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# Logging Slash and Forest Protection

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CONTENTS

# Logging Slash and Forest Protection

WHAT TO DO with the brush after logging? This question has been debated in Wisconsin throughout the entire history of lumbering. In the popular mind, the occurrence of severe forest conflagrations has invariably been associated with the presence of logging slash on the ground. The occurrence of vast forest fires was noted by explorers and fur traders long before logging began on a commercial scale in the Lake States. The great historic fires—like the Peshtigo fire which occurred October 9, 1871 in which 1500 lives were lost and 1,280,000 acres were burned over or the Phillips fire of July, 1894 in which 13 people perished and over 160,000 acres of forest were consumed—owe their origin primarily to exceptional weather conditions such as unprecedented drought, strong winds and low humidity rather than to the accumulation of slashings. The latter was undoubtedly a large contributing factor and made the fires more severe, more widespread, and more difficult to control.

The agitation for slash disposal has re-occurred with new vigor after each disastrous fire season. In 1908, a very bad fire year, the State Forester of Wisconsin came out with the statement that, "one of the laws which is most urgently needed is that all slash must be piled and burned." (State Forester's Annual Report 1907-08).

In the winter of that year, at a meeting of timberland owners, a resolution was passed recommending legislation which would require piling and burning of all brush.

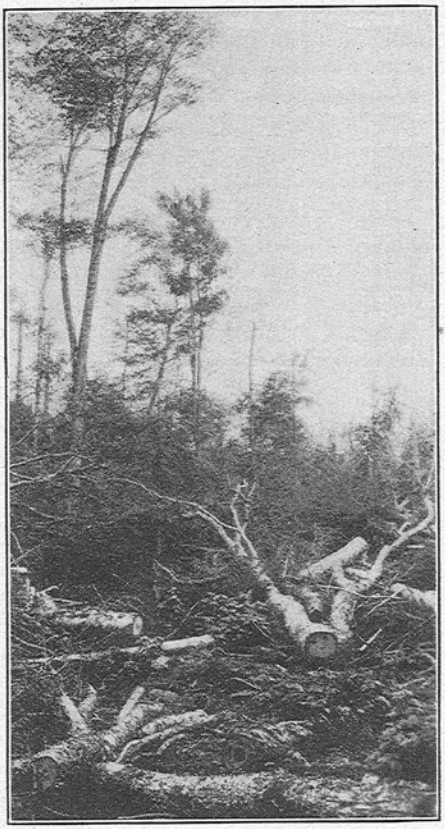

FIG. 1.—HEAVY SLASH RESULTING FROM LOGGING VIRGIN HARDWOOD TIMBER IN WHICH A LARGE AMOUNT OF HEMLOCK WAS PRESENT. (Sawyer County, Wisconsin)

After another dry season in 1910, the Northern Hemlock and Hardwood Manufacturers' Association passed a resolution to the effect, "that the State Board of Forestry should have the right to order the disposal of slash adjacent to standing timber or other valuable property in such a manner as to provide a reasonably safe fire line."

In the light of experience with a compulsory slash burning law enacted and enforced in Minnesota, the Lake States Forest Fire Conference in December, 1910, went on record as, "opposed to a general slash burning law, as experience has proven it unsatisfactory, impractical and dangerous." It recommended, however, that the Commission should be given authority to order the disposal of dangerous slashings sufficient to establish a safe fire line around standing timber or other valuable property.

None of these recommendations crystallized in concrete legislative action and while Minnesota experimented with several laws and policies, Wisconsin continued to watch and wait. Bad fires in 1923 and 1925 again opened the question of slash disposal throughout the Lake States. A new slash disposal law was enacted in Minnesota in 1925 and in Michigan in 1927. A bill was introduced in the Wisconsin legislature in 1929 for disposal of slash but this bill failed to pass.

The Conservation Commission, sensitive to the trend of public opinion, feels the need for getting the exact facts in the situation, upon which to build a sound and practical program of forest fire protection. It needs to know: What is the extent of slash in Wisconsin at the present time? How dangerous are these slash areas? To what extent do they contribute to the forest fire hazard? What are the possible means of reducing the danger of slash fires?

To obtain an answer to some of these questions, the Conservation Commission, the University of Wisconsin and the Lake States Forest Experiment Station of the U. S. Forest Service undertook cooperatively to make a slash survey in the state during the season of 1930. The results of this survey are presented in this report. This work was confined to the sixteen counties in the nine northern fire protection districts. It has consisted of a check-up of the areas of existing slash created within the last five years, a canvass of the remaining areas of virgin timber as an indication of the amount and location of slash which may be expected in the future, a record of what is being done to reduce the hazard of this slash as well as more detailed observations as to quantity of slash, its distribution and rate of decomposition on selected areas.

In the progress of this survey, the opinions of forest rangers, emergency patrolmen, county officers, woods superintendents, practical lumbermen and many other people, whose opinion was backed by long

years of experience in Wisconsin woods, were obtained on the problem of slash disposal.[1]

On the strength of these findings, the Conservation Commission, after a conference with lumbermen, has drafted a set of regulations for the disposal of slash. These regulations have been enacted into law by the State Legislature in 1931 and constitute the first step in the solution of the slash disposal problem in Wisconsin. According to this law, all slash smaller than four inches must either be dragged away or burned for a distance of fifty feet from the edge of the right of way of all public highways and common carrier railroads, and fifty feet from the center line of main line logging roads within a year after the cutting operation. Slash must also be removed for a distance of sixty-six feet from valuable forest growth and for a distance of twenty rods in the case of hardwood slash and forty rods in the case of coniferous slash, from school houses and buildings of any small community, or any settler. In addition all dead snags or stubs more than eight feet high must be felled within these cleared strips and for four rods beyond except in standing timber.

## Extent of Slash in Northern Wisconsin

### Definition of "Slash"

Logging slash is a general term applied to all debris and waste incident to logging operations. It consists of tops of trees, large and small limbs and trees broken or cut down which are too small to be sawed up into logs or used for any other product. For the purpose of practical application of slash-disposal measures, some state laws have defined slash as the material under four inches in diameter since the larger pieces are not so readily inflammable and, of course, are very much more difficult to dispose of. (Fig 1.)

### Area and Age of Slashings

An inventory of slashings conducted during the summer of 1930 disclosed some 540,000 acres of recently made slash in the northern 16 counties of Wisconsin. This slash ranges from one to five years of age. Probably 95 per cent of all slash which is not over five years

[1] Valuable assistance in the form of advice and help in obtaining the desired information was given by J. D. Mylrea and O. T. Swan of the Northern Hemlock and Hardwood Manufacturers' Association, C. L. Cecil of the Cornell Wood Products Company, W. A. Holt, President of the Holt Lumber Company and R. B. Goodman of the Goodman Lumber Company.

Most of the field work in this survey was done by Harold C. Moser and Harold F. Scholz, members of the Lake States Forest Experiment Station.

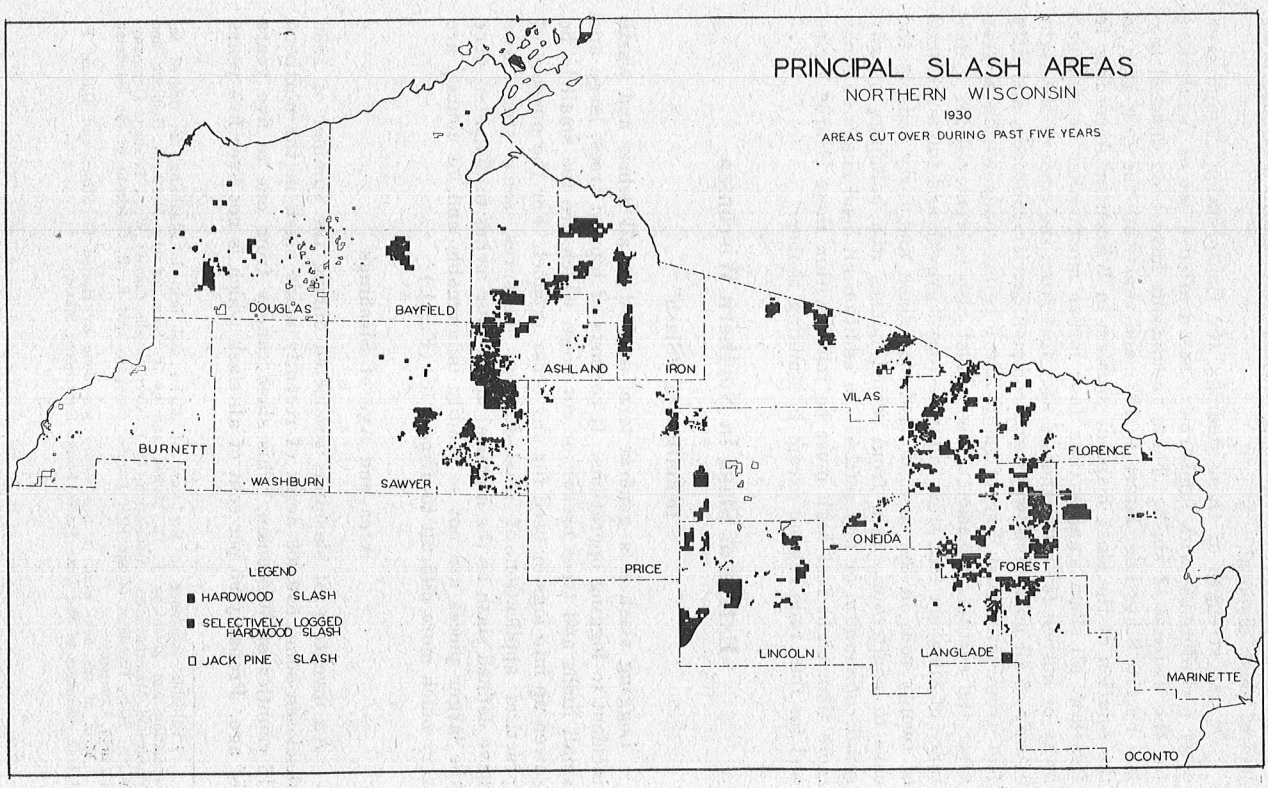


FIG. 2.—PRINCIPAL SLASH AREAS IN NORTHERN WISCONSIN (1930) These areas were cut over during the past five years.

old has been included in this inventory and a few areas six or seven years old which were intermingled with the fresher slash are included. (See map showing area of slash in Northern Wisconsin by Types.) Separate blocks of slash older than five years have not as a rule been listed. Although a large share of the older slashings has been burned over, there are some rather extensive and heavily cut tracts, particularly in northeastern Sawyer county and the southern parts of Bayfield, Ashland and Iron counties. These may total as much as 100,000 acres and must still be reckoned with, although, of course, they no longer constitute as acute a fire hazard as the more recently cut areas. (Table 1)

There are innumerable small cut-over areas from a fraction of an acre up to ten or twenty acres which have not been listed. Although covered with slash, their aggregate acreage is not large and their effect upon the fire problem is almost negligible.

Table I shows the acreage of slash listed by counties and by types. Apparently new slash is being created at the rate of about 100,000 acres per year.

The total acreage needing protection from forest fires in Wisconsin is estimated to be 13,187,000 acres. About 80 per cent of this acreage lies within the counties and fire districts covered by the inventory. The area of recent slashings, therefore, makes up about 5 per cent of the area under protection. This percentage varies, of course, in different district. It runs up as high as 17 per cent in Forest and Florence counties and drops as low as 2 per cent in Washburn and Burnett.

*Table I.—Acreage of Fresh Slashings in Sixteen Northern Counties.*

| County | Acreage of Slashings | | |
|---|---|---|---|
| | Jack pine (acres) | Mixed Hardwood (acres) | Total (acres) |
| Burnett | 7,600 | | 7,600 |
| Ashland | | 62,520 | 62,520 |
| Bayfield | 4,360 | 15,520 | 19,880 |
| Douglas | 11,880 | 19,920 | 31,800 |
| Florence | | 13,840 | 13,840 |
| Forest | | 103,060 | 103,060 |
| Iron | | 49,360 | 49,360 |
| Langlade | | 14,840 | 14,840 |
| Lincoln | 1,760 | 58,280 | 60,040 |
| Marinette | 2,880 | 13,240 | 16,120 |
| Oconto | 80 | 13,760 | 13,840 |
| Oneida | 8,120 | 25,640 | 33,760 |
| Price | | 8,960 | 8,960 |
| Sawyer | | 60,470 | 60,470 |
| Vilas | 1,280 | 24,800 | 26,080 |
| Washburn | 11,920 | 4,600 | 16,520 |
| Total | 49,880 | 488,810 | 538,690 |

*From one to five years old.

### Kinds of Slash

Of the half million acres of slashings less than 10 per cent is classified as jack pine and 90 per cent as mixed hardwood slash. The mixed hardwood slash includes considerable quantities of hemlock commonly associated with the northern hardwoods, also some swamp conifers, spruce, balsam and cedar, too small to be mapped or considered separately in such an extensive survey, but of considerable importance in the general problem.

Within this area are also included a few aspen operations where excelsior bolts are being cut. These aspen slashings, however are light and do not cover large areas (seldom more than 20 to 40 acres in one place).

### Probable Area of Future Slashings

Will the rate of accumulation of slashings in the future be as rapid as it has been until now? The rate at which new slashings are to be created and where the future accumulations are to be, are important considerations from the standpoint of measures necessary to combat the special slash fire menace.

The extent of future slashings will depend upon the rate of cutting, the acreage of available old merchantable timber, and the method of logging. An attempt was made during the summer of 1930 to ascertain the location and acreage of virgin timber remaining in northern Wisconsin and to estimate the probable rate of removal. The results of this survey, although not entirely complete, give a very good clue to the trend of future operations. (See map Principal Stands of Virgin Timber)

The total area of remaining virgin timber, as given in Table II by counties, is in round figures 400,000 acres. The remaining timber acreage is thus considerably less than the acreage of slashings. It seems safe to conclude that there will never again be an accumulation of new slash as large as is found today. This is particularly evident when the number and nature of the remaining operations are considered.

Of the thirty-five or so large hardwood operating companies which have contributed to the present accumulation of slashings, sixteen have closed down and gone out of business during the past few years as a result of the exhaustion of their timber supplies. Judging by the extent of the Wisconsin holdings almost an equal number will be forced to close up their operations in virgin hardwood in the coming five years. Future virgin timber operations will then be confined to a few of the large lumber companies which may have a supply for the next 15 or 20 years. Logging operations will, of course, be con-

*Table II.—Approximate Acreage of Virgin Timber Remaining in Private Hands in Northern Sixteen Counties.*

| County | Virgin Timber (acres) |
|---|---|
| Ashland | 11,100 |
| Bayfield | Neg. |
| Burnett | Neg. |
| Douglas | Neg. |
| Florence | 72,760 |
| Forest | 76,930 |
| Iron | 59,000 |
| Langlade | 29,380 |
| Lincoln | 36,200 |
| Marinette | 3,280 |
| Oconto | 7,160 |
| Oneida | 21,000 |
| Price | Neg. |
| Sawyer | 33,600 |
| Vilas | 10,440 |
| Washburn | Neg. |
| Total | 360,850 |
| Miscellaneous (est.) | 40,000 |
| | 400,850 |

tinued and extended on second-growth areas and selectively cut lands. Such operations, however, do not leave the heavy slash now being created by clear cutting in virgin stands and may contain little or no hemlock. Second-growth cuttings in balsam, spruce and jack pine, of course, create a serious hazard and must be reckoned with in the future.

With the new forest tax law, which favors selective logging and even permits listing of old merchantable timber under certain conditions, the rate of slash accumulation may be considerably retarded. The utilization of hardwoods is slowly but steadily improving. This, again, will be reflected in a smaller amount of slash left on the ground.

Pulpwood stands, particularly jack pine, are being blocked up in several localities by paper companies for the purpose of maintaining a permanent supply of wood. These pulp and paper companies may be expected to conduct their logging operations conservatively and give their cut-over lands more protection than the average owner is able to give today.

On the whole, the outlook is that both on account of the reduction in the rate of cutting in virgin stands and improvement in the character of ownership and operation, the slash situation should gradually improve in the years to come. The greatest menace is apparently in the slash areas already created. Any measures that are to be taken must be directed toward remedying the present situation fully as much as dealing with the new slash which will be created in the future.

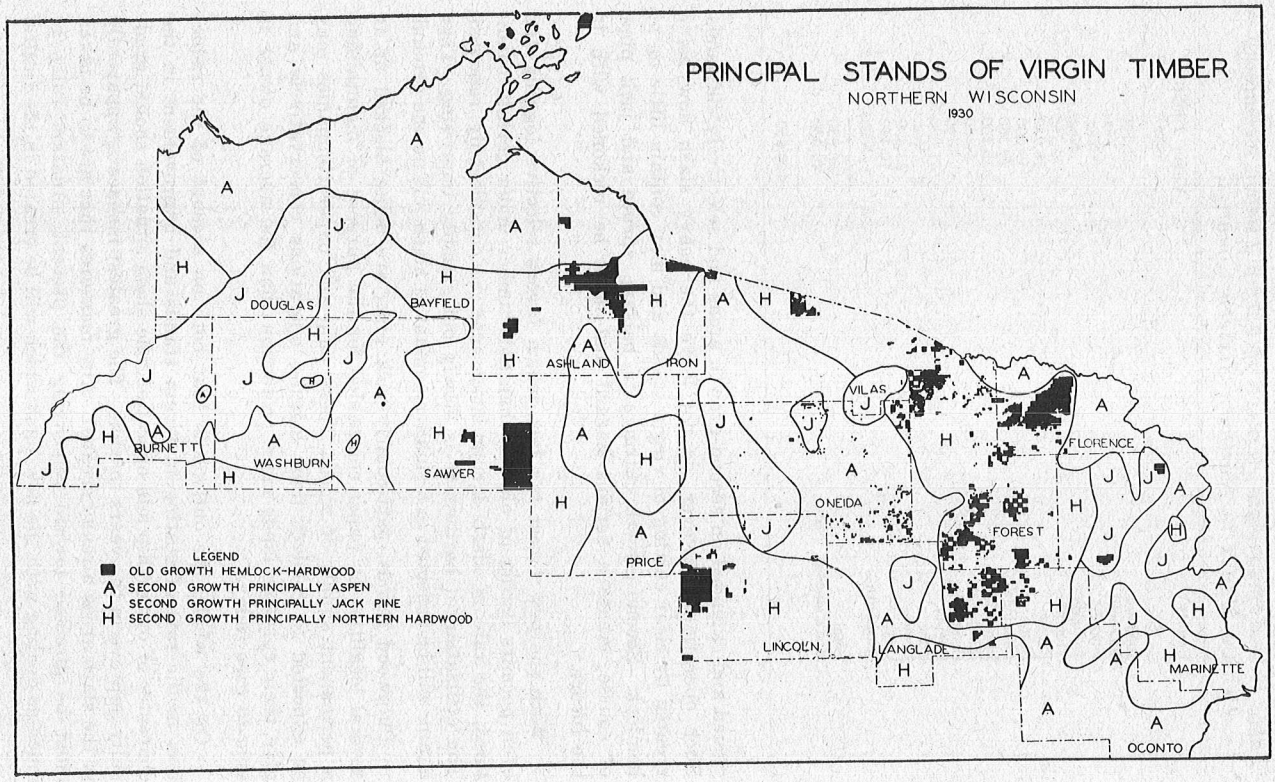


FIG. 3.—PRINCIPAL STANDS OF VIRGIN TIMBER IN NORTHERN WISCONSIN (1930)

## Slash As a Fire Hazard

### Present Character of Slash

Some of the bad reputation that slash has as a spreader of disastrous fires comes from recollection of earlier days in the pine woods when slash left from heavy cutting in white and Norway pine, undoubtedly contributed to a great extent to the severity of the conflagrations which periodically swept the country.

"It is a matter of common knowledge among lumbermen", wrote the State Forester in 1908, "that only a portion of the once magnificent forests of northern Wisconsin was ever utilized, and that not to exceed 40 per cent of the timber ever reached the sawmills. This was due to the fact that in the early logging operations only the choicest trees were cut and forest fires fed by the high inflammable pine slash, which was not disposed of in any way, were so fierce that nearly all the remaining trees were destroyed . . . The result, as we all know, is that great stretches were left almost a barren waste."

Conditions have changed greatly in thirty years. Today there are practically no big operations in white and Norway pine. Instead of the pitchy pine tops and limbs the slash now is from hardwood logging or from pulpwood operations in jack pine. The annual cut of lumber in Wisconsin has fallen off from 3,389,166,000 board feet in 1899 to 818,850,000 board feet in 1928 and is still declining. Large improvements have been made in general forest protection and individual logging companies are unquestionably giving more attention to fire prevention. On the other hand, public travel through the forests, and consequently the opportunity for fires to start, has increased many fold in recent years and it must be recognized that hardwood slash with its mixture of hemlock and other conifers, although less inflammable than the old pine slash, is, nevertheless, a real fire hazard under ordinary logging practices.

### Amount of Slash Left after Logging

The amount of slash created by logging operations varies with the kind of timber, its size and the density of the stand. Conifers, in general, make more fine slash than hardwoods but leave less heavy fuel; small trees leave more debris per unit of product than do large trees and open-grown trees are more bushy and leave more limbs than timber from dense stands. In the hardwood operations typical of Wisconsin, where only saw-log material is utilized and the trees are cut to a top diameter of from ten to fourteen inches, an enormous amount of debris is left on the ground. In cuttings at the Upper Peninsula Experimental Forest[2], from 27 to 38 cords per acre of actual useable wood have been salvaged after the sawlogs, amounting to

[2] Field station of the Lake States Forest Experiment Station located near Marquette, Michigan.

FIG. 4.—CUTTING CHEMICAL WOOD FROM THE TOPS AND CULL LOGS IN NORTHERN HARDWOOD OPERATIONS

(Upper Peninsula Experimental Forest, 1929) This field station of the Lake States Forest Experiment Station is located near Marquette, Michigan.

from 10 to 12 thousand board feet, were taken out. This cordwood which was used for chemical distillation was taken down to three inches in diameter and still left from a quarter to a third of the area covered with leaves, twigs and branches from a few inches up to three or four feet in depth. (Fig. 4).

There is no definite ratio between the volume of saw timber removed and the volume of slash left on the ground on account of natural variations in the timber[3], but it is probably safe to say that in ordinary hardwood operations for each thousand board feet removed from the forest there is about three cords of wood besides a large quantity of finer material left on the ground.

In jack pine stands which are cut down to four inches in diameter at the top, the amount of slash is somewhat less although even here it not uncommonly covers from 40 to 50 per cent of the area to a depth of one to three feet.

Aspen is seldom cut clean on any area and the slash is consequently more widely scattered. Individual cuttings likewise are not large, usually not over ten to twenty acres in a place.

Swamp cuttings also are likely to be rather light because the better timber has usually been taken out at some earlier date. One

[3] In Western Yellow Pine, Munger and Westveld found that the quantity of slash left per thousand board feet of timber cut varied from a minimum of 139 cubic feet, where the timber was heavy (24 M per acre), up to 620 cubic feet, where the merchantable stand was only 4,000 board feet per acre. With stands running 10,000 board feet per acre, the slash amounted to 278 cubic feet for each thousand feet of sawlogs.

balsam operation of considerable size was examined where the average yield was only three cords of pulpwood and eight ties to the acre. The best acres of pulpwood timber in this operation cut out about eight cords and left slash from four to five feet deep over about 50 per cent of the area.

On most operations observed, the slash was not distributed uniformly over the ground but was heaped up in irregular piles to facilitate the skidding out of logs. Much of the jack pine slash was windrowed, the space between the windrows being used as a roadway for the pulpwood trucks. The diagrams for hardwood and jack pine slash areas (Figs. 6 and 7) give a picture of the distribution of slash on two actual operations.

### Inflammability of Slash

From the standpoint of inflammability, or the ability to ignite quickly from a carelessly tossed match or cigarette, slashings must be rated lower than many other fuels found in the forests of Wisconsin. In a study of fire hazards in hardwood and jack pine lands in northeastern Wisconsin in 1928[4] the conclusion was reached that dead dry grass is the most inflammable fuel, followed by jack pine needles, dead hardwood leaves and twigs, dead herbaceous vegetation and dead and down wood in the order named. (Fig. 5).

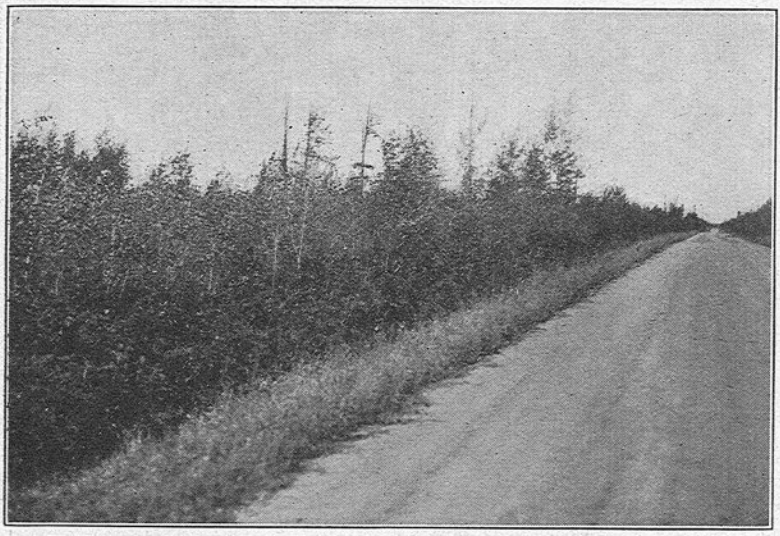

FIG. 5.—ASPEN AND CHERRY GROWTH WITH DRY FERNS, GRASS AND WEEDS BORDERING THE ROADBED

This is an easier place for a fire to start from a carelessly thrown match or cigarette in the spring or fall than ordinary hardwood slash.

[4] *Forest Fire Hazard as affected by weather conditions,* Forest Type and Density of Cover—J. A. Mitchell and Raphael Zon, 1929. Bulletin 91—University of Wisconsin.

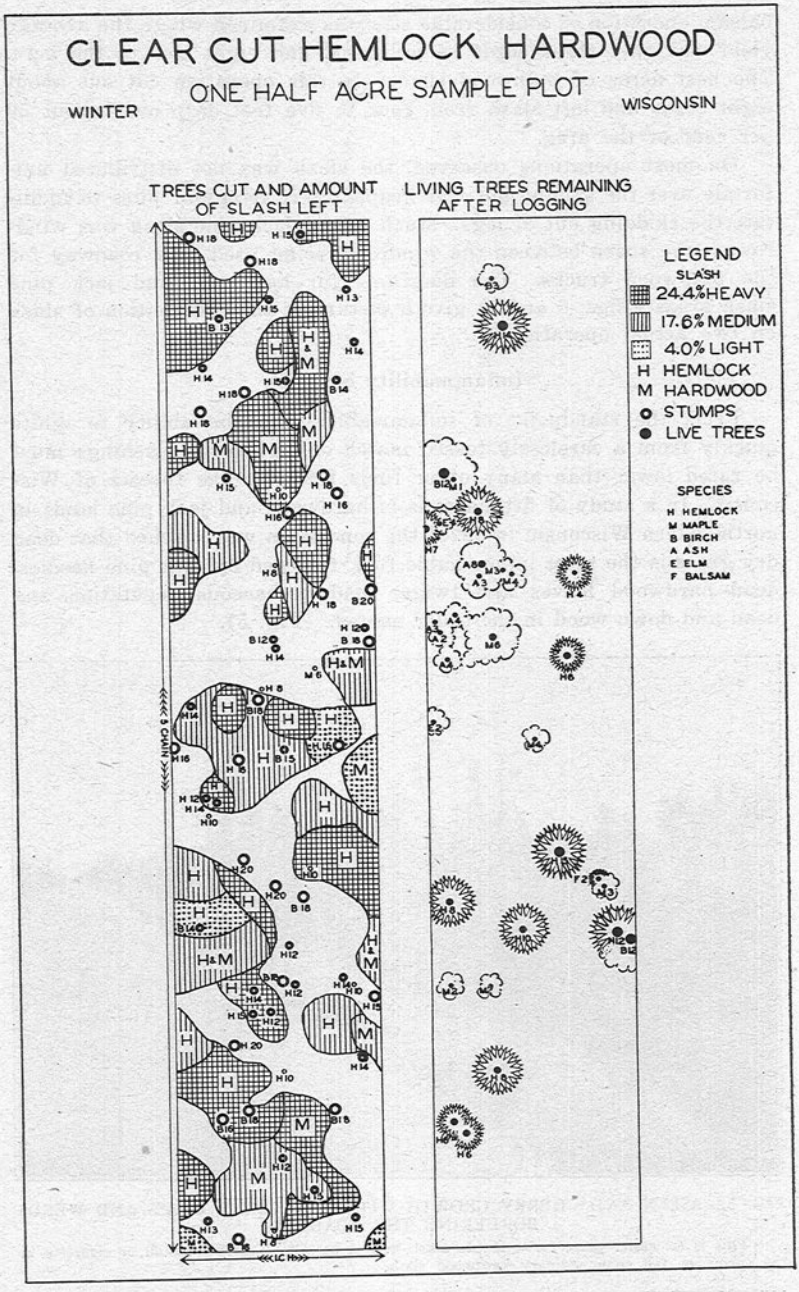


FIG. 6.—CLEAR CUT HEMLOCK HARDWOOD

Left hand strip shows the location, the species and the diameter of the trees cut on an area one chain (66 feet) wide and 5 chains long. It also shows the density of the slash (by different hatchings) and the principal species of timber which go to make it up (by initials). The right hand strip shows the diameter and species of the remaining trees.

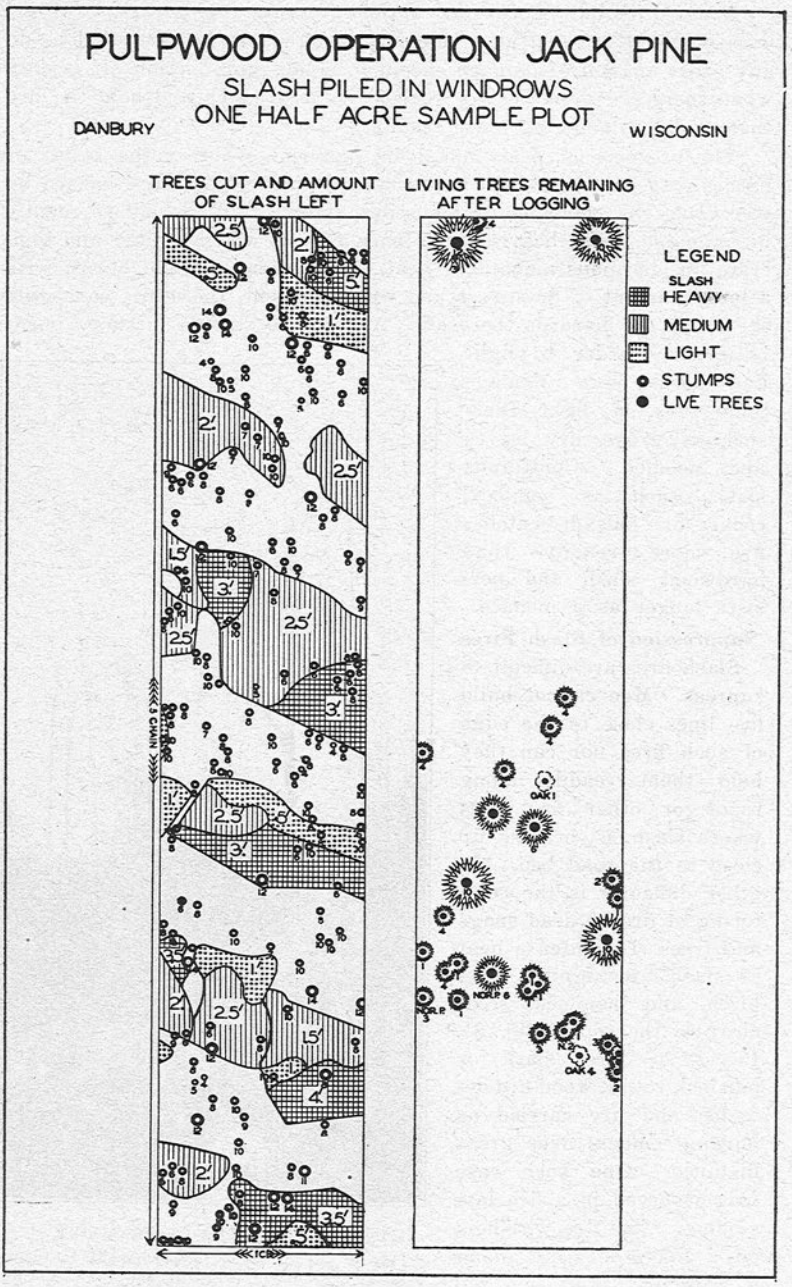


FIG. 7.—PULPWOOD OPERATION JACK PINE

All trees in this diagram are jack pine except where otherwise indicated. In the left-hand strip, the average depth of the slash in feet is shown.

Grass dries out readily and spreads fire rapidly. Grass, however, does not hold fire and as a rule not enough heat is generated to do any great amount of damage except to small reproduction. It is only when there are some heavier fuels present to catch and hold the fire that a really damaging blaze results.

The presence of dead and down material, whether the result of natural causes, logging, or fire, serves to intensify the fire hazard by increasing the amount of combustible material. While not so readily inflammable, these heavier fuels burn fiercely when ignited and generate an enormous amount of heat. Slash areas and old burns, with a large amount of dry grass and weeds present, therefore, constitute the worst fire hazards there are. A fire once started in slash, burns hotter, is harder to fight and does more damage than fires in light fuels such as grass, dry leaves and needles. Coniferous slash, such as hemlock, cedar or balsam catches fire more readily than hardwood slash and persists longer as a menace.

**Suppression of Slash Fires**

Slash fires are difficult to supress. Men cannot build fire lines close to the edge of such fires nor can they hold them readily along roads or other fire lines where slash is heaped up close to the road bed. Another difficulty is the scattering of fire by dead snags and trees. The intense heat of slash fires ignites dead birch and hemlock trees clear to the top. (Fig. 8). Pieces of birch bark or hemlock rotten wood are detached and are carried as burning embers over great distance. One such case was observed in a fire last summer. The fire was held on a five-mile front along a highway but an old stub or "rampike" stand-

FIG. 8.—BIRCH STUB OR "RAMPIKE"
This is one of the principal means by which fires manage to jump roads and other natural fire breaks and one of the factors making fires extremely difficult to control.

FIG. 9.—FIRE RUNNING THROUGH JACK PINE—OAK LAND WHICH HAS BEEN REPEATEDLY BURNED BEFORE

ing a short distance back from the road caught fire and an unfavorable wind carried bits of flaming bark well across the road.

### Damage Done By Slash Fires

From the standpoint of damage, slash stands at the top of the list of fire hazards. The intense heat of slash fires will usually kill all remaining trees and young growth.

Thus, not only is the forest severely damaged, but the dead and falling trees, and the grass and weeds which come in create a further fire hazard so that not uncommonly such areas burn over repeatedly until the land is practically a barren waste. The first slash fire which changes the natural forest to a weed patch of brush, aspen and cherry, and paves the way for further fires is a real catastrophe. It may require generations to build up the soil and reestablish a forest of desirable species. (Fig. 9).

### Slash and Frequency of Forest Fires

The impression is general that most slash burns sooner or later and there is some support for this belief in the scarcity of large areas of old unburned slash, especially from clear-cutting operations. It must be remembered, however, that it is only within the past few years that forest protection had been at all adequate or general in the state and that until recently fires were prevalent everywhere during the spring and fall seasons. The fact that there are now over one-half

million acres of slashings which have survived several fire seasons, including one of the driest of record, is some evidence that it is not entirely impossible to prevent fires from starting and spreading uncontrolled in slash areas.

There is no reason to believe that fires occur more frequently in slashings than on other areas in Wisconsin, in fact, according to statistics compiled by the Wisconsin Conservation Commission fires from logging made up only 3½ per cent of the fires from known origin for the period 1920 to 1929, inclusive. The principal causes were as follows:

| | |
|---|---|
| Lightning | 1% |
| Railroads | 19% |
| Land clearing | 34% |
| Logging | 3½% |
| Camp fires | 12% |
| Smokers | 21% |
| Incendiary | 5½% |
| Miscellaneous | 4% |
| | 100% |

There is some evidence, however, that slash fires are relatively more of a problem than the number of logging fires or the relative area of a slash would indicate. In the five counties of Forest, Florence, Marinette, Lincoln and Oneida, slash covers about 7.3 per cent of the total area protected. The fire study[5] of 1928 brought out the fact that slash fires in these five counties accounted for 2,193 acres or 27 per cent of the total acreage burned that year. This checks fairly well with the record in the Upper Peninsula of Michigan, where slash fires made up 21 per cent of the total acreage burned in 1927 and 1928. A point of interest is that of the total 134 fires reported in these five Wisconsin counties in 1928 only thirteen were slash fires and 121 fires were on other types of land. Yet the thirteen slash fires averaged 169 acres each and burned over a quarter of the whole acreage while the other 121 fires averaged only 49 acres each. This would seem to indicate that slash fires, although not as frequent as in some of the other types of fires, are harder to check and burn over more ground before they are brought under control. Of the thirteen slash fires, five were caused by logging locomotives.

### Life of Slash as an Extra Fire Hazard

How long after logging does the slash remain a fire hazard? Because of the great variety of conditions found in the woods as regards the amount of slash, the species and the factors speeding or retarding decay, the opinions of lumbermen, rangers and other woodsmen as to the time required for slash to cease to be a special fire

[5] Bulletin 91. University of Wisconsin.

menace vary to such an extent as to be almost meaningless. These estimates run from two to thirty years.

On the basis of observations conducted under different conditions of stand and degree of utilization, it may be conservatively stated that heavy hardwood-hemlock slash under the ordinary conditions of logging constitutes an extra fire hazard for at least eight years and jack pine slash about seven years. Other coniferous slash may remain a source of fire danger for from 12 to 15 years. Of course, in all of these slash areas, there is some additional fuel present for a longer period which is somewhat of a threat in the spring and fall. For instance, observations made by the Lake States Forest Experiment Station indicate that basswood logs and stumps may be a hazard up to 10 or 12 years; the danger completely disappears after 15 to 18 years when nothing remains except a rounded heap of moldy wood. Similarly in 15 to 17 years sugar maple and yellow birch is so rotten that little inflammable fuel is left. Elm resists decay more than any of the northern hardwoods but stumps and logs apparently cease to be a fire menace in 20 to 25 years. Cedar and hemlock must be reckoned as combustible for 20 to 30 years. The period of extra acute fire hazard, however, is about eight years.

Based upon observations made in slash areas of different ages in 1930, a typical history of a hardwood slash would be about as follows:

Immediately after logging, the bulk of the slash is in large piles distributed aimlessly over the area but so broken up as not to interfere with skidding. Scattered branches or "light slash" lie in the spaces between piles and serve to make the cover of debris more or less continuous. Large, unlopped birch tops often form skeletons for the masses of slash, the smaller branches of hemlock, maple, etc., being thrown over them to clear the way for teams. The ground is well stirred up from logging and much of the old litter is thrown out to the side of the skidroads. Slash varies in depth from a few inches in the case of scattered branches to ten feet in the larger masses. Usually there is little young reproduction, except for occasional maple seedlings and very little herbaceous growth.

The first summer after logging, there occurs little change in the appearance of the cut-over area. Hemlock needles die and begin to fall off. Basswood stumps sprout profusely. Some of the open spots begin to come in to grass and fireweed grows in places. There is no apparent change in the hardwood slash other than seasoning of the wood.

In the second year, growth of herbaceous vegetation is greater. Grass takes over the skidroads and spaces between the brush piles. Raspberries begin to come in and fireweed is well represented. This is probably the period of greatest danger from fire. In favorable places some maple and elm reproduction comes up—basswood sprouts continue to grow. There is little change in the appearance of the slash,

except that the hemlock needles are well gone and the wood becomes thoroughly seasoned. The small twigs are all retained.

During the third and fourth years the undergrowth becomes dense and obscures all but the larger piles of slash. Raspberries are dense and a heavy cover of grass comes up in the open spaces. The slash has lost much of its bark and many of the smaller twigs have become soft and break off readily. Slash piles have settled down considerably and the scattered twigs and small branches are quite soft.

During the fifth and sixth years, decay progresses rapidly. At the end of the sixth year, however, there is still a great deal of combustible fuel.

By the end of the eighth year most of the small branches up to a half inch or more are quite rotten and successive snows have broken them up pretty well. The scattered slash is now well disintegrated. Hemlock alone remains a menace. Remnants of the slash piles persist up to 15 or 16 years but by that time they are thoroughly broken down and rotted. Branches of three inches and up remain but barely

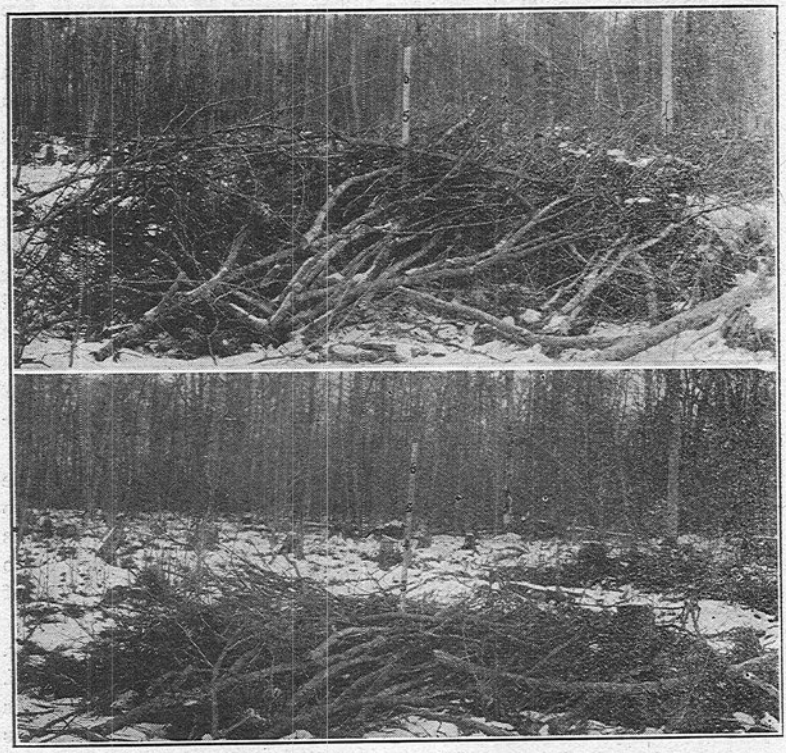

FIG. 10.—HARDWOOD SLASH PILE FIRST YEAR AFTER LOGGING, UPPER PENINSULA EXPERIMENTAL FOREST. (*upper picture*) SAME SLASH PILE SECOND YEAR AFTER LOGGING. (*lower picture*)

FIG. 11.—APPEARANCE OF JACK PINE SLASH AREA FIVE YEARS AFTER LOGGING

maintain their original shape. The special hazard may be said to be completely gone. (Figs. 10 and 11).

The survey conducted in 1930 was started with the idea that only slashings up to five years of age need be considered as dangerous, but the observations and suggestions obtained during the season point to an eight-year period as a more justifiable rule-o-thumb figure for hemlock-hardwood slash with a year less as a satisfactory estimate for jack pine. (Fig. 12).

If instead of going through this period of natural decay the slash is accidentally burned the picture is entirely different. The fire running through the slash kills the remaining trees, which, however, remain standing for several years. Grass and fireweed will first cover the area. (Fig. 13). A few basswood sprouts will appear but aspen spreading from root suckers will generally replace the better hardwoods. As soon as enough dry leaves and other material have accumulated fires may recur and the small aspen and other growth will be killed back. The dead material, which continues to fall from year to year, keeps the ground covered with debris, a constant invitation for the return of fires until the area is practically a barren waste.

Thus, although the natural decay of slash over a period of seven to eight years largely takes care of the extra hazard caused by logging, it involves serious risks and can be considered a satisfactory process only if adequate precautions are taken to keep fires out during this critical period.

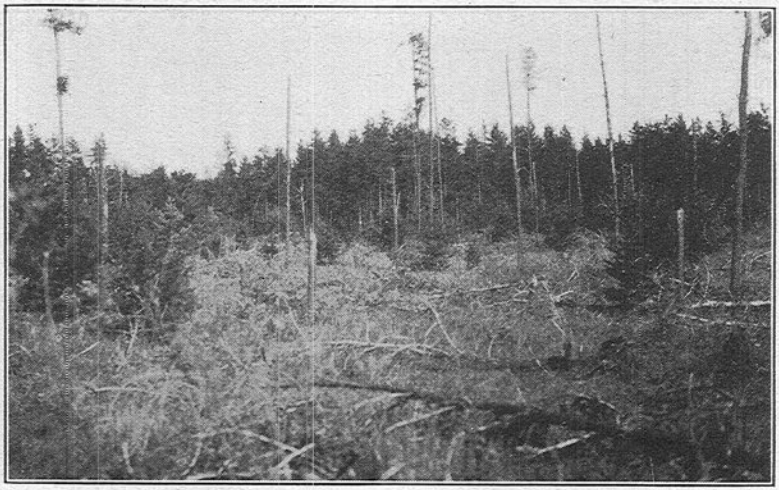

FIG. 12.—JACK PINE SLASH EIGHT YEAR AFTER LOGGING.
The dry grass is the most inflammable part of this ground cover.

## Method of Logging and Slash Accumulation

Whether a forest is cut clean or selectively determines the amount of slash left on the ground, its rate of decay and, therefore, its fire hazard.

### Fire Hazard Reduced Under Selective Logging

A forest cut selectively is not so great a fire hazard as a clear-cut area. The amount of slash left per acre is less, the more scattered slash breaks up and decays more quickly, and the general inflammability of the forest floor under the shade of the remaining trees is less than in the open cut-over areas. Furthermore, the timber operator, because of his interest in the remaining timber, is likely to take more full and effective precautions to prevent forest fires.

In selective cutting, where only a part of the merchantable volume is removed, the amount of slash left after logging is proportionately smaller than on clear-cut areas. On several hardwood cuttings made at the Upper Peninsula Experimental Forest in stands also typical of Wisconsin, it was found that with 39 per cent of the merchantable stand cut and the tops and cull logs utilized for chemical wood, only 8 per cent of the area was covered with slash of any kind. One per cent was covered with heavy slash (depth 6 inches to 12 inches), 4 per cent with medium slash (3 inches to 6 inches) and 3 per cent with light slash. On one half-acre sample plot taken on a selectively logged area in eastern Wisconsin, it was found that heavy slash covered only one per cent of the ground and that altogether only 21 per cent of the area was covered with slash of any kind. The half-acre plots

taken on clear-cut hardwood acres showed an average of 40 per cent of the ground to be slash covered, two-fifths of which was classified as heavy slash. Likewise, on clear-cut jack pine plots in pulpwood operations 44 per cent of the area was found to be covered with slash. The particulars for these six plots are as follows:

| Plot no. | Type | Percentage of ground covered by slash | | | |
|---|---|---|---|---|---|
| | | Heavy | Medium | Light | Total |
| 1 | Clear-cut hardwood-hemlock | 11 | 14 | 12 | 37 |
| 2 | Clear-cut hardwood-hemlock | 24 | 18 | 4 | 46 |
| 3 | Clear-cut hardwood-hemlock | 16 | 18 | 4 | 38 |
| 4 | Selectively cut hardwood-hemlock | 1 | 7 | 13 | 21 |
| 5 | Clear-cut jack pine | | 26 | 17 | 43 |
| 6 | Clear-cut jack pine | 8 | 30 | 7 | 45 |

Heavy means 3 to 10 feet in depth
Medium means 1 to 3 feet in depth
Light means under 1 foot in depth

Selective logging does not do away with slash as a fire hazard but it hastens its disintegration. Under selective logging in a hardwood forest in which no hemlock is present and the trees are cut for both sawlog material and chemical wood, slash should cease to be a menace in two or three years. A good example of such selective cutting can be seen at the Experimental Forest in the Upper Peninsula of Michigan where after logging the slash did not occupy over 8 per cent of the ground surface. After four years, it is now so well decayed, crushed down, and hidden by ground vegetation and young growth that it is hardly noticeable at all and is of no importance from the fire-hazard standpoint. (Figs. 14 and 16).

On another cutting at the Experimental Forest where the slash was left and scattered, it was hardly visible at the end of two years.

Where hemlock is mixed with hardwoods and the chemical wood is not utilized, slash may continue to be a fire menace for a considerably longer period, but not as long as on the clear-cut areas.

The effect of forest cover in general is to reduce the fire hazard. Selective logging by maintaining overhead shade modifies conditions in several favorable ways. The remaining timber reduces wind movement, lowers temperatures, and raises the relative humidity. The Wisconsin Fire-Hazard Study in 1928 found that there was a consistent difference between the hardwood forest and the adjacent open land in all of these important factors. In the spring of 1928, for instance, the wood litter in the forest contained 29.2 per cent more moisture than in the open and in the fall 35.5 per cent more moisture. The spring air temperature averaged 2.4 degrees lower in the forest while the average litter temperatures varied by as much as 22 degrees between the forest and the open ground at certain hours of the day. The relative humidity of the air was one to three per cent lower in the open during the critical part of the day.

FIG. 13.—RESULTS OF A SPRING FIRE IN WISCONSIN HARDWOOD SLASH.

Picture taken the following fall. All advanced growth killed. Note bare spots where tops lay and dense growth of fire weed where fire was less hot.

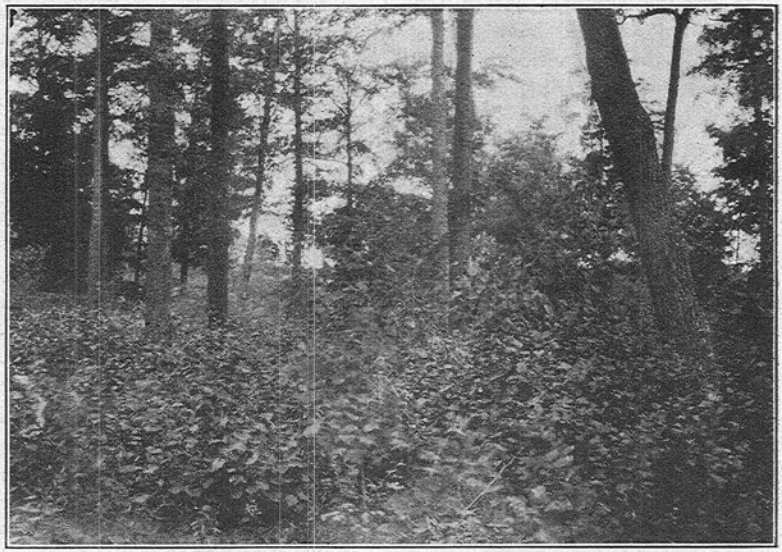

FIG. 14.—SELECTIVELY LOGGED VIRGIN HARDWOOD, MARINETTE COUNTY, WISCONSIN, 1928.

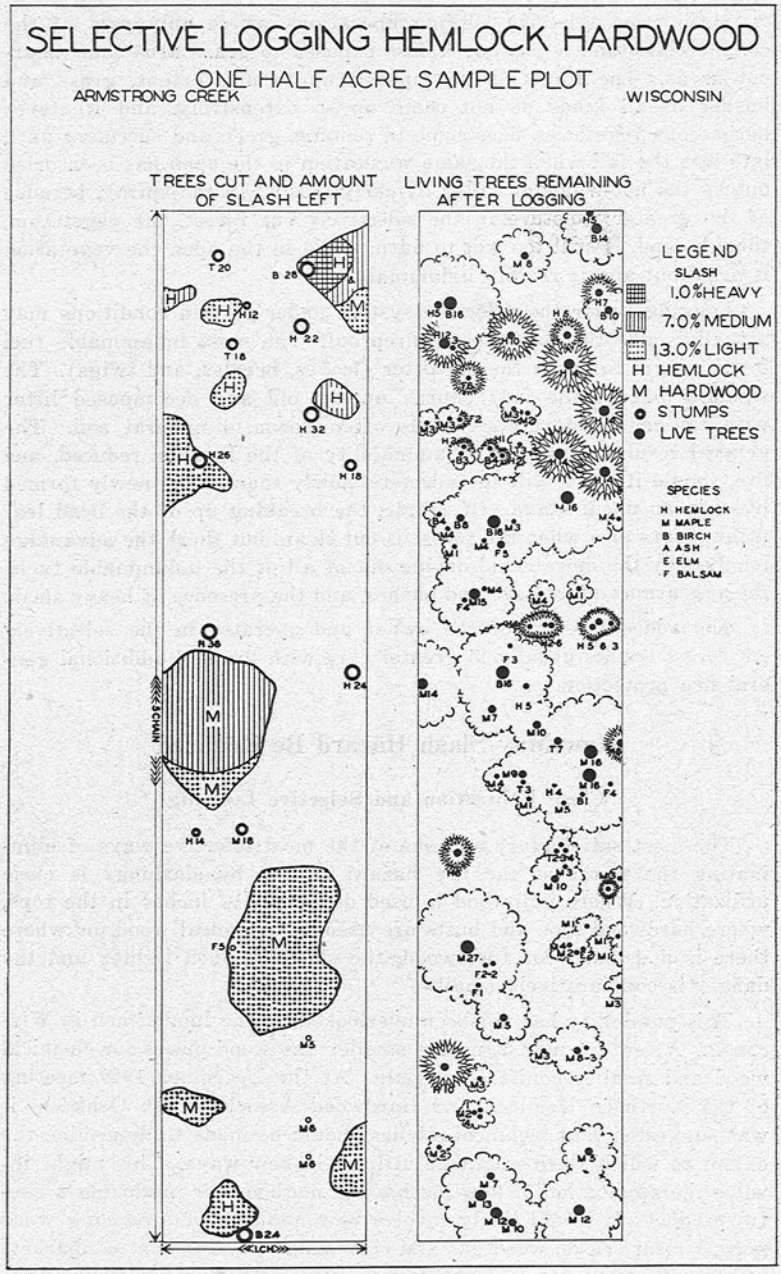


FIG. 15.—SELECTIVE LOGGING HEMLOCK HARDWOOD.

Figures following the initials designating the tree species indicate the diameter of the trees.

Slash from selective logging operations where only part of the commercial stand is cut out is less exposed to grass fires than clear-cut areas. The forest is not opened up to any extent, grass and bushes of all kinds do not come up so extensively, and whatever herbaceous vegetation does come in remains green and succulent until late into the fall when the same vegetation in the open has been dried out by the hot winds or killed by early frosts. In the spring, because of the greater moisture in the selectively cut forest, the vegetation, though dead, is still too wet to burn, while in the open the vegetation is dried out and is readily inflammable.

Logging under the selective system under certain conditions may actually make the forest more fireproof. The most inflammable fuel in the virgin forest is the old litter (leaves, needles, and twigs). The skidding out of the logs churns up the old and decomposed litter with the new and scrapes trails often down to mineral soil. The general result is that the inflammability of the litter is reduced, and fire, should it start, will spread more slowly than in the newly formed litter in an uncut stand. Of course, the breaking up of the dead leaf litter occurs also when the forest is cut clean, but there the advantage is offset by the more rapid drying out of all of the inflammable fuels, the appearance of grasses and bushes, and the presence of heavy slash.

The added interest of the owner and operator in the selectively cut forest results usually in greater care with fire and additional general fire protection.

## How May Slash Hazard Be Reduced

### Close Utilization and Selective Logging

The most satisfactory and one of the most effective ways of eliminating the worst of the fire hazard caused by slashings is close utilization. Where pulpwood is used down to 3½ inches in the tops, where hardwood tops and butts are used for chemical wood, or where there is a demand for fuel wood, the slash is much lighter and the danger is comparatively small.

This possibility has not been overlooked by the lumbermen in Wisconsin. A few are now using the smaller hardwood pieces for chemical wood and smaller conifers for pulp. At the December 1929 meeting of the Northern Hemlock and Hardwood Association in Oshkosh, it was suggested that technical studies should be made to determine the extent to which slash might be utilized in new ways. This might involve the application of new mechanical methods for producing a useful product. It would likely involve new methods of producing wood pulp, carbon bricks, wood gas and chemicals. Development of markets for fuel wood in some of the larger cities is a very promising possibility. It seems entirely possible that the slash problem will eventu-

ally solve itself as market conditions for various by-products are built up and as studies develop new uses for wood.

Selective logging has been mentioned as another means of greatly improving slash conditions. These measures, however, offer no remedy for existing slash nor can they be applied by any and all operators on a few months' notice. They are desirable objectives, but unfortunately are not blanket cures for the present situation.

The other possible methods of reducing the fire hazard resulting from present clear-cutting operations fall into two classes: (1) complete or partial disposal of slash, and (2) special protection for dangerous areas until the slash ceases to be an extra fire hazard. Lopping and scattering of slash, which is somewhat of a transition step between disposal and protection, may be included with the first class. These measures are in addition to an effective general fire-protection system for the entire state.

### Slash Disposal

Slash may be disposed of by burning in several different ways: (1) broadcast burning, (2) piling and burning, or (3) progressive or swamper burning.

### Broadcast Burning

Burning the slash broadcast as it lies after logging was not uncommon in the old pine operations, but the method has a few advocates in the present day hardwood or jack pine stands.

In the old white and Norway pine operations, particularly in Minnesota where disposal was required by law, it was the common practice fifteen years ago to go out early in the spring and set fire to the winter accumulation of slash, letting the fire run pretty much at will over the entire area. If the ground was too wet, only the finer material would be burned and the fire hazard only partly reduced. If too dry, the fire might easily get out of control and spread to adjoining property. Under the most favorable circumstances, the fire could consume the accumulated debris, but in so doing would kill most of the remaining tree growth on the land which in time would fall and produce fuel for another destructive fire.[6] Many of the more or less barren areas in the northern Lake States are the result of just such methods of slash disposal.

Hardwood slash areas do not lend themselves readily to broadcast burning. Whenever slash is dry enough to burn broadcast, conditions are right for a running forest fire, and, as a result, very little general burning has been tried. Everyone consulted in northern Wisconsin was opposed to any such use of fire on the hardwood cut-over areas.

It is possible to dispose of jack pine slash by broadcast burning. This slash is usually windrowed so that the slash will burn fairly

[6] Munger and Westveld in western yellow pine found that broadcast burning on certain areas measured killed between 50 and 60 per cent of the area of reproduction where the fire did not burn very freely and killed over 90 per cent where there was a clean burn of the slash.

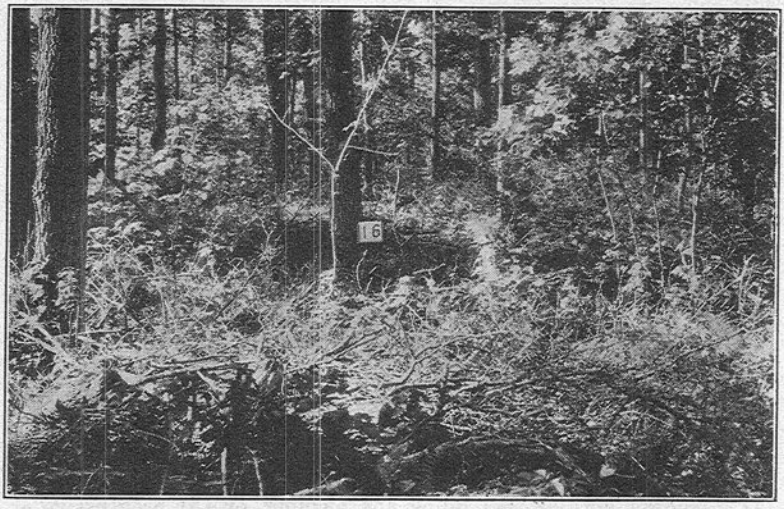

FIG. 16.—LIGHT SCATTERED SLASH.
This resulted from selective logging with utilization of cordwood down to three inches in diameter—Upper Peninsula Experimental Forest.

clean. By carefully burning around the outside of the slash area the night before, the danger of the fire getting out of bounds can be reduced. But here again the fire will kill most of the young jack pine, and on account of the grass which comes in will leave the area almost if not quite as inflammable as it was with the slash on it. Another difficulty lies in the fact that most of the jack pine logging is done during the spring, summer, and fall, seasons of the year during which it is not safe to use fire in the woods.

Broadcast burning is cheap except for the occasional fire that gets out of control. One company, which burned thousands of acres of pine slash in northern Minneosta, estimated the average cost to be 10 to 20 cents an acre.

The objections to broadcast burning are that it is dangerous, it is destructive, and it is inefficient as a hazard reduction measure.

### Piling and Burning

Lopping the tops, piling the boughs and sticks into compact piles, and burning the piles at a safe time when the fires will not spread is a measure primarily applicable to coniferous slash. It has been a common practice for years on National Forest timber sales in the West. It was used on Indian Reservations in Wisconsin as much as twenty-five years ago.

Piling and burning has been practiced on the Menominee Reservation in hemlock-hardwood stands.[7] The method followed was to fall

[7] Utilization and Brush Disposal on the Menominee Reservation—B. A. Eger, Am. Lumberman—April 15, 1922.

the hemlock first, swamp and pile the brush, and then fall the hardwood on top of the piles. This resulted in large but fairly compact piles that because of their foundation of hemlock brush burned readily and fairly clean. Burning was usually done in the early spring. In these operations the sawyers were paid by piecework and no extra compensation was given for piling the brush. In addition to piling the slash, the sawyers were required to cut all snags as a fire precaution, but for this they were given extra pay at the rate of 25 to 35 cents per snag.

The piling and burning of the slash on this hardwood operation was not altogether successful from a silvicultural standpoint. The large piles loosely thrown together burned fiercely and often burned over the entire area, damaging or killing many of the small trees. The practice favored in more recent hardwood cuttings on the Menominee Reservation has been selective logging with close utilization and no slash burning.

There is no doubt that the jack pine slash can be successfully disposed of by piling and burning. (Fig. 17).

Piling without burning is not to be recommended. The cost is nearly as great as with burning, the fire danger is reduced very little, and the rate of decay in the slash is in many cases actually decreased.[8]

FIG. 17.—JACK PINE SLASH.

This is piled ready for burning on the Forest Fire Experimental Station area, Roscommon, Michigan, 1930.

[8] Long (Investigations of the Rotting of Slash in Arkansas, U. S. D. A. Bul. 496) found in oak slash that by the end of five years the top and bottom of piles had rotted to a considerable extent but the brush in the center was just beginning to rot. He estimates it takes from 3 to 5 years longer for brush in piles to disintregate than brush which is left alone.

### Progressive or Swamper Burning

On National Forest timber sales in the Lake States region, the slash from Norway, white, and jack pine is usually burned progressively at the time of logging. Fire is started with some dry wood and the brush is heaped on the fire as it is cut. This method has several distinct advantages. It results in good slash disposal. It removes the slash before skidding, which helps in logging. It saves rehandling the slash. Fires are easily controlled and do little or no damage to any standing timber and young growth on the land. It destroys less soil humus and vegetable matter than other types of burning. It saves logs that would otherwise be left in the woods.

Progressive burning has been used to a very limited extent by private operators to dispose of hardwood-hemlock slash. According to the Superintendent of one operation in Michigan, no difficulty was experienced in burning the brush green or in the winter once a fire was started. The cost of this disposal was about two dollars per thousand, but a part of this cost was offset by reduced logging costs and recovered logs. Spruce and balsam slash has been extensively handled by progressive burning on Dominion Forest Reserves.

Aside from its possibilities as a general slash-disposal measure, progressive burning is adaptable to partial disposal methods. It is probably the best method for clearing road or railroad right of ways and dangerous areas around camps and settlements. It can be used to dispose of the hemlock and balsam slash in the mixed stands leaving the less inflammable and more easily decayed hardwood debris to rot.

### Lopping and Scattering

Lopping which has had rather wide advocacy at one time or another is based upon the belief that bringing the limbs and twigs close to the ground will hasten their decay. What evidence there is concerning this effect, however, is not altogether conclusive.

Studies made in connection with the compulsory toplopping law in New York seemed to indicate clearly the much more rapid disintegration of lopped tops in the case of spruce and some of the other conifers. It was estimated that the lopped tops would cease to be a fire hazard in about seven years while the unlopped would persist for 15 years.

With white pine tops, Spaulding[9] found that on soils that are moist the year around, slash lying directly on the ground became waterlogged, so that fungi could not attack it. Lopping was thus a disadvantage. On sandy soil exposed to the sun, scattered slash tends to dry excessively and resists decay for a long time. Here rather close piling so that a minimum surface will be exposed to the sun will be preferable to scattering. On medium situations the slash can be left

[9] Decay of Slash of Northern White Pine in Southern New England—Perly Spaulding, U. S. D. A. Technical Bul. No. 132, 1929.

more or less as felled, but with as much in contact with the soil as possible. Lopping will help somewhat.

In hardwood slash in northern New England, Spaulding[10] concluded that lopping will not pay with aspen or paper birch because they rot quickly and lopping can not hasten decay appreciably. Lopping is also liable to bring on water logging in these species. Beech, maple, and basswood waterlog easily and lopping is of questionable value as it places the slash in the most favorable position to absorb water from the soil. Yellow birch slash seems especially prone to waterlog and it should rarely be lopped.

Conditions in Wisconsin are not identical with those of New England and further experimentation may indicate the desirability of lopping in this region.

## Special Protection for Slash Areas

Among the practicable measures to prevent the occurence and spread of fires may be enumerated: (1) breaking up the slash areas with natural and artificial firebreaks. (2) thorough protection to prevent fires in current logging operations, (3) intensive protection for a period of years until the extra fire hazard has disappeared.

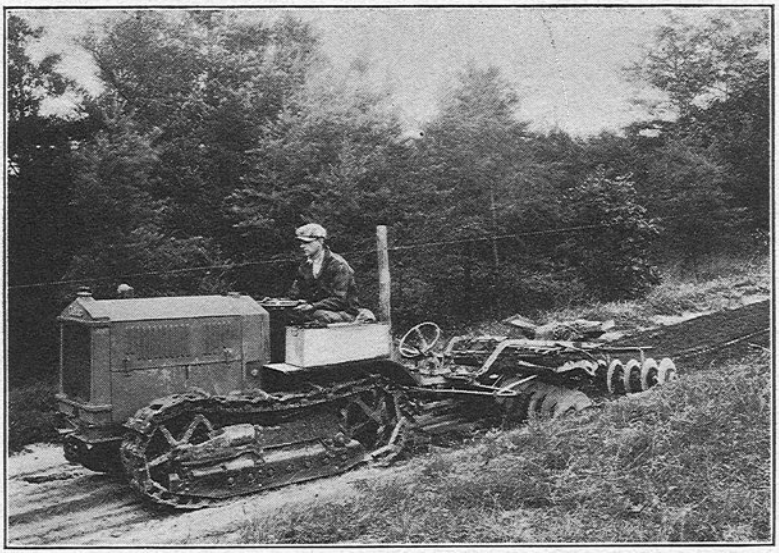

FIG. 18.—FIRE-LINE CONSTRUCTION IN PINE LANDS OF MICHIGAN. Tractor and disk used for annual maintenance.

[10] Journal of Forestry, April 1930, p. 567.

### Breaking Up of Slash Areas by Fire Lines

Fire-fighting crews are often able to make good use of streams, wet swamps, railroad grades, highways, etc., in checking the spread of fires. Even cow trails or single wagon ruts can sometimes be used to advantage as a place to start a backfire. This is particularly true in fires spreading through logging operations where very commonly it would be out of the question to stop a fire without such aid on account of the intense heat generated by the burning slash which will hinder men in constructing fire trenches.

A less fortunate but quite common experience is to attempt to use such lines and to find that it is impossible to do so. There may be a gap in the line which permits the fire to go through. The road may be overgrown with inflammable grasses. Heaps of slash or old dry snags along the right of way may throw the fire across.

These experiences, both successful and unsuccessful, suggest a more systematic use of firebreaks in areas of particularly high hazard. This would not necessarily mean the construction of a large mileage of regular fire lines, but would involve some well considered

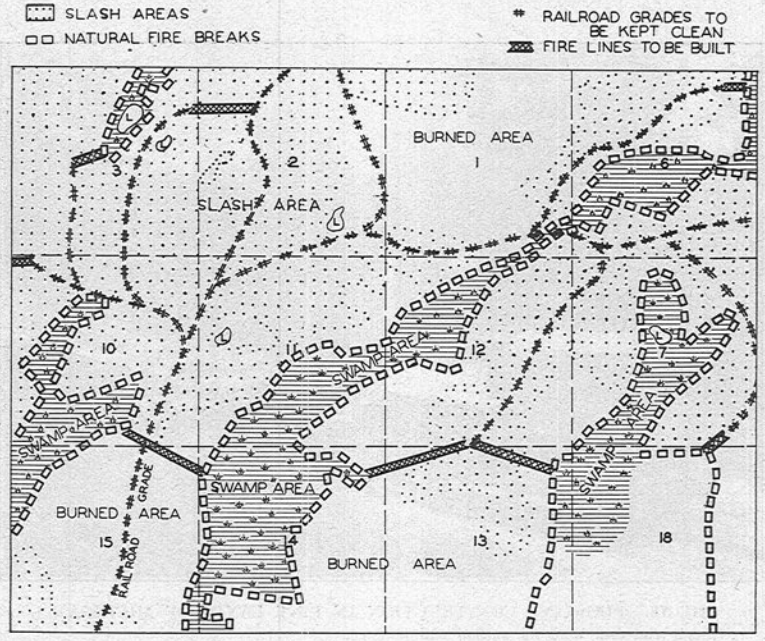


FIG. 19.—SYSTEM OF FIRE LINES.

Diagram of typical hardwood operation showing possibilities of breaking up the slash areas by natural and artificial fire breaks.

planning of fire control means, some clearing out of overgrown roads and railroad grades, some connecting up of these natural firebreaks so as to break the entire area up into relatively small blocks where fires can be completely surrounded. The accompanying diagram of a typical hardwood logging operation in northern Wisconsin suggests some of the possibilities. The state has constructed a considerable mileage of fire line for the protection of parks and game refuges, and is making some extension of the system each year. (Figures 18 and 20). This work may be made to dovetail fairly well with fire patrol in providing yearlong work for the main protective organization.

At the same time the State is projecting a system of roads into the more inflammable districts which will serve not only to break the area up into units, but will also make it possible to reach fires in a much shorter time. Many old logging railroad grades can be used for this purpose.

The value of green timber as a natural firebreak was illustrated by occurrences last year:

On August 17, a broken high-tension line started a fire in slashings a short distance back from the state highway in Bayfield county. A hot fire ran over about a section and completely consumed the slash and humus material to bare mineral soil. The operating company, however, had left a strip of mature hemlock-hardwood timber about 160 feet wide along both sides of the road. The fire was easily stopped

FIG. 20.—FIRE-LINE CONSTRUCTION ON PINE LANDS
Double line type in the Huron National Forest.

at the edge of this timber although the heat was great enough to kill some of the nearest trees.

A few days earlier a fire started and spread into jack pine slashings in Barnes township in the same county. The fire here was stopped at the edge of the green jack pine timber by back firing from a wagon rut.

In another instance, a fire burning in two-year-old slash of hemlock-hardwood burned out immediately on reaching an uncut stand. Another fire in similar slash burned about 100 feet into the virgin stand feeding on litter and small undergrowth. None of the large timber was severely injured. Pine forests are much less effective than hardwood because the litter is more inflammable and, of course, hardwood timber is not so effective as a firebreak in the spring and fall as in the summer. On the whole, however, strips of green timber along some of the roads will be found a great aid both in the prevention and control of fire.

### Safety Strips

Similar in aim to the building of firebreaks is the clearing of a safety strip on either side of highways and railroads. A considerable number of states, among them Michigan and Minnesota, have laws requiring that no slash shall be left within specified distances (15 to 100 feet) of highway and railroad right of ways. The purpose of this provision is not so much to prevent fires from getting a start along these routes as it is to make it possible to check and control fires, using the roadbed as a firebreak.

By far the most satisfactory kind of safety strip along highways is a reserved strip of green timber at least two hundred feet on each side of the road. Only slightly less satisfactory is a strip of similar width which has been lightly logged by a selective system and the most inflammable slash disposed of by progressive burning. For clear-cut areas, the burning of the slash on a strip combined with the falling of snags will doubtless be of advantage.

### Precautions in Logging Operations

Although not as frequent as fires from many other sources, lumbering fires are usually very destructive. The prevention of fires starting from logging locomotives or from carelessness of employees is an important consideration.

Although some operating companies take every possible precaution to guard against fires, logging camp protection is not universally satisfactory. Some operators either do not recognize the danger which is involved in leaving slash indiscriminately around their buildings along railroads or highways with little or no preparation to suppress

FIG. 21.—FIRE-LINE CONSTRUCTION ON PINE LANDS.
Fire-line road on Michigan Fire Experiment Station.

a fire when it starts, or they are poorly advised as to what precautions should be taken to properly protect human life and property. What apparently is needed is a reasonable fire prevention code based upon the experience and practice of the most thoughtful operators. This code should be a valuable guide to all conscientious operators.

Such a code should cover in detail the equipment which should be kept on hand and the precautionary measures to be taken during dry periods.

The equipment needed would vary between operations but for a typical railroad operation would likely include:

1. Several 8,000-gallon car-tanks with pumps.
2. Steam pump and hose on each locomotive.
3. Numerous portable hand pumps.
4. Tool packs with shovels, axes, buckets, kept within easy reach of crew.
5. Efficient spark arrestors on locomotives.

Special precautions during dry periods might consist of:

1. Regular patrol behind logging trains.
2. Patrol of slash areas.
3. Cooperation with farmers to avoid brush fires.
4. Posting warnings along highway calling attention to high fire hazard.

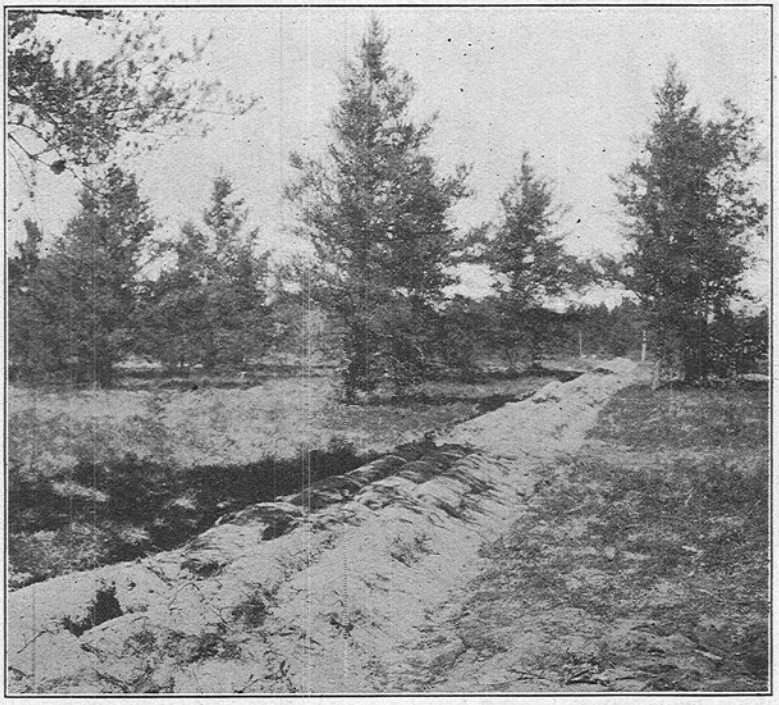

FIG. 22.—FIRE-LINE CONSTRUCTION ON PINE LANDS.
An interior fire line at Michigan Fire Experiment Station.

### Intensive Protection

It is the consensus of men who have studied the slash problems in northern Wisconsin that a special intensive protection for existing slash areas, together with other practical measures to prevent the occurrence and spread of fires, will be one of the most effective means of controlling the special hazard resulting from the partial leaving of slash.

In fairness to the lumbermen, it should be pointed out that no inconsiderable share of the fires which threaten the slash areas are from agencies in no way connected with the logging operation. With 34 percent of the fires of known origin started by farmers clearing land, 21 per cent by smokers, 19 per cent by railroads, and 12 per cent by camp fires, the general public must assume a share of the responsibility for striking at the source of these fires.

## Conclusions

1. Slash from one to five years old covers an area of about 540,000 acres in northern Wisconsin. In addition, there may be another 100,000 acres of older slash which still is somewhat a fire menace. Thus altogether slash occupies over 600,000 acres.

2. The slash areas form about 5 per cent of the total forest area under protection. Ninety per cent of the present slash is hardwood-hemlock which is quite different from the slash of the past which was principally from white and Norway pine. Ten per cent is from pulpwood operations in jack pine.

3. Slashings have been accumulating at the rate of about 100,000 acres a year. There is now probably the largest accumulation of slash that will ever be found in Wisconsin.

4. The remaining old virgin timber in northern Wisconsin occupies roughly only 400,000 acres. Hardwood lumber production is on the decline. In a few years it will be concentrated in the hands of a few operators who have a supply of timber for the next 15 to 20 years. With fewer operations, with better fire protection, with a tax law encouraging selective logging, both the rate of accumulation in area and the volume of slash per acre is bound to decrease. The greatest fire danger is from slash already created rather than slash which will be made in the future.

5. From the standpoint of inflammability, slash is less dangerous than dry grass or dry leaves and needles. From the standpoint of the severity of the fires, the difficulty of suppression and the amount of damage done, slash fires are the greatest menace.

6. Clear cutting creates the greatest amount of slash and not infrequently covers 40 to 50 per cent of the ground with slash from one to ten feet deep. The inflammable material left in some cases amounts to as much as 40 cords to the acre. Forty cords of dry maple or birch are capable of liberating over 800 million British thermal units, equivalent in heating value to thirty tons of coal.

7. Slash left after clear cutting of hardwood forests remains an extra fire hazard for about eight years.

8. Selective logging leaves less slash than clear cutting (from 8 to 21 per cent of the area being covered.) It is more scattered and remains an extra fire hazard for only about three or four years.

9. Close utilization of the timber lessens the amount of slash and consequently reduces the fire danger.

10. Measures to reduce the fire hazard of slash are an important and necessary part of fire protection in Wisconsin. The menace may be lessened by closer utilization and also by selective logging. Although steady progress is being made along these lines, they do not offer an immediate solution to the slash problem.

11. The solution of the slash problem in Wisconsin lies (1) in cleaning up of slash along highways, railroads, buildings, and adjoining green timber, or preferably reserving strips of green timber or partially logged land adjacent to the highways; (2) in breaking up the slash areas by firebreaks, utilizing as far as possible such natural barriers as roads, streams, bogs, and railroad spurs; (3) by construction of rough roads into inaccessible slash areas; (4) in precautionary protective measures in logging operations; (5) in intensive fire protection and, finally, (6) by close cooperation between the State organization and the loggers.

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JACKSON, H. C., In charge of Dairy Husbandry
JOHNSON, J., Horticulture
JONES, E. R., In charge of Agr. Eng.
JONES, L. R., In charge of Plant Pathology
KEITT, G. W., Plant Pathology
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KOLB, J. H., In charge Rural Sociology
LEITH, B. D., Agronomy
LINK, K. P., Agricultural Chemistry
MANNING, HAZEL (Home Economics) In charge Clothing and Textiles.
MARLATT, ABBY L. (Director Home Economics) In charge Foods and Administration.
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MCNALL, P. E., Agr. Economics
MILWARD, J. G., Horticulture
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MORTIMER, G. B., Agronomy
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WEHRWEIN, G. S., Agr. Econ.
WHITSON, A. R., In charge of Soils
WILSON, H. F., In charge of Economic Entomology
WRIGHT, A. H., Agronomy
ZON, RAPHAEL, Forestry

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ALFONSUS, E. C., Economic Entomology
ENGLEBRECHT, MILDRED, Agr. Bact.
HOLMES, C. E., Poultry Husbandry
HULL, H. H., Soils
LANGDON, GRACE, Agr. Journalism
OGDEN, W. B., Horticulture
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ROCHE, B. H., Animal Husbandry
SAGEN, H. E., Agr. Bact.
SCHAARS, M. A., Agr. Econ.
STRANGE, C. R., Vet. Science
ZEIMET, AGNES, Genetics

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DRAEGAR, C., Ashland and Spooner
GEBHARDT, HANS, Dairy Husbandry
GEHRMAN, A., Marshfield
HENDERSON, LEWIS, Admin.
HENIKA, F., Horticulture
HOCKING, C. H., Dairy Husbandry
HOGGAN, ISME, Horticulture
HOLT, DAVID, Sturgeon Bay
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KOCH, K. L., Economic Entomology
KLINE, O. L., Agr. Chemistry
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LOWE, JAMES T., Agr. Chem.
MILLER, B., Plant Pathology
MITCHELL, D. R., Agr. Economics
NEAL, N. P., Genetics
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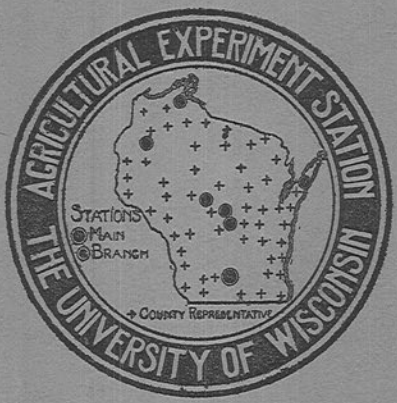
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