3.1 O.K. HRP

FIRE CONTROL PLANNING

by

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INTRODUCTION

The purpose of this paper is to introduce a new and original method of fire control planning, so that elapsed time standards will be based on factual material and not on haphazard judgment of one or more individuals. It is an extensive plan that is applicable to any size area that is in need of protection from fire and any area that is large enough to need more than two men on protective work. Only slight changes, if any, will be necessary to apply this plan to any type of forest within the United States.

Fire protection is one of the greatest jobs of the Forester today. There is no need of a forester making a management plan or any other use plan unless destruction by fire can be prevented. Fire damage has greatly been reduced in the past few years. This is the result of much advanced and detailed work on suppression of fires and also due to the fact that the men now in the field have had several years experience of fire suppression work. Some progress has been made on fire control planning, but it still rests primarily on the judgment of the District Ranger. The result being that many rangers will have many opinions and there is no standard to use as a measuring stick for experienced rangers and no guide to be used for the inexperienced ones.

By intelligent use of this plan, not only can a large reduction be made in the amount of damage done by fires,

but also a reduction in the cost of suppression and pre-suppression work, by aiding in proper location of the protective force, roads, trails, lookouts, telephone lines, and radio stations.

It has been the writer's experience to note how certain fireguards have been located in the past. The following is a typical example.-- Ranger Jones notices that the last fire on Elbow Ridge nearly escaped control because the guard at Willow Creek had too far to travel. Ranger Jones then recommends to the Supervisor that a guard be placed at Spruce Fork next year. This method proceeds on down the line and the fire control plan is changed to fit the need for the new guard. Such things as the above have been the reason for the need of a plan to eliminate this judgment method of planning, as all rangers do not know the "why" of such recommendations.

The writer has found much improvement in the determination of the basic factors of fire control planning in recent dates, but no one has taken the final step to base the elapse time standard on the actual facts. All continue to base the elapse time standard on judgment. There are a few minor suggestions to be made in making a more detailed study of these factors from the practices now in use, but most of the methods are well founded.

The first basic factor of action to consider is "Rate of Spread" or the spread of the fire in the many types of

forest land. The second is the "Resistance to Control", or how hard it is to construct a trench capable of stopping the fire. Each of these factors have been divided into four classes of low, medium, high, and extreme. When these basic factors of action are so regulated by the class of day taken from the Fire Danger Board, the elapse time standard can be determined for any forest type in any location, and, this in turn will govern the suppression plan.

RATE OF SPREAD

Rate of spread as used here is defined as the increase of the perimeter of the fire in terms of a given unit of length.

The base map for the work to be done, both in the field and the office, should be 1-inch scale. This is large enough to increase the accuracy of the mapper and it will not be too large to be awkard.

The size of unit to cover for one map should be the size of the ranger district or some similar sized tract of forest land. The maps then will be convenient in size for use in either the Ranger's office or in the Supervisor's office, and also be complete for that given area. The map should be made in the field and using all existing sources of information. The finished map to be made in the office and so constructed that they can be reproduced in any desired quanity, as many maps may be needed.

The mapper should be, if possible, one having much and long experience with fires, or at least should be a man with some experience and trained by an experienced man. If at all possible all men to be used as mappers in one Region should be trained by one man, as it is very important to have all maps as uniform as possible for the region. It is even desirable that all maps in the United States, either public or private, be standardized so that a man being transferred from one place to another would

not be confronted with the problem of learning the new standard used. The U.S. Forest Service has more or less standardized this mapping but some differences still exist between regions and should be eliminated as soon as convenient. The classes and colors used in this paper are the same as used by Region 6 of the U.S. Forest Service, but it is not the purpose of this paper to form a standard of that kind.

The rate of spread is based upon an average bad condition which would be similar to August conditions in this region, but might be of any other time in some other region, as long as it was the worst condition. It is based on fuel conditions and regardless of the time mapped it is bsed upon this average bad conditions. The area should be a map of existing conditions and not what that person thinks the fuel will be in a few months from the time of mapping, unless, it is a small logging or slash area that is to be burned before the next fire season, then the area should be mapped like the condition is expected to be after the burn. However, as soon as the area has been burned it should be checked to see if the area and that representative part of the map are the same class. This is important as often times the result of a burn is not what was anticipated and even occasionally the condition is actually worse after the burn. For example; the reporduction and brush may be killed by the fire and the dried needles and leaves would constitute a worse condition than existed before.

Fuel type specifications as used by the Forest Service are divided into four classes to determine the rate of spread. These classes could be further divided if greater accuracy is to be desired, but greater accuracy would also be necessary in mapping the area. The four classes used by the Forest Service are as follows:

Low----------L

Moderate----------M

High----------H

Extreme----------Ex.

These could be divided into other similar classes as long as they are kept standard with those of all other forests.

The items having the greatest effect on rate of spread are as follows:

The amount and kind of fine fuels. Some fuels may burn faster when green than other fuels would burn when dry and therefore an experienced mapper is desirable.

The size of the fuels--as the smaller the fuel the greater the rate of spread.

The arrangement of both the fine and coarse fuels, but in particular the fine fuels as they have the greatest effect on rate of spread.

The slope of the ground--as the steeper the slope the greater the spread of the fire.

The degree of the exposure of the fuels to the sun--as the more direct heat the drier they will become.

The normal wind velocity and degree of exposure of the fuels to the wind--as wind rapidly dries the fuels especially the fine fuels.

Other special items, such as snags, bug-killed trees, moss, duff, etc. that would affect the spread of the fires.

The intensity of the work to be based on the accuracy desired. A recommended minimum size of area for each class is as follows, when the average annual risk for the given area shows low or moderate:

Low----------160 acres

Moderate----------160 acres

High---------- 80 acres

Extreme---------- 40 acres

However; as the plan is used over a period of years the intensity could be increased and each size of type could be lowered accordingly.

Areas with a "high" or "extreme" mean annual risk should be mapped to a minimum size as follows:

Low----------80 acres

Moderate----------80 acres

High----------40 acres

Extreme----------20 acres

The idea of this being that a more intensive plan is desirable where the greater number of fires occur and the suppression force to be regulated accordingly.

The mapper will find that certain types of cover will, as a rule, be a certain rate of spread--for example, the

densely shaded mature type of Douglas Fir where moss and duff are the principal ground cover is classed as a standard "Low" when the slope is low or moderate. Other standard types will follow this closely which will in turn greatly aid the mapper in covering the ground when using type maps as is used by the Forest Service, but it is to be remembered that "accuracy first and then speed is to be practiced."

The slope to be considered in determining rate of spread is divided into four classes as follows:

Low----------Less than 25%

Moderate----------25% to 50%

High----------50% to 75%

Extreme----------75% or over

These slope classes are also recorded on the finished map to aid the ranger or fire chief in dispatching crews to the fire.

The most important type of material responsible for rate of spread is recorded on the fuel type map. T his type of material is recorded by abbreviations and the one used by the U.S. Forest Service is shown on page 17 of this paper. Such things as brush, fern, grass, duff, etc. are the main materials and the mapper should familiarize himself with these and be able to determine the primary item to record on the map. By so mapping, it will not only aid the person in becoming better acquainted with the area,

but will serve as a check in determining the accuracy of the map.

RESISTANCE TO CONTROL

Resistance to Control, as used in this paper, is defined as the resistance offered by any material in constructing fire line. "It is measured in terms of units of held fire line per man hour to time of corral (exclusive of SOS)."[1]

Resistance to control will be mapped at the same time as rate of spread and the scale of the map and size of area will be the same for each, which has been given in the preceeding chapter.

This mapping is another job that must be standardized. It is also highly desirable to have a man with much experience in building fire line to do the mapping. In some cases it will probably be necessary to actually construct fire line through a characteristic type and measure the number of units of constructed fire line per man hour, or if the occasion will permit to take actual measurements on the fires of the season. Again, the same as mapping for rate of spread, it is to be remembered that accuracy is very important. If possible, it is even more important in mapping resistance to control than rate of spread as not only the elapse time standard is to be based on this map, but it is also to be the guide for the dispatcher in

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1 Fire Control Hand Book of North Pacific Region Part II p. 71

determining both the number of men and the kind of tools to be sent to the fire. When a fire is reported in a given area the dispatcher will only need a glance at the map to know the type of resistance to be expected. An accurate map will eliminate the chance of having the crew with a supply of saws when they should have hoes or some other kind of tools. Such an occurrence as the above example has increased the acreage burned each year too many times what it should have been.

Factors that may influence resistance to control to a more less degree are:

Condition of the ground cover, such as brush, vines, berry bushes etc. These may greatly slow up the progress of the crew and should always be considered in mapping.

Brush and reproduction that are larger than the lower ground cover, as these will require different tools and type of construction.

Number, kind, size and condition of snags is important as some are very pitchy or decayed so that they are much more difficult to cut than others.

Kind, number, size and condition of windfalls should be considered for the same reason as the snags.

Soil condition such as rock, roots, etc. that will affect the rate of progress by preventing the use of certain tools.

The depth of duff, litter etc. as in some places the

depth is many times greater than other places and would require more time in trench construction.

Slope of the ground, as man can not work as efficiently on steep as on level ground.

The principal factor contributing the most resistance to control is recorded on the map to aid the dispatcher in selecting the number and kind of tools to be sent on the fire. Abbreviations of these factors as used by the U.S. Forest Service are found on page 17.

The resistance to control is always based on hand work as this plan is primarily intended for class "A" and "B" fires, although whenever it is possible to use a machine it is recorded on the map to aid the suppression of large fires. Machines of many kinds and description have come into use recently in fire line construction and many of them have proven very effective. It is anticipated that they will prove much more valuable in the future.

Resistance to control is divided into four classes as used by the U.S. Forest Service. The same applies to these as to rate of spread in that they could be further divided if greater accuracy is to be desired to intensify the plan. The classes are as follows:

Low----------L

Moderate----------M

High----------H

Extreme----------Ex.

The intensity of the mapping is the same as for rate of spread, that is, dependent on the accuracy desired. The recommended minimum size of area for each class of "Resistance to Control", when the average annual risk is moderate or low, is as follows:

Low----------160 acres

Moderate----------160 acres

High---------- 80 acres

Extreme---------- 40 acres

Areas with a "High" or "Extreme" average annual risk should be mapped to a minimum size of:

Low----------80 acres

Moderate----------80 acres

High----------40 acres

Extreme----------20 acres

The idea of this being the same as for "Rate of Spread" that the plan should be more intensive when the greater risk occurs.

The factors that will determine the type line of the area can be either rate of spread or resistance to control. For example---a large tract of forest land may all be classed as "High" rate of spread, but would be divided into several types as the resistance to control might change many times over the area and the types could show "High" rate of spread with "Low", "moderate", "High", or "Extreme" resistance to control. The more severe factor in each

fuel class will govern the intensity of the map." [1] For example ML would be mapped to the same size as a LM etc.

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[1] Fire Control Handbook North Pacific Region Section II p. 7j

THE COMPLETED FUEL TYPE MAP

The first thing done in the field and shown on the completed map is the different type lines for the different classes of resistance to control and rate of spread. The fuel type is outlined in its rate of spread color by a narrow but heavy line. The resistance to control is colored lightly but solid by its color.

The colors used by the U.S. Forest Service of the North Pacific Region are as follows:[1]

Extreme	(Ex)	Red	Dixons 321½
High	(H)	Orange	" 324
Moderate	(M)	Blue	" 320
Low	(L)	Green	" 354½

The symbols used must be complete for each type and as there are occasionally factors that affect resistance to control that are not consistant through a type, it is recommended that a set of symbols be placed for each square inch of map space. The symbols used <u>should always</u> be in the following order to comply with the U.S. Forest service of this region and to standardize the system.

The order is as follows:

"First symbol representing rate of spread;

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[1] Fire Control Handbook for North Pacific Region by the U.S.F.S. Section II p. 7m.

second represents resistance to control--for example, LM, MM etc. (on first line).

Beneath this, abbreviation indicating the Forest Survey type--for example, T6, T20 etc.

Next below, abbreviation indicating most important factor contributing to rate of spread.

Beneath this, abbreviation indicating most important factor contributing to resistance to control.

Next below, indicate the average prevailing per cent of slope---for example H%, M%, etc..

Below this, indicate any special items such as machine show etc..

Example:

HM (High rate of spread--Moderate resistance to control)
T6 (Forest Survey type 6)
B Fern (Bracken is the predominant item contributing to rate of spread.)
VM (Vine Maple is the predominant item contributing to resistance to control.)
H% (50 to 75 per cent slope)" [1]

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[1] Fire Control Handbook of the North Pacific Region
By the U.S.F.S.
Section II pp. 7h, 7i.

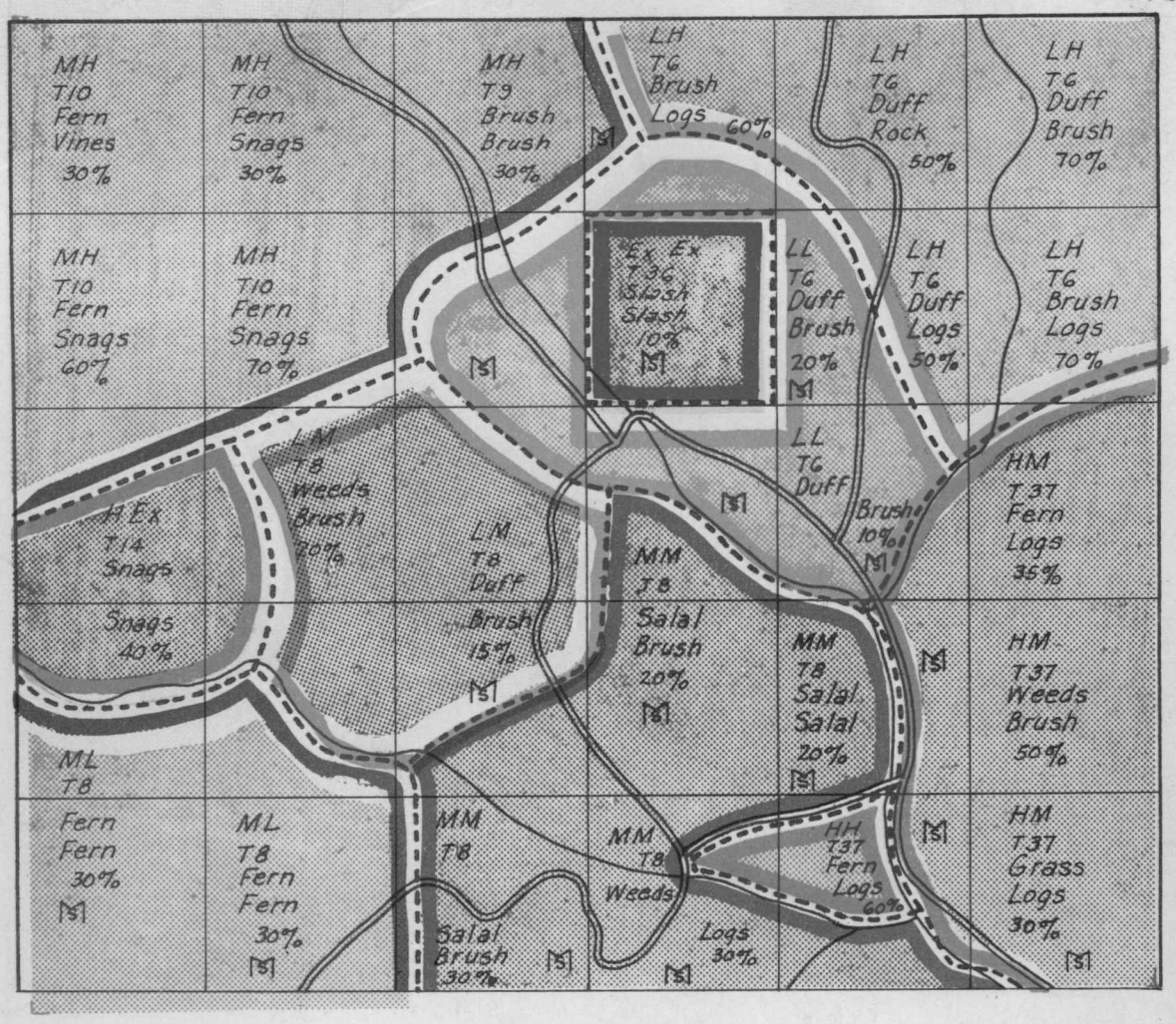
"Abbreviations to use for Cover Items Affecting Rate of Spread and Resistance to Control." [1]

Bark-	Bark
Bear Grass-	B. Grass
Bitter Brush-	Bit. Br.
Blackberry Vine	BB. Vine
Bracken Fern-	B. Fern
Brush, Misc.-	Brush
Ceanothus	Cenths.
Cones	Cones
Devil Club-	Dev. Club
Dead Limbs-	Dd. Lmbs.
Dog Wood-	Dg. Wood
Elder Berry	El. Ber.
Fire Weed	F. Weed
Fern, Bracken	B. Fern
Fern, Sword	S. Fern
Grass	Grass
Ground Moss	Gr. Moss
Huckleberry	Hu. Ber.
Leaves-	Leaves
Litter-	Litter
Logs-	Logs
Mahogany-	Mhagny.
Manzanita	Manzta.
Mountain Alder-	M. Alder
Needles	Ndls.
Oregon Grape-	Ore. Gr.
Rhododendron-	Rhod.
Reproduction-	Reprod.
Rotten Wood	Rt. Wood
Salal	Salal
Salmon Berry-	Sal. Ber.
Sage Brush-	Sage Br.
Snow Berry-	Sn. Ber.
Sword Fern-	S. Fern
Thimbleberry-	Th. Ber.
Thistle-	Ths.
Tree Moss	Tr. Moss
Vine Maple-	Vn. Map.
Weeds-	Weeds
Willow-	Will.

[1] Fire Control Handbook North Pacific Region 1935 U.S.F.S. Section II p. 7 I

ACKNOWLEDGMENT

The author wishes to express his appreciation to the Northwest Forest Experiment Station for the pictures in the following pages on Fuel Type Mapping.



FUEL TYPE MAP

LEGEND

Boundary of fuel types - - - - - -

Rate of Spread of fire and Resistance to Control are both typed as either Extreme (Ex), High (H), Moderate (M), or Low (L).

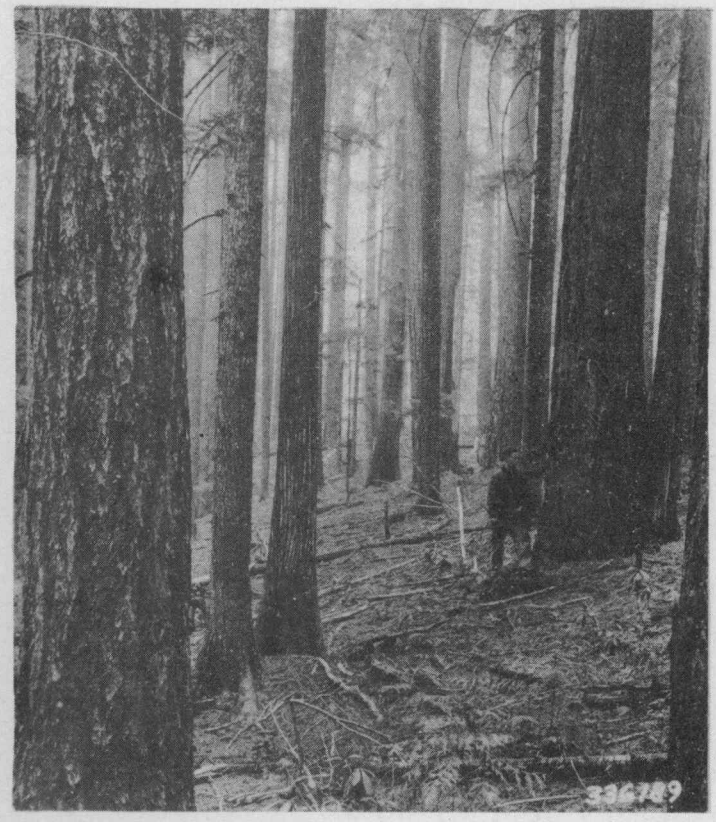
Each fuel type area is outlined in its rate-of-spread color and colored solid with its resistance-to-control color, as follows:

Extreme (Ex)	Red	Dixon's 321½
High (H)	Orange	" 324
Moderate (M)	Blue	" 320
Low (L)	Green	" 354½

Explanation of Fuel Type Symbols:

- HM - High rate of spread and moderate resistance to control
- T6 - Forest Survey type 6
- Salal - Salal is principal item contributing to rate of spread
- Brush - Brush is principal item contributing to resistance to control
- 50% - 50 percent slope
- M - Machine show (or other special item)

These items are always listed in this order.



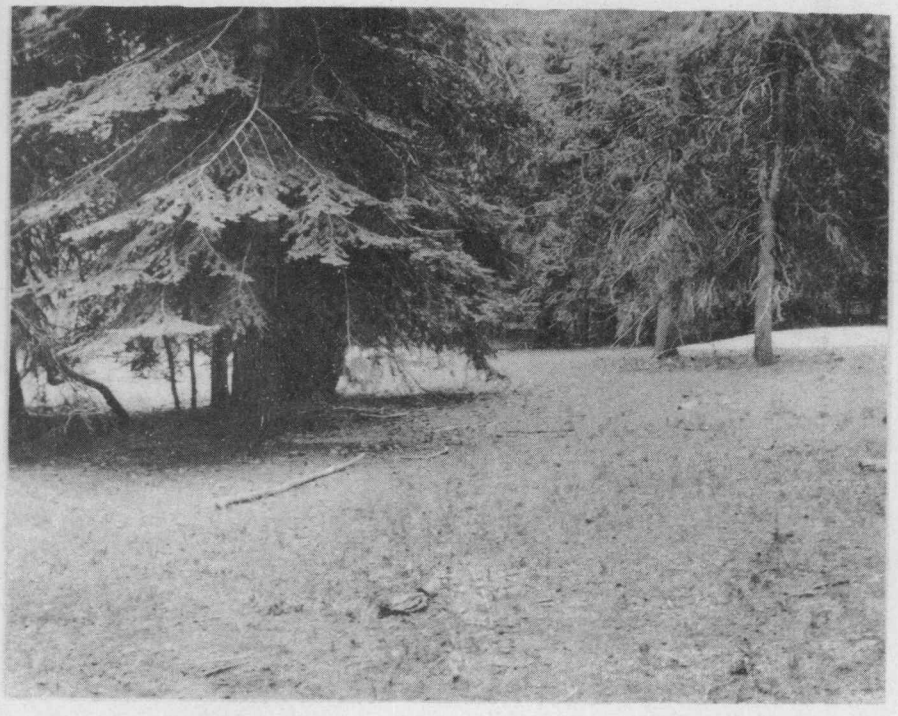
LL
T6
Litter
Duff
L%
M
S

Timber type: Dense stand of Douglas fir, hemlock, and cedar (Forest Survey types 6, 7, 14 or 17).

Ground cover: Litter, duff, and rotten wood. Open, not much brush. Few logs or snags.

Slope: L or M. Steeper slopes might be rated ML.

Exposure: Any.



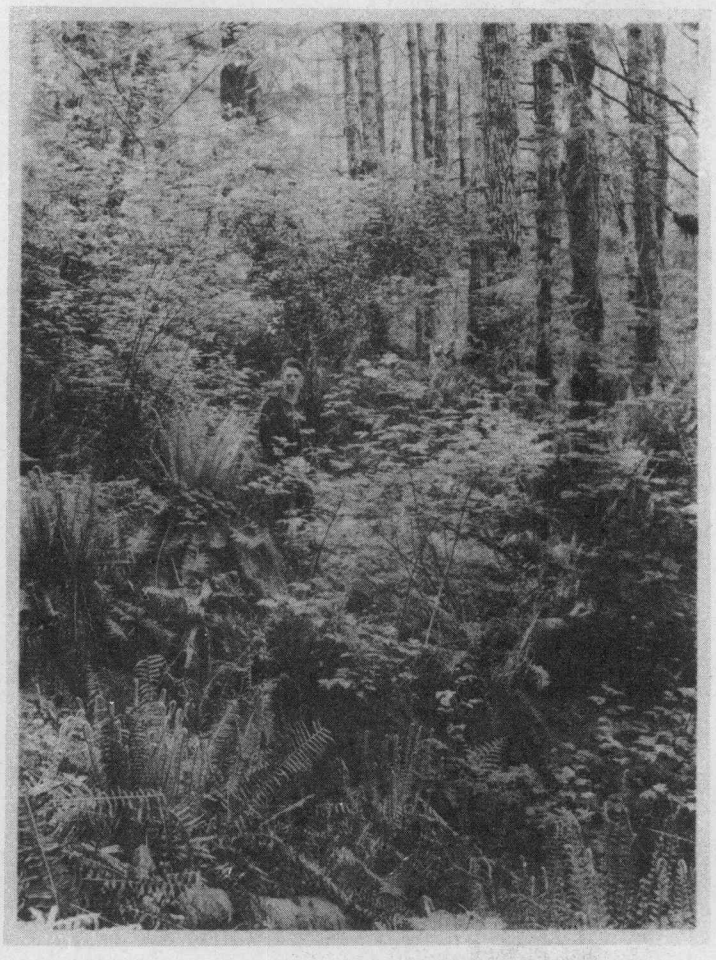
LL
T23
Duff
Duff
L%
M
S

Timber type: White fir, lodgepole, or subalpine (Forest Survey types 23, 26, or 33).

Ground cover: Thin duff packed by deep snow.

Slope: L or M. Steeper slopes might be rated ML.

Exposure: Any.



LM
T8
Sword Fern
Brush
M%
M
S

Timber type: Dense stand of second-growth Douglas fir and alder (Forest Survey types 8 or 9).

Snags and logs: No snags and very few logs.

Ground cover: Continuous stand of sword fern 2 to 3 feet high. Clumps of vine maple and salmon berry brush. Moderately deep moss and duff.

Slope: L or M.

Exposure: Any exposure with full shade.

LH
T14
Moss
Logs
L%
M
S

Timber type: Decadent western hemlock or Sitka spruce stand. (Forest Survey types 14 or 11).

Snags and logs: Many dead topped trees, many snags and logs.

Ground cover: Deep moss, rotten wood, and duff. Sword fern, salmon berry, and devil's club. Dense shade.

Slope: L or M. Steeper, more exposed slopes might be rated MH.

Exposure: Any.

ML
T20
Needles
Logs
L%
M
S

Timber type: Ponderosa pine (F.S. type 20).

Snags and logs: Snags almost absent, an occasional large log.

Ground cover: Needles and cones and very thin brush.

Slope: L or M.

Exposure: Any.

ML
T8
Litter
Logs
M%
M
S

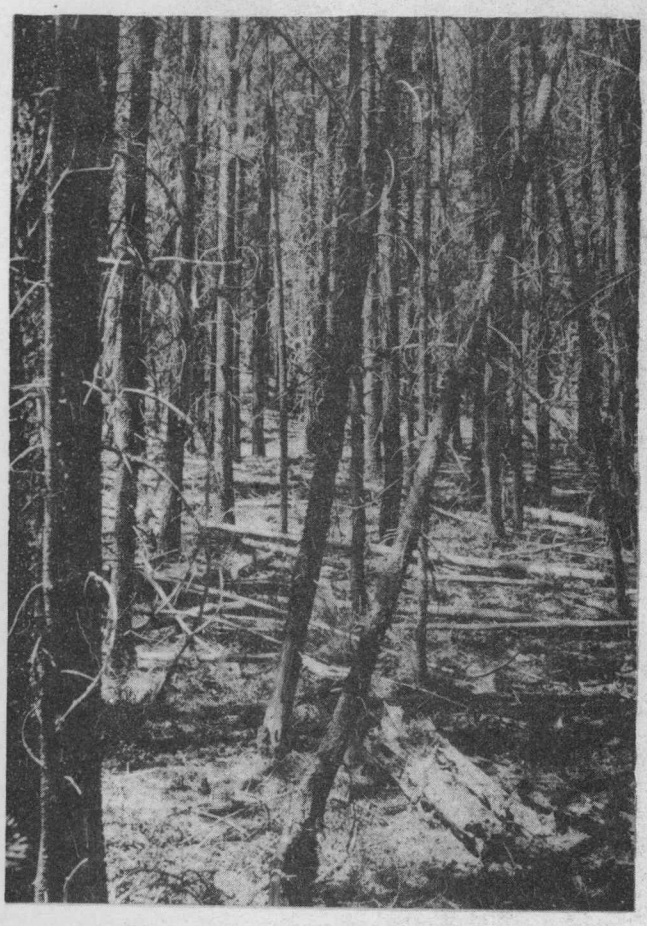
Timber type: Large second-growth Douglas fir (F.S. type 8).

Snags and logs: No snags and very few logs.

Ground cover: Mostly salal and Oregon grape. Deep litter.

Slope: M and H.

Exposure: Any except damp north slopes and except south exposure on H slopes.



MM
T26
Litter
Poles
L%
M
S

Timber type: Lodgepole pine (Forest Survey type 26).

Snags and logs: Many standing and down dead poles.

Ground cover: Litter and scattered grass and weeds.

Slope: L or M.

Exposure: Any.

MM
T8
Litter
Logs
H%

Timber type: Second growth Douglas fir (Forest Survey type 8 or 9).
Snags and logs: Few large snags, many small logs and few large logs.
Ground cover: Dead limbs, ferns, weeds, and brush.
Slope: M and H.
Exposure: Any on M slopes. Any but south on H slopes.

MH
T10
Bracken
Logs
L%
M
S

Timber type: Douglas fir poles in burn or cutover (F.S. type 10 or 34-10).

Snags and logs: Large, short snags and many large logs.

Ground cover: Jungle of bracken, salal, and brush.

Slope: L or M.

Exposure: Any except north.

MH
T26A
Logs
Logs
L%
M
S

Timber type: Lodgepole reproduction (Forest Survey type 26-A).

Snags and logs: Very few lodgepole pine snags standing. Many medium or small-sized logs.

Ground cover: Mostly needles and twigs with some grass and weeds.

Slope: L or M.

Exposure: Any.

HL
T20
Grass
Sod
L%
M
S

Timber type: Ponderosa pine (Forest Survey types 20, 20.5 or 20A).

Snags and logs: Absent or not important.

Ground cover: Continuous cover of cheat grass and other grass and weeds.

Slope: L or M.

Exposure: Any.

HM
T37
Litter
Logs
M%
M_s

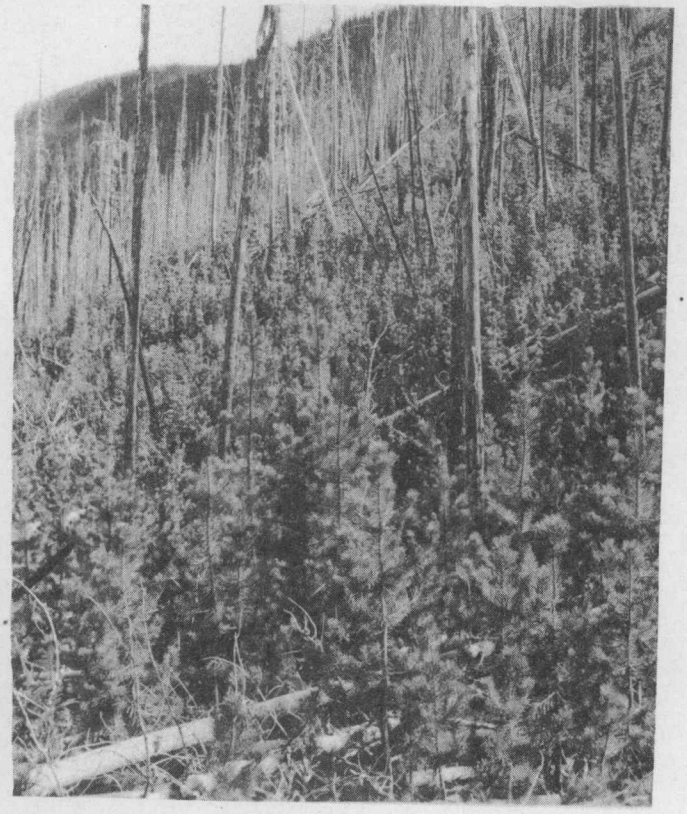
Timber type: Second burn which killed reproduction on old burn (Forest Survey type 37).

Snags and logs: Few snags, many medium sized short rotten logs.

Ground cover: Dead poles, dead brush, bracken, weeds, vines, and clumps of brush.

Slope: L, M, or H.

Exposure: Any except L and M north slopes.



HH
T26
Litter
Poles
H%

Timber type: Lodgepole pine (Forest Survey type 26A.)

Snags and logs: Many. Small.

Ground cover: Grass and weeds.

Slope: M or H.

Exposure: Any.

HH
T34-10
Bracken
Logs
M%
M
S

Timber type: Cutover - Douglas fir and hemlock (F.S. type 34-10).
Snags and logs: Few snags and large dead topped hemlocks. Many small to medium sized logs.
Ground cover: Bracken and grass in openings. Clumps of brush. Some reproduction.
Slope: M or H.
Exposure: Any except north.

HX
T36
Slash
Logs
L%
M
S

Timber type: Recent cutover in Douglas fir, cedar, hemlock, and white fir stand. (Forest Survey type 36).

Snags and logs: Very few snags but extreme number of logs.

Ground cover: Fresh slash with needles on.

Slope: L or M.

Exposure: Any.

XL
T5½
Grass
Grass
H%

Timber type: Scattered ponderosa pine. (Forest Survey type 5½.)

Snags and logs: Almost absent.

Ground cover: Cheat grass, almost continuous.

Slope: H or X.

Exposure: Any exposed slope.

XM
T37
Grass
Logs
M%
M
S

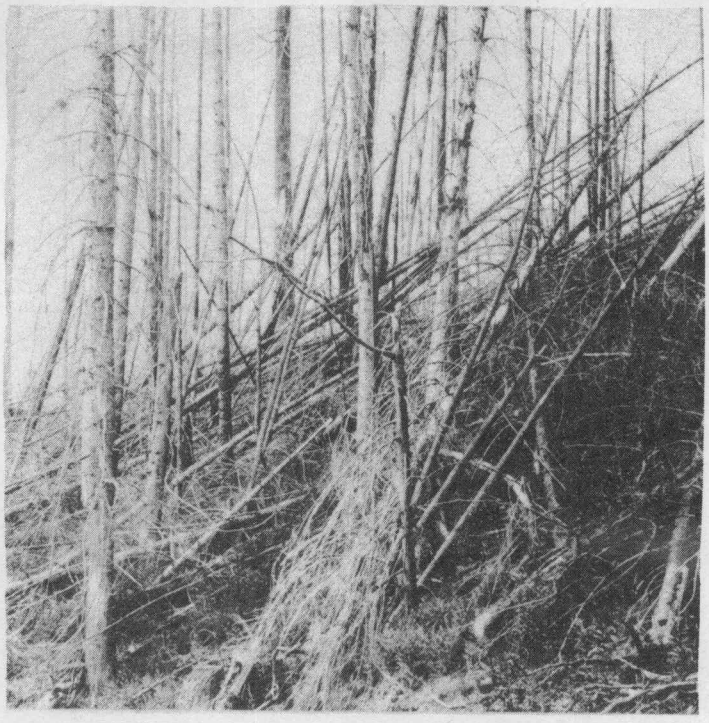
Timber type: Deforested burn in ponderosa pine type (Forest Survey type 37.)

Snags and logs: Many, medium sized.

Ground cover: Cheat grass, other grass, weeds, and dead brush.

Slope: M or H.

Exposure: Any on H slopes. Any except north on M slopes.



XH
T37
Dead poles
Poles
M%

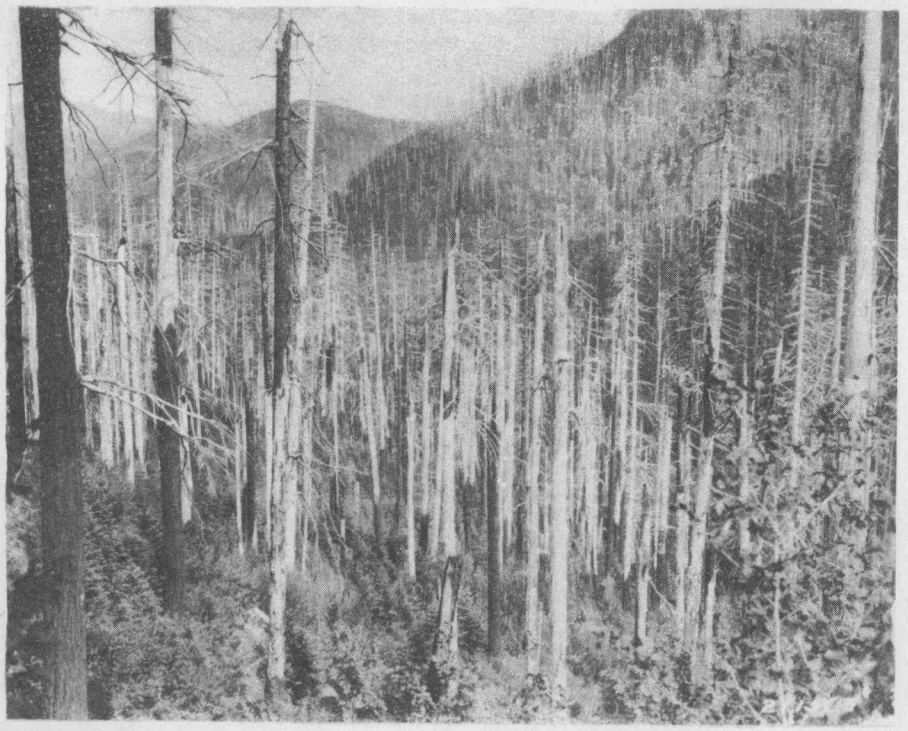
Timber type: Fire-killed Douglas fir, white fir, and hemlock poles (Forest Survey type 37, 37-9, or 37-10).

Snags and logs: Extreme number of standing and down dead poles 4"-8" diameter with limbs on and loose bark. Few large snags and logs.

Ground cover: Litter from poles, also fireweed and blackberry vines.

Slope: M or H.

Exposure: Any except north on M slopes.



XX
T10
Snags
Snags
H%

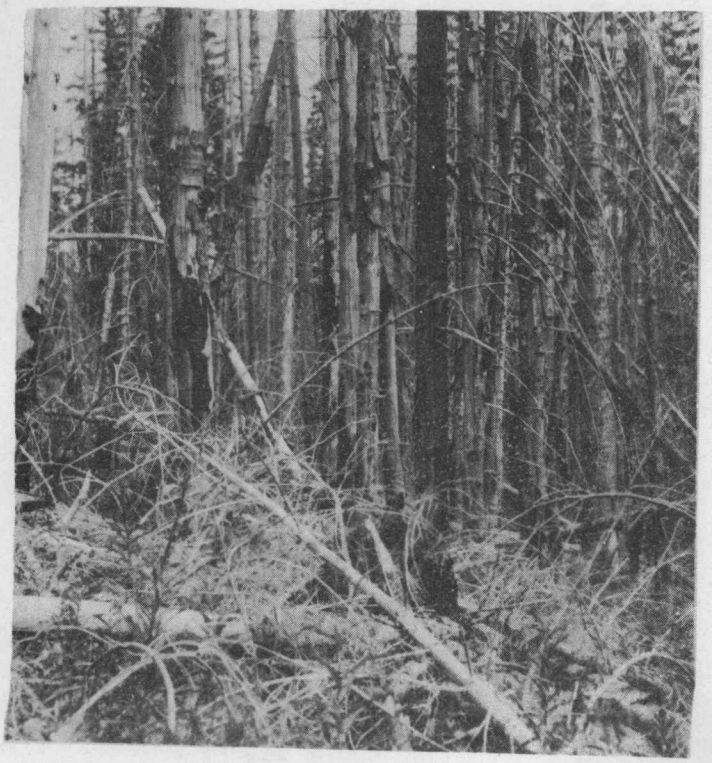
Timber type: Douglas fir single burn 10 to 40 years old. (F.S. Type 37 or 10, etc.)

Snags and logs: Many and large.

Ground cover: Brush, reproduction, bracken, vines, weeds and litter.

Slope: H or X.

Exposure: Any.



XX
T37
Snags
Poles
M%

Timber type: Pole stand of Douglas fir and white fir. (F.S. type 37.)

Snags and logs: Many dead poles, standing and down. Dead limbs. Also large snags and logs.

Ground cover: Dead poles and limbs conspicuous, also fireweed, bracken, and vines.

Slope: M, H or X.

Exposure: Any except North on M slopes.

CLASS OF DAY

The following is the present method of determining the class of day by the U.S. Forest Service of this region.[1]

Fuel Moisture Content is determined by weighing the "½ x ½" inch Ponderosa Pine sapwood fuel moisture content sticks. The weighings are taken three times each day--8 A. M., 1 P.M., and 5 P.M. Each of these weights are recorded on a special sheet at one station, usually the Ranger Station. There should be several stations throughout the district and they should be so located as to give a good sample of the actual condition of the forest. After the 5 P.M. readings the lowest reading for each station is recorded, all readings added together and divided by the number of stations to get the average for the district. This average is used with the other factors in the integration table to determine the "Burning Index." The classes used on the Fire Danger Board are as follows:

Class	0	25 per cent or over	White
"	1	18.1 " " to 25	Green
"	2	10.1 " " " 18	Blue
"	3	7.1 " " " 10	Orange
"	4	0. " " " 7	Red

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1 Fire Control Handbook, North Pacific Region, U.S. Forest Service 1935 edition, Section II p. 6

Relative Humidity--at each station selected over the district the humidity is recorded three times daily the same as the fuel moisture content and the low for each station is added and divided by the number of stations to get the average. The obtained value is then used with the other factors on the integration table to determine the burning index.

Wind Velocity-- is recorded at each station the same as the preceding factors and the same procedure is followed to determine the burning index. The classes used are as follows:

Class	1	0 to 3mph.	Green
Class	2	3.1 to 7 mph.	Blue
Class	3	7.1 to 12 mph.	Orange
Class	4	12.1mph. and over	Red.

Herbaceous stage--these are plots eight feet by eight feet established at each station to determine the herbaceous condition (condition of grass and weeds). They are located on different exposures to get good samples throughout the district. These stages are divided into three classes and by inspection the average for the district is determined to use with other factors in determining the burning index. The classes are as follows:

Class	1	Green	Green
Class	2	Curing	Orange
Class	3	Dead	Red

Burning Index--is obtained from the average of the Fuel Moisture Content, Relative humidity, Wind Velocity and Herbaceous Stage combinations on the Burning Index Integration Table. This table is furnished with each Fire Danger Board.

Visibility--records are taken at one and five P.M, the results recorded the same as the other factors, the average of these two readings averaged and then the average found for the district by averaging the other averages. This value is used with the burning index to determine the class of day. The classes of visibility are as follows:

Class	1	8.1	to 15 mi.	Green
"	2	5.1	to 8 mi.	Blue
"	3	1.1	to 5 mi.	Orange
"	4	o	to 1 mi.	Red

Risk as given in the U.S. Forest Service Fire Control Handbook for this Region.[1]

" Risk

Definition: Activity of fire-starting agencies.

Local specifications of the risk factor should be defined in 4 classes on each ranger district, in accordance with the region-wide specifications indicated below. In making these local definitions no weight would be given to the fuel moisture content, wind velocity, herbaceous stage, or visibility. The definition of each risk class must be independent of other factors and based solely on the activity of fire-starting agencies present on the ranger district.

Region-wide specifications of risk are:

Class 1 - Low Risk. Less than normal risk.

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1 Fire Control Handbook, North Pacific Region, U.S.F.S. 1935 Edition Section II p. 6.

Class 2 - Normal Risk. Use of the forest by the usual number of recreationists, timber sale operators, grazing permittees, and other users normally expected during the fire season.

Class 3 - Heavy Risk. Forest users and recreationists appreciably above normal, or initial outbreaks of incendiarism, or when lightning forecasts indicate probable occurrence of lightning storms, or when local cloud formations together with dew-point indications predicate the occurrence of lightning storms.

Class 4 - Extreme Risk. Worst probable condition of risk due to lightning or extreme activity of man. Severe incendiary outbreaks should be the only man-caused activity justifying the rating of "extreme." When a lightning storm has occurred within the 24-hour period of 5 p.m. to 5 p.m. since the board was last rated, a Class 4 risk may be indicated for the next 48 hours; i.e., lightning within the past two days should be considered a class 4 risk. However lightning includes only those storms with one or more bolts reaching the ground and these strikes must be within the protective boundaries of the ranger district.

The classes of risk are as follows:

Class	1	Low	Green
Class	2	Normal	Blue
Class	3	Heavy	Orange
Class	4	Extreme	Red

Class of Day---The burning index, the visibility and the class of risk are used in the Class of Day Integration Table to determine the class of day. The class of days are as follows:

Class	1	Year long force	White
"	2	Skeleton Detection Force	Green
"	3	Primary Protection "	Blue
"	4	Normal " "	Yellow
"	5	Primary Emergency "	Orange
"	6	Full " "	Red
"	7	All available Forces	Red

In practice the use of "risk" with the fire danger board has not been as practical as was anticipated. It has, on some districts, been the cause of a class 4 day when in reality only a class 3 day existed. This is another case of where judgment is left up to the individual and there is no standard to follow or any way of measuring the judgment.

The following plan is offered as a solution to the above problem. There are two causes of fires starting, man caused and lightning. The first to consider here will be man caused fires. If records are kept over a period of years it will show the relation between fires and the number of people in a given class--that is, it may be found that one fire occurs to every 200 hunters; one fire to every 800 fishermen; one fire to every 150 berry pickers etc.. In a given locality there is a close correlation between the number of fires and the number of users. This will have to be determined for each district and may even be determined for one small area surrounding a lake. After the above data has been obtained, then the risk can be determined by knowing approximately how many visitors of each class is present on the area.

The risk caused by lightning can be determined by past fire reports. Lightning has a peculiar habit of striking a large number of times in certain areas and few or no strikes in other places. The fires and dates of occurrence plotted on a map would give the desired

information--for example--if a given area showed one or more lightning fires per section per year for 10 years, then it would be classed as an extreme area whenever a lightning storm was forecast, while the storm was present, and for two days after the storm. Should the area show a lightning fire per section every other year, it would be classed as high under the above conditions. A fire per section every 5 years as moderate and one or less fires per section every 10 years, low. These values of risk will vary throughout the district and should the district be large, it might be desirable to determine the risk for the different parts of the district. This change should be taken into consideration when determining the elapse time standard. Incendiarism would be considered the same as a class of users of the forest.

The average annual risk can be determined by the number of fires to a given area. When the location and date of the fires are plotted to determine the risk for the class of day, it will also be possible to class the areas into mean annual risk classes. That is, the areas where the greatest number of fires occur would be classed higher than where few or no fires occur. Any desired number within reason could be set as a limit for each class, provided the number used is standardized for all areas. They would be classed into the following classes of: Extreme, High, Moderate and Low.

CHARTS TO DETERMINE ELAPSE TIME STANDARD

Now that the two factors, rate of spread and resistance to control have been determined for the district, little or no attention will have to be given them during the fire season as they will remain nearly constant until an area is logged or has been the subject of a wind storm or fire. Should anything occur to change either of these factors, the map should be corrected immediately. It is suggested that the map be brought up to date every five years. If these two factors remain constant then the only factors to change are those used in determining the class of day. These factors as a rule change slowly in one way or another so that it is possible to place men at the strategic points if a plan has been made before such a time arrives. Therefore, it is desirable that the plan can be based on factual material and not on judgment.

If the elapse time standard can be pre-determined for any given area with any change in class of day, the plan can be put into effect immediately upon the existance of such a condition. It will also be possible to pre-determine the most desirable location of roads, trails, and any other factors contributing to the suppression of fires.

The elapse time standard as used here is the time between the starting time of the fire and the time the fire is corralled. As the time to corrall a fire is

influenced by four main factors; how fast the fire will burn and how fast the crews can construct fire line; detection time and travel time, all of these factors can be determined. Then it is possible to determine the elapse time standard under any given condition and for any given area. This is possible as every factor influencing the rate of spread of the fire and resistance to construction of fire line has been taken into consideration in the rate of spread, class of day and resistance to control, travel time, and detection time. As these values can be accurately measured then the result is one of factual findings rather than one of judgment of the individual.

These values may be integrated in many different ways to give the result in elapse time standard. Mr. Wilkinson of the Northwest Forest Experiment Station believes that these values will have to be integrated by judgment as has been done in determining the burning index and class of day. It is the author's opinion that these values can be obtained by alignment charts and the charts constructed from the actual conditions as it exists in the forest. For example--an experimental fire can be started on an area with sufficient crew to keep the fire to the desired size of class "A" (less than $\frac{1}{4}$ acre) and the elapse time standard can be determined as also can the class of day, the rate of spread and the resistance to control. The number of experimental fires would depend upon the accuracy desired in the final charts.

This procedure can be followed for several of the different combinations of the three factors concerned and the results used to construct the final charts to give the elapse time standard. The results for every possible combination will not have to be obtained, as the charts can be constructed from half that many points or results. There will be a need for data on certain combinations to give a wide range of the different factors. T he data might possible be obtained from actual fires over the forests if this information could be accurately recorded. The date should not be taken from past fire reports as there is a chance for erroneous values to be placed on the report by some inexperienced individual or a misrepresentative value given by some one that has constructed the report to show favorable for himself.

The basic chart for the elapse time standard will be some what tedious and complicated, but when once constructed will be usable for many years. It is impossible to get the time in hours from any mathematical formula and a trial and error method must be used to get the final chart. The more accurate the basic chart, the less work there will be in constructing the completed one.

The accompaning chart is only theoretical and <u>not</u> to be taken or used as the completed or final chart. It is used here <u>only</u> to illustrate the principle and use after construction.

The chart is very flexible and the values can be changed by moving the axis of any of the factors closer or farther away from the other. Different values can also be obtained by graduating the axis of any factor to a different scale. Both the distance of one axis to the other and the scales will have to be adjusted to fit the field data taken from the actual or experimental fires until the chart will fit the many combinations of all the factors.

The detection time has, in most forests, been determined by mapping the area as to the length of time in detecting fires for given areas based on the degree of visability. It is then possible for the dispatcher to tell the length of time the fire has been burning when the fire is reported.

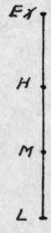
Travel time has been determined by zoning the areas according to the distance the fire guard is from the area and taking into consideration, method of travel and all factors affecting travel time, such as conditions of roads, trails, brush etc.. It is possible at present then to determine the length of travel time.

The detection time and travel time are both deducted from the actual time it will take the fire to reach the minimum size of $\frac{1}{4}$ acre as determined by the alignment chart. The resultant number of hours left will be the actual number of hours that a crew will have to work on the fire before it has reached the minimum size of $\frac{1}{4}$ acre.

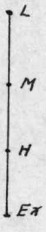
The Forest Service has a policy that all fires starting before midnight of a given day must be under control by 10 A.M. the following day. If this policy time is shorter than the time shown by the chart, then it will be used as the time left for the crew to construct the trench around the fire.

It has been shown on the preceding pages that the exact length of time possible to spend in fire line construction can be determined for any fire for the existing conditions. The area will have a given resistance to control (taken from the map) that will mean a certain number of chains of fire line can be constructed per man hour and the average fire ¼ acre in size will have a given number of chains in perimeter. This will show the number of hours to work before the controlling time is reached and also the number of man hours required to construct the trench. From this the dispatcher can determine the number of men to send to the fire.

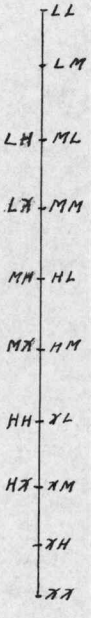
Resistance to Control



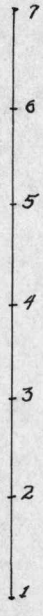
Rate of Spread



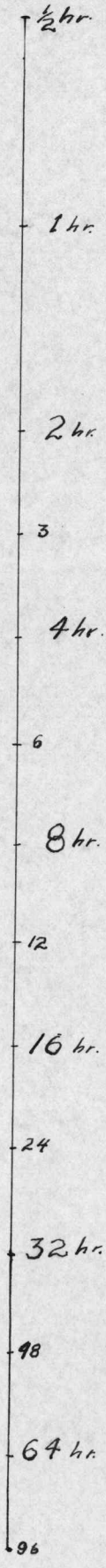
Action Factors



Class of Day



Elapse Time Standard



CONCLUSION

By taking advantage of all the factors affecting the spread of a fire and all the factors affecting the suppression of a fire, the number of men can be determined to send to each fire by integrating as shown in the preceding pages.

The Ranger can use the same method in pre-determining the location of roads, trails, look-outs, fire guards etc..

It can be used as a guide for the new Ranger to follow. It can be used as a measuring stick for the fire chief to place along side the Ranger or Dispatcher to see if the right number of men were sent to the fire. If the fire was not controlled at the proper time, then the fire chief has a check to see why it was not and he can find and correct the cause.

BIBLIOGRAPHY

1. Fire Control Handbook for North Pacific Region, United States Forest Service, 1935 Edition