

THE FIRE PROBLEM
on the
MALHEUR NATIONAL FOREST¹

Annual Technical Report

of

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Contents

A. INTRODUCTION	4
B. HAZARD.....	4
C. FIRE SEASON	5
D. CHARACTER OF FIRES.....	5
1. Types	
2. Causes	
3. Speed of burning	
(a) Topography	
(b) Ground cover and litter	
(c) Condition of the atmosphere	
(d) Damage to the timber and range	
E. COOPERATION.....	10
1. Introduction, advantages	
(a) Present systems	
(1) Methods	
(a) With state	
(b) With counties	
(c) With timber land owners	
(d) With Forest users	
2. Results	
(a) With state	
(b) With Forest users	
3. Suggested system of cooperation	
(a) With state	
(b) Extention of individual cooperation	
(c) With fire protective associations	
(d) Maps, etc.	
F. METHODS OF PREVENTION.....	12
1. Enforcement of fire laws	
2. Signs	
G. METHODS OF DETECTION.....	14
1. Present system	
(a) Lookouts	
(b) Patrol	
(c) Voluntary detection	
2. Suggested system	
H. METHODS OF SUPPRESSION.....	17
1. Tools	
2. Trenching, fire lines	
(a) Where to make	
(b) How to make	
(c) How to maintain	

- 3. Back firing
 - (a) Factors influencing
 - (b) When to back fire
 - (c) Where to back fire
 - (d) How to back fire
 - (c) Patrol

I. CONCLUSION23

A. INTRODUCTION

The Malheur National Forest comprises a gross area of 1,262,840 acres, located in the heart of the Blue Mountains of Eastern Oregon. The greater part of the Forest lies at elevations ranging from 4,000 to 6,000 feet above sea level. The Forest includes a part of the watersheds of the middle and south forks and the main John Day river, the north fork and main Malheur river, and the Silvies river.

It contains an open but valuable stand of about six and one-half billion feet of western yellow pine, Douglas fir, western larch, and several minor species, which is worth, at a conservative estimate, thirteen million dollars.

Settlers and ranchers of the John Day and Harney valleys and the lower Malheur depend on this timber for their fuel and lumber. Approximately two million feet of timber is sold annually for local consumption, and in addition to this about three-quarters of a million feet of timber is given to settlers under free use permits.

Nearly every acre of this Forest contains, in the summer time, a crop of grass and herbage which offers excellent summer range to about 24,300 cattle and horses, and 135,500 sheep.

Fire protection on this Forest is doubly important in that fires not only destroy its valuable stands of mature timber, advanced growth and reproduction, but also severely injure the range, thus reducing its carrying capacity and effecting the welfare of the whole Forest as well as those dependent upon it.

B. HAZARD

The fire hazard is effected by the character of the timber and ground cover, the topography, and the human element as exemplified in the presence or absence of railroads, factories, lumber camps, attractive camping, hunting, or fishing grounds, etc. In addition to these direct factors, there are the indirect factors of droughts, hot seasons, hot waves during the summer and fall months, warm winds, etc.

The fire hazard on the Malheur is not especially high. However, lying at an elevation of from 3,000 to 9,600 feet, and exposed to the hot summer winds of Eastern Oregon, the forest floor is soon dried out and constitutes an immanent fire risk.

The forest floor consists of grasses, a more or less thickly matted accumulation of the resinous needles of the pine, and the hardwood litter of the sage brush, mountain mahogany, and buck brush. When dry, these ignite readily, the matted mahogany holding fire for long periods.

The forest floor may be divided into three classes: (1) The treeless sage brush regions. (2) The mahogany-juniper regions. (3) The timbered areas. The scarcity of vegetation on the first two, and the sparsity of timber on the third, permit the ready penetration of the rays of the sun and the consequent rapid evaporation of the surface moisture. This results in a dry ground cover which is readily inflammable. In the timbered areas the stands are seldom dense, but the dried, rosinous needles constitute an ever-present risk during the danger season.

The semi-arid character of much of the Forest tends to greatly increase the fire hazard through the effects of droughts, warm winds, hot waves, etc. These bring the already inflammable ground cover into a state of dryness such as to constitute an increasing menace with the prolongation of the fire season.

The human element in the fire hazard on the Malheur is not especially active. There are no railroads operating in the Forest, nor are there any factories, the employees of which might constitute a fire hazard. There are six sawmills and lumber camps operating on the Forest, but the owners have so much at stake personally, in the way of investments, etc., and are so familiar with the results of forest fires, that they are remarkably careful in this respect. If a fire is discovered in the vicinity of their mills they are usually glad to furnish men, equipment and supplies to fight it.

While there are abundant hunting and fishing grounds of an attractive nature on the Forest, still the men who take advantage of them for the most part understand the fire danger and sympathize fully with the efforts of the Service to control it.

C. FIRE SEASON

The length of the fire season is influenced by the amount of snowfall the previous winter, prevalence of winds tending to early dry out the forest floor, droughts during the summers, etc.

The fire season on the Malheur may be said to continue from July 1 to September 15. The actual dates of the fire season differ in the several ranger districts, the variations being due to differences in topography, forest cover, altitude, and similar factors. The following table showing the fire season in the different districts was compiled from information obtained from the rangers.

<u>Name of Ranger</u>	<u>District</u>	<u>Type of Range</u>		<u>Season</u>		
		<u>Sheep</u>	<u>%</u>	<u>Cattle</u>	<u>Beq.</u>	<u>Ends</u>
T. M. Ray	1	90		10	7/15	8/20
S. R. Bennett	3			100	7/1	9/15
F. C. Mack	4	60		40	7/1	9/30
J. B. McEntire	5	30		70	7/15	10/15
F. V. Bradford	7	80		20	7/1	8/31

During this fire season an average of 16.4 fires per year have occurred in the last five years. The number of fires has been increasing. This may be due to the fact that the efficiency of the Forest Service is increasing and the actual number of fires reported is thus greater, or it may be due in part to the fact that since the creation of the National Forests the people as a whole are beginning to feel that fires are the concern of the Forest officers, and consequently make less efforts on their own initiative to prevent or suppress them.

D. CHARACTER OF FIRES

1. Types: Fires on the Malheur may be divided into three main classes, with subdivisions as follows:

- (1) Timber fires,
 - (a) Surface fires
 - (b) Ground fires
 - (c) Crown fires
- (2) Brush fires
- (3) Sage brush fires

The following tables show the types and percentages of fires, according to rangers' estimates, for six of the eight districts on the Forest:

Percent of the total number of fires on sheep and cattle range: Sheep 26%, cattle 74%

The sheep range comprises about 51% of the total forest range.

Percent of fires on sheep and cattle range by types and classes:

<u>Type of Fire</u>	<u>Sheep</u>	Range %	<u>Cattle</u>
Timber	20		7.6
Ground	6.8		6.0
Surface	60.2		65.1
Crown	3.0		7.7
Brush	7.4		7.8
Sage brush	<u>2.6</u>		<u>5.8</u>
	100.0		100.0

Fires of the first division are by far the more common. Of these, ground fires, or those burning under the surface of the ground, in contradistinction to the surface fires, which run through the needles and litter of the forest floor, are seldom encountered. Occasionally, however, situations are found where this type of fire has to be dealt with. Dense accumulations of mahogany leaves often hold fire for days, thus having the appearance and results of ground fires.

Surface fires furnish about sixty-four percent of the total number of fires for an average fire season. These surface fires not infrequently run up the bark of pines into their crown, and often consume the whole of such low trees as the mountain mahogany, buck brush, and the other unimportant hardwoods of the forest, as well as the small pines of reproduction and advanced growth.

The surface fire is differentiated from the crown fire in that the latter burns for considerable distances in the crowns of the trees, while where the surface fire does run up into the crowns it soon burns itself out unless the wind and inflammable material suffice to develop it into a true crown fire. A crown fire can not continue for any distance without at least a breeze unless the stand is far more dense than the average on the Malheur. Thus the surface fire may infrequently develop into a crown fire. There must be a surface fire before a crown fire is possible.

Owing to the relatively sparse timber on the Malheur, crown fires are infrequent, and where started soon check themselves by lack of sufficient inflammable material, the open spaces in the timber and its general lack of uniformity serving well in this purpose.

It often happens, however, that a miniature crown fire will start in dense reproduction or advanced growth, in which case natural fire lines or fire breaks, utilized for checking these fires, must be augmented by the felling of bordering trees. (See "Trenching, fire lines, hot to make").

Brush fires are most apt to occur in old slashing from lumbering or cordwood operations. These are usually hot fires and can be best handled by back firing from a cleared fire trace surrounding the slash area.

Sage brush fires rarely do much damage, unless they communicate themselves to adjacent timber. They burn rapidly and are easily checked by slight natural and artificial barriers.

2. Causes: The origin of the fires on the Malheur for the last five years has been attributed to the following causes:

<u>Cause</u>	<u>No. of Fires</u>	<u>Approximate Percent</u>
Lightning	27	33
Brush burning	1	1
Campers	23	28
Saw mills	1	1
Unknown	22	27
Miscellaneous	8	10

Under the classification of unknown and miscellaneous causes are listed such as the following:

Carelessness in the nature of matches and tobacco.
 Unproven lightning, campers, and malicious fires.
 Fires not traceable to any immediate origin.

3. Speed of burning: The following factors influence the speed with which fires burn:

Topography
 Ground cover and litter
 Condition of the atmosphere
 Season of the year, time of day, etc.

(a) Topography: Quoting from Graves' "Principles of Handling Woodlands,"

"A fire runs up hill with great rapidity, because the heated air currents draw the flames upward."

This is strikingly illustrated by every large fire which burns in the vicinity of a back fire. The smoke from the back fire is drawn from every direction towards the main fire. This main fire acts as an enormous draft that sucks the surrounding air currents towards it and carries them upward with its own heat. This explains the rapidity with which the flames of a fire advancing up hill are carried towards the summit.

"If the litter is evenly distributed, the velocity with which a fire will run up a slope is in direct proportion to the steepness of the slope. After passing the crest, a fire travels more slowly in its descent on the other side."---Graves.

This is a factor of which great advantage can be taken in fighting fires. Those place where the fire is advancing up hill must be attended to first, leaving the slopes down which the fire is burning until later.

"Mechanical obstruction, such as abrupt walls, narrow ridges, outcropping ledges, and so on, tend to check a fire and to prevent its gathering volume. On extensive level ground fires burn more uniformly, generally do more damage, and extend over a larger area than in rugged topography."---Graves.

(b) Ground cover and litter: The severity with which ground fires burn depends in a large measure on the amount and condition of the inflammable material on the ground. In fighting fires on the Malheur situations are often encountered where the dense accumulations of resinous needles found under mature stands and thick reproduction give way to a sparse ground litter on the upper slopes and summits of gravelly ridges. This is of great importance in fire fighting as it permits more dangerous localities to be attacked first, and offers a natural barrier towards which the advance of the main fire can be headed by the judicious use of fire lines and back firing. Fires in pine needles burn much faster than those in the litter of

mahogany, buck brush, willows, etc. The former also wet through and dry out faster than the accumulation of hardwood leaves, thus rendering them more readily inflammable.

(c) Condition of the atmosphere, season of the year, time of day, etc.: Fires burn less rapidly on a cloudy day than when the sun is shining. This is because the atmosphere, and the inflammable material itself, is relatively cool, thus acting as a check on the speed of the fire.

Fires burn slowest at night. This is one of the reasons advocated for fighting fire at night. Another is that then it is cool and thus not so trying on the fire fighters. In this respect, it is thought that the opportunity to fight fires at night should be embraced whenever possible, but that with night fire fighting it is necessary to know at least the general direction of the back fire line. Otherwise a great deal of unnecessary work may be done and many thousands of feet of timber needlessly destroyed, either by working too far in advance of the main fire or too near it. In the latter case the main fire may get away with the heat of the day and all the work thus have to be done over again.

Places along a fire line that seem cold and safe at nine o'clock in the morning, may break into flames at two in the afternoon, especially if there is a little wind. This necessitates the most careful watching of back fire lines between the hours of ten a.m. and four p.m. (For a further discussion of this point see "Patrol" under "Methods of Suppression.")

With exception of hot spells and droughts during the spring and fall, it goes without saying that fires burn with greatest rapidity in the summer time, when as a rule everything is dry and inflammable.

(d) Damage to timber and range: The average fire on the Malheur does relatively little damage to the mature timber. The stands are so open that crown fires seldom extend over large areas. Unless the mature tree is severely scorched its changes of recovery from the effects of a light surface burn are very favorable, owing to the fire-resisting character of its bark. Considerable damage, however, is done to advanced reproduction and young growth, which is often extremely dense on this forest. In such situations the ordinary surface fire is very apt to develop into a miniature crown fire. This is always fatal to a large percent of the reproduction.

The effect of fires on the condition of the range is apt to be far more serious than the damage to standing timber. In this respect there is a marked difference between the injury sustained by the sheep range and that by the cattle range. There is usually less trash and ground litter on sheep range than on cattle range. Consequently fires on sheep range are not apt to be so serious in their effects as those on cattle range.

The actual damage to the range may consist of one or more of the following:

- (1) The exposed portion of grasses are burned to the ground.
- (2) The exposed portions of grasses and their roots are burned, thus killing the plant.
- (3) Browse, hardwood leaves, coniferous tips, and weeds are burned.

The severity of fires burning in grass is measured by the density of the grass rather than by its height. For this reason, since sheep eat the range much more closely than do cattle, fires on the sheep range are less severe and do less damage to the forage crop.

From the estimates of several rangers the following figures were compiled as to the period required for grass to get a new start, and also to completely recover from the effects of fire, on both the sheep and cattle range:

Sheep Range		Cattle Range	
<u>Years</u>	<u>Average</u>	<u>Years</u>	<u>Average</u>

Required for new start 1.2 to 6 2.5 1.5 to 4.5 2.7

Required for complete recovery 1.9 to 7 3.6 2.0 to 7.0 4.0

The figures given as average do not represent actual averages, but weighted averages according to the rangers' reports.

Following is a summary of the annual fire reports from 1911 to 1915, inclusive. Under table 5 is given the actual damage to timber, forage, and reproduction:

Summary of fire reports, Malheur National Forest, for the years 1911, to 1915, inclusive:

Table	Item	1911	1912	1913	1914	1915
1	Class A fires	7	2	4	12	
	Class B fires	8		2	5	14
	Class C fires	4		2	5	16
	Total	—	—	—	—	—
		19	2	8	22	30
2	Location or origin					
	N. F. land	14	1	4	17	25
	P. lands inside	3		1	5	1
	Outside N. F.	2	1	3		4
3	Causes:					
	Lightning	8	2	3	4	10
	Brush burning				1	
	Campers	7		1	9	5
	Sawmills				1	
	Unknown	3		4	3	12
	Miscellaneous	1			4	3
4	Area burned over					
	N.F. land, timber	1756		2.1	858	5345
	open	<u>400</u>		<u>1</u>	<u>311</u>	<u>1</u>
	Total	2156		3.1	1169	5346
	Private lands:					
	timbered	128		.2	8	40
	open			<u>55</u>	<u>10</u>	
	Total	<u>128</u>		55.2	18	<u>40</u>
	Average acres per fire	120.2		7.3	53.9	179.5
	5	Damage to timber, reproduction, forage, etc.:				
Timber, N.F. Land						
M.B.F.		284			35	10637
value		710			70	26592
Reproduct. Value		1501			1460	6000
Forage, value		<u>297</u>			<u>6</u>	<u>50</u>
Total value		2508			1536	32642

	Timber, private land					
	M.b.f.			.50	5	19
	value			.50	0	47
	Reproduct. Value					
	Forage value					
	Total value			.50	10	47
6	Costs of fire fight.					
	F. officer's labor	233	9		167	294
	Temporary labor	231		32	119	753
	Trans., tools, etc.	<u>158</u>		<u>18</u>	<u>25</u>	<u>549</u>
	Total cost	<u>622</u>	<u>9</u>	<u>50</u>	<u>311</u>	<u>1596</u>
	Cost less f.o. labor	389	0	50	144	1302
7	Division of costs:					
	N.F. land	550		7	305	1465
	P.L. inside	50		5	5	44
	P.L. outside	22		38		87
8	Value of cooperation					
	N.F. land				10	10
	P.L. inside			6	1	11
	P.L. outside					<u>11</u>
	Total			<u>6</u>	<u>11</u>	<u>32</u>

E. COOPERATION

A selected summary of the advantages to be derived from cooperation in fire protection shows the following:

- (1) Centralizes responsibility; avoids duplication of effort; reduces delay in attack.
- (2) Provides for closer supervision, thus increasing efficiency.
- (3) Induces a better public sentiment, and renders general cooperation between the government, state, and individuals more effective.
- (4) Extends the field of successful protection beyond that possible under individual effort.
- (5) Stabilizes fire fighting expenditures
- (6) Equalizes relationship between large and small owners.

Part 1

(a) Methods: cooperation in fire protection on the Malheur National Forest may be divided into four classes, as follows:

First: Cooperation with the State. The existing agreement between the State Forester and the Forest Service provides for the patrol, by Forest officers, of certain privately owned timber lands both inside and adjacent to the Forest. In return for this service, a certain specified sum, being the rate per acre for fire patrol on National Forest land, is paid into the treasury of the United States. Since no state patrolmen are employed in the vicinity of this Forest the agreement above referred to constitutes the only cooperation rendered by the state.

Second: Cooperation with the counties. County officials have verbally expressed their willingness and desire to report any fires which they may discover or learn of. In the past this has proved of some practical value.

District Game Warden Hazeltine, and his special deputies, use every means in their power to cooperate with this Forest in the work of fire protection. Mr. Hazeltine's personal influence with hunters, campers, and other Forest users is of great value to the Service.

Third: cooperation with private timber land owners. Much of the best privately owned timber land within the Forest is held by large corporations and nonresident timber owners who employ no special patrolmen. For the most part, however, their lands lie within the areas covered by the cooperative agreement with the state. For this reason, except where fires may threaten their holdings adjacent to National Forest land little or not actual assistance can be expected in the matter of fire protection or cooperation from this class of owners.

Fourth: Cooperation with Forest users. In each district a more or less complete list of the settlers and Forest users has been compiled. These lists contain the names, addresses, and telephone calls, where such exist, of the settlers and users, and also contain information as to the number of men, horses, and the character and quantity of equipment and supplies that may ordinarily be depended upon from each settler in case of a fire.

As rapidly as possible these lists are being extended and revised and a personal understanding or agreement reached between the rangers and settlers to furnish all practical assistance in cases of emergency.

The success of this method depends entirely upon the ability of the Forest officers to cooperate with the settlers and stockmen. It requires an earnest desire on the part of the rangers to be of all possible assistance to the Forest users, who in turn appreciate this attitude and are anxious to render assistance in time of need, the more so in that they realize that it is to their ultimate financial advantage to suppress fires, thus protecting the range, water and timber upon which they depend in a great measure for their livelihood.

(b) Results: Under the present system of cooperation the following results have been obtained:

First: Cooperation with the state. During the past season officers of the Malheur Forest have patrolled approximately 400,000 acres of private lands, both within and adjacent to the Forest, under the provisions of the agreement with the State Forester.

Three fires occurred on this acreage with a loss of 53 M.b.f. They burned over a total acreage of 1,085 and cost for patrol and suppression 0.15 per acre.

Second: Cooperation with Forest users. Under the present system of cooperation between the rangers and Forest users a fair degree of success and cooperation is obtained. This, however, may be greatly increased as suggested in Part 2 of this report.

Part 2

Suggestions for the further development of fire cooperation:

(a) Cooperation with the state: It would seem that the state, under its cooperative agreement with the Forest Service, might be divided into sections whereby the returns to the Service would be commensurate with the actual cooperation obtained. On the Malheur Forest the cooperation is rather one-sided. The remuneration received by the Forest Service for the time and energy which is devoted to the detection and suppression of fires on private lands is entirely inadequate.

(b) Extension of personal cooperation: It is along this line that we hope to accomplish the most in cooperative fire protection. The settlers' lists, mentioned above, are to be compiled, and

definite agreements, so far as is possible, are to be made by the rangers with settlers, stockmen, and other Forest users.

In addition to this, rangers will be instructed to secure the good will and aid of hunters, campers, mill operators, wood cutters, teamsters, and buckaroos. Of these last there are between 300 and 400 riding the range each season, and active, friendly cooperation on their part would give the Service an auxiliary fire patrol force of inestimable value.

In the past this system has resulted in actual active cooperation between the settlers and Forest officers, but it is felt that the system can be extended and made of much greater value.

It is further suggested that at the close of the fire season a mimeographed letter, signed by the supervisor of the Forest, be sent to all Forest users who have rendered valuable aid in the prevention and suppression of fires, and that a personal letter be sent to these same men by the rangers in whose districts they live. It is felt that this would thus express our appreciation of their efforts and would encourage them to further cooperation.

(c) Cooperation with fire protective associations: It is anticipated that at some time in the future a fire protective agreement, similar to that used in District 5, may be entered into between the District Forester and a fire protective association of the larger timber holders on this Forest.

In addition to the annual fire plan showing the amount of money and supplies appropriated for the current fire season, there should be two maps prepared--a composite map for the supervisor's office, and a separate map for each ranger station. These maps should show as accurately as possible the locations of streams, ridges, roads, trails, dangerous situation, and the location of tool caches, available men and supplies. If especially efficient fire fighters are continuously available it is well to indicate their location by means of a star, check or other distinguishing mark. The idea is to put out such a map as will assist a new man in efficiently combating a fire by giving him an idea of what to expect in the locality where the fire has been reported. By indicating the more dangerous situations both as to hazard and liability, a new man, or an old ranger for that matter, could be gathering help, or at least locating promptly available help as he was riding to the fire.

F. METHODS OF PREVENTION

1. Enforcement of the fire laws: There should at all times be a strict enforcement of the forest fire laws. In case of violation the offender should be vigorously prosecuted, unless there be clearly mitigating circumstances in his favor. This prosecution of criminal offenders is for the purpose of serving as a deterrent to others with fire-setting proclivities. During the last three years there have been no prosecutions for incendiarism on this Forest.

2. Signs: At present there are only the more conventional of the signs of the Forest Service used on the Malheur. These are posted along the stage roads, at intersections of wood roads, along trails, near sawmills, logging camps, etc. They are frequently defaced and are replaced only as chance allows.

New signs should replace old ones as they are destroyed. Signs should be changed or added to each year in order to keep the public reading them. The use of verbose law notices is alright in its place, but a brief, snappy fire notice posted along a road or trail will accomplish more good than any number of dry legal dissertations.

There is not sufficient originality in the signs themselves or in their use. Opportunities are neglected which, if grasped, might result in much good to this Forest, and to the Service in general. For example: at John Day each fall there is held a county fair. It would seem well to me to have a short, catchy fire notice appended to the general notices of this fair, and also to

put a large fire prevention sign at the gates of the fair ground. People come from a great distance to this fair, and by an extended use of signs the gospel of fire prevention could be widely extended at but slight expense.

This year, aside from a short talk by the Forest Assistant to the school teachers of Grant County, at the teachers' institute, on the relation of school children to fire prevention, the Malheur National Forest was not represented at the John Day Fair. This in my opinion is a mistake. It would not cost the Service much to fit up an interesting exhibit at such a fair, illustrating the methods of fire prevention, and such an exhibit would be sure to attract attention in this community where the business of so many is in a measure dependent on the forests.

I think there should be rubber stamps in the supervisor's and rangers' offices with some fire warning on them, and these stamps used on all mail leaving the offices. Another method is to have small, catchy fire notices, in the form of dodgers, placed in all mail to Forest users.

It has been suggested that a series of neatly-framed pictures illustrating the results of forest fires and the methods of detecting and combating them, be hung on the walls of the school buildings. This visual method of presenting the fire situation would serve the double purpose of a continual object lesson to the teachers and school children, and would also be in evidence when the school buildings were used for meetings of various sorts.

Cheap hand bills showing the dangers of forest fires, the methods of their escape and the results should be printed and distributed to the school teachers to give to the pupils. A young generation trained to appreciate the fire danger and to sympathize with the efforts of the Government towards fire prevention and suppression will mean, in a few years, a community that understands the fire situation and is ready to lend its help to the Forest Service.

A hand bill showing the proper methods of brush disposal, and the results of an escaped fire, if carried by the school children to their homes, might be the means of insuring the exercise of a much greater degree of control in the use of fires by the settlers in their fall brush burning and land clearing. It seems to me that it is these little points which should not be overlooked in the general administration of the Forest, especially where they can be secured at so small an expense.

To those settlers who are known to be clearing land or anticipating such it would be well to send copies of the circular letter relative to the proper methods of brush burning. This would indicate a desire on the part of the Forest Service to cooperate with the settler, and would tend to insure his burning being done in a proper manner.

Too much emphasis can not be placed on the personal element in the administration of the fire protective policy. A little assistance rendered hunters, fishermen, and campers will go a long way towards the establishment of friendly relations between Forest officers and this class of users. Reliable information should always be given by Forest officers as to the best hunting and camping grounds, even at the possible jeopardization of their own interests. They are there to serve the public, not their own interests. A friendly suggestion to travelers will not be taken in bad humor, and a pamphlet on fire protection distributed to campers will give them something to read after supper if it accomplishes no other immediate results. Since education of the public to the whole fire situation is the thing to be desired, all these little means, small in themselves, but large in the aggregate, should be employed by Forest officers, and every available means should be used for getting the facts before the public in a striking manner. This means popular, catchy advertising.

The day of active opposition to fire prevention is past, but the era of widespread education on the subject is still with us, and there is not enough of this work being done on the Malheur.

G. METHODS OF DETECTION

1. Present system: (a) Under the present system of fire detection there is but one stationary lookout maintained on the Forest during the danger season. This is located on Strawberry mountain, and is equipped with an Oregon fire finder, field glasses, wind gauge, camp outfit, tools, etc.

The present system of stationary lookouts is unsatisfactory and inefficient. This is due to its personnel and incompleteness. The Forest maintains a lookout on Snow mountain in cooperation with the Ochoco. But a single fire was reported to our office by this man during the past fire season, although two fires were handled by our officers over the Ochoco line. It seems highly improbable that, had this lookout been on the job, he could have missed all the fires occurring in the southwest section of the Forest, a portion which is completely visible from this lookout point.

The second reason for the inefficiency of the present lookout system is its lack of completeness. Before the next fire season it is suggested that a second lookout be established on King mountain in the south end of the Forest. This would complete a triangle with Strawberry and Snow mountains and, were wide-awake men put on these points, would insure a complete covering of the greater part of the Forest.

King mountain has an elevation of about 6,000 feet, is bald, and affords a remarkable opportunity to cover a large territory. It is so situated that triangulation from Snow and Strawberry would accurately locate the great majority of the fires in the whole southern and central section of the Forest. There is already a trail up this mountain, but it takes the ranger a full four hours to ride to the summit and return to his station. This time, in addition to that of the ranger in District 2 would be saved by the establishment of a permanent lookout, to say nothing of the actual saving of time on all fires spotted from the lookout, and a consequent saving in the cost of fire fighting and the amount of timber burned.

It is possible that had there been a stationary lookout on King mountain this past summer the fire on Myrtle creek, which burned over some seven sections and twenty-two million feet of timber, costing approximately \$1000 for its suppression, could have been handled by the ranger and forest assistant in the district at a cost of only their time for four days at the most, since it was twenty-four hours after discovery before they even got to the fire, and almost forty hours before actual work commenced in its suppression.

The day before the fire was discovered the ranger returned from the lookout at noon, thus giving 26 hours that the fire may have burned undetected. This would not have been possible had there been an efficient lookout on King mountain; nor, indeed, would it have happened had the lookout on Snow mountain been on his job, since he should have seen the smoke from that fire long before it was detected by Ranger Bennett.

There are trees for a considerable portion of the distance from the nearest telephone line to the summit of the mountain, thus reducing the cost of installing a telephone on the summit. There also is an excellent camping place, with an abundance of wood and good water within a eighth of a mile of the summit, but it is recommended that a cabin be placed on the summit and the lookout stationed there. He can get up his water after supper, and wood could be hauled before the fire season starts. E. E. Purington's saw mill is only a short mile from the summit, thus reducing the cost of hauling lumber for a lookout cabin.

The cost of installation of a telephone line would probably not be over \$250. A guard could be gotten for \$75 a month. The cabin could be built and equipped for less than \$125, and the result would be an adequate protection of a large area at a figure so small as to render hesitancy in the installation of such a lookout extremely short-sighted.

To thoroughly complete this lookout system, two secondary lookout points should be established, one on Nipple Butte, north of the John Day river, and the other on Fields Peak, south of the river. It is further suggested that college students who are studying Forestry be placed at all lookout stations, since as a rule their work as lookouts is entirely satisfactory.

As to lookouts in general on this Forest: It is suggested that if possible a composite map of all the Forests of Eastern Oregon be assembled to one scale on the same sheet. This would enable the projection of a line on a fire reported by a lookout outside this Forest through to our forest, and the location thus more accurately determined.

Telephones to lookout points should be located at the lookout, and should have bells sufficiently powerful, or be equipped with resonators such as to insure no mistake in the calls that come to the lookout. It will be found that the settlers and cattlemen will come to place a great deal of confidence in the stationary lookout, and he will receive many calls when the atmosphere begins to get smoky or hazy.

In addition to this map, there should be a good map of this Forest at each lookout station showing the topography if possible, or at least the accurate location of all important streams. With this and a pair of field glasses there is no excuse for a lookout not locating a fire as accurately as within one mile in 100 of its true location. This degree of efficiency has been attained on the Coeur d' Alene Forest, where the lookout system has been perfected and is extremely efficient.

The location of these lookout points must be accurately plotted on the central map at the supervisor's office. Strings from these points stretched to correspond with the azimuths on the fire turned in by the several lookouts will often locate the fire so closely that it would be impossible to put a pin point between them. In other cases the triangle of error is so small as to be of no importance when compared with the scale of the map. The present system, in which only the ranger's knowledge of the country is depended on for the location of a fire from the position of its smoke, is to say the least very unsatisfactory and inefficient. In this case, when traveling to a fire, it is often necessary to climb several trees in order to locate the fire before it is actually arrived at. Each tree climbed means that time is lost, when time means money, and the loss of times means greater acreage burned before suppression is actually begun.

Where permanent lookouts are installed two suggestions are offered towards increasing their efficiency, namely: When a lookout turns in a fire report he should be informed by the ranger as to the handling of the fire as soon as possible, either that the ranger went to it and put it out, with the size and amount of damage, or that his report was communicated to the ranger in whose district the fire actually was, and what the latter did on it. The other suggestion is, that the lookout should be relieved of service at least once a month, better every two weeks, and be permitted twenty-four hours to do as he pleases. This will result in a much higher degree of efficiency at but small additional cost.

(b) Patrol: Not infrequently situations are found which can not be covered by a lookout on account of intervening hills, as for example Canyon creek, south of Canyon City, which is an extremely deep gorge through the Blue mountains, and is not visible from any of the lookout points. Or there may be especially dangerous situations such as routes of heavy public travel through the timber, sawmills and logging operations, all of which are in need of special patrol. These should be covered by special patrolmen to supplement the lookout.

Such a patrol should have a regular beat if possible and have appointed times at which he must report to the ranger, lookout, or other person in authority. This will serve the double purpose of keeping the patrolman on the job, and of giving the ranger a check on his movements so that in case of a fire in advance of the patrol's beat he can be advised of it and thus save time.

In the danger season the patrol should be constant and daily. The patrolman should know his country and be on familiar terms with the settlers and ranchers, and he should give accurate information to travelers as to the best fishing, hunting, or camping grounds. This will result in the building up of an extremely favorable sentiment towards fire protection, not only on the part of the residents of the country but by those transients who will carry a favorable opinion with them of the Forest Service and its work wherever they go.

(c) Voluntary detection: This third form of detection is especially important on the Malheur. Cattlemen and homesteaders realize the destructiveness of forest fires and are anxious to cooperate with the Forest Service in detecting and suppressing them, since in so doing they are virtually working for the maintenance and welfare of their own business.

An understanding with the settlers to this effect by the district ranger, and patrolmen, will result in prompt information as to the location of fires that break out in the vicinity of the settlers.

The spirit of "well, let her burn, it's the Forest Service's funeral, not ours," is noticeably absent on this Forest. This is because so many of the people living in and adjacent to the Forest are dependent to a greater or less extent on the forests for their very existence, in the protection of the range and the timber, and cooperation is naturally pleasing to the, especially if they are encouraged and educated to it.

In the publicity work of fire protection there are two distinct branches of educational work, both of which are of immense importance. One is the education of sportsmen, campers, loggers, ranchers, etc., through the medium of rangers and patrolmen who come into personal contact with these men. The other is the education of the general public, and county and town officials, through the circulation of printed matter, talks at public gatherings, movies, newspaper items, advertisement in papers, booklets which reach the desired class of people, and notices posted in conspicuous places.

In connection with education in fire protection the writer strongly recommends that a rangers' meeting be held on the Forest each year. In this meeting there would be an interchange of ideas on all matters of general interest to the Forest which would prove of value to all in attendance.

Such a meeting could be held in the fall or early spring and need not last more than two or three days, in which time a program could be discussed that would prove of great value to all. It would be well to have at least one man from the district office in attendance, and also to intersperse with the more serious business of the meeting games, shooting matches, etc.

Each season some ranger hits on some method or trick of the trade which enables him to work more efficiently, and as there is no organ here in which such suggestions can be made public they persist only with the ranger himself and are not the property of the other rangers, serving to help them in the administration of their districts.

2. Suggested system of detection: In the anticipation of a fire season it would be well for each ranger to have in mind some improvement which would be of value in fire prevention or suppression. This might be, for example, the placing of a barrel in a spring or water hole to conserve the water that would otherwise be completely evaporated before the termination of the fire season. The knowledge of the location of such a water supply might prove of great value in the suppression of an individual fire. Again, this improvement might be a few hours work in bettering the facilities of a natural corral to be of possible service in a fire season. Another which has been suggested, but which seems hardly to have a place on this Forest, is to have the rangers locate the best fishing or camping grounds and prepare rough fire places for campers. This would tend to confine the camp fires of this class of Forest users, thus reducing the danger. Where such camping places are located near used trails or roads it is suggested

that tourist pastures be established where campers and travelers must turn in their stock. This for the protection of the general range. At present there is but little need of such procedure on the Malheur since the quantity of forage consumed by the campers' stock is not great.

Trails are a most important adjunct to fire protection. Actual work on fires is often delayed for many hours through the inability to get men and supplies to the fire. Both for trails and telephones a system of extension should be worked out by each ranger for his particular district and then the whole correlated and unified in the office by the supervisor or one familiar with the Forest and its present and future needs. Each trail should be plainly marked as to its length and termination, also as to the points of interest along its route. As a rule these trails should begin and end at definite points, such as roads streams, etc., so as to make them generally available, and to connect with the source of men, tools, and supplies in case of fire.

Before the beginning of each fire season it would be well to have rangers whose districts adjoin, cooperate with each other in plans for the coming season, such as the handling of fires most convenient to each, riding to lookouts for patrol when either it is absent from his station, etc.

Another problem that the rangers should study is the methods of hiring and handling men. In District 3 Ranger Bennett has arrangements with a garage and store in Burns to furnish him men, supplies and necessary tools, and to get them to the fire as soon as possible. This leaves him free to ride at once to the fire on notification of its discovery.

Bennett also has suggested the plan of borrowing money at the beginning of the fire season in order to finance temporary employees. Rather than force this itinerant help to wait for its pay until the pay checks can come from Portland, it is his plan to pay cash and deduct 25¢ interest, taking a subvoucher in each case, and securing reimbursement on Form 4. This plan, the men gladly accept, and the amount thus accumulated pays the interest on the borrowed money.

H. METHODS OF SUPPRESSION

1. In the matter of tools it is of prime importance that they be kept in good condition and readily available in case of fire. Before the beginning of the fire season all tools for which there might be use during the season should be gone over, repaired and sharpened.

These should be kept in a shed or room especially devoted to their storage. Fire fighting tools should not be sent out on other projects or loaned to hunters and campers during the fire season. In storage they may be grouped according to kind in racks, or may be put up in bundles sufficient for crews of varying sizes.

The following tools have been used to advantage in fire suppression on the Malheur:

Hoes: These have been found far superior to shovels in fighting fires on this Forest. They are light, easy to pack, can be used to advantage among rocks, and are even serviceable in heavy turf. With an ordinary hoe a man can dig about three times as much line in a given time as one man using a shovel, and the resultant line will be a much cleaner and better one.

The heavier a hoe is, within limits, the better it is for fire fighting. The disadvantages of a hoe are that it is hardly the tool to use in thick grass or heavy turf, and that it tends to pull up the leaves, litter, and debris into windrows back of the fire line. These constitute a fire hazard in that the flames of the back fire itself may ignite this piled up debris. But such piles are easily and quickly disseminated by the kick of a boot or the stroke of a hoe.

Further advantages of the hoe are that grass and needles can be forced into its crook and it thus used to scatter fire along a back fire line. Small pieces of resinous wood, roots, etc., can be impaled on the point of a hoe and used for the same purpose.

Shovels: These are extremely useful in throwing dirt, sod, or gravel, and for cutting a fire line through thick grass and turf. Their disadvantages are that they are heavy, cumbersome and hard to pack. But for all-around work they are hard to beat.

Plows: Any plow, in situations where it is possible to plow at all, can be used to advantage in building fire lines. But the work performed by a portable plow, such as that patented by Cy J. Bingham, supervisor of the Malheur, is far superior to the ordinary plow. By the use of a plow a couple of furrows can be plowed in a relatively short time. These plows should be followed by men with hoes or shovels to make sure of the fire line and connect any places that the plow happens to skip.

Road V's: In lieu of a plow a heavy road V. about 6' long by 3' wide, made on the job if necessary, can often be used to good advantage. It clears a wide line which requires only a little work by men with hoes to be transformed into an admirable fire line. An instance is on record on the Ochoco where one of these V's was dragged by a ranger's Ford to good advantage in clearing a fire line.

Axes: These are useful to cut brush and trees from the fire line, fell snags, chop fallen logs in two, etc. With axes, as with hoes and shovels, it is well to supply sharp files to be used in keeping an edge on the tool after repeated digs in the dirt or blows against stones and rocks have dulled the cutting edge.

Buckets: Collapsible canvass buckets have been used to good advantage to pack water from nearby springs or streams, both for fire fighters and to quench stumps, logs, and even the advance fire itself.

Canvass water bags and canteens: These are invaluable in fire fighting. A packhorse can handle four 5-gallon water bags. The individual fire fighters often wish to pack canteens. Expense in the purchase of canteens is a good fire suppression investment since a man whose throat is not parched by thirst is far more efficient than one whose throat is in this condition.

Mattocks and Grub Hoes: These are of relatively little use where hoes and shovels are available but it is well, however, to keep them among the fire fighting tools.

Fire torches: Although there are not torches in use on this Forest it is thought that where a considerable length of back fire line must be set by a few men in a short space of time, such a tool could be used to great advantage. I have submitted rough plans to the district office for such a torch, to burn kerosene or coal oil, and to be used in fire fighting and in brush burning.

2. Trenching, fire lines: Actual, cleared fire lines, as such, have but little place on the Malheur under present conditions of management. It is thought, however, that the time will come, possibly with the subdivision of all National Forests, when a few well-located, permanent fire lines may be used to advantage. These will probably be a development and extension of the present sheep trails and driveways, which in themselves constitute efficient fire lines since they are practically clear of all vegetation.

In connection with fire lines, however, it must be remembered that it would take a very wide line, well maintained, to be effective in actually stopping, unattended, the average fire, which is liable at any time to spring up into the tree crowns. Thus scattering the burning embers beyond the confines of the fire line. But a narrow tract from which to backfire is, in 99 cases out of 100, ample to stop an ordinary fire if the line is patrolled and maintained, for the reason that by the time the main fire had reached the back fire this latter has already consumed the greater part of the inflammable material, and the advance of the main fire is thus automatically stopped through lack of fuel.

(a) Where to make: Fire traces, or trenches as they are called in this section of the country, for the purpose of back firing, should be made as close to the main fire as possible, yet far enough away to allow a sufficient interval for the back fire to have burned over enough ground to stop the advance of the main fire. The nearer to the main fire the back fire is set the less fire line will have to be dug. But in this connection one must size up the fire with good judgement, taking into consideration the character of the material through which it is burning and will burn, the topography, the atmospheric conditions, etc., because a back fire line started too close to a main fire will not be completed before the main fire is onto the fighters, or if it is, it will not have burned sufficient territory to check the advance of the main fire. Where the back fire has burned over only a limited space the heat from the main fire coupled with its sparks and brands is often sufficient to sweep the fire across both the burned area and the fire trace. In such a case all the labor will have gone for naught and a much greater length of fire line will have to be dug to head off this new advance.

In fighting fires where there are outcrops of rocks advantage may be taken of these by leading the fire lines up to them and utilizing them as a part of the fire line. When the rocks are in the form of a rugged pile, however, care must be taken that the fire does not communicate itself beyond the fire line by means of the needles and debris which collect in the pockets and crevices of the rocks. Where this condition is met with it is better to extend the fire line around the pile of rocks thus permitting the fire to run over the rocks, as this lessens the danger of the fire crossing the back fire line at this point.

When fallen logs are encountered the fire line should be lead around them so as to prevent the fire burning up the length of the log and thus escaping beyond the fire line.

(b) How to make: In the main, there are two ways of making a fire line from which to back fire:
(1) Hoe or shovel the material moved from the fire line towards the main fire. The advantage of this is that the debris is thus burned by the back fire when there is but little danger of the fire getting away, and leaves the other side of the fire line with a minimum amount of material to feed a fire. The disadvantages of this method is that it makes a pile of material which often does not completely burn at the time of backfiring and remains as a fire menace as long as there is a fire in it. This is especially dangerous on side hills and exposed positions where slight gusts of wind might suffice to carry fire from these piles or windrows across the fire line, thus starting new fires.

(2) The second method is to hoe or rake the material away from the main fire, that is, to the opposite side of the fire line from the fire. The advantage of this is that the start of the back fire is thus attended with but little heat and is the more easily controlled and stamped out if it crosses the line. But the disadvantage lies in the fact that the piles of inflammable material just across a narrow fire trace constitute a fire risk in that it would require but the slightest breeze in many cases to carry fire across the line into this piled up material. Despite this disadvantage, however, it is thought best to remove all material away from the main fire, and where there is danger of the back fire setting a new fire in this material, to scatter it by a kick or stroke of the hoe.

This practice, however, is not to be recommended where the fire line crosses the slope of a hill on contours, or nearly so, and where the main fire is burning below the fire line. For in this case there is too great a danger of the flames being sucked up hill into the piled up material.

Here the litter should be pulled down hill into the fire leaving as little inflammable material as possible on the uphill side of the line to catch fire. But as a general rule it is safe to advocate the raking of material away from the fire line on the opposite side from the fire, thus burning as little material as possible.

In the use of fire lines and back firing under dense reproduction or advanced growth up to twenty feet in height, it is well to fell the young trees immediately bordering the cleared fire line on the side farthest from the main fire. This is to prevent or check a possible crown fire. The trees that are cut must, of course, be felled away from the fire, care being taken to throw them sufficiently far so that the heat of the back fire or main fire will not ignite them.

(c) The work of stopping a fire is not complete with the construction of a fire line and the setting of a back fire. Indeed, it has but just begun. Now comes the extremely important duty of patrolling this fire line. This is where the beginner is apt to make mistakes resulting in the escape of the fire apparently under control.

In the maintenance of a fire line care must be exercised not to unwittingly introduce material such as dried straws, small seedlings of pine, or stalks of buck brush, snow brush, and the like, which have been burned off at the roots and are being supported by the press of their surroundings. It is a very easy matter in walking or riding along a fire line to knock such material into the line thus making a bridge for the fire to cross to the unburned area. So slight a means of communication as a single straw may suffice to undo the work of a large crew of men.

Another factor that has to be contended with in the maintenance of fire lines is cones. These annoying fire brands have the habit of rolling from the burned area into the unburned, carrying fire in them and thus scattering it across the line. They hold fire for a long time and it is a wise precaution to throw all such material as is adjacent to a fire line far into the burned area in order to preclude the possibility of their rolling across the line. This, of course, applies only to cones already ignited. Where unburned cones are adjacent to a fire line they, as well as all other inflammable material, should be thrown away from the advance of the main fire in accord with the principles already discussed.

Manure also holds fire for long periods and will be found smoldering long after the remainder of the burned area is cold and dead. When there is danger of this communicating fire to the unburned area it should be thrown far into the burned area or covered with dirt. The same applies to stumps, snags, and fallen logs near the fire line. These should be covered with dirt or soaked thoroughly if possible. Burning snags should always be felled if there is the slightest chance of their communicating fire to the unburned forest. This work can best be done a night since the changes of starting new fires by scattering of sparks from the falling snag is thus materially lessened.

Where the back fire has burned into a deep accumulation of needles, leaves, or moss, care must be taken in hoeing away the unburned portion in order to check the spread of this creeping fire, not to inadvertently pull fire across the line. Only that material which is absolutely safe and dead should be taken across the line, all the rest should be thrown back into the burned area. In fact it is a safe rule, where once the back fire has burned, or the main fire for that matter, to throw all dangerous material as far as possible into the burned area, thus precluding or at least lessening the possibility of further escape.

3. Back firing: (a) Factors influencing: In considering the advisability of back firing, and in determining on the location of the back fire line, the forest officer must take into consideration a number of factors. Often this consideration must be in a limited space of time and he must be able to feel, rather than attempt to weight, the worth of the various factors affecting a back fire proposition.

Perhaps the most important factors are the speed with which the main fire is burning, and the number of available men and tools. Often there is no choice as to the location of a back fire line, but in a vastly greater number of cases the Forest officer has a real problem before him in deciding where to put the fire line. He should get it as near the main fire as possible, in order to

avoid the unnecessary destruction of valuable material, and to curtail the necessary amount of work, and yet he must not get it too near the fire, or in situations where it is liable to get away either through the force of its own intensity or augmented by the approaching main fire.

One rule may be laid down with safety and emphasis, to-wit: It is time and money saved to first ride around the entire length of the main fire since this enables a man to size up the whole proposition and to concentrate his efforts at the locations most in need of them.

Another factor which influences the location and construction of back fire lines is the character of the ground cover and topography. These influence the speed of the fire. It is well known that as a rule fires burn comparatively slowly down hillsides, and with increased intensity when ascending hills. Pine needles burn much more rapidly and intensely than hardwood litter such as is found on this Forest.

The time of day, position of the sun, condition of the atmosphere, presence or absence of wind, etc., all influence the decision as to back firing. Where once the route of the back fire line has been determined far more can be accomplished in the control of the fire at night than in the day because of the lack of energy with which fire burns at night. Here, however, care must be exercised that the officer does not make the mistake of setting a back fire too close to the main fire at night, else, with the approach of the heat of the day, the main fire will jump the back fire line, unless a considerable area has been burned over.

Where there is a scarcity of men and tools it will necessitate building the fire line farther from the fire than would otherwise be necessary.

(b) When to back fire: It is here that Forest officers have to think and act quickly, the saving or destruction of millions of feet of timber often depending on a prompt and accurate decision. A good rule is to size up the whole situation and then play safe. A man may get away with a chance, but more frequently he will have his work to do over again and on a larger scale, thus involving the loss of much additional timber.

As to playing safe, a word might well be said as regards the officer going to a fire to size it up himself before getting aid. In such fires as occur on the Malheur it is the rare exception rather than the rule, that a man can not handle such fires as start, by himself, or with one or two assistants, if he is informed of them soon enough. This statement presupposes existing conditions as to discovery, location, and methods of transportation. It therefore would seem a needless expense to be collecting a crew of fire fighters as he is going to the fire. However, if from his knowledge of the country or from his fire map he finds that a smoke is in an especially dangerous situation he is amply justified, in my opinion, in collecting a suitable crew as he goes. Moreover, it is always good policy to go to fires prepared, with at least a blanket and some food in the saddle bags. From the appearance of a smoke there is usually no means of telling how long or how short a time will elapse before its suppression is complete, and sleepless nights with a lack of nutritious food means inefficient fire fighting in the long run. In this connection, when a fire is located late in the evening many rangers advocate it as a good policy to pack the buckboard and get everything ready for an early start in the morning rather than attempt to get to the fire at night. The wisdom of this method is questioned.

In the matter of deciding where to back fire, ridges should be favored rather than valleys where possible, for the reason that no matter which way the wind blows the fire is bound to burn relatively slowly down hill. The heat of a fire rushing up hill is carried on into the air rather than turned down the slope on the other side of the crest of the hill. Moreover, this checking of the flames at the crest of the ridge will greatly reduce the chances of a fire jumping the fire line. Where a back fire line is put down a valley, unless there is ample time for a considerable area to be burned over, a slight wind may suffice to develop a crown fire in advance of the main fire.

This will often sweep across narrow valleys into the timber on the other side, a thing which it would be unlikely to do were the fire line on the crest of the ridge.

There are natural advantages of placing fire lines either on ridges or in valleys as opposed to side hills, in that in these situations one can often take advantage of bare crests or dry gulches, stream beds, etc. This often reduces the amount of line that it is necessary to build in order to encompass the fire. Where, however, it is necessary to go up and down hills the line should cross the contours at right angles if possible rather than at oblique angles for the reason that the danger from rolling cones, falling bushes and snags is thus greatly reduced. Here, however, it will usually be found a case of individual decision depending on the direction of the wind and the advance of the main fire. Often a short oblique line across a hill will check a fire that might assume tremendous proportions in the time used to construct a line from the top of the hill to its base no matter how correct the technique of this may be. But here, as in most other questions, it is all a matter that must be decided on the ground at the moment and the theory of books will more often be lost in the stress of the situation confronting the Forest officer.

(d) How to back fire: After the back fire line or trace has been constructed comes the actual setting of the back fire. This can best be accomplished by two or more men who follow those digging the fire line, thus carrying on the two operations simultaneously. It is a good plan to have one man move rapidly, setting fires as he goes, and to have him followed by a second who connects the spaces where the fires of the first man did not unite or catch. This is for the reason that it is desirable in back firing to have the back fire burn over as much ground as possible before it meets the main fire, because a back fire often burns without serious injury to the timber, while the main fire may kill the trees outright with the intensity of its heat. Again, by covering a considerable area, the chances of the main fire jumping the fire line are greatly reduced.

In setting back fires the following may be used to advantage. A torch, in that it concentrates the heat and enables a man to move rapidly from one place to another setting fires considerably faster than where he has to continually stop to replenish his fuel as is the case with a shovel or hoe. A shovel is the next best tool with which to back fire as dry needles, litter and the like can be scooped up on it, set on fire, and dropped along the line. It is well to have the shovel full burning briskly before attempting to spread the fire as thus a man can walk rapidly along the line dropping the burning needles, and not have to wait for the fire on his shovel to communicate itself to the needles and litter on the ground.

The same results can be obtained with a hoe but less material can be carried and it tends to fall out too rapidly. The hoe has another use, however, and that is in the impaling of pitchy pine roots and knots on its sharp points. These are then dragged along the ground or over the needles and thus a man is enabled to set a considerable length of fire line in a short space of time. Where neither a shovel or a hoe is at hand grass and litter can be held in a forked stick and fire thus scattered along the line. At a pinch, bunches of grass and pine needles can be used to set fire.

A very good natural torch is a dried tuft of needles adhering to the branch. These burn intensely and last for some time. Matches may be used to set fires in spots along a fire line with the intention that these spots will increase in size and finally unite, but this is a poor substitute for shovel or torch, and is a slow method of setting a back fire.

In all back firing care must be exercised not to inadvertently carry fire across the fire line. It is easy to do this. Burning material may adhere to ones boots or to the shovel, and care must be taken that this material does not start a new fire. After one has been across the fire line and walks onto the unburned area it is well to look back along ones path to see that no fires have been started.

(e) Patrol: It is here that the beginner usually makes his mistake, leaving the fire before it is completely out and safe. Patrolling the fire line after a long hard fight is weary sleepy business, and the thoughts of a hot mulligan and warm blankets at camp are often sufficient to induce men to leave fire lines before they should.

Patrolling requires constant attention for there is not telling when or where the fire may get across the line. More men and a stricter patrol are needed in the heat of the day, and the officer in charge of the fire should make provision for the relief of the patrol by fresh men at noon time in order that they may not all leave the fire line to eat. As a matter of fact, in the handling of any large fire it is well to divide the force into two or more crews since this tends toward increased efficiency by allowing some rest to all.

Where an officer is not confident of his crew one method of insuring efficient patrol is to have some instructions passed along the line from one man to the next. This means that the whole fire line will be watched. It is well for the officer in charge to be mounted in that as he can thus ride the whole line and see that things are going as they should. In the case of an outbreak he can then rapidly summon help from distant portions of the line. Where there are guns in a fire fighting crew a prearranged signal may be used to advantage to summon men in case of need on a hurry call. Here, however, it is well to have it clearly understood by all, and especially by hunters who may be detailed to bring in fresh meat, that the game laws but be observed.

Where buckaroos are available it is well to have them patrol the long, apparently safe stretches of the line, concentrating the men on foot at the dangerous portions. By this method the whole line can be efficiently patrolled and in case of need the mounted men can rapidly summon help. Each buckaroo should pack a hoe and they should be chosen men who know how to head off a fire in case it gets across the line. On one fire this summer a Forest officer found a buckaroo riding around the fire at top speed, circling it and recircling it with no attempt to put out the fire that had broken across the line in several places.

The fire patrol should last just as long as there is the slightest danger of the fire getting away. It is wise to take out a portion of the crew after the fire has been headed, leaving a few picked men with a Forest officer or a trustworthy man with authority in charge. Where a few men are left to patrol, it is well to vary their beats in order that the monotony of their route may not cause inefficiency.

In all crews there should be a foreman or subforeman to take command in the absence of the Forest officer. This should of course be a picked man, and one whose authority men will respect.

I. CONCLUSION

In the preparation of this report the title has been constantly in the mind of the writer, and much extraneous discussion, while of possible interest and value in itself, has been sacrificed for direct application to the Malheur National Forest.

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