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THE DAMAGE DONE TO MERCANTILE TIMBER BY SURFACE FIRES.

The statement is frequently made that light surface fires, such as those that run through the forest consuming the dry surface litter and under growth, without scorching the foliage of the trees do no harm to the mercantile timber. A field study was therefore made in the fall of 1910 of a number of areas which had, during the preceding summer, been burned over by surface fires or by ground fires. By surface fires are understood "those which burn the surface layer of dry leaves and other litter, dry grass, brush and small trees." By ground fires are meant those which occur where the mineral soil is covered with a deep accumulation of vegetable mould, and which on account of the peaty character of the material, burn much more slowly than surface fires. The object of this study was to classify the trees according to the damage which they had sustained by the fire. To gather the data, strips one chain wide were run in various directions through representative parts of the burn. Each tree on the strip was scrutinized and tallied by species, by diameter (in estimated 6 inch classes) and by damage it had sustained in the fire. Four classes of damage were distinguished; 1) "burned to death", trees which were killed by the heat of the surface

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fire about their bases, in this class were placed no trees, which were not positively killed, trees which had been killed by fire in their crowns were not included since the strips were not run where the fire was a crown fire; (2) "felled by fire", living trees which were burned off at the base by fire eating into basal fire scars; (3) "scarred by fire", trees which were first scarred at their base, i.e. where they were so damaged by fire that wood of the tree was exposed. Under this heading were included trees which had been fire scarred by previous fires as well as those scarred by recent fire since it was impossible to determine when the scar originated, (4) "O.K.", trees which, at the date of examination, showed no bad effects from the fire. On one or two of

the first burns examined, classes (1) and (2) were not distinguished, the trees that were killed by being scorched and those that were killed by being burned off, being grouped together. It is realized that this classification is not altogether satisfactory and that areas were cruised too soon after the fire to get final results, yet the data under estimates rather than over estimates the damage done. Some of the trees are classified as "scarred" which will probably, within a few months, fall and die because they are so severely scarred, some trees are also classified as "O.K." which probably were fire scarred, but their scars will not be visible until the bark peals off.

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Altogether 354 ½ acres of strips were examined and described, divided up among ten different burns in Oregon, about half of which were located east of the Cascades on the Wallowa Wenaha National Forests and the remainder in the Douglas fir region on the Oregon, Cascade, Umpqua, and Crater National Forests.

Most of the burns which were examined had been burned over previously one or more times before, but, for the most part not within the previous ten years. This year fire was, in most cases, an average surface fire, which as is usual with surface fires, in places burned so gently that only a part of the seedlings were scorched, and in other places rushed through the forest with such intensity that all the saplings, seedlings, and brush were killed and partly consumed.

The following table shows what the condition of the merchantable timber is after such a fire. An analysis of them shows that the number of trees which are actually killed, both by being over heated about its bases and by being burned off at the base, is quite large and that the number of trees that are fire scorched form a considerable proportion of the total stand.

Table 1 gives a summary of the results of the study of seven burns, in which the trees as classified according to the damage which they sustained in the fire, expressed both according to the number of trees per acre and their percentage of the total stand.

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Another burn, the data upon which are not included in Table 1, illustrates the real damage which is done by a light, seemingly harmless, grass fire. It covered but 23 acres of an open

yellow pine forest which had been repeatedly burned over and the only inflammable material on the ground was dry pine grass, needles, a few seedlings and brushes, yet the fire which ran over the area lasted but an hour or two, killed six out of the 297 merchantable yellow pine trees on the area. This meant a direct loss of about – 6% of the merchantable timber, besides which many of the trees were fire scarred, and the basal scars on many of the trees which had been previously made were enlarged. Many fires in the yellow pine region are of just this mild character; a single fire kills but a small proportion of the merchantable timber, but the sum of the damage done by a number of such periodic fires is enormous.

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Showing for the average acre on seven representative areas after surface fires, number of trees per acre of each species, and their proportion of the total stand in four classes, according to the damage which they sustained in the fire.

SPECIES	Burned to Death		Felled by Fire		Scarred by Fire		O. K.		Total	
	No. Trees Per Acre	% Total Stand	No. Trees Per Acre	% Total Stand	No. Trees Per Acre	% Total Stand	No. Trees Per Acre	% Total Stand	No. Trees Per Acre	% Total Stand
Medical Springs Fire, Wallowa National Forest (Average of 70 Acres)										
W. Yel. Pine	1.21	5.12			7.70	32.59	8.92	37.75	17.83	75.46
Other Spec.	.61	2.57	*	*	1.15	4.87	4.04	17.10	5.80	24.54
Big Minam River Fire, Wallowa National Forest (Average of 30 Acres)										
W. Yel. Pine	.03	.12	.60	2.12	6.70	30.90	9.27	32.92	18.57	65.94
Doug. Fir	.33	.12	.10	.36	.96	3.44	4.12	14.67	5.21	18.59
West. Larch			.17	.58	1.60	5.69	2.60	9.25	4.37	15.52
Devil's Run Fire, Wallowa National Forest (Average of 30 Acres)										
W. Yel. Pine	.50	1.52	.43	1.31	8.34	25.23	9.02	27.24	18.28	55.30
Doug. Fir	.33	1.01	.36	1.10	2.43	7.36	7.54	22.78	10.66	32.25
Other Spec.	.43	1.30	.16	.50	.59	1.82	2.93	8.86	4.11	12.48
Proctor Meadows Fires, Wenaha National Forest (Average of 24-1/2 Acres)										
Grand Fir	4.00	10.47			8.68	22.73	17.94	46.99	30.62	80.19
West. Larch			*	*	.68	1.77	1.78	4.66	2.46	6.43
Doug. Fir	.08	.20			.36	.93	.48	1.24	.92	2.37
W. Wh. Pine	.20	.51			.36	.93	.28	.72	.84	2.16
Eng. Spruce	.89	2.33			1.55	4.06	.90	2.35	3.34	8.74
North Fork Fire, Cascade National Forest (Average of 100 Acres)										
Doug. Fir	.24	.71	.51	1.52	4.55	12.01	24.66	65.17	29.96	79.21
W. R. Cedar	.01	.03	.23	.64	1.92	5.05	1.09	2.87	3.25	8.59
Other Spec.	.01	.03	.09	.27	2.12	5.61	2.42	6.41	4.64	12.32
North Umpqua Fire, Umpqua National Forest (Average of 30 Acres)										
Doug. Fir	.81	2.12	.60	1.58	7.99	21.11	21.40	56.47	30.80	81.20
Other Spec.	.30	.80	.03	.09	2.97	7.84	3.81	10.04	7.11	18.77
Cedar Creek Fire, Oregon National Forest (Average of 45 Acres)										
Doug. Fir	2.29	3.63	.04	.06	2.09	3.32	16.42	26.14	20.84	33.15
West. Hem.	2.66	4.23	.11	.17	7.97	12.69	18.14	28.88	28.88	45.97
W. R. Cedar	2.53	4.03	.86	1.37	5.92	9.42	2.42	3.86	11.73	18.68
Noble Fir	.60	.96			.10	.15	.66	1.05	1.36	2.16

*On these burns, both the trees which were "burned to death" and those that were "felled by fire" were classified as "burned to death."

In the following (Table 2) is summarized by species, for all the burns considered, the condition of the merchantable trees after the ordinary surface fire. Surface fires vary so in their character and intensity that the damage to one species in one locality may be very different from the damage in another locality. The data is thought to be sufficient to show quite conclusively for Western Yellow Pine and for Douglas Fir the proportion of trees that suffer each form of injury. For the other species, the data is based on the study of too few fires to give an average which is conclusive for all fires.

TABLE 2

Showing the percentage of each form of injury that trees of various species receive from surface fires.

(Average of 320 ½ A.)

Species	Burned to death	Felled by fire	Scarred by fire	Apparently O. K.
Yellow Pine	3.13	1.88	42.54	49.75
Douglas Fir	4.38	1.39	17.88	76.35
Grand Fir	13.06	----	28.36	58.59
Western Larch	----	2.49	33.38	64.13
White Pine	25.81	----	42.86	33.35
Englemann Spruce	26.65	----	45.40	26.95
Noble Fir	44.12	----	7.35	48.53
Western Hemlock	9.21	.38	27.60	62.81
West. Red Cedar	16.95	7.28	52.34	23.43

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The following table (Table 3) shows what proportion of Western Pines and Douglas Firs of each size are burned to death, felled by fire and scarred by surface fires. It shows rather interestingly that with Yellow Pine the larger the tree the less the chance that it escapes fire damage, and the greater the chance that it becomes fire scarred; while with Douglas Fir the reverse is the case, although to a much less degree, Douglas Fir trees seem to be more subject to being scorched to death than Yellow Pines, (except the smaller sized Yellow Pines), but Douglas Firs are less apt to be felled by having fire gnaw through their butts.

TABLE 3.

Showing the percentage of each form of injury that trees of each diameter class receive from surface fires, for the two species, Western Yellow Pine and Douglas Fir:

Western Yellow Pine

D.B.H Inches	Burned To death	Felled by fire	Scarred By fire	Apparently O.K.
12-18	7.68	.83	32.22	59.27
19-24	4.96	5.22	39.69	50.13
25-30	2.98	3.20	50.96	42.86
31-36	5.83	2.92	60.00	30.53

Douglas Fir

12-18	3.40	2.26	19.91	74.43
19-24	7.38	2.87	20.90	68.85
25-30	10.75	3.23	17.98	68.10
31-36	7.54	1.38	15.60	75.68
37-42	7.66	3.83	12.77	75.74
43-48	3.64	2.48	18.65	74.90
49-54	1.56	2.49	17.45	78.50
55-60			2.00	98.00
0ver 60			4.08	95.92

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Conclusions and Observations

An analysis of the preceding tables brings out several interesting conclusions as to the actual amount of damage done to merchantable trees by surface fires.

1. The character of surface fires is distinctly different in the Yellow Pine region from their character in the Douglas Fir region. In the Yellow Pine region, the surface litter every year becomes exceedingly dry, but there is ordinarily not much brush and inflammable litter to burn, and the fires are, therefore, not exceedingly fierce; in the Douglas Fir region it is only in the drier seasons that surface fires run and then they burn with great severity, and may at any moment develop into crown fires.

2. The number of trees that are burned to death, i. e., killed by being over-heated around the base and lower limbs, depends almost entirely upon how close to the ground the crown of the tree comes and upon the severity of the fire, which in turn depends upon the amount of inflammable brush and litter on the ground, the severity of the wind, the topography, time of day, etc.

3. The following species are those that are particularly liable to be burned to death by surface fires, placed in the order of their susceptibility to this form of injury, -Noble Fir, Englemann Spruce, Western White Pine, Western Red Cedar, Grand Fir and Western Hemlock. Their susceptibility is largely due to the fact that their crowns often reach to the ground.

4. Even in open Yellow Pine forests a surface fire will occasionally run up a single tree or a clump of trees and kill them.

5. The number of trees that are felled by fire depends not on the severity of the fire, nor the amount of debris on the ground, but on the frequency of preceding fires, which have made scars which each succeeding fire enlarges.

6. With most species, the larger the trees the greater the number of fire scars, owing partly to the fact that the larger trees are older and have been subjected to the fire scarring influence of more surface fires, partly to the fact that with old trees the scars are more slowly grown over, and partly to the fact that there is a greater accumulation of inflammable litter about old trees.

7. A tree is not ordinarily so severely fire-scarred at the base by one fire that it is killed, but repeated fires make large fatal scars. Even the slightest grass fire will burn down trees which have been scarred previously, it being necessary for the fire only to gain access to the wood to completely burn the tree off, provided the butt is pitchy and the weather conditions right.

8. The following species are those which are particularly liable to fire-Scarring: Western Red Cedar, Englemann Spruce, Western Yellow Pine, Western White Pine, Western Hemlock and Grand Fir.

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9. In the average Yellow Pine forest, which has been subjected to surface fires, 45% of the Yellow Pine over 12” in diameter are fire scarred.

10. Fire scarring in Yellow Pine forests is ordinarily most severe not when the stand is the heaviest and the amount of litter on the surface is the greatest, but on the rocky ridges when the trees are somewhat scattered and the surface vegetation is rather scanty. The reason for this is thought to be that the trees on ridges have more pitchy butts and are there exposed to the winds, so that fire in a basal scar burns very fiercely.

11. The presence of many dry fallen snags, which hold a slow fire for a long time close to living trees, largely increases the number of trees that are fire scarred and felled by fire.

12. Thickness of bark is not a sure criterion of the susceptibility of a tree to fire scarring, since many of the basal scars are caused by fire eating up the duff about the base of the trees and gaining access to the wood below the point where the thick bark stops.

13. Though a relatively small number of Douglas Firs are fire scarred, the scars are apt to be serious and result in a large proportion of the trees eventually succumbing, chiefly because these fire scars are the entering place for decay which undermines the whole butt of the tree.

Indirect Results of Surface Fires.

This study has been concerned chiefly with determining the direct effects of surface fires in killing and scarring merchantable trees. There are a number of other serious consequences of fires, without at least a mention of which a discussion of surface fires would not be complete.

(1) The killing of small trees and reproduction; the ordinary surface fire kills a very large proportion of the seedlings, many of the saplings, and some of the poles. Especially severe fires may destroy all the younger trees in the stand. In the Yellow Pine region where the normal forest is an uneven-aged forest to be managed by the selection system, the loss of the younger trees means an actual diminution in future crops of timber. Repeated fires in this type prevent the development of younger trees to take the place of the ones which die or are cut. In the Douglas Fir region where a clean cutting system is practiced, the loss of the advance reproduction in an old stand is less serious, but is by no means inconsiderable.

(2) The burning of the vegetable mould and the surface litter

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injures the productive capacity of the soil by removing from the soil some of its most valuable nutritive material, and by injuring its physical condition. This damage to the soil acts directly in lessening the rate of growth and thriftiness of the forest.

(3) The burning of the surface litter and vegetation removes the protective soil cover, promotes the rapid drying out of the soil, and lessens its moisture conserving capacity, thereby influencing unfavorably the growth of the Forest.

(4) The capacity of destructive insects is much stimulated by surface fires, and trees which have been in no serious way injured by the fire may be actually killed by the beetles which attack them as a result of their being weakened or their bark somewhat dries out. This source of secondary injury is particularly noticeable in Yellow Pine forests.

(5) Fungi are extremely apt to enter the tree at fire scars, and cause decay which is many times more serious than the original fire scar. Much of the butt-rot in Douglas Fir and Grand Fir – which is often very serious – is directly traceable to fire scars which in themselves are of slight consequence.

(6) The “pitching of the butts” is one of the serious after effects of surface fires, but it is not conspicuous and, therefore, easily escapes consideration. Where the base of the tree is subjected to heat, there is a tendency with some kinds of trees for a quantity of pitch to be formed and deposited there. This results in pitchy butt logs which are worth less than logs which are not pitchy. This is a decided economic loss, with Yellow Pine particularly, for it means that forests which have been scourged by repeated fires will yield less high grade lumber than those which have been protected from fire. The effect is particularly serious since the “pitching” takes

place in the butt log, the part of the tree that normally ought to yield the largest proportion of high grade lumber.

(7) Degeneration in the forest type: In certain regions the periodic occurrence of surface fires has the effect of altering the forest type as, for example, making possible the replacement of Yellow Pine, Larch and Douglas Fir stands by Lodgepole Pine. The present degenerate condition of the forest in many parts of the States is due to repeated light fires which have discouraged the reproductiveness of the better species, encouraged the inferior species, like Lodgepole Pine, periodically swept away the encroaching stand of Lodgepole Pine, and opened up and scarred the stands of other species.

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Summary of Conclusions.

The lesson which this study teaches is that all surface fires, no matter how gentle and harmless they appear to be, (if of sufficient area), always –

(1) Kill a certain amount of merchantable timber.

(2) Damage much of the merchantable timber that survives so that its commercial value is lessened, both in direct and indirect ways.

(3) Kill off much of the young growth, which should be the basis for the next crop.

(4) Exert an unfavorable influence on the forest soil, thereby decreasing its productive capacity.

The moral of this lesson is clear, i. e., the absolute prevention of forest fires in all types of standing timber.