FOREST RESEARCH NOTES

Issued by the

PACIFIC NORTHWEST FOREST EXPERIMENT STATION

No. 15 Portland, Oregon. Nov. 15, 1934

FIRE RESEARCH ISSUE

By Richard E. McArdle and Donald N. Matthews

CONTENTS

FOREWORD

This number of Forest Research Notes is primarily for the forest fire protectionist. It comsists of a number of very short articles, each of which gives the essence of the results of a study made recently by this Forest Experiment Station. These so-called fire studies which are represented herein by brief fragments are all part of an organized research program, having as its objective the betterment of forest fire prevention, detection, and control.

It is my feeling that even the condensed results of these studies, some of which are still incomplete, have possibilities for very practical application by those responsible for forest protection organizations by adding to their knowledge of the basic facts, by showing up the weak spots in present fire protection practices, and by suggesting improved technics.

Temporary assistants furnished through the CWA and ECW programs have contributed largely in bringing these studies to the point where these results are forthcoming.

The following short paragraphs are but flashes concentrated from voluminous and detailed data; further particulars on any of these topics can be furnished to any who wish them by writing the Forest Experiment Station (424 U. S. Court House, Portland, Oregon). -- T. T. M.

NEW INSTRUMENTS FOR MEASURING FIRE DANGER

Why Instrumental Measurements Are Necessary

For several years forest protection agencies have felt the need for more reliable information from more localities on more of the physical factors which influence fire danger. Far too frequently important decisions have to be based on incomplete information about the fire danger. What is the relative humidity? How hard is the wind blowing? When did it rain last and how much rain fell? How dry are the fuels? These are some of the things a ranger or supervisor wants to know when he has to decide whether or not to send more men to a fire, hold a road crew near a telephone, or close an area to travel.

On many national forests these fire danger conditions vary widely within a single ranger district. Old growth timber may be relatively safe, whereas, at the same time cutovers and old burns may be extremely inflammable. Areas at high elevations may be more or less hazardous than those at low elevations. Moreover, since information on these conditions must come chiefly from the short term men who vary vastly in experience, education and intelligence, it is absolutely essential that measurements of the physical factors of fire danger replace estimates and guesses whenever possible.

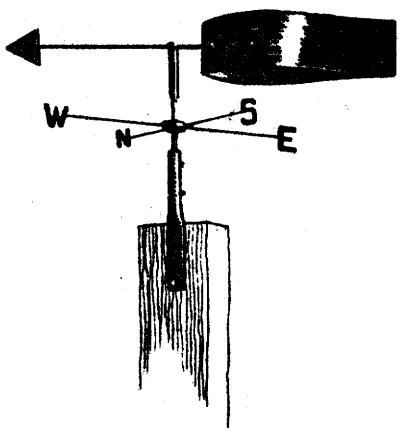
Fire Danger Stations Established

Instruments are available for measuring some of the fire danger factors--such as temperature, wind velocity, and relative humidity--but none for estimating visibility conditions at lookout stations. However, existing instruments were too expensive to permit equipping more than a very few stations. A complete set of inexpensive instruments was needed. To meet this need the equipment described here was designed and made at the experiment station. A complete installation of this equipment in the field is known as a "fire danger station". In 1934, 125 stations were established.

These fire danger stations are more than a collection if instruments for taking measurements. The stations are established to meet an administrative need for correct current information on all fire danger factors as they may exist at any hour. They are for immediate use and principally concerned with present conditions. Records are kept and should prove to be increasingly valuable with each passing year but it is not a principal purpose of the stations to accumulate records. Rather their greatest service is in supplying the day by day demands of the fire control organization for correct localized information on current fire danger factors.

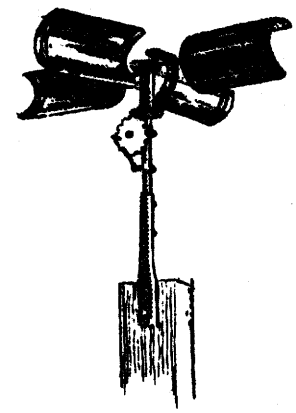
FIRE DANGER STATION EQUIPMENT

DESIGNED BY
PACIFIC NORTHWEST FOREST EXPERIMENT STATION
PORTLAND, OREGON

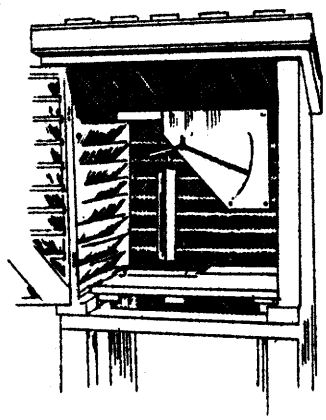


WIND VANE

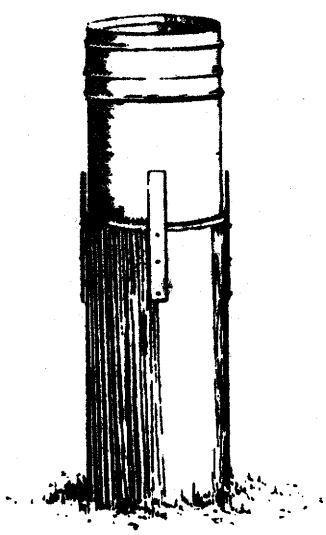
HAZE METER



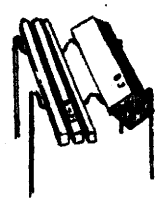
WIND VELOCITY GAUGE



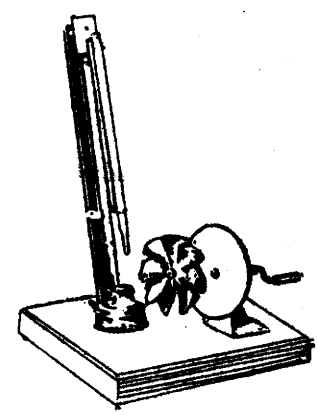
INSTRUMENT SHELTER AND
HAZARD INDICATOR STICK SCALES



RAIN GAUGE



HAZARD INDICATOR
STICKS



FAN PSYCHROMETER

Description of Fire Danger Station Equipment--illustrated on page 4

Instrument shelter -- Made in sectional units and shipped unassembled. Door can be locked. Double roof of cedar. Strong enough to be left exposed on lookout points all winter. Fuel inflammability indicator scales are mounted inside shelter. Fan psychrometer also mounted inside. Additional space provided for hygrothermograph if this instrument is available.

Rain gauge -- Outer container made of galvanized iron; inner container made of seamless brass tubing. Rainfall magnified 10 times. Measuring stick made of red gum, plainly marked with waterproof ink.

Fan Psychrometer -- A friction-driven fan circulates air across stationery thermometers. The probability of accurate readings is increased greatly because the operator can constantly watch the wet bulb thermometer and obtain the lowest reading, because thermometer bulbs do not touch observer's hands, and because angle of sight to thermometer is constant. Frequent observations are more likely to be taken because measurements are easy to make. Breakage of thermometers is reduced to a minimum.

Fuel inflammability indicator -- Specially prepared sections of wood known as "hazard indicator sticks" are exposed in the open on wire supports. Fuel inflammability is indicated in terms of the moisture content of these sticks of wood. Moisture content is obtained by weighing the sticks on special scales marked in moisture percentages.

Wind velocity gauge -- Half cylinders of aluminum mounted on a pivot that revolves fast or slowly according to the speed of the wind. An electrical contact on a geared wheel sounds a buzzer when the cylinders have turned a certain number of times. Wind velocity is measured by counting the number of buzzes for 2 minutes and referring this count to a table sent with the instrument. The gauge will measure accurately wind movement as light as $1\frac{1}{2}$ miles per hour.

Wind vane -- An accurately balanced instrument with streamlined vane to give immediate response to changes in wind direction. Letters indicating the 4 cardinal directions make it easy to observe wind direction.

Cost of equipment -- Now that the experimental and designing stage is passed, the Experiment Station is not in the manufacturing business and does not have instruments to sell; however, some rough estimates as to the cost of the instruments should be of general interest. Materials for all the instruments cost very little. The big item is labor. Those chiefly responsible for designing and manufacturing the present lot of instruments estimate that the instruments could be made in quantities at a price of about $25 for the entire set exclusive of the instrument shelter and haze meter, which would probably cost something less than $10 each. Of this $25 the rain gauge accounts for about $1, and the wind gauge and fan psychrometer for less than $10 each.

NEW INSTRUMENTS FOR MEASURING FIRE DANGER

The Haze Meter---a device to assist lookouts in rating visibility

This instrument, which has been named the "Byram haze meter" as a tribute to its inventor, is based on the discovery that a smoke column is just visible to lookouts with good eyesight against a background approximately 60 percent as bright as the sky at the horizon. It provides a mechanical means for finding the background that is 60 percent as bright as the horizon.

The instrument is roughly "L"-shaped, about nine inches long, $1\frac{3}{4}$ inches square along the shank of the "L", and $1\frac{3}{4}$x3 inches at the foot of the "L". The small end has a sighting hole; the foot of the "L" is pointed in the direction for which a measurement is desired. Looking through the instrument, the observer sees a small colored bar superimposed on the field of vision. By means of neutral filters the brightness of this bar has been adjusted so that it corresponds to 60 percent of the brightness of the sky at the horizon.

The observer directs this bar at a point a few degrees above the horizon. Then by slowly turning a mirror in the upper part of the instrument he brings up, opposite the bar, the reflection of first one ridge and then another. When a ridge approximately 60 percent as bright as the sky at the horizon is reflected the bar disappears. The instrument is so arranged that when any ridge differing from the horizon bar brightness is reflected the bar becomes darker or brighter than the reflection. When the bar disappears, the observer notes which ridge appears opposite it. He then determines, with the aid of a map, if necessary, how far it is from his station to that ridge. The distance in miles is the "visibility distance", or the maximum distance at which he can expect to detect a smoke-column of standard size in that direction at that particular time.

NEW INSTRUMENTS FOR MEASURING FIRE DANGER

Hazard Indicator Sticks for Rating Fuel Inflammability

The hazard indicator sticks used at the fire danger stations are made from "live" untreated wood; each one is so prepared that its moisture content can be determined at any time simply by weighing it. They are exposed to the weather on wire supports a few inches above the ground in typical forest fuel types such as virgin timber, fresh slash, old burns, and cut-overs, and are weighed once or more each day to determine moisture content. Their moisture content is used as an index of the inflammability of the forest fuels. This is sound practice because the inflammability of the common forest fire fuels is dependent upon the amount of water that they contain. The drier the fuel, the more dangerous the condition.

As the result of extensive experiments using different species of wood and several methods of preparation, means have been devised at the experiment station whereby it is practicable to select and prepare sticks that will all respond in practically the same degree to changes in atmospheric moisture. For instance, if all the sticks prepared this year were exposed side by side they would all have the same moisture content and all show uniform response to atmospheric moisture changes. Also the new sticks that must be prepared each season can be selected so that they will respond in the same way and to the same extent as those prepared in previous years. This uniformity of response makes each stick a standard measure.

The sticks are put out in sets of two. A Douglas fir stick 2 by 2 inches square by about 14 inches long makes up one member of the set and three ponderosa pine sapwood sticks 1/2 by 1/2 inch square and about 18 inches long joined together with dowels with spaces between the pieces is the other member of the set. The determination of a satisfactory combination of the kind of wood and the size to be used was made by testing several hundred pieces of various species of wood made up in sizes from 1/4 inch to 4 inches in cross section.

The 2 by 2-inch Douglas fir sticks are slow in their reactions and so are depended upon to reveal the cumulative drying out of the heavier forest fire fuels such as limbwood and the surface layer of logs and snags as the fire season progresses from beginning to end. Today's drying is added to yesterday's and the effect of rain or fog or east wind on fuels is indicated by these sticks because they are exposed to the same conditions as the fuels and because they react in practically the same manner. The smaller and more absorptive ponderosa pine sapwood sticks take on or lose water rapidly and are therefore indicators of the moisture changes taking place from hour to hour in the lighter, finely divided fuels such as dead bracken fern, or needles and twigs.

Hazard indicator sticks do not take the place of relative humidity measurements. They are a distinct source of information on fuel inflammability and fire danger conditions. The psychrometer and hygrograph will continue to have important use because they give prompt measurement of the moisture condition of the air; but they do not measure the effect of the sequences and combinations of all the weather factors that determine the relative inflammability of forest fuels. The peculiar field of the sticks is to furnish a standard, comparable measure of the resultant inflammability of forest fuels after they have been affected by all the weather factors.

FIRE DETECTION STUDIES

How Many Fires Do Lookouts Discover?

Analyses just completed show that lookouts make first discoveries of about half (47%) of all fires occurring in the national forests of Washington and Oregon. Considering the very small amount of area directly visible to the usual run of lookouts, this is a rather good record for lookout detection.

For the 8-year period, 1923-1930, lookouts east of the Cascades detected 47% of the class A fires, 67% of the class B fires, and 64% of the class C fires, averaging 53% for all classes of fires. In the 9-year period, 1923-1931, the West Side lookouts accounted for 30% of the class A fires, 54% of the class B fires, 49% of the class C fires, and averaged 40% for all classes of fires. The East Side lookouts thus were somewhat more effective than those west of the Cascades.

Lookouts have made first discoveries on 62% of all lightning fires but have detected only 28% of all man-caused fires. The fire reports show that lookouts get only 17% of the class A man-caused fires whereas they make first discovery of 58% of the class A lightning fires. Lookouts probably never have a chance to detect many class A man-caused fires because these unquestionably are seen and extinguished by travelers before they are large enough to be visible to the lookouts.

How Far Away Do Lookouts Discover Fires?

The fire reports for the 5-year period preceding 1933 indicate that 81% of all fires east of the Cascades were less than 15 miles from the lookouts who made first discovery, 92% were within 20 miles, and only 1 fire in every 50 discovered by East Side lookouts was more than 25 miles from the lookout. For West Side lookouts, 92% of their first discoveries were within 15 miles, 98% were within 20 miles, and only 2% were more than 25 miles away.

The average discovery distance for fires discovered within 15 miles of the lookouts is 7.3 miles for East Side forests and 6.7 miles for West Side forests. The average discovery distance for all fires discovered by lookouts is 9.8 miles east of the Cascades and 7.7 miles on the West Side.

These figures support the assumptions made in detection planning that the primary lookout system should not, except in certain instances, count on fire detection beyond 15 miles, and for peak load and mid-season periods, the radius of detection probably should not exceed 8 miles.

FIRE DETECTION STUDIES

How Large Are Fires When Lookouts First Discover Them?

An analysis of about 3,000 fires discovered by lookouts in the 5-year period 1928-1932 indicate the following proportion of fires of various sizes at the time of discovery:

Less than 50 sq. ft.	24%
51 to 500 sq. ft.	14%
501 to 4,999 sq. ft.	21%
1/8 to 1/4 acre	12%
1/4 to 1 acre	22%
Larger than 1 acre	7%
	100%

It is significant that nearly 40% of all fires discovered by lookouts were seen before they had exceeded 500 square feet (about 24 by 24 feet), and 71% of the fires discovered by lookouts were less than 1/4-acre in size when discovered.

The East Side lookouts apparently pick up a slightly greater proportion of small fires than do the lookouts west of the Cascades, but the difference in this respect is small. Size on discovery admittedly is a guess but it is evident from the records that attempts generally are made to harmonize the estimates made by the lookouts with what the fireman actually finds when he reaches the fire.

How Long Do Fires Burn Before Lookouts See Them?

From a hasty look at the results of the studies on time-frequency of fire origin and those on the time-frequency of fire discovery by lookouts it might appear that because there are about the same proportion of fires discovered in the morning as start in the morning, about the same percentages for origin and discovery in the afternoons and about the same for origin and discovery at night, the detection of fires is rather prompt. This, however, is known to be untrue.

The average discovery time for 5709 fires discovered by lookouts is 16.9 hours for man-caused fires, 34.6 hours for lightning fires or 29.2 hours for all causes of fires. Even if the fires for which discovery time was unreasonably long (72.0 hours was taken as an arbitrary limit) are eliminated, the average detection time for lookouts is 7.9 hours for man-caused fires, 11.8 hours for lightning fires or 10.5 hours for all causes of fires.

FIRE DETECTION STUDIES

Do Lookouts Discover Fires When Looking Toward the Sun?

Because it is difficult to search for fires when facing the intense glare of the sun it is commonly assumed that lookouts pick up few fires in the quadrant facing the sun. Experimental work with artificially produced smoke columns strongly indicated that small smoke columns can be seen as far when the lookout faces the sun as when he has the sun at his back. But it is hard on the eyes to look toward the sun and for this reason it was thought that lookouts actually do not discover as many fires toward the sun as away from it. What does the experience record show?

An analysis of all fires discovered by nearly 500 lookouts in the 5-year period 1928-1932 shows that, as a group, lookouts consistently have discovered more fires when looking toward the sun than in any other quadrant. Wherever the sun happened to be, there also were discovered the greatest number of fires. Following the sun around, nearly half of the fires regularly and consistently were discovered in a 60-degree segment facing the sun; the rest of the fires were discovered in the remaining five-sixth of the 360 degree circle.

The fires discovered in the quadrant facing the sun were, according to the records, slightly smaller on discovery than those discovered in other quadrants. Moreover, the distance of discovery was slightly greater when fires were in the quadrant facing the sun. And most of the fires detected at more than 15 miles from the lookouts were discovered when the lookout faced the sun.

Since the analysis proves that lookouts can and do detect as many or more fires in the direction of the sun as in any other direction, it appears that smoke must be somewhat more visible in that direction. An explanation of why this should be true is found in well known principles of physics. Smoke is more visible when looking toward the sun because it is illuminated by the light passing through it and therefore appears to be brighter and in greater contrast with the background than when smoke is illuminated by reflected light as it is in all directions that are not toward the sun.

Although it is demonstrated that lookouts see fires most readily when looking toward the sun, nevertheless, looking toward the sun is fatiguing to the eyes and causes more eye strain than looking in any other direction. To reduce eyestrain lookouts have been furnished special goggles developed by the experiment station. By using the goggles they are able to see as well in the afternoons as in the mornings when their eyes are fresh.

FIRE DETECTION STUDIES

At What Time of Day Do Fires Start?

Some of the significant results of an analysis of 11,081 fires occurring in recent years on the national forests of Washington and Oregon are as follows:

(1) The chief differences between time of origin for man-caused fires and time of origin for lightning fires is that over 30% of the man-caused fires start in the forenoon, whereas only about 7% of the lightning fires start during those hours. For the night hours, 6 p.m. to 6 a.m., the situation is almost exactly reversed with over 30% of the lightning fires but only 15% of the man-caused fires originating then. The peak of lightning fire occurrence is in late afternoon and early evening, from about 3 to 8 p.m., but the peak load for man-caused fires comes in the late forenoon and early afternoon. There is very little difference between East Side and West Side forests in respect to these items.

(2) Most man-caused fires, as a group, and most lightning fires start in the period from noon to 6 p.m. About 55% of all fires are reported to have started in the afternoon hours. Again, there is practically no difference between East Side and West Side forests.

(3) There appears to be no particular difference between the time of origin of small fires (classes A and B) and that for the larger fires (class C); however, fires that start in the morning are somewhat more likely to develop into class C fires (over 10 acres) than are fires starting at any other time although the tendency in that direction is not very strong. The analysis shows that 13% of all fires starting in the forenoon develop into class C fires, 10% of the afternoon fires reach that size and 7% of the night fires become class C fires.

(4) Certain types of man-caused fires have peculiarities all their own as concerns time of origin. Campers' fires for example, exhibit three rather definite peaks: one around breakfast time (6 to 9 a.m.), another at lunch time (noon to 1 p.m.), and a third peak about supper time (after 6 p.m.). Over half of the fires attributed to campers start in these three periods.

FIRE DETECTION STUDIES

At What Time of Day Do Lookouts Discover the Most Fires?

A study of about 6,000 fires discovered by Forest Service lookouts in the period 1924 to 1932 indicates that:

(1) The "peak loads" for fire discovery by lookouts come in the afternoon hours. About 56% of all fires discovered by lookouts are first seen during this period whereas only one-fourth of all fires discovered by lookouts are seen in the forenoon. About 17% are discovered at night, chiefly between 6 and 10 p.m. This record is essentially the same for lookouts, as a group, both east and west of the Cascades.

(2) The safest hours for lookouts to be away from their stations appears to be after 8 p.m.; the next best time to be absent is early morning, before 8 a.m. It would seem advisable for lookouts to be especially alert between 11 a.m. and 7 p.m., as the experience record shows that nearly three-fourths of all the fires seen by lookouts are discovered during those hours.

(3) Although only 7% of all lightning fires originate in the forenoon, about one-fourth of those lightning fires discovered by lookouts are detected in the 6 a.m. to noon period. From other studies it appears that the fires discovered in this period are those originating the previous day. The morning after a lightning storm is the time for lookouts to be especially watchful.

(4) The number of fires discovered in each hour period gradually builds up to a peak in the afternoon and then falls off gradually. The peak of maximum fire discovery for fires which get to be class C size comes about 2 hours earlier than the peak for A and B fires. This holds true for both man-caused and lightning fires and for both East Side and West Side conditions.

FIRE DETECTION STUDIES

Is Delay in Fire Detection by Lookouts Related to Time of Day When Fires Start?

One of the first steps in reducing the excessively long time required by lookouts for fire detection is to find out whether it is the fires that start in the morning, afternoon, or night that are chiefly responsible for these long discovery times. For example, are fires starting in the morning usually discovered (if discovered by lookouts) that same day? The following table gives the average discovery time for fires starting in the morning, afternoon, and night:

Average Discovery Time (in Hours) According to Time of Day When Fires Originated

Class A, B, and C Fires Combined

(For all fires discovered by lookouts on all forests in Region 6, 1924-1932, inc.)

Cause of fire	Time of day when fires start					
	6 a.m. to noon		Noon to 6 p.m.		6 p.m. to 6 a.m.	
	Number of fires	Average discovery time	Number of fires	Average discovery time	Number of fires	Average discovery time
Man-caused	599	13.6	890	15.8	236	29.0
Lightning	276	26.3	2441	33.0	1271	39.3
AAll causes	875	17.6	3331	28.4	1507	37.7
Fires with discovery time of 72.0 hours or more omitted						
Man-caused	573	5.8	847	8.2	230	11.9
Lightning	246	7.8	2173	11.2	1096	13.9
All causes	819	6.4	3020	10.3	1326	13.6

The table indicates that fires starting in the morning have the shortest discovery time and that the fires that start at night have the longest discovery time. It also shows that the fires that start in the morning are on the average more likely to be discovered by lookouts on the same day that they start than are fires that start in the afternoon or night.

The detailed figures by causes on which this table is based bring out the significant fact that campers' fires as a class and regardless of what time of day they start have the longest discovery time of any class of fires discovered by lookouts, being longer even than the discovery time of lightning fires. This would seem to indicate that patrol may be more efficient than lookouts in finding this class of fires especially when campers' fires are known to be localized in distribution.

What Materials Are First Ignited?

Lightning fires -- When a lightning storm is expected, the fire protection organization can better estimate the danger that lightning fires will be set if it is known what materials are most likely to be ignited by lightning strikes. If, for example, most lightning fires start in needles and duff, and if the duff were too wet to burn on the day the storm was expected, there probably would be little danger of fires. If, on the other hand, the duff were very dry there would be plenty of danger to prepare for.

Over the region as a whole, 42% of the lightning fires have started in the needles and duff. This means that nearly half of the lightning fire danger depends on the inflammability of the needles and duff. When the duff is soaking wet the lightning fire danger probably is less than half of the danger which exists when the duff is dry.

The most outstanding difference between the West Side and East Side forests in the material first ignited by lightning strikes is in regard to snags. On the West Side forests 25% of the lightning fires start in snags in contrast to only 10% on the East Side. Green trees are the first material ignited in about 20% of the fires on both sides of the Cascades. Grass is of little importance as a kindling material for lightning fires on the West Side but it is important on certain East Side forests.

Kindling fuels in man-caused fires -- Reports on 4,000 man-caused fires which occurred on the national forests of Oregon and Washington from 1925 to 1930 show that 41% of all man-caused fires start in the needles and duff. Twenty-four percent start in the grass. In general, these two fuels form the bulk of the man-caused fire hazard. Rotten wood, brush, logs, trees, snags, and slash are of much less importance, since each is the starting point for only 10% or less of the fires.

The relative hazard of forest materials varies for different types of man-caused fires. The fires of smokers and campers, which make up about 70% of all man-caused fires, are started mostly in needles or duff, and secondly in grass. Incendiary fires, which compose 15% of the man-caused fires on national forests west of the Cascades, are started mostly in brush, and secondly in duff and grass. East of the Cascades, where camper fires form only 2% of the man-caused fires, they are started mostly in the grass. Sixty-five percent of the railroad fires are kindled in the grass, and only 10% or less are started in each of the other forest materials. Sixty-three percent of the lumbering fires, as would be expected, are first ignited in slashings and only 12% start in each of the other principal fuels.

The relative fire hazard of each type of fuel depends to a certain extent on the relative amount of that fuel in comparison with other fuels. Thus, if rotten wood constitutes only 10% of the total quantity of forest fuels and is a starting point for a large number of fires, it is relatively more dangerous than more generally distributed fuels with the same number of fires. These analyses, if properly interpreted, however, should be of value in fire control planning.

LIGHTNING FIRE STUDIES

Lightning Fire Altitude Zones

Since lightning is the cause of half of the forest fires in the national forests of Washington and Oregon it is important to know where they occur. It is often said that altitude is an important factor in determining their distribution. This assumption has been tested by tabulating by forests all the lightning fires which started in each 2,000-foot altitude zone from 1925 to 1930 inclusive.

On the West Side forests as a whole, 51% of the lightning fires have started at altitudes between 4,000 and 6,000 feet, 34% were between 2,000 and 4,000 feet, 9% started below 2,000 feet, and only 6% originated at altitudes above 6,000 feet.

East Side forests show higher general altitudes for lightning fires than the West Side forests, because the land rises from a plateau which in most places is more than 2,000 feet above sea level. Here 61% of the lightning fires occurred between 4,000 and 6,000 feet. Only 22% started between 2,000 and 4,000 feet, and only 2% started below 2,000 feet altitude.

This altitudinal distribution of lightning fires compared with man-caused fires demonstrates the different characteristics of the two types. Only 12% of the West Side man-caused fires started at altitudes between 4,000 and 6,000 feet as compared with 51% of the lightning fires. Below 2,000 feet was the zone of most man-caused fires, but of least lightning fires; 57% of the man-caused and only 9% of the lightning fires occurred there. The West Side forests thus have had most of their man-caused fire problem at altitudes below 4,000 feet and most of their lightning fire problem above this level. Although the general level of the East Side forests is higher than on the West Side, there also man-caused fires average lower in elevation than lightning fires.

This higher altitudinal occurrence of lightning fires does not mean that they are restricted to high altitudes. Intensive analyses on certain national forests completely covered by topographic maps show that the number of lightning fires per acre at low altitudes equals the number at high altitudes when both areas are affected by the same number of lightning storms. Man-caused fires, on the other hand, are restricted more or less to low-altitude zones because these are usually the most accessible.

Other studies have shown that the bulk of the lightning fires are set by a few storms each season, therefore, plans for placement of lookouts and firemen should recognize that on most days the danger is from man-caused fires and these are generally at low altitudes. The records indicate that it would generally be unnecessary to make personnel shifts for "local" lightning storms, because this type of storm sets practically no fires. But, until dependable localized warnings of lightning storms are available, it is suggested that the wisest course is to concentrate detection and suppression forces at higher altitudes whenever any lightning storms are expected.

William G. Morris

FIRE DAMAGE STUDIES

Logging as a Cause of Forest Fires

It is generally recognized that practically all logging operations tend to increase both the fire hazard and the fire danger. First of all because logging converts the green forest which is a relatively safe type into slash and cut-over land which are highly inflammable types and second, because the presence of large numbers of men and the operation of machinery in the highly inflammable debris incident to logging are in themselves potent causes of fires starting. The very real danger of losing valuable property such as equipment and logs by fire has forced loggers to take certain precautions in their own self interest. Statutory regulations also require them to take steps to prevent fires from starting and to be prepared to promptly stop such fires as do start. However, in spite of all the precautions taken in self interest and the statutory regulation, logging fires have caused enormous loss of property.

In order to demonstrate the role played by logging and logging fires in the losses caused by forest fires in the last decade an analysis has been made of the state forester's individual reports of all fires occurring on private lands in fifteen counties in the Douglas fir region in Oregon for the period 1921 to 1932 inclusive. This comparison of the destructiveness of logging fires versus all other fires is presented in the accompanying tables. A study of these tables will reveal that although logging is credited with causing but 11% of the total number of fires in the period studied, logging as a cause is responsible for 26% of the total area burned, 23% of the loss of merchantable timber, 49% of the loss of logs and logging equipment, 37% of the total damage and 35% of the total fire fighting cost.

It should be noted that these figures do not include 1933, hence the Tillamook fire, which was a logging fire and did more damage than all the fires put together in the period studied, is not included.

AREA BURNED, DAMAGE AND FIRE FIGHTING COSTS FOR LOGGING FIRES VS. ALL OTHER FIRES

PRIVATE LAND IN THE DOUGLAS FIR REGION OF OREGON (CLATSOP, COLUMBIA, WASHINGTON, TILLAMOOK, MULTNOMAH, YAMHILL, CLACKAMAS, LINCOLN, POLK, MARION, BENTON, LINN, LANE, DOUGLAS, AND COOS COUNTIES) FOR THE PERIOD 1921 TO 1932 INCLUSIVE.

AREA BURNED

	MERCHANTABLE TIMBER		REPRODUCTION		LOGGED, GRASS, BRUSH, AND OTHER LAND		TOTAL AREA BURNED	
	ACRES	%	ACRES	%	ACRES	%	ACRES	%
LOGGING FIRES	54,867	19	24,642	13	232,923	32	312,432	26
ALL OTHER FIRES	236,324	81	159,682	87	495,992	68	891,998	74
TOTAL	291,191	100	184,324	100	728,915	100	1,204,430	100

DAMAGE

	MERCHANTABLE TIMBER				LOGS & LOGGING EQUIPMENT		ALL OTHER PROPERTY VALUE		TOTAL DAMAGE°	
	M BD. FT.	%	VALUE DOLLARS	%	DOLLARS	%	DOLLARS	%	DOLLARS	%
LOGGING FIRES	269,795	23	497,711	23	1,752,794	49	256,304	27	2,506,809	37
ALL OTHER FIRES	880,426	77	1,632,075	77	1,846,703	51	706,765	73	4,185,543	63
TOTAL	1,150,221	100	2,129,786	100	3,599,497	100	963,069	100	6,692,352	100

(°LOSS TO REPRODUCTION VALUE OMITTED BECAUSE IT IS SHOWN ONLY FOR 1931 - 1932)

FIRE FIGHTING COST

	TOTAL FIRE FIGHTING COST	
	DOLLARS	%
LOGGING FIRES	611,715	35
ALL OTHER FIRES	1,129,918	65
TOTAL	1,741,633	100

NUMBER OF FIRES

LIGHTNING		INCENDIARY		RECREATION		LAND CLEARING		LOGGING		RAILROAD		MISCELLANEOUS AND UNKNOWN		TOTAL	
NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
282	3	2,565	31	2,297	28	1,227	15	871	11	138	2	777	10	8,157	100