one column is headed "Special message." The column to the extreme left lists the mobile or tower units.

When a unit signs on the air, the clerk places a green nail in the hole opposite the name and under the proper county. If the unit is called to a fire, a green nail is added to the horizontal column under the vertical heading "On fire." Should the unit sign off the air to go in on the fire, the clerk replaces the 3 green nails with red ones. If a special message comes in for the off-air unit, a yellow reminder nail is placed in the special message column. When the unit signs on, the red nails are replaced with green, the special message is given, and the yellow nail is removed.

A large district map—a montage of county maps on which towers are located and provided with azimuth circles and strings—is used to supplement the dispatcher's ready-reference board (fig. 2). This map is covered with clear plastic, the kind used for inexpensive storm windows. As fires spring up, entries are made on the plastic with grease pencil, and a note as to who from the district office is on a fire is also entered. Mistakes or changes are easily erased with a swipe of a cloth. Of course, the ready-reference dispatch board and plastic-covered work map are valuable only if they are kept up-to-date and supplemented with essential, written or otherwise, posted material.



FIGURE 2.—A grease pencil is used to keep information current on this plastic-covered, fire locator map.

OLD-GROWTH CONVERSION ALSO CONVERTS FIRECLIMATE

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Converting an old-growth forest presents problems that have long challenged foresters, engineers, and economists. Road location, method of cutting, fire control, and slash disposal are all critical jobs. In terms of fire control, the forest manager has been concerned primarily with slash disposal and fire suppression in slash areas. He has frequently observed the great difference in fire behavior between slash and uncut areas, and quite naturally has associated this difference with the obviously different fuel conditions.

Although the general relations between weather factors, fuel moisture, and fire behavior are fairly well known, the importance of these changes following conversion and their combined effect on fire behavior and control is not generally recognized. The term "fireclimate," as used here, designates the environmental conditions of weather and fuel moisture that affect fire behavior. It does not consider fuel created by slash because regardless of what forest managers do with slash, they still have to deal with the new fireclimate. In fact, the changes in wind, temperature, humidity, air structure, and fuel moisture may result in greater changes in fire behavior and size of control job than does the addition of more fuel in the form of slash.

Conversion which opens up the canopy by removal of trees permits freer air movement and more sunlight to reach the ground. The increased solar radiation in turn results in higher temperatures, lower humidity, and lower fuel moisture. The magnitude of these changes can be illustrated by comparing the fireclimate in the open with that in a dense stand. It is the same kind of difference that occurs when a closed, mature stand is clear cut.

In the open, solar radiation impinges directly on the earth's surface. Because both the earth and the air above it are poor conductors, heat is concentrated at the surface and in the layer of air next to it. Ground fuels can thus become superheated. In full sun at midday, it is not uncommon for surface temperatures to reach 165° F. or more.² At the same time, air temperatures measured at the standard height of 4½ feet in an instrument

¹Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California. This article was first published in the Society of American Foresters' Meeting Proceedings for 1955.

²From unpublished data in files of California Forest and Range Experiment Station. Similar findings were also reported by:

GEIGER, RUDOLF. CLIMATE NEAR THE GROUND. (Trans. 2d German ed.) 482 pp., illus. Cambridge, Mass. 1950.

KITTRIDGE, JOSEPH. FOREST INFLUENCES. 394 pp., illus. New York and London, 1948.

shelter may not exceed 85° or 90°. Temperatures in the lower layers of air in the open decrease rapidly with height above the ground. In a typical temperature profile in northern California, for example, the temperature was 135° at the surface and decreased to 77° at 5 feet (fig. 1).

Relative humidity will vary inversely to the temperature of the air as long as the amount of water vapor remains constant. A relative humidity profile, then, can be expected to be the inverse of the temperature profile, and in the open relative humidity near the surface is much lower than that at the standard 4½ feet.

These temperature and humidity relations have an important influence on fuel moisture. In the absence of precipitation, the moisture content of dead fuel decreases as humidity decreases and as temperature increases. Surface fuels can thus be expected to be materially lower in moisture content than fuels a short distance above the ground and exposed to the cooling effect of wind. Measurements of standard half-inch fuel-moisture indicator sticks at the California Forest and Range Experiment Station have shown that the minimum daily moisture content of surface fuels averages only about half that of fuels 10 inches above ground.

A mature, closed stand has a fireclimate strikingly different from that in the open. Here nearly all of the solar radiation is intercepted by the crowns. Some is reflected back to space and the rest is converted to heat and distributed in depth through the crowns. Air within the stand is warmed by contact with the crowns, and the ground fuels are in turn warmed only by contact with the air. The temperature of fuels on the ground thus usually approximates air temperature within the stand.

Temperature profiles in a dense, mixed conifer stand illustrate this process (fig. 2). By 8 o'clock in the morning, air within the crowns had warmed to 68° F. Air temperature near the ground was only 50°. By 10 o'clock temperatures within the crowns had reached 82° and, although the heat had penetrated to lower levels, air near the surface at 77° was still cooler than at any other level. At 2:00 p.m., air temperature within the stand had become virtually uniform at 87°. In the open less than one-half mile away, however, the temperature at the surface of pine litter reached 153° at 2:00 p.m.

Because of the lower temperature and higher humidity, fuels within the closed stand are more moist than those in the open under ordinary weather conditions. Typically, when moisture content is 3 percent in the open, 8 percent can be expected in the stand.

Moisture and temperature differences between open and closed stands have a great effect on both the inception and the behavior of fire. For example, fine fuel at 8-percent moisture content will require nearly one-third more heat for ignition than will the same fuel at 3-percent moisture content. Thus, firebrands that do not contain enough heat to start a fire in a closed stand may readily start one in the open.

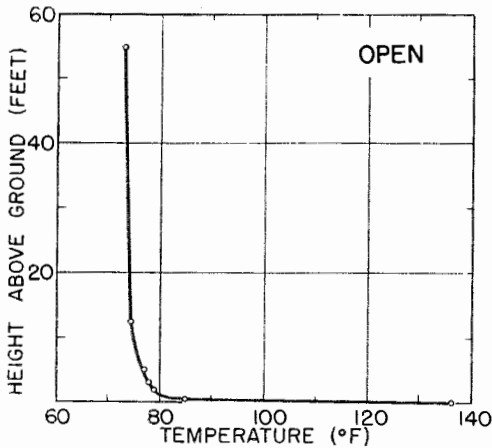


FIGURE 1.—Typical temperature profile over bare ground in the open. (Data taken at 12 a.m., Sept. 16, 1943, Shasta Experimental Forest.)

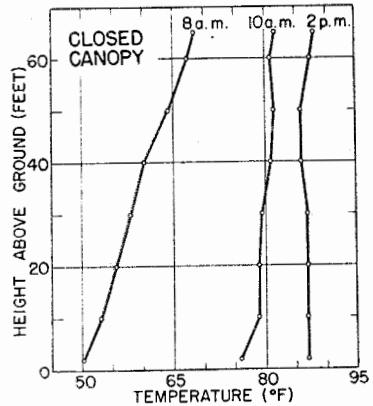


FIGURE 2.—Temperature profiles in a dense, mixed conifer stand in northern California showing the progressive downward transfer of heat into the stand from the crowns. (Data taken Sept. 22, 1943.)

Fires starting in the open also burn more intensely and build up to conflagration proportions more quickly since less of the heat produced by the fire is used in evaporating water from the drier fuels. Strong convection columns that can carry burning material aloft develop rapidly; these columns and the relative ease of ignition in the open are largely responsible for one of the major fire control problems in clear-cut slash areas—that of spread of fire by spotting.

Another very important difference between fireclimate in a closed stand and fireclimate in the open is in air movement. In general, wind direction and velocity 2,000 feet or more above the surface are the result of widespread pressure differences and general weather conditions. In the layer of air below 2,000 feet, surface friction and local landscape features have an increasingly important effect on air movement. Consequently, over an extensive closed stand wind velocity decreases only slightly above the crowns. Within the stand, however, air movement is much restricted, seldom exceeding 3 or 4 m. p. h. even with velocities of 25 to 30 m. p. h. above the canopy or in the open (fig. 3).³

Since the rate of forward spread of fire is largely dependent upon wind velocity, a much faster rate can be expected in the open, at least in the initial stages of the fire. For example, under

³KITTREDGE, JOSEPH. FOREST INFLUENCES. 394 pp., illus. New York and London. 1948.

FONS, W. L. INFLUENCE OF FOREST COVER ON WIND VELOCITY. Jour. Forestry 38: 481-487, illus. 1940.

GISBORNE, H. T. HOW THE WIND BLOWS IN THE FOREST OF NORTHERN IDAHO. U. S. Forest Serv., North. Rocky Mt. Forest and Range Expt. Sta. 12 pp., illus. 1941. [Processed.]

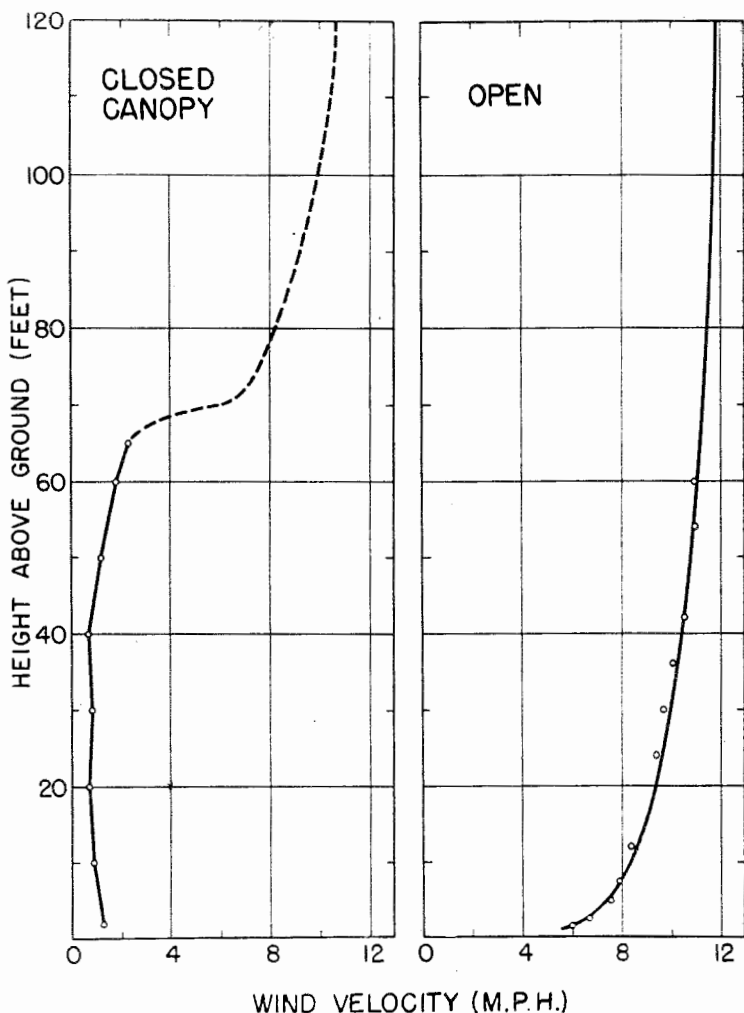


FIGURE 3.—*Left*, Typical daytime wind profile in and over dense conifer stand. *Right*, Typical daytime wind profile over level ground in the open.

moderate conditions of fuel moisture and temperature, a wind velocity of 25 m. p. h. will result in a rate of spread more than 5 times as great in the open as in a closed stand because of wind differences alone.

Clear cutting, then, can change fireclimate so that fires start more easily, spread faster, and burn hotter. The effect of these changes on the fire control problem is extremely important. When a standard fire weather station in the open indicates a temperature of 85° F., fuel moisture of 4 percent, and a wind velocity of 15 m. p. h.—not unusual burning conditions in the West—a fire starting on a moderate slope will spread 4.5 times as fast

in the open as in a closed stand. The size of the suppression job, however, increases even more drastically.

Greater rate of spread and intensity of burning require control lines farther from the actual fire, increasing the length of fireline. Line width also must be increased to contain the hotter fire. Less production per man and delays in getting additional crews complicate the control problem on a fast-moving fire. It has been estimated that the size of the suppression job increases nearly as the square of the rate of forward spread. Thus, fire in the open will require 20 times more suppression effort. In other words, for each man required to control a surface fire in a mature stand burning under these conditions, 20 men will be required if the area is clear cut.

Methods other than clear cutting, of course, may bring a less drastic change in fireclimate. Nevertheless, the change resulting from partial cutting can have important effects on fire. The moderating effect that a dense stand has on the fireclimate usually results in slow-burning fires. Ordinarily, in dense timber only a few days a year have the extreme burning conditions under which surface fires produce heat rapidly enough to carry the fire into the crowns. Partial cutting can increase the severity of the fireclimate enough to materially increase the number of days when disastrous crown fires can occur.

Forest management is impossible without adequate fire control, and it is axiomatic that fire control planning is a vital part of timberland management. It is important to recognize that besides creating additional fire hazard in the form of slash, stand conversion can alter the fireclimate for many years. Therefore, the effect of silvicultural practices on fireclimate must be given major consideration in the management plan for the forest. Protection must be adequate to compensate for the changes in fireclimate as well as for slash. This is the only way to insure that we convert our old-growth forests to managed stands and not to wasteland.

ICE HYDRANT PROVIDES EMERGENCY WINTER WATER SUPPLY FOR FIRE FIGHTERS

Federal Civil Defense Administration¹

Glen Miller, Civil Defense Fire Chief, Moose Pass, Alaska, has developed an ice hydrant, first of its kind, that can provide an emergency water supply for fire-fighting forces in those communities located near lakes and streams which are frozen over during winter months.

Miller's idea involves the use of diesel oil to keep a water hole open in the ice of a lake or stream. A 55-gallon oil drum, with both ends removed and supported by timbers, is inserted into a water hole (fig. 1). The drum is braced so that approximately 12 inches remains above the surface of the ice. Miller calculated that 30 gallons of diesel oil in the drum would be necessary to extend the oil level through 18 inches of ice to the water level.

After two successful tests of the device at Lake Hood, Anchorage Civil Defense officials reported these details of the project, together with their recommendations:

1. In areas faced with excessive icing, ice-hydrant oil containers should consist of two 55-gallon drums welded together for a total length of 72 inches. Any sturdily constructed steel or iron cylinder, such as 24-inch culvert pipe, will serve as well as 55-gallon drums.

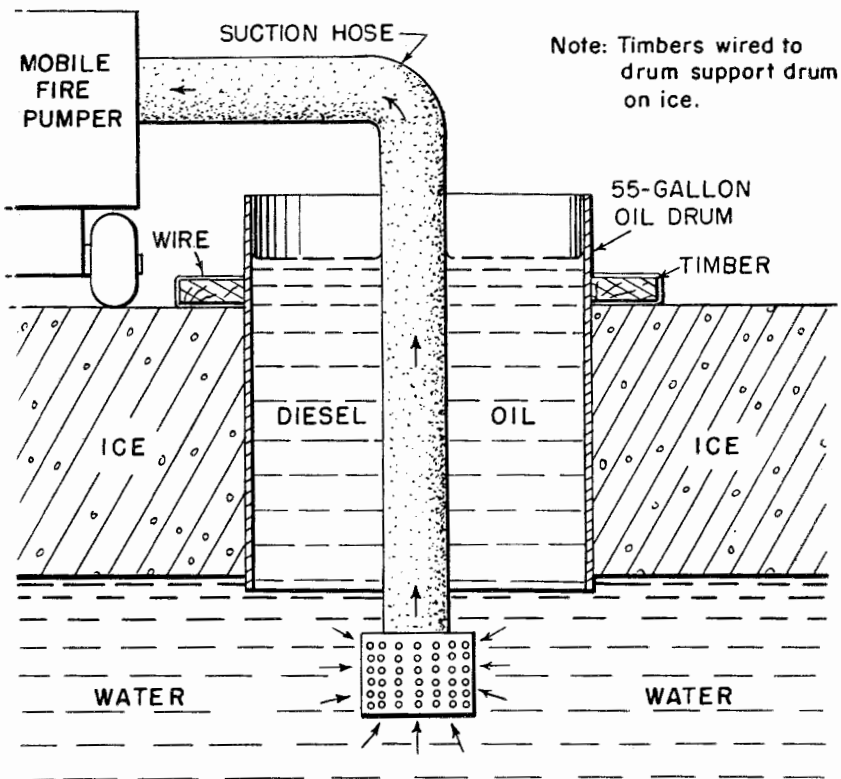
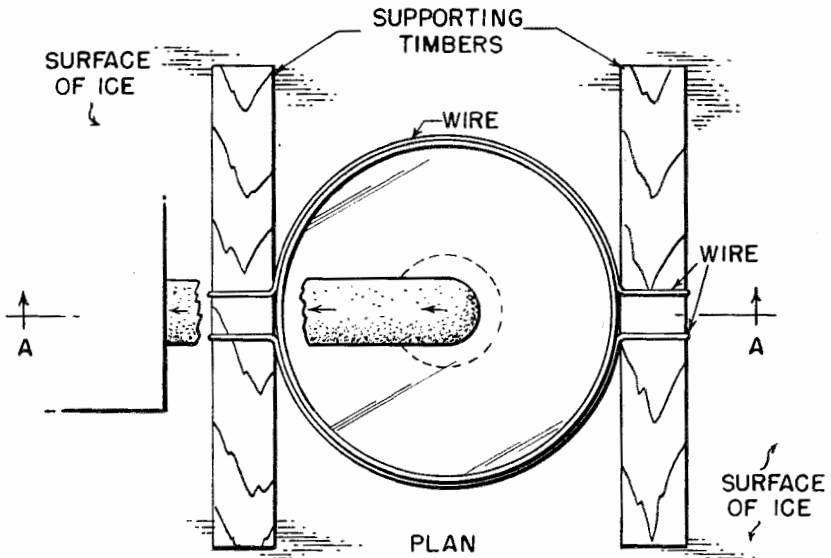
2. By increasing the height of the oil column in the cylinder to 24 or 30 inches above the upper ice surface, sufficient oil pressure would be developed to reduce the degree of freezing below the oil level.

3. Twenty-foot lengths of 4½-inch hard suction hose are more adaptable for use in an ice hydrant than 10-foot sections of 4-inch hose. In pumping through an ice hydrant, the suction hose should be connected to the pump before passage through the oil cylinder into the water, in order to cut down or eliminate the intake of oil.

4. The degree of bend required to extend hard suction hose from a pumper through the ice hydrant indicates that an oil cylinder with a diameter of less than 24 inches would be impractical if not unworkable.

5. Hard suction hose to be inserted in the ice hydrant should be wrapped with masking tape as protection against oil damage. In the brief test, however, 6 feet of the exterior of the hose was covered with diesel oil, with no evidence of damage. Methyl alcohol was used to remove all trace of the oil after the test.

¹This slightly shortened article appeared originally in March 1956 as Fed. Civ. Defense Tech. Serv. (Fire Off.) Leaf. 289.



Note: Timbers wired to drum support drum on ice.

SECTION A-A

FIGURE 1.—Ice hydrant.

6. A tight-fitting, well-insulated cover for the ice hydrant will cut down the formation of ice and prevent humans and animals from falling into the oil-filled hole.

7. A 6-foot long ice chisel or bar and an 8- to 12-inch mesh strainer should be stationed near each hydrant for clearing and removing ice from the cylinder.

8. Until an oil-tight cover is developed for attachment to the intake end of the hard suction hose, the initial discharge of water should not be played on a fire. Such oil as enters the hose is cleared in a matter of seconds after pumping has started.

9. Before a thaw, the oil in the ice hydrant should be removed or burned to avoid water contamination or harm to fish or wildlife.

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The IBM and Forest-Fire-Report Computation

The State of Louisiana has 7,000 to 10,000 wildfires each year, most of which occur during a 6-month period. Until recently, the computation and recording of statistics from these fires required the services of a full-time clerical helper. During the height of the fire season the reports were so abundant that statistics could not be kept current; and during the green season there was time to spare.

The clerical position was not particularly interesting because of its routine nature, and this fact created a personnel turnover; with each turnover the system bogged down. The major weakness in our system, however, was borne out vividly after the 1952 emergency fire season. On top of the Gargantuan job of compiling the fire statistics came requests for detailed comparisons of fire records. It was next to impossible to meet this request.

The problem seemed to have no solution—i.e., until we decided to explore the International Business Machines System. Under this system the greater part of the information recorded on each fire report is punched into a card: Description of acreage burn (natural forest acres, planted or open); date of fire; district, parish or county; cause; time factors; equipment; man-hours; forest types and fire intensity (Class Fire Day); burning and build-up index; and damage.

The greatest single time and cost factor in this system involves punching the information into the cards. After that, summaries are mechanical. The cost per individual fire report is 18 cents as opposed to about 28 cents when computed by clerical help. In addition to this advantage, greater accuracy results, current information is available, and less storage space is required. Very soon we shall be in a position to furnish statistical comparisons in 2 days' time—a feat that used to take months or was impossible.—LAMBERT H. ROMERO, *Staff Forester, Louisiana Forestry Commission.*

EFFECT OF FIRELINE MECHANIZATION ON AREA OF BURNS

DIVISION OF FIRE CONTROL
Region 8, U. S. Forest Service

A question frequently arises as to how great a reduction in fire losses can be expected from the use of powered fireline-building equipment in the place of handtools. Past studies have indicated that the reward of mechanization is a reduction in suppression costs and in size of burns and resultant damage. However, findings from those studies were subject to qualifications imposed by the limited number of years of mechanization and extent of areas available for comparative study. Region 8 has now completed 10 years during which a significant number of ranger districts were sufficiently supplied with mechanized fireline units to yield sound conclusions.

An analysis has been made of the records of 22 Coastal Plain and 8 upland mechanized ranger districts to determine the number of fires and national-forest acres burned during the past 15 years. The data were assembled by 5-year-period totals, with the fast-fire-spread Coastal Plain areas separate from the upland districts. Although ranger districts were divided and names and boundaries changed during the analysis period, each 5-year statistical period still covers the same protection areas.

The period 1941-45 reflects results of handtool fire fighting: 1½ years of Civilian Conservation Corps labor and 3½ years of hired crews. However, there were some tractor-plow units at work throughout that period, with increased number in 1945, which no doubt reduced the amount of timber that otherwise would have burned.

During 1946-50 the design and quality of mechanized units were improved and new units were acquired and assigned in numbers that gave the ranger districts an attack strength more nearly equal to their suppression problems. However, some of the fires during peak loads still had to be fought by hand.

In the period 1951-55 only a few additional mechanical units were acquired. Suppression action and results, however, were better because of past experiences that developed clearer tactical concepts of mechanized attack and increased the skill of the operators and supporting crews.

The base data employed in this analysis is massive, involving a total of 24,344 Coastal Plain and upland fires on 5,383,138 acres, and covering the variety of forest conditions and fire problems found in the approximately 1,000 miles from South Carolina to Texas. Because of the number of fires analyzed and their geographic distribution, and the spread of time involved, such effects as human error or seasonal variations are blended. The resultant figures also absorb the effects of the steady increase

in burning intensity and resistance to control occasioned by buildups in ground fuels and timber-stand densities that developed along with reductions in burned area.

The most significant revelation in table 1 is found in the end-result figures that show a saving of two-thirds of the average acreage lost per fire when mechanized suppression methods are used. On the basis of present-day fire occurrence and with continuation of handtool methods on these districts, assuming no increase in suppression difficulties, 44,000 acres would burn annually rather than 14,000 acres. The calculation of average fire damage shows an annual saving in excess of \$500,000. This indicated annual saving in damage alone is greater than the total investment in fireline equipment for the ranger districts involved. They now have 91 tractor-plow units, a concentration of 1 unit to 59,000 protected acres, with an average annual occurrence of 25.2 fires per 100,000 acres.

TABLE 1.—*Effects of fireline mechanization on average loss per fire on 22 Coastal Plain¹ and 8 upland² national-forest ranger districts, 1941-55*

Suppression method	Coastal Plain			Upland		
	Fires	Total burn	Average loss per fire	Fires	Total burn	Average loss per fire
Handtool:	<i>Number</i>	<i>Acres</i>	<i>Acres</i>	<i>Number</i>	<i>Acres</i>	<i>Acres</i>
1941-45	7,183	279,775	38.95	2,078	21,100	10.15
Mechanized:						
1946-50	6,573	96,925	14.74	1,714	8,914	5.2
1951-55	5,132	63,050	12.28	1,664	7,817	4.7

¹Alabama, Florida, Louisiana, South Carolina, Mississippi, Texas.

²Mississippi, Alabama, Georgia, South Carolina.

SODIUM CALCIUM BORATE AS A FIRE RETARDANT:

A Progress Report

HARRY R. MILLER

Forester, California Forest and Range Experiment Station¹

[Because of its high abrasive and soil-sterilant qualities, the use of sodium calcium borate is limited to the California experiment until further experience is obtained and fire apparatus specifically designed to handle the mixture is made available. By agreement with the manufacturer, sodium calcium borate is supplied only through the California Forest and Range Experiment Station until the experiments have been completed.—Ed.]

Tests conducted in 1955 suggest that chemical fire retardants can open up a new era in forest fire control. Retardants were successfully used to hold the flanks and rear and cooler parts of the head of wildfires in brush and grass and for rapid construction of backfire lines. Aerial delivery of retardants was shown to be feasible.²

Several chemicals had shown promise for wild land fire control during Operation Firestop in 1954. Since only plot tests were used in Firestop, however, the practicability of using chemical retardants on going wildfires needed testing before research to develop the most effective methods and formulations was undertaken. Consequently, a cooperative research study was established to meet the following objectives:

1. To test the feasibility of using chemicals in wild land fire control under full-scale field conditions.
2. To gain information on the problems involved in the use of chemicals on fires.

Cooperators with the California Forest and Range Experiment Station in the field program were the California Division of Forestry, Los Angeles County Fire Department, and the Pacific Coast Borax Company.

TEST PROCEDURE

Sodium calcium borate was the retardant selected for use in this study. This substance is representative of the group of chemicals which retard firespread by their insulating qualities as well as chemical action. Sodium calcium borate is an ore mined and processed on the West Coast. The chemical is nontoxic to human beings and livestock. It is slightly corrosive to zinc and brass but is not corrosive to iron. Such borate compounds may be used as soil sterilants and herbicides when applied at the rate of 10 to 15 pounds per 100 square feet of surface area (fig. 1). Less

¹Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California.

This article first appeared in a slightly different form as U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Forest Res. Note 105, CHEMICAL and Range Expt. Sta. Forest Res. Note 99, 12 pp., illus. 1955. [Processed.]

²ELY, JOSEPH B., AND JENSEN, ARTHUR W. AIR DELIVERY OF WATER HELPS CONTROL BRUSH AND GRASS FIRES. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Forest Res. Note 99, 12 pp., illus. 1955. [Processed.]



FIGURE 1.—An area in Amador County, Calif., 10 months after borate had been applied on a test fire at about 15 pounds per 100 square feet. Application inhibited the germination and growth of all annual grasses in the area treated.

than 2 percent of the material is soluble in water; but when finely ground, it can easily be put into a stable suspension at concentrations up to 8 pounds per gallon of water. Besides a high melting point ($1,000^{\circ}$ C.), the chemical has other properties particularly desirable in a fire retardant to be applied in spray form. It covers well and adheres well to vegetation.

Standard pumper tankers equipped with centrifugal pumps³ were modified slightly for these field tests. Openings were made in the top plate of the tank so that dry chemical could be poured easily into the water. Agitation for mixing was obtained by leading a bypass pipe from the pump back to the bottom of the tank.

Before each unit was put into operation, its crew was oriented by personnel from the Pacific Coast Borax Company and the experiment station. Proper mixing and possible methods of application were demonstrated. One member of each tank-truck crew was trained to observe the effect of the chemical on fire and to record the information necessary for evaluating results. Crew foremen designated the method of application on each fire. In order to encourage exploration of different uses and techniques, precise procedures or limitations were not established.

³A small, positive displacement pump under test at the Arcadia Equipment Development Center was seriously damaged by the chemical within 10 minutes.

USE AND RESULTS

In spite of the severe 1955 fire season in California, the test units had only a few opportunities to use chemicals. Nevertheless, results were encouraging.

Wild land fires.—Approximately 5,800 feet of firelines, 4 to 6 feet wide, were pretreated (sprayed in advance of the fire) through grass and light to medium-heavy brush to hold the flanks, rear, and head of fires. The fuel was coated with retardant applied as a fine spray at about 3 gallons per 100 square feet, 5 to 30 minutes before it was reached by fire. This chemical line held except for one small section in grass which burned through at the head of a fire.

According to the associate State ranger in charge, the sodium calcium borate assured control of one flank of the 700-acre Camanche Fire that occurred in Calaveras County in September 1955. The fire boss reported that attempts to backfire from a plain waterline were ineffective, and the tanker crew was forced to abandon the attack. About 2,000 feet of chemical line was then prepared along the east side of the fire and fired from successfully.

Controlled burning.—On a moderate slope, 1,600 feet of line 6 to 8 feet wide was treated through grass and light to medium-heavy brush across the head and on the flanks of the fire. The retardant was applied to the fuel as a fine spray at 3.5 gallons per 100 square feet and allowed to dry 3 to 4 hours before the area was fired. The flanks and cooler parts of the fire head were contained by the chemical line. Hot parts of the fire head burned through the line. Experienced observers reported that these same fire heads probably would have swept across cleared firebreaks of the same width.

Spot fires.—A serious source of spot fires in the oak-woodland type was reduced by pretreating scrub oaks inside the fireline. Surface fuels at the base of trees and about 4 feet of the lower part of each crown were sprayed with retardant. The chemically pretreated scrub oak did not ignite and "crown-out," whereas untreated trees burned readily.

Backfiring lines.—The use of a chemical retardant for rapid construction of backfiring lines showed excellent possibilities as a fire tool. Crews moved through light brush and grass at a fast walk, applying retardant on 2- to 4-foot strips. Backfiring was successfully done from these lines 0 to 20 minutes later.

Direct attack.—The chemical was applied as a spray directly on burning light brush and grass fuels along 1,500 feet of fire edge. It appeared to be as effective as water in cooling down and extinguishing the fire. Fewer reignitions were observed than would normally occur when water was used under the same conditions.

Equipment.—A Bean type spray gun proved most suitable for applying the chemical directly to burning fuels. An overshot or basement applicator (in common use by city fire departments) equipped with a shutoff valve and a spray tip was used for pre-

treatment of fuels. This applicator, 5 feet long with a 30 degree bend about 10 inches from the tip, was excellent for spraying tall or dense brush.

Measurements on a Berkeley 4-stage centrifugal pump used in Amador County showed wear of .015 to .022 inch between the suction eye and wear ring of each stage, and .028 inch in the tail shaft bearing at the discharge end of the pump. Although this amount of abrasion is large compared to that experienced with clear water, it is about the same as normally occurs with dirty irrigation water. Much of the wear probably resulted from the mixing process, which required the chemical to pass through the pump several times.

Penetration and coverage of fuels were best when the sodium calcium borate was applied at a concentration of 5 pounds per gallon of water, through a spray nozzle of 4.5 to 7.0 gallons per minute capacity, and at a pressure of about 150 pounds per square inch.

CONCLUSIONS AND RECOMMENDATIONS

1. Chemical fire retardants have a significant advantage over water for control of brush and grass fires. Chemicals can be used effectively to stop fires or materially reduce spread whenever heat output is not too great. This means that chemicals can be used to control small spot fires and the flanks, rear, and weak heads of large fires. The chief superiority of chemical attack over water lies in the long time that chemicals remain effective. This lasting quality of retardants permits treating fuel well in advance of the fire. For example, the chemical can be sprayed in a straight line ahead of a rough irregular fire edge, whereas water has to be applied directly to the fire edge.

2. Chemical retardants appear to have much broader uses in forest fire control than could be tested in 1955. Among potential uses which may be of major importance are aid in slash-fire control, widening existing firebreaks, and building fireline in rocky soil where bulldozers cannot be used. More intensive field testing under a wider variety of fuel and burning conditions is needed to establish the limits of potential chemical use.

3. Preliminary indications are that aerial application of fire retardants is feasible. Further development of techniques and equipment is needed to utilize the full potential of chemicals in this method of fire attack.

4. Equipment and methods to simplify and speed the mixing of chemicals with water are needed. If mixing could be done at the pump, then chemicals could be carried dry in hoppers and either water or chemical attack could be selected at will. Mixing at this point should also eliminate most abrasion in the pump.

5. In conjunction with field tests, laboratory studies are needed to determine the best formulations, concentrations, and application rates for various fire situations.

PREVENTIVE MAINTENANCE PAYS OFF

ROBERT F. WELLS

Missouri Conservation Commission

Preventive maintenance of vehicles and heavy equipment has paid dividends for the State of Missouri. Before our maintenance program was organized, we were troubled with constant breakdowns of equipment during critical periods, and also by costly repair bills. As the number of vehicles in operation by the department increased, the problem became acute.

Our program is organized with a Central Repair Shop to supervise the maintenance and repair of all the equipment. All new vehicles are received there, furnished with special equipment and sent on to the field. Major overhauls are also handled there. In addition, each Fire Protection District is equipped with a small shop where repairs and maintenance designated for the district level are undertaken. The work done at the district level largely accounts for the fine care our vehicles now receive.

Our entire program is geared in the operator's direction. Once each month an inspection is made at the district level to check the condition of each piece of equipment and determine what repairs are required. Constant pressure is exerted on the operators to see that they keep their equipment in the very best of condition. These inspections also serve as the means of keeping the operators informed on their progress. In addition, men from the Central Repair Shop visit the districts once a year and inspect all equipment. This inspection permits us to evaluate the effectiveness of the work of the district equipment men and the operators. It also furnishes information to be used in planning for the replacement of various units.

In order to compare the care given the equipment by the various districts, and as a means of judging the work, a system of numerical grading is used by men from the Central shop on their annual inspection. The maximum attainable grade is 100, and 75 is the lowest acceptable minimum. Grading takes into account the normal wear and tear on equipment and places emphasis on items that should be handled by the operator or district men. Districts are advised of the results of the inspection, and the relative standing of the various districts is given. The grade assigned to each piece of equipment is also available if desired.

The first year that numerical values were used, we had an average annual rating of 76 on a total of 110 units. Four years later we had an average rating of 93 on a total of 170 units. This upswing in average rating is a good indication of the effectiveness of our program of preventive maintenance. We have long since eliminated the problem of breakdowns during critical periods and the costly repairs that plagued us. Also, our operators have a pride in the appearance and condition of their vehicles that was not evident before the program was put into effect.

A secondary and perhaps more important result of the program has been the competitive effort between districts. District foresters and district-level maintenance men have striven to bring their districts' average rating up to or above that of other districts. Since one or two low ratings on a district lowers its average, more emphasis is placed on proper use of equipment to prevent unnecessary damage. The poor driver or one who fails to properly maintain his vehicle is considered an administrative problem and steps are taken to remedy the situation.

Another important result of the preventive maintenance program is that our trade-in vehicles require much less repair prior to resale than most trade-ins; dealers have therefore increased their allowances for our old vehicles. In many cases dealers do not even look at the units we trade in. The average trade-in allowance has increased about \$100 since our preventive-maintenance program was initiated.

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Published Material of Interest to Fire Control Men

- What Is New in Suppression Equipment?*, by E. E. Silva. West. Forestry & Conserv. Assoc. Proc. 46: 36-38. 1955.
- How We Can Communicate the Forest Fire Menace More Effectively*, by C. E. Hartford. South. Pulp & Paper Mfr. 19 (4): 86, 88. 1956.
- Fire Prevention: Let's Hit the Ball!*, by V. Perry. Brit. Columbia Lumberman 40 (1): 24-25, 27, 31. 1956.
- The Forest Fire Problem in the South*, by E. Kauffman. South. Lumberman 191 (2393): 144-146. 1955.
- Making It Hot for Woods Arsonists*, by E. Kerr. Prog. Farmer [Miss.-Ark.-La. ed.] 71 (3): 33, 200. 1956.
- The South's No. 1 Problem: Catch That Arsonist! Speed Justice!*, by J. E. McCaffrey. Pulp & Paper 30 (3): 116-118. 1956.
- Thetford-Type Static Water Tanks*, by F. G. Dufton. Gt. Brit. Forestry Comm. Jour. 23: 67-69. 1952/54.
- The Effect of Prescribed Burning on the Occurrence of Wild Fires*, by G. K. Schaeffer. South. Lumberman 191 (2393): 177-178. 1955.
- The Battle of the Forests*, by Bill Towell. Mo. Conserv. 17 (4): 1-3, illus. 1956.
- Effect of Slash Burning on Some Physical Soil Properties*, by R. F. Tarrant. Forest Science 2: 18-22. 1956.

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SMOKEY

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with matches
with smokes
with campfires
with every fire!

SMOKEY

Remember- Only you can

PREVENT FOREST FIRES