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JOURNAL OF AGRICULTURAL RESEARCH

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THE USE OF LIABILITY RATINGS IN PLANNING FOREST FIRE PROTECTION [1]

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INTRODUCTION

Two main objects were in view in undertaking this study. In the first place, it was desired to ascertain if some scientific method could be found by means of which it would be possible to determine how much money can justifiably be spent for fire protection on the national forests. The second object was to provide a basis for the proper distribution of available protection funds between the different units of the organization.

The results of the study seem to indicate that so far, with the inadequate data available, no absolute mathematical rules or formulae can be established to fulfill either of these purposes. Scientifically accurate formulae require accurate basic data, which can be gained only through years of intensive research, and through detailed records, carefully kept for a considerable period. Moreover, the correct application of such formulae would require accurate detailed knowledge of the resources that we want to protect, which can be gotten only by means of intensive survey and mangement plans for the entire national forest area.

It is believed, however, that the study, even though based on admittedly unsatisfactory data, has yielded some material which, supplemented by a fire plan reconnaissance, will be of considerable value both in helping to determine the total amount of expenditures justifiable, and in distributing allotments within the organization. As better data accumulate, upon which to base more reliable figures than those worked out in the following pages, they will become more useful for these purposes. It is extremely important that such data be collected and kept as permanent records so that they may be utilized as the basis for future research.

BASIC PRINCIPLE GOVERNING EXPENDITURES

The best measure by which to judge the sufficiency of any fire protection organization is the net result accomplished. This net result may be expressed in terms of cost of protection plus losses incurred in spite of protection; and the smaller this sum, the more efficient the protection. As one factor, cost of protection, goes up when the other, loss, goes down, it is evident that there will always be some point below which the sum can not be reduced. Up to this point, expenditures for protection are justifiable.

Since the object in view is to reduce the sum of cost plus loss to a minimum, and not to eliminate all loss, regardless of cost, it is evident that justifiable costs should be determined by weighing against them the losses likely to be incurred.

Protection costs are in two distinct categories. One, which may be called primary protection, includes the cost of the organization for prevention, detection, and suppression (including personnel, equipment, and improvements), and is determined in advance. The second includes actual costs of suppression, such as temporary labor, subsistence, and transportation, as well as the time of forest officers taken off from other work. These costs, like losses, can not be determined in advance, but together with the losses depend upon the occurrence of fires. They can not, or should not, be limited by the arbitrary allotment of funds in advance, because with exceedingly few exceptions all fires must be fought, the question of "how soon" being answered by weighing probable losses plus suppression costs against the expenditures required to attack them within given periods. Even in the case of open lands with low liability, it

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will usually be necessary to suppress fires to keep them from running over on lands with greater liability, or because of the consequent effect on the fire hazard in general.

The principle may be illustrated by a diagram (fig. 1), which shows the curve for loss plus suppression costs (X-Y) descending as the line representing primary protection costs (A-B) rises, while the curve S-T, representing the sum of the two, falls to a point P, then rises steadily. The expenditure at which P is attained, or E, represents the proper amount to spend for primary protection. A greater expenditure might indeed reduce the loss and suppression cost, but not sufficiently to reduce the total, and so might not be justified.

The purpose of this study, then, was to determine whether it is possible to rate the liability of loss as well as the probable cost of suppression, which together may be termed the total liability. No attempt was made to actually rate the fire hazard and liability for specific forest units, but principles and methods have been worked out as a basis for a detailed field survey or "fire reconnaissance," which must necessarily lie at the foundation of any rating for specific forest units.

FACTORS OF HAZARD AND LIABILITY

The probability of loss is governed primarily by the values of destructible resources, and by the hazard, or chance of their destruction as a result of exposure to fire. Values of forest resources may be classified under the following heads: (1) Timber, including mature timber, young growth, and the forest capital, which includes soil productivity; (2) forage; (3) indirect values, including watershed protection (regulation of streamflow and prevention of erosion and floods) and occupancy values, such as recreational use, improvements, game resources, and the like.

FIRE HAZARD

The chance of destruction by fire of the values on a given forest area depends upon the probability of its being burned over, and upon the probability that the values will be destroyed as a result of such burning. Its chance of being burned over depends upon whether fires will start on or near it, and upon the area that such fires will cover.

Whether or not fires will start depends upon the presence or absence of causative agencies during the period in which fires can start. These agencies may be classified as follows:

Human agencies: Campers (including campfires and fires caused by smokers and hunters), lumbering operations, railroads, brush burning, incendiaries, and miscellaneous.

Natural agencies: Lightning.

The area that will be burned over depends upon a large number of factors and subfactors, which may be outlined as follows:

1. Inflammability determines rate of spread, and depends upon the character of:
   a. Cover, including timber, undergrowth, and litter, all of which furnish the fuel for fires. Inflammability of timber depends upon the species, age, density, and uniformity of the stand; and the condition of the stand, including such points as the presence of catfaces, moss on the trunks and lower branches, and standing dead snags. Inflammability of the undergrowth depends upon its character (grass, weeds, brush, or tree reproduction), amount (density and height), and uniformity of distribution. Inflammability of the litter is determined by its character (duff, dead grass and herbage, needles, twigs, cones, branches, logging slash, windfalls), its amount, and its condition as to dryness, decay, compactness, etc.
   b. Climate and weather, which not only have much to do with determining the character and condition of the cover, but also influence directly the action of fires. The important climatic factors are: (1) Precipitation, both annual and seasonal, especially its amount and distribution during the dry seasons; (2) temperatures, means and maxima, especially during dry parts of the year; (3) humidity, including fogs, dews, etc., during the dry seasons; (4) evaporation, affecting the rate of drying of inflammable material; (5) soil moisture; (6) wind direction and velocity during the dry season.
   c. Topography, which with climate practically determines the character of cover, and also directly affects the spread of fires, by the degree of slope, by the aspect, by the uniformity of terrain, and by the absolute and relative altitude, which influence atmospheric factors.
2. Controllability determines whether fires can be extinguished while small, or whether they will burn over large areas. It depends upon:
   a. Men and equipment available to fight fires.
   b. Accessibility—the time required to detect and to reach a fire, together with the routes and possible methods of travel.
   c. Topography and soil, which influence the speed and cost of control work, such as trenching. Natural breaks, such as cliffs, streams, and bare ridges, and artificial breaks, such as roads and fire lines, should be considered here, as may also the availability of water for use on the fire line.
   d. Type of forest and ground cover, which influence the method of attack, as well as the speed and cost of the work.
   e Degree of efficiency with which suppression work is carried on.

Even though a given area of forest may burn over, it does not necessarily follow that all or even a major part of the values on the burned area will be destroyed. The chance of destruction, which may be called the loss ratio, or the destructibility, depends upon the susceptibility of the various resources to direct and indirect fire damage, and also upon the intensity of the fire. These in turn depend upon

several factors, chief of which is the type of cover. The type of cover involves kind, age, density, and condition of the timber and other cover, and the amount and condition of duff and litter. The kind and depth of soil not it will be a surface, ground, or crown fire.

COST OF SUPPRESSION

Cost of suppression may also be considered as a resultant of fire hazard,

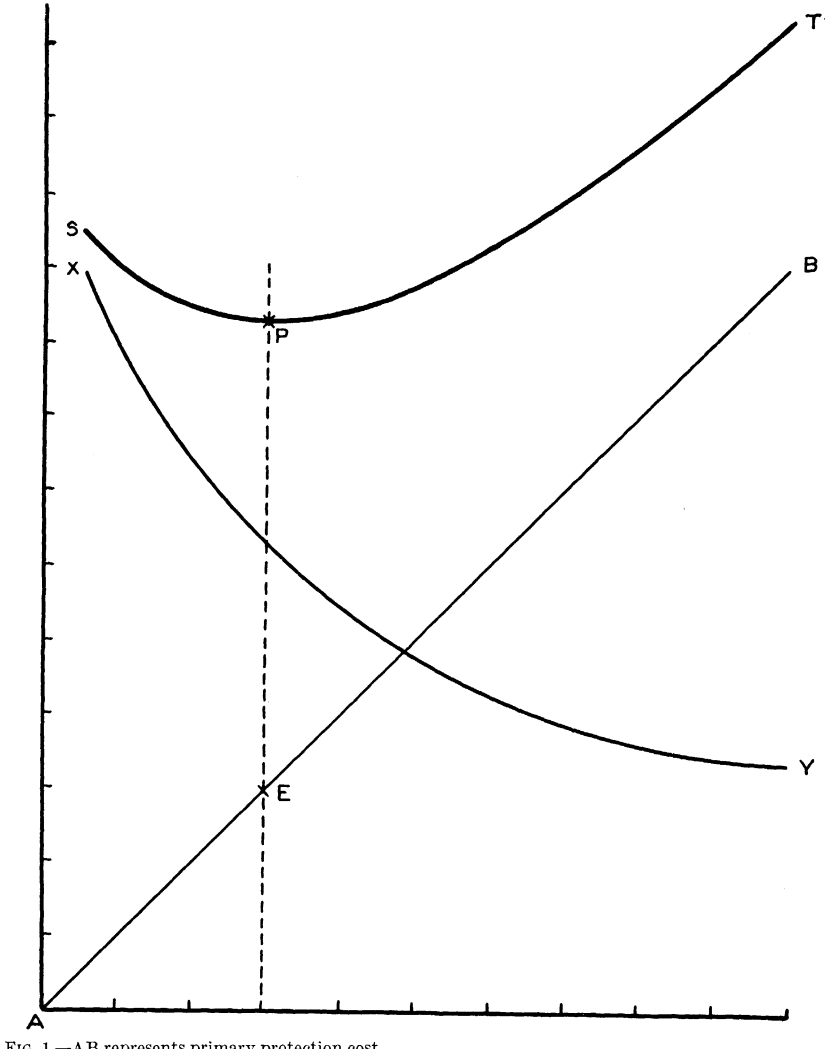

FIG. 1.—AB represents primary protection cost
XY represents sum of suppression cost plus losses "or total liability"
ST represents sum of AB plus XY
E marks the point of proper primary protection cost, where sum of all costs plus losses is at its lowest point P

is also important, because of its relation to forest productivity as well as to the watershed protection values. All of the factors listed above under inflammability influence the intensity of the fire, and determine whether or since it is determined very largely by the same factors that govern the inflammability and controllability. It is also affected by variation in wage rates and in costs of tools and subsistence, and by differences in degree of efficiency.

COST OF PRIMARY FIRE PROTECTION

Against the sum of loss plus suppression cost or total liability, we must balance protection cost—what for the sake of convenience has been termed primary protection, to distinguish it from the cost of fire suppression. This is the known quantity—the amount that is figured in advance when a definite organization is developed to prevent, detect, and control fires. There is a certain overlapping here, unless we leave out of consideration in the suppression cost the services rendered by the primary protection organization already provided for in advance. It was not practicable to make this separation in the present study; hence the suppression costs as determined, and given in the accompanying tables, include some of the cost of the primary protection organization. The more intensive the organization, the greater will be the proportion of fires handled by it without calling on outside help; consequently the real saving in liability with decrease in hour-control will tend to be somewhat greater than the differences between suppression costs indicate. The cost of primary protection will be determined by the length of the period during which it is in effect, which depends upon the length of danger season, by the number of men, and amount of equipment used for the purpose, and by salary rates and costs of maintaining equipment.

BASIS FOR STUDY

The problem of developing a method for rating hazard and liability requires study of the relations between the various combinations of factors that may be found in different units, and of the results in losses plus suppression costs. The only scientific basis for such a study is what has actually happened, that is, the actual fire history of the different forest areas. For this purpose, the present study made use of the available records of individual fires that occurred on the national forests during the period 1911–1915 (summarized in Table I). Records previous to 1911 are too incomplete or inaccurate to be useful, and those for years after 1915 were not available at the time the study was undertaken. Records for some national forests for some of the years between 1911 and 1915 are missing. The records for subsequent years should be studied in addition to those already used, to follow up the methods for rating hazard and liability outlined in the following pages. Figures based on 10 or more years should be much more reliable than those based on only 5 years, not only because the longer period gives a much better average than does the shorter (and it is known that climatic conditions were more dangerous and fires more numerous and destructive during the 5 years following 1915), but also because the later records are more complete and accurate than the earlier ones. Only fires that burned on national forest land were used, because the records of others are less complete and, for several reasons, not comparable. Moreover, without data regarding the areas of different forest types on private lands both within and outside the forest, it would be impossible to relate either numbers of fires or areas burned over to the total acreage exposed to fire danger. (See Tables II and III.)

The records do not give detailed information regarding most of the factors whose effect it is desired to study, and even if such data were available, it seems probable that to consider them all separately would so complicate the problem that it could not be solved. Even if methods for rating could be worked out, to apply them would require us to rate nearly every individual

TABLE I.—*Fires on national forest land (1911–1915) used as a basis for study*

Region	Fires due to general risk			Fires due to special risk		
	Number of fires	Area burned	Average area per fire	Number of fires	Area burned	Average area per fire
		Acres	*Acres*		*Acres*	*Acres*
1	56	4,474	79.9	103	215	2.1
2	382	32,858	86.0	236	350	1.5
3	904	26,008	28.8	155	309	2.0
4	326	27,992	85.9	6	95	15.8
5	82	15,431	188.2	20	680	34.0
6	1,984	77,823	39.2	17	39	2.3
7	723	33,246	46.0	20	79	4.0
8	714	83,306	116.7	16	595	37.2
9	170	9,199	54.1	27	46	1.7
10	218	18,063	82.9	3	3	1.0
11	406	20,703	51.0	103	2,234	21.7
12	108	359	3.3	80	418	5.2
13	120	1,748	14.6	101	1,385	13.7
14	53	2,832	53.4	1	15	15.0
15	117	15,415	131.8			
16	1,093	56,515	51.7	100	3,418	34.2
17	605	148,141	244.9	38	2,582	68.0
18	1,308	121,913	93.2	154	1,435	9.3
19	250	4,637	18.5	113	2,200	19.5
20	187	22,224	118.8			
21	121	25,674	212.2	181	5,638	31.1
Totals	9,927	748,561	75.4	1,474	21,736	14.7

TABLE II.—*Approximate areas of forest types by regions* [a]

Region	Areas in thousands of acres by forest types												
	Western yellow pine	Western yellow pine, sugar pine, incense cedar	Douglas fir and larch	Lodgepole (and knobcone) pine	Spruce	Fir, hemlock, and cedar	White pine	Subalpine	Aspen	Pinon-juniper and oak-digger pine	Hardwood	Brush	Grass and sage	Total net national forest area
1	48		477	1,108	66			412				(b)	383	2,745
2	891		1,837	1,957	315		133	1,230				(b)	325	6,948
3	272		1,882	217	188	69	1,128	689				(b)	553	5,079
4	906		1,229	409	240	301		807				(b)	128	4,390
5	2		3,571	123		1,655		1,887				1,331	(b)	8,470
6	597	1,303	1,935	124		346		95		210		1,615	97	6,441
7	(b)	2,352	183	620		402		340		477		413	427	5,296
8	3,539		2,843	2,207	366	77		1,511	1			498	1,200	12,561
9	2		952	2,214	86			917	26			(b)	1,408	6,076
10	35		1,156	3,510	576			1,399	550	18		(b)	3,757	12,470
11	1,448				6							(b)	348	1,803
12	859		65	440	836			16	40	45		20	156	2,850
13	2		28	1,512	1,297			(b)	1,051	35		212	797	5,298
14	206		327	615	646			117	806	831		838	654	5,352
15	183		43	102	60	339		(b)	490	2,925		866	2,425	7,816
16	865	1,720	60	333		455		447		213		1,143	129	6,308
17		336	111					6			144	2,726	39	3,376
18	5,433		(b)		(b)			(b)	(b)	3,259		5,179	(b)	13,871
19	4,739		(b)	230	(b)			(b)	743	713		1,598	(b)	8,682
20	578		(b)		(b)			(b)		2,409		554	(b)	3,541
21				543	130	80	160		(b)		185	(b)	30	1,128
Total	20,605	5,711	16,699	[c]16,264	4,812	3,724	[d]1,421	9,873	3,707	11,135	329	16,993	12,856	130,501

[a] These are in many cases based on very rough estimates.
[b] Indicates area included with some other type. Totals for each region do not in most cases agree with sums of figures for separate types, because barren areas are also included in totals (sometimes barren is included in brush, grass, or subalpine).
[c] Includes 543,000 acres jack pine in Region 21. [d] Includes 160,000 acres white and red pine in Region 21.

TABLE III.—*Percentages of total areas of different types burned over each year; averages for 5-year period, 1911–1915* [a]

Region	Commercial timber types								Nonmerchantable types [b]						
	Western yellow pine	Western yellow pine, sugar pine, incense cedar	Douglas fir and Douglas fir-larch	Lodgepole pine	Spruce, cedar, hemlock, and firs	White pine	Hardwoods	Total commercial timber types	Subalpine	Aspen	Pinon-juniper and digger pine-oak	Chaparral and brush	Grass and sage	Total	All types
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1	(c)		0.007	0.066				0.045	(c)				0.034	0.015	0.033
2	0.067		.199	.099	0.047	0.053		.125	0.009				.017	.010	.095
3	.037		.076	.007	.475	.198		.133	.025				.004	.016	.102
4	.128		.441	.108	.418			.345	.012				1.418	.044	.245
5			.139		.515			.210	.016			0.318		.281	.246
6	.063	0.273	.497	.163	.305			.304	(c)		0.081	.494	.137	.390	.329
7		.278		.255	.047			.242	.012		.001	.337	.278	.141	.196
8	.440		.210	.108	(c)			.236	.015			.003	.354	.114	.207
9			.041	.031	.168			.038	.002				.066	.042	.037
10	.146		.043	.009	.009			.018	(c)				.066	.050	.031
11	.257							.257				.116		.116	.230
12	.006		.008	(c)	(c)			.003	(c)	0.005			.002	.002	.003
13			.079	.008	.003			.006		.004			.016	.009	.007
14	.003		(c)	(c)	(c)			(c)		(c)	(c)	.042		.020	.012
15	.015		.003	.001	(c)			.004		(c)	.009	.017	.112	.046	.040
16	.265	.079		(c)	.021			.110	.021		.656	.452	.663	.395	.196
17	.259		.870				0.022	.322	.003			.985	2.122	.999	.878
18	.385							.385			.024	.018		.020	.180
19	.014			.002				.014			.001	.006		.005	.011
20	.438							.438			.050	.128		.064	.125
21				[d].683	(c)	.574	.145	.445					.817	.817	.455

United States average: 86,878 acres out of 55,971,000 acres timber=0.155 per cent; 58,718 acres out of 47,839,000 acres noncommercial=0.123 per cent; 145,596 acres out of 103,810,000 for all types=0.140 per cent.

[a] Based on incomplete records for some regions, especially Washington and Oregon.
[b] Open and woodland types often combined; figures given apply to two or more types combined.
[c] Less than $\frac{1}{1000}$ of 1 per cent. [d] Jack pine. [e] None burned.

TABLE IV.—*Important climatic characteristics of the several national forest subregions* [a]

Region	Precipitation			Temperature			Length of growing season	Prevailing winds during fire season	Characteristic types of forest
	Total annual (average and range)	July and August	Rainy days (over 0.01 inch)	Mean annual	Mean maximum	Days per year above 90° F.			
	In.	*In.*	*No.*	° *F.*	° *F.*	*No.*	*Days*		
1	13(10–15)	2.0	95	44	55	6–13	150	W., SW	LP.
2	16(15–20)	2.0	100	43	54	1–2	130	W., SW	YP, WL–DF.
3	33(25–40)	2.5	120	43	55	5–6	115	S., SW	WP.
4	14(10–30)	0.7	60	47	58	8–16	120	S	YP, WL–DF.
5	64(37–140)	1.7	150	51	60	1–11	210	W., SW	DF.
6	44(35–70)	1.8	115	53	65	0–8	200	NW	DF, redwood.
7	14(8–23)	0.6	65	46	62	8–39	130	S., NW. [b]	YP.
8	16(15–35)	0.8	70	49	61	4–34	135	S., NW. [c]	YP.
9	13(10–15)	1.2	65	41	55	1–17	[d] 90	W., NW	LP, DF.
10	15(10–20)	1.7	75	39	52	0–6	[e] 85	S, SE.; W., SW. [f]	LP.
11	17(12–25)	5.0	75	44	55	5–29	150	N., NW.; E., SE. [g]	YP.
12	13(10–15)	2.0	60	46	62	2–29	125	N.; SE. [h]	YP, LP.
13	15(9–27)	2.7	90	39	55	0–20	100	N	LP, ES.
14	12(8–16)	1.5	60	48	62	12–47	140	SW., W	DF, ES.
15	9(7–12)	1.5	50	46	62	19–51	[i] 115	SW., S	Pinon, juniper.
16	49(35–80)	2.2	70	50	(j)	(j)	120	S., W., NW	YP-SP-IC.
17	14(10–20)	1.6	35	62	70	1–15	300	W., NW	Chaparral.
18	14(8–18)	[k] 1.4	60	54	70	16–51	160	E., S., SW	YP.
19	12(7–16)	[k] 2.1	55	50	66	2–79	[l] 155	W., SW	YP.
20	13(9–16)	[k] 1.1	55	62	75	46–80	230	N., NW	Woodland, YP.
21	32(27–35)	[m] 4.0	[n] 90–120	[o] 37–41	[p] 49–52	1–10	[q] 105–130	N., S., SW.; SE. [r]	WP, jack pine.

[a] Data based on Bulletin Q, Weather Bureau, United States Department of Agriculture.
[b] S. in southern part, NW. at north end.
[c] NW. and S. in western part, S. and SW. in east.
[d] Range, 55 to 120 days.
[e] Range, 65 to 105 days.
[f] SE. and S. in northwest, W. and SW. in south.
[g] E. and SE. in May.
[h] SE. in May, July, August, September.
[i] Range, 95 to 130 days.
[j] Data lacking.
[k] Figures are for April–May–June.
[l] Range, 130 to 180 days.
[m] Figures are for October–November.
[n] Minnesota, 90 days; Michigan, 120 days.
[o] Minnesota, 37°; Michigan, 41°.
[p] Minnesota, 49°; Michigan, 52°.
[q] Minnesota, 105 days; Michigan, 130 days.
[r] Minnesota, N. in spring, S. and SW. summer and fall; Michigan, SE. in spring and fall.

acre separately. If, however, numbers of factors can be grouped together in such a way as to reduce the number of items that must be considered in rating, and so as to make it possible to use the data concerning the history of past fires, which are already at hand or obtainable, it may be possible to develop a method that can be applied. This involves the principle of classification of risks, somewhat analogous to that used in the insurance business, where rating is based on the probable losses for a class of risks, rather than for each individual risk separately.

CLASSIFICATION OF RISKS

The object of such a classification should be to throw together into one class all forest tracts whose factors of risk are so substantially similar that the probable fire loss and suppression cost per unit of area, over a period of years, will be fairly uniform. Because of the nature of the data available for study, and also in order that ratings can be applied in working out actual protection organizations, the classification must be along rather broad lines, with a minimum of detail. Accordingly, the following general scheme was followed:

1. To allow for general difference in climatic and seasonal factors and the resultant differences in general forest conditions, the western national forest region, exclusive of Alaska, was divided into 21 subregions, mainly on the basis of climatic characteristics. (See Table IV and figs. 2 and 3.) These subregions are as follows:

1. Northern Rocky Mountains.
2. Western Montana.
3. Northern Idaho.
4. Eastern Washington.
5. Western Washington and Oregon. [2]
6. Southern Oregon and Northern California Coast Ranges.
7. Southeastern Oregon and northeastern California.
8. Eastern Oregon and southwestern Idaho.

[2] The study did not cover Alaska or the eastern national forests.

9. Central Idaho and southwestern Montana.
10. Yellowstone plateau region.
11. Black Hills and eastern Montana.
12. Eastern Colorado.
13. Northwestern Colorado and southern Wyoming.
14. Wasatch and Uinta Ranges.
15. Interior desert region—mostly Nevada.
16. West slope of Sierras.
17. Southern California.
18. Colorado Plateau region.
19. Northern New Mexico and southwestern Colorado.
20. Southern Arizona and New Mexico.
21. Lake States.[2]

values, fire hazard, and cost of suppression. The grouping of types within each region is shown in Table V. Such a classification is crude, it is realized, since it does not allow for such factors as age of stand or for the wide local variations in inflammability of individual stands of a given type, due to such factors as the presence of logging slash or other débris. Ratings obtained, therefore, will represent aver-

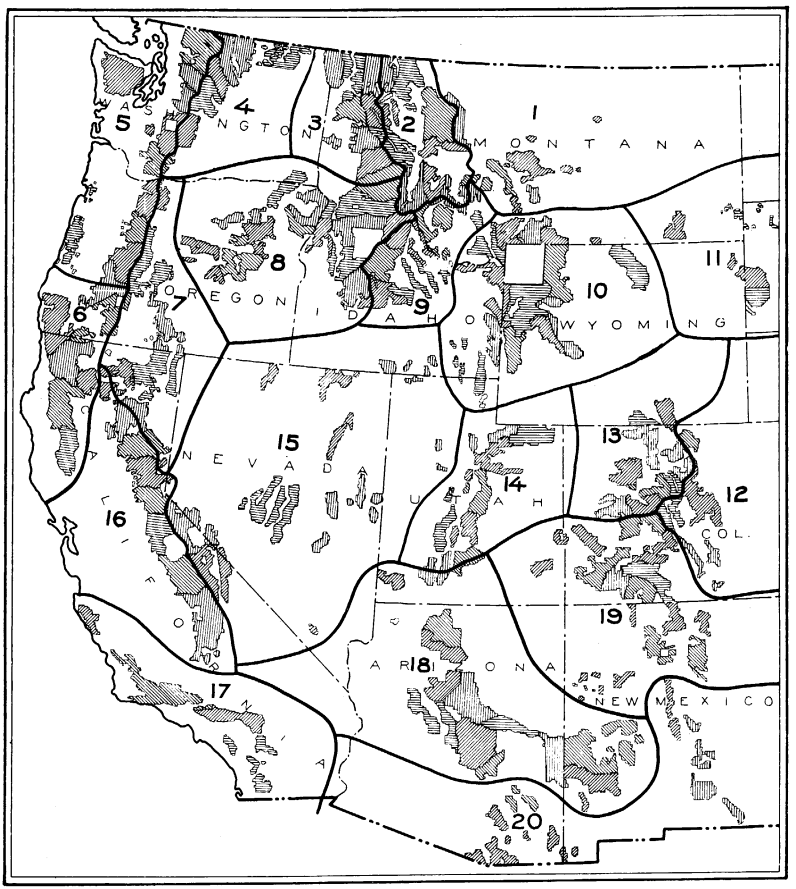

FIG. 2.—Subregions used in studying fire hazard. (Region 21, Lake States, not shown)

2. Within each of these regions it seems reasonable to assume that a given type of forest is in a broad way fairly uniform in its composition and general characteristics, so that within the region classification of the forest areas according to type of cover will in a general way allow for variations in the factors which determine total and destructible

ages of fairly broad application, but may not show what can be expected on individual small units. These factors can be allowed for only when the fire records and the inventory of our forest resources include information concerning them. It is hoped that this can be done in future work.

[2] The study did not cover Alaska or the eastern national forests.

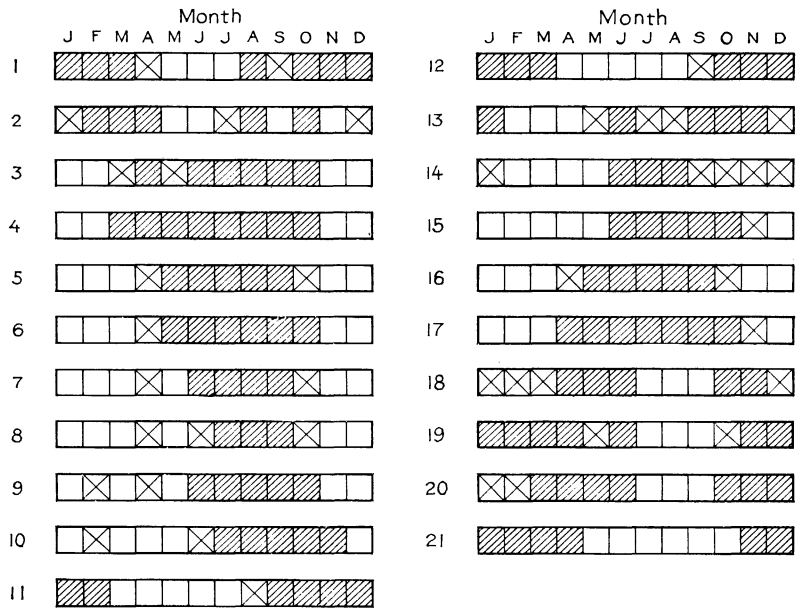

FIG. 3.—Distribution of precipitation by months, for the several forest regions

TABLE V.—*List of subregions and forests, with the classification of forest types* [a]

Region	Forests	Forest types	Representative weather stations
1. Northern Rocky Mountains.	Lewis and Clark, Helena (except west end), Jefferson, Gallatin (northern part), Absaroka (northern part).	Douglas fir, lodgepole pine, subalpine (including Engelmann spruce), open (grass, sage, etc.).	Helena, Great Falls.
2. Western Montana.	Blackfeet, Bitterroot, Flathead, Missoula, Helena (W.), Deerlodge (N.), Kootenai (E. of range 31 W.), Cabinet (E. of range 29 W.), Lolo (E. of line from NE. of T. 19–28 to NW. of T. 17–29).	Western yellow pine, Douglas fir–western larch, lodgepole pine, spruce–cedar–hemlock–white fir, western white pine, subalpine, open (grass, sage, etc.).	Kalispell, Missoula.
3. Northern Idaho.	Kaniksu, Pend Oreille, St. Joe, Coeur d'Alene, Kootenai (W.), Clearwater, Cabinet (W.), Selway (Lochsa drainage), Lolo (W.).	Same as Region 2, with "open" separated into "brush" and "grass."	Priest River, Porthill, Murray, Wallace, Sandpoint, Spokane.
4. Eastern Washington.	Colville, Okanogan, Chelan, Wenatchee, Rainier (E.), Columbia (E.).	Same as Region 3, except that western white pine not used.	Ellensburg, Colfax, Lakeside, Spokane, Lyle.

[a] Common and botanical names for the species listed here and mentioned elsewhere in this article are as follows: Western yellow pine (*Pinus ponderosa*), sugar pine (*P. lambertiana*), jack pine (*P. banksiana*), western white pine (*P. monticola*), lodgepole pine (*P. contorta*), eastern white pine (*P. strobus*), red or Norway pine (*P. resinosa*), Jeffrey pine (*P. jeffreyi*), pinon pine (*P. edulis*), digger pine (*P. sabiniana*), Douglas fir (*Pseudotsuga taxifolia*), bigcone spruce (*Ps. macrocarpa*), lowland white fir (*Abies grandis*), red fir (*A. magnifica*), balsam (*A. balsamea*), Engelmann spruce (*Picea engelmanni*), white or eastern spruce (*P. canadensis*), black spruce (*P. mariana*), western larch (*Larix occidentalis*), tamarack (*L. laricina*), western hemlock, (*Tsuga heterophylla*), juniper (*Juniperus* spp.), redwood (*Sequoia sempervirens*), incense ceder (*Libocedrus decurrens*), red cedar (*Thuja plicata*), aspen (*Populus tremuloides*).

TABLE V.—*List of subregions and forests, with the classification of forest types*—Con.

Region	Forests	Forest types	Representative weather stations
5. Western Washington and Oregon.	Mt. Baker, Snoqualmie, Olympic, Rainier (W.), Columbia (W.), Mt. Hood, (W.), Umpqua (N.), Santiam, Siuslaw, Cascade.	Lower slope (Douglas fir, cedar, hemlock, spruce, etc.), upper slope (true firs, hemlock, etc.), subalpine.	Olympia, Snohomish, Centralia, Portland, Seattle, Albany, Glenora.
6. Southwest Oregon and northwest California.	Umpqua (S.), Crater (W.), Siskiyou, Klamath, Trinity, California, Shasta (W.).	Western yellow and sugar pine, Douglas fir, red and white firs, subalpine, oak and digger pine, brush fields, grass.	Ashland, Roseburg, Eureka, Sisson, Ukiah, Weaverville.
7. Southeastern Oregon and northeastern California.	Oregon (E.), Deschutes, Fremont, Crater (E.), Modoc, Shasta (E.), Lassen (E.), Plumas (E.), Tahoe, (E.).	Western yellow and sugar pine, lodgepole pine, fir, subalpine, woodland, brush, grass and sage.	Prineville, Dayville, Lakeview, Silver Lake, Cedarville, Susanville, Reno.
8. Eastern Oregon and southwestern Idaho.	Ochoco, Malheur, Umatilla, Wallowa, Whitman, Minam, Wenaha, Nez Perce, Selway (S.), Weiser, Idaho, Payette, Boise, Salmon (N. and W.), Sawtooth (W.).	Same as Region 2, except no white pine.	Walla Walla, Pomeroy, Baker, Joseph, Payette, Boise.
9. Central Idaho and southwestern Montana.	Sawtooth (E.), Salmon (E.), Challis, Lemhi, Beaverhead, Deerlodge (S.), Madison (N.).	Douglas fir, lodgepole pine, Engelmann spruce, subalpine, brush, grass and sage.	Butte, Soldier.
10. Yellowstone Plateau.	Madison (S.), Gallatin (S.), Beartooth, Absaroka (S.), Shoshone, Bighorn, Bonneville, Bridger, Washakie, Teton, Targhee, Palisade, Wyoming, Caribou, Cache, Pocatello.	Same types as Region 9	Henrys Lake, Yellowstone Park, Thayne, Lander.
11. Black Hills and eastern Montana.	Black Hills, Harney, Sioux, Custer.	Western yellow pine, open (brush and grass).	Miles City, Oakdale, Spearfish.
12. Eastern Colorado.	Colorado, Pike, San Isabel, Leadville (S.).	Western yellow pine, Douglas fir, lodgepole pine, Engelmann spruce, subalpine, open (brush, grass, and woodland).	Fort Collins, Denver. Colorado Springs, Salida, Saguache, San Luis.
13. Northwestern Colorado and southern Wyoming.	Hayden, Routt, White River, Sopris, Battlement, Medicine Bow, Arapahoe, Holy Cross, Leadville (N.)	Douglas fir, lodgepole pine, Engelmann spruce, subalpine, aspen, brush, grass.	Laramie, Cheyenne, Rawlins, Walden, Meeker, Pagoda, Breckenridge.
14. Wasatch and Uinta Ranges.	Ashley, Uinta, Manti, Powell (N.), Fillmore, Fishlake, Sevier (N.), Wasatch (exc. W.).	Western yellow pine, Douglas fir, lodgepole pine, Engelmann spruce, subalpine, aspen, pinon-juniper, brush, grass, and sage.	Vernal, Provo, Salt Lake.
15. Interior desert region (Nevada).	Minidoka, Humboldt. Santa Rosa, Nevada, Wasatch (W.), Mono, Ruby, Toiyabe, Moapa, Inyo.	Western yellow pine, lodgepole pine, Douglas fir, red and white fir, pinon-juniper, brush and chaparral (including aspen and mahogany), grass and sage.	Winnemucca, Potts, Elko, Ely, Oakley, Idaho, Independence, Calif.
16. West slope of Sierras.	Sequoia, Stanislaus, Tahoe (W.), Lassen (W.), Sierra, Eldorado, Plumas (W.), Shasta (S., center.)	Western yellow and sugar pine, red and white fir, lodgepole and knobcone pines, subalpine, oak and digger pine, brush fields, grass and open.	Auburn, Sisson, Summit, Laporte, Yosemite, Quincy.
17. Southern California.	Monterey, Santa Barbara, Angeles, San Bernardino, Cleveland.	Western yellow and Jeffrey pine, fir and pine slopes, subalpine, hardwood bottoms, chaparral, grass, sage, desert.	San Diego, Redlands, Los Angeles, Santa Barbara, Santa Cruz, San Bernardino.
18. Colorado Plateau.	Sevier (S)., Powell (S.), Coconino, Prescott, Apache, Datil, Crook (N.), Dixie (except Moapa), Kaibab, Tusayan, Tonto, Sitgreaves, Gila.	Western yellow pine, Douglas fir mixed, spruce and subalpine, pinon-juniper, brush and aspen, sage and grass.	Holbrook, Prescott, Fort Apache, Fort Bayard.
19. Southwestern Colorado and northern New Mexico.	LaSalle, Gunnison, Rio Grande, Durango, Carson, Manzano (W.), Uncompahgre, Cochetopa, Montezuma, San Juan, Santa Fé.	Same as Region 18, with addition of lodgepole pine at north end.	Moab, Utah; Durango, Colo.; Aztec, N. Mex.; Santa Fé; Fort Wingate.
20. Southern Arizona-New Mexico.	Manzano (E.), Coronado, Lincoln-Alamo, Crook (S.).	Same as Region 18	Mesilla Park, Tucson, Dudleyville, Fort Huachuca.
21. Lake States	Minnesota, Superior, Michigan.	Eastern white and red pines, jack pine, spruce, balsam, tamarack, hardwoods, grass and open.	Sault Ste. Marie, Park Rapids, Grayling, Mount Iron.

3. The causes of fire may be classified as "general" or "blanket" risks, and "special" or "local," sometimes called "fixed" risks. The latter include such causes as railroads, lumbering operations, and brush burning, whose locations are definitely fixed within certain restricted known localities. Some camper fires might also be included in this class, because they are localized along established travel routes or at established camp sites. Since, however the data contained in the fire records do not permit segregation of such fires from the other camper fires, they are all thrown together with fires caused by lightning, incendiaries, miscellaneous, and unknown causes, into the general risk class, which includes those fires that may occur practically anywhere within a forest unit.

For the purpose of rating the general hazard of given regions and forest types, only these general risks were considered. Rating of special risks will have to be done for each unit individually, according to the kind, extent, and location of of the fixed causes of fire within or adjacent to it, and according to the character of forest covering the particular parts of the unit exposed to such risks.

CHARACTER OF RATING

The rating of risks for different types within each of the 21 subregions was based on the following considerations:

1. No data are available to indicate what losses might amount to without any protection whatever. It has sometimes been stated that such data would afford a good measure for justifiable protection expenditure, but such is not the case. It is more important to know, and it is possible to learn, what losses may be expected with protection of different degrees of intensity.

2. Intensity of protection can be measured best by what may be termed the "hour control"—that is, the time within which fires on a given area are reached. The larger the personnel, or the better the facilities for detection, communication, and travel, the smaller will be the hour control. Reduction of hour control may be expected to result in reduced fire loss and also in reduced suppression cost, but will in general involve also increases in the cost of primary protection, which will partly offset the saving.

3. Data on primary protection costs for different types of forest and for protection of different degrees of intensity are not available nor can they be worked out on the basis of averages, but will vary according to the particular circumstances in each individual forest unit.

4. Such general rating as can be made, therefore, will attempt to show probable fire losses and the probable costs of fire suppression, per unit of area in different forest types of the several regions, with protection of various degrees of intensity. The balancing of these liabilities against costs of maintaining the corresponding degrees of protection will not be undertaken.

CALCULATION OF BASIC DATA FOR USE IN RATING

In the first place, the records of individual fires were segregated by subregions and as far as possible by types within these regions. This could not be done in all cases, because of the incompleteness of the data contained in the original records. Each group of these records was then studied along the following lines.

RELATION BETWEEN HOUR CONTROL AND SIZE OF FIRES

The areas burned per fire were correlated with the time elapsed before control work commenced. The purpose of this was to tie in the area burned with the intensity of protective organization. Area here means final area burned over by the fire up to the time it was extinguished; the time factor used is the elapsed period between discovery of the fire and the time when actual work of suppression began. Discovery time was used rather than the time when the fires started, because the latter was seldom reported. Fires which had obviously been burning for a long time before discovery were not included in the calculations, nor were fires that occurred under especially unfavorable conditions, as evidenced by abnormally slow spread. It is well known that fires usually spread very slowly, often hardly at all, during the night, and suppression crews usually can not get to a fire as fast at night as during the day. For these reasons, in order to put all the elapsed periods on approximately the same basis, the hours between 9 p. m. and 6 a. m. were rated at only half the actual elapsed time.

Fires were grouped according to elapsed periods—e. g., less than 1 hour, 1 to 2 hours, 2 to 3 hours, etc.; and the elapsed times and final acreages for the fires in each group were averaged and plotted as abscissae and ordinates,

respectively. Curves were then drawn on the basis of these points, showing the average size that fires may be expected to attain for different elapsed periods. (See figs. 4 to 18.)

RELATION BETWEEN SIZE OF FIRES AND COSTS OF SUPPRESSION

In organizing the suppression work, it is important to know the relation between the speed of attack, which is determined by the intensity of the protective organization, and the cost of putting out fires that may occur. The cost of suppression depends more directly on the size of the fire than on the speed of attack, though the latter has much to do with determining the size of fire. Accordingly, the fires were grouped by area classes—less than one acre, one to two acres, etc.—and the average areas and average suppression costs of fires within each group were then plotted on cross-section paper, as abscissae and ordinates, respectively. From the curves based on these points it is possible to determine the probable average suppression cost for fires of any given size, and from these curves and those of size based on elapsed time, the suppression cost according to speed of attack can be ascertained (Table VI and figs. 19 to 36).

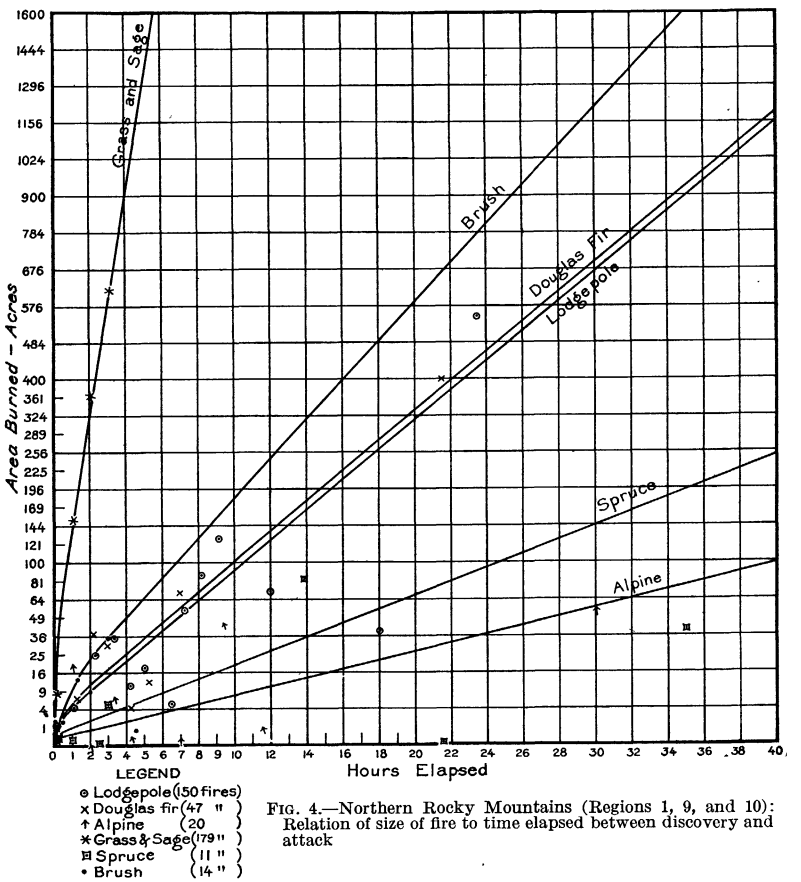

FIG. 4.—Northern Rocky Mountains (Regions 1, 9, and 10): Relation of size of fire to time elapsed between discovery and attack

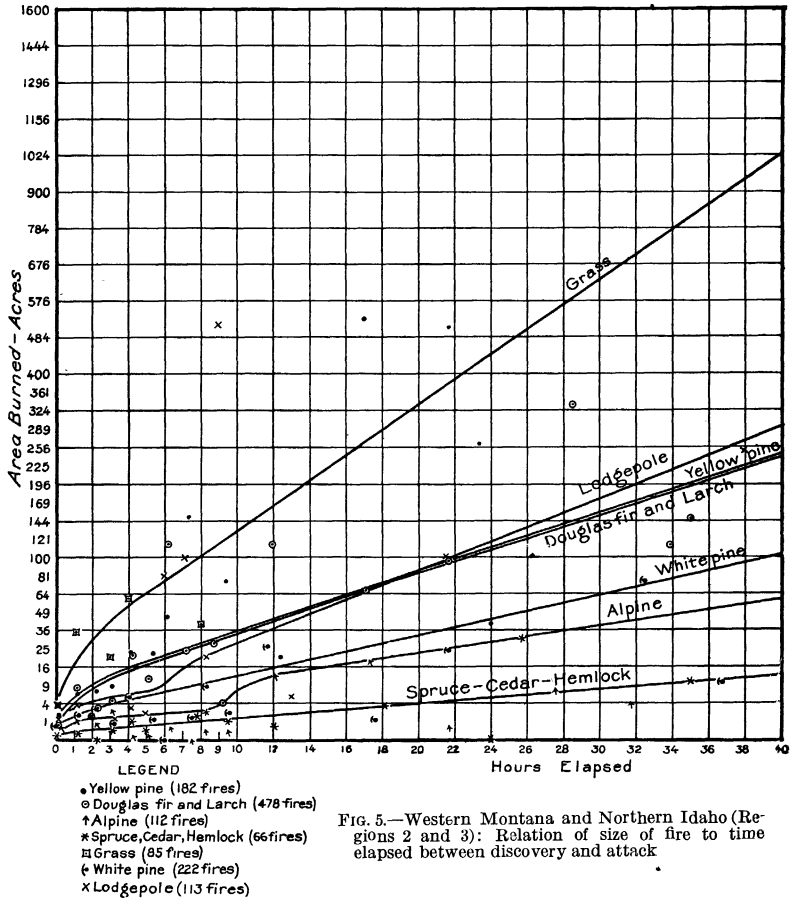

FIG. 5.—Western Montana and Northern Idaho (Regions 2 and 3): Relation of size of fire to time elapsed between discovery and attack

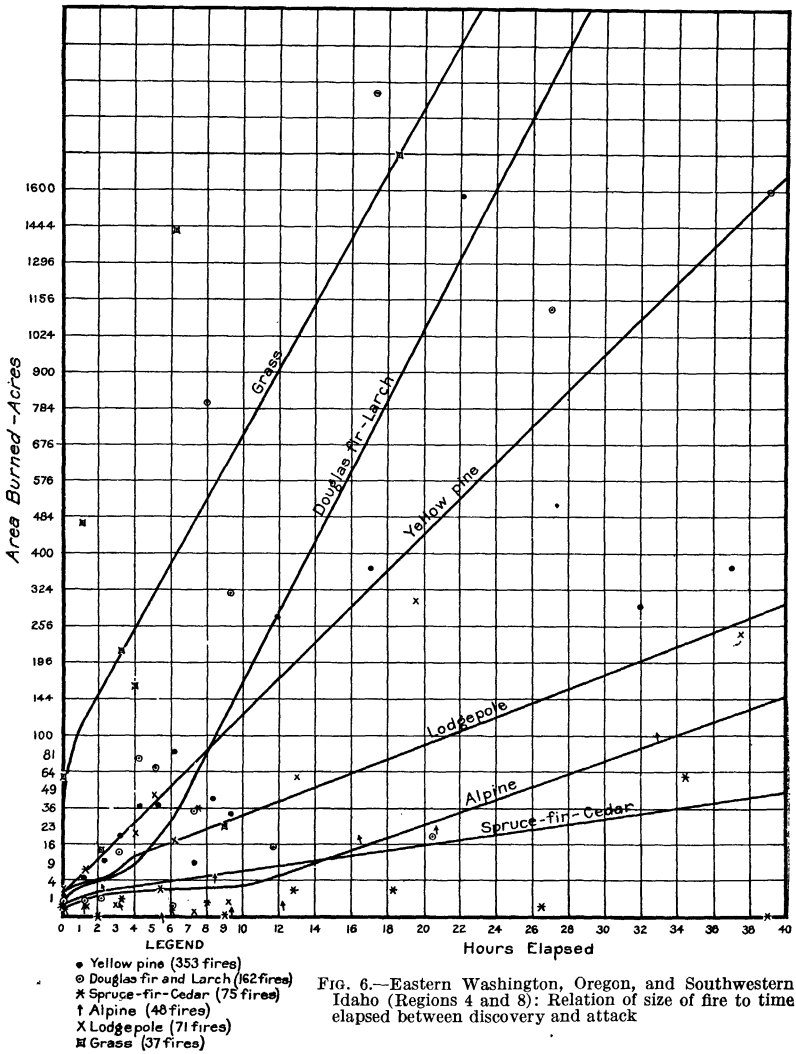

FIG. 6.—Eastern Washington, Oregon, and Southwestern Idaho (Regions 4 and 8): Relation of size of fire to time elapsed between discovery and attack

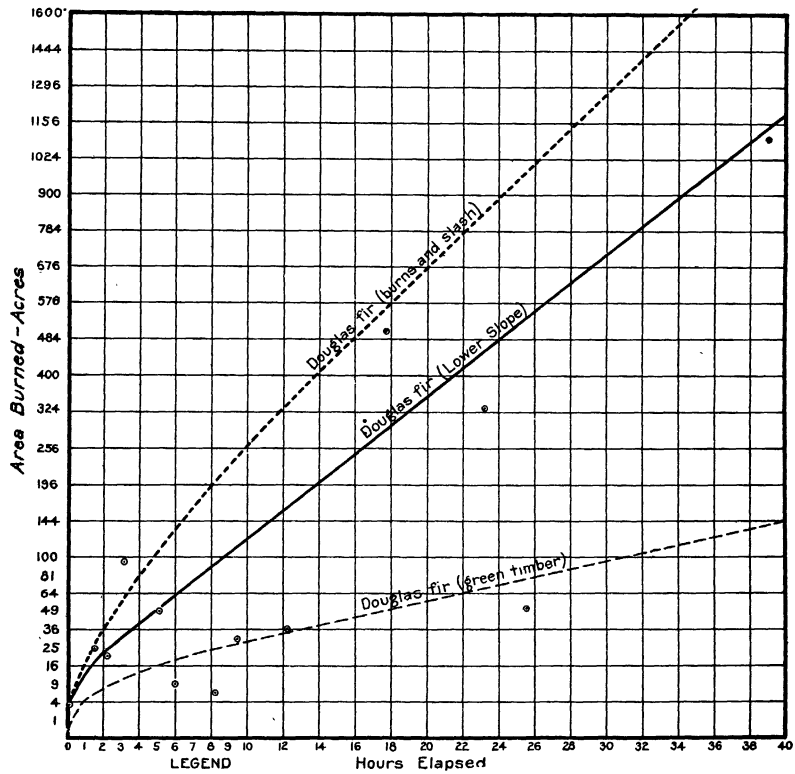

FIG. 7.—Western Washington and Oregon (Region 5): Relation of size of fire to time elapsed between discovery and attack

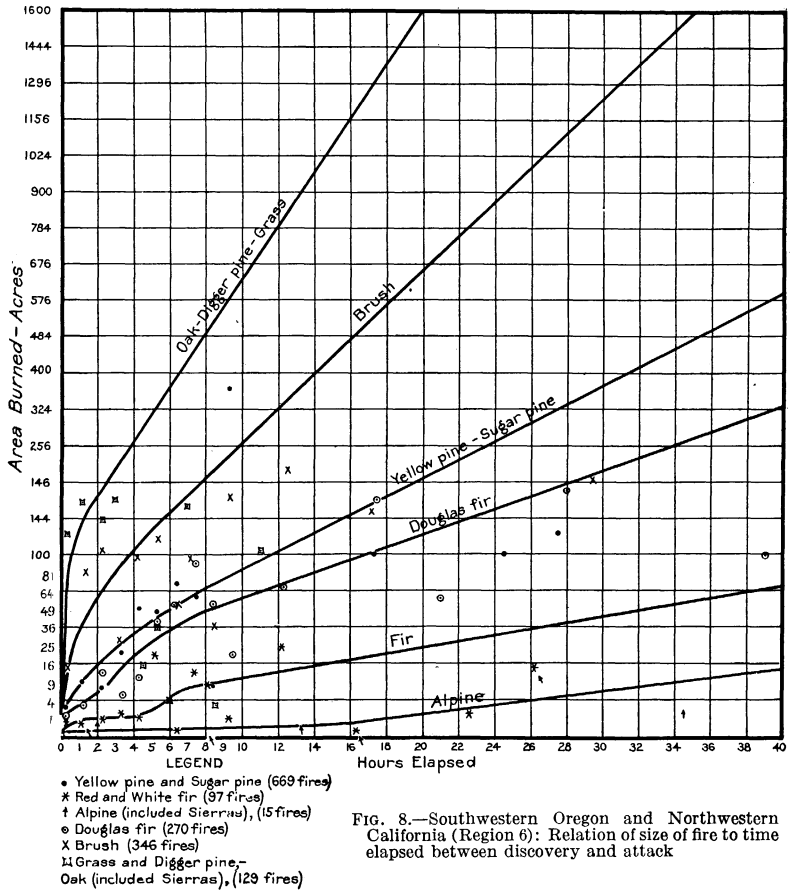

FIG. 8.—Southwestern Oregon and Northwestern California (Region 6): Relation of size of fire to time elapsed between discovery and attack

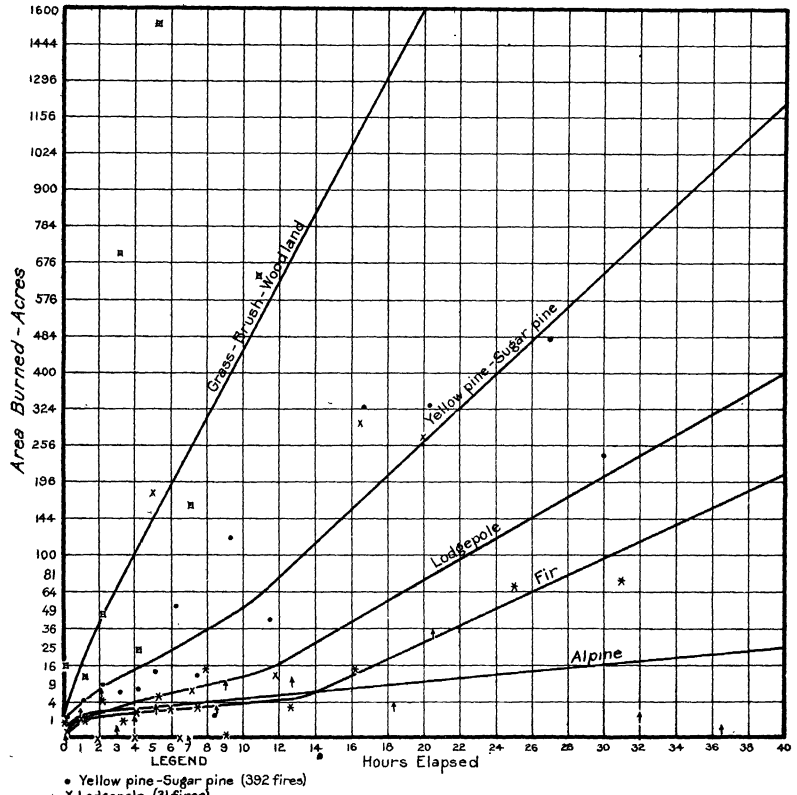

FIG. 9.—Southeastern Oregon and Northeastern California (Region 7): Relation of size of fire to time elapsed between discovery and attack

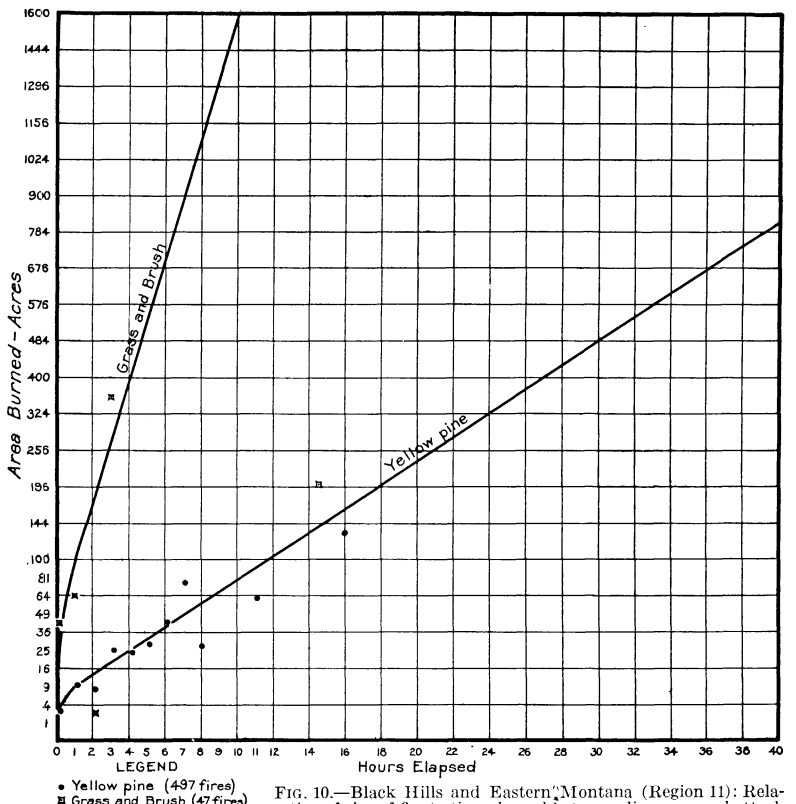

FIG. 10.—Black Hills and Eastern Montana (Region 11): Relation of size of fire to time elapsed between discovery and attack

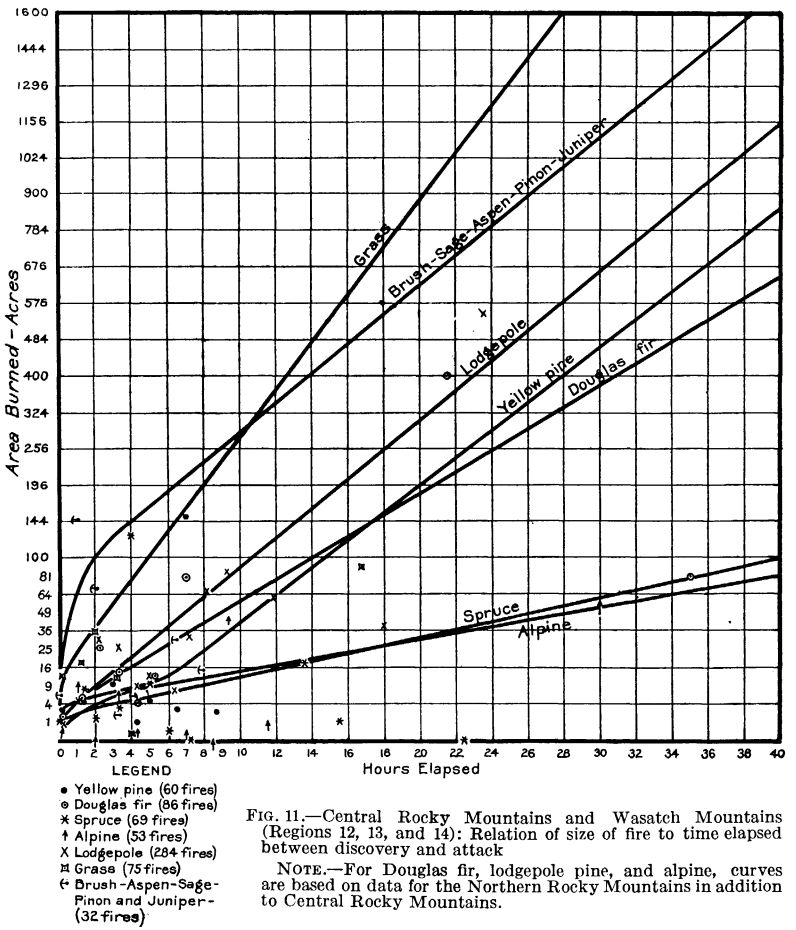

FIG. 11.—Central Rocky Mountains and Wasatch Mountains (Regions 12, 13, and 14): Relation of size of fire to time elapsed between discovery and attack

NOTE.—For Douglas fir, lodgepole pine, and alpine, curves are based on data for the Northern Rocky Mountains in addition to Central Rocky Mountains.

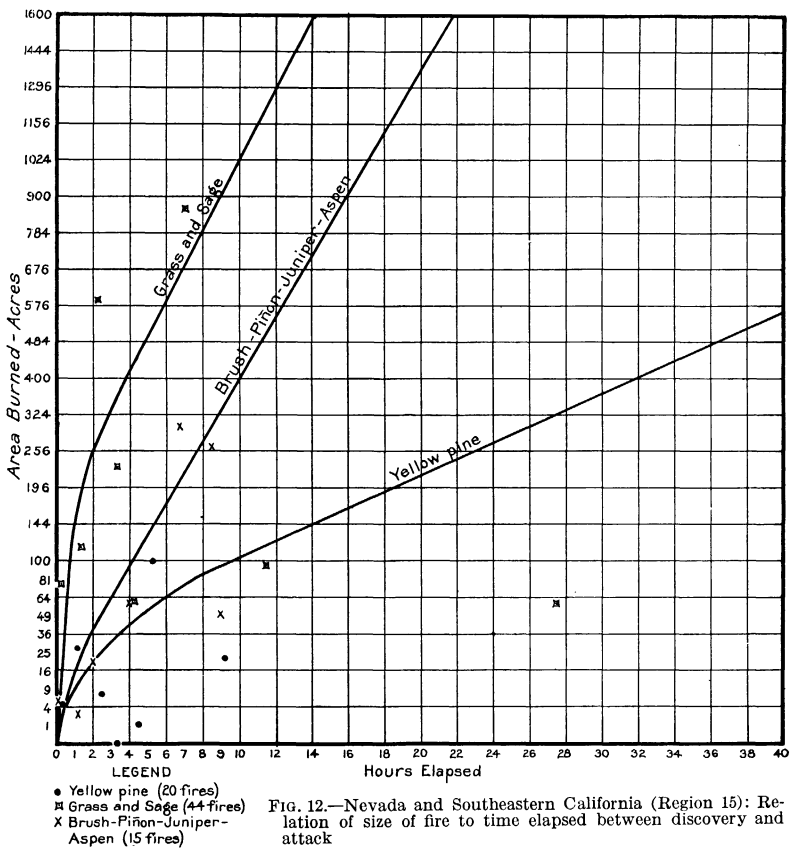

FIG. 12.—Nevada and Southeastern California (Region 15): Relation of size of fire to time elapsed between discovery and attack

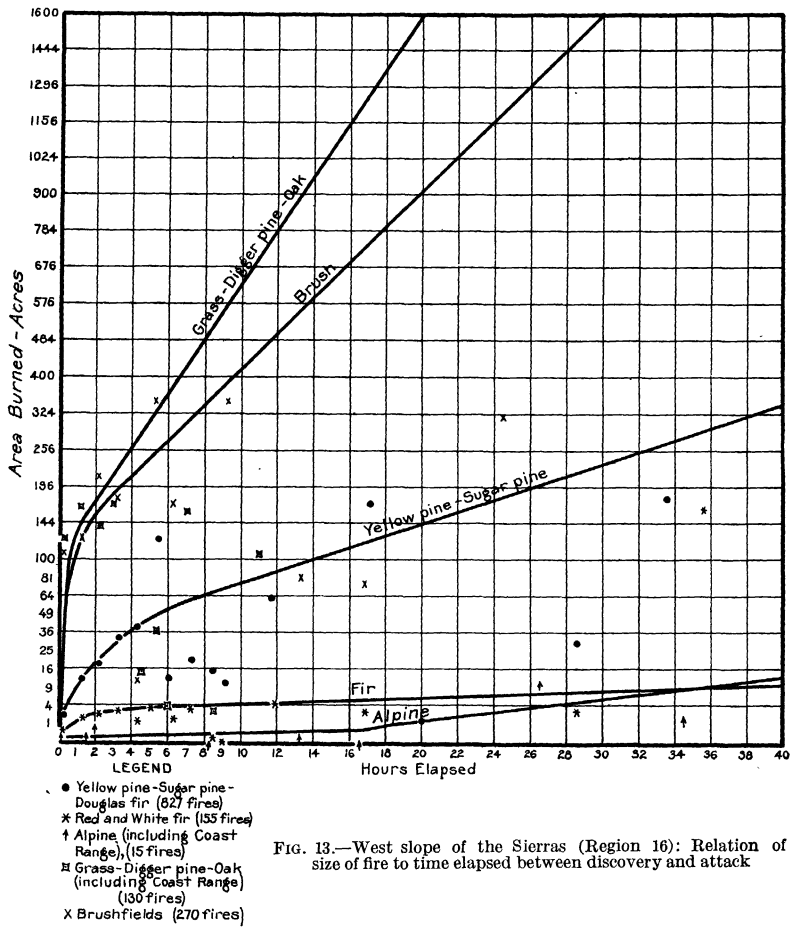

FIG. 13.—West slope of the Sierras (Region 16): Relation of size of fire to time elapsed between discovery and attack

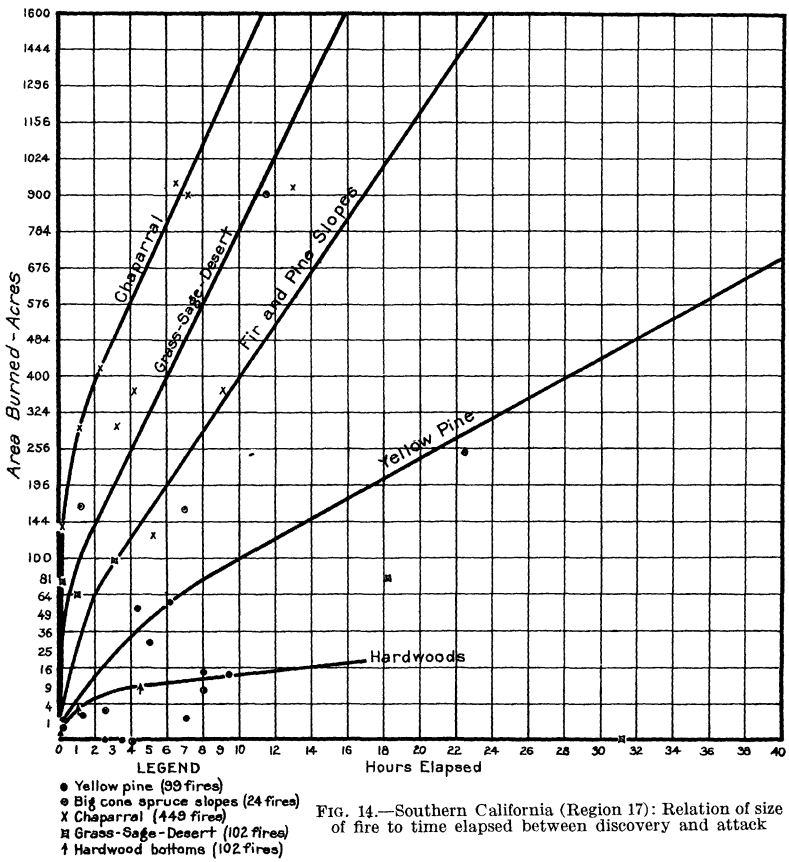

FIG. 14.—Southern California (Region 17): Relation of size of fire to time elapsed between discovery and attack

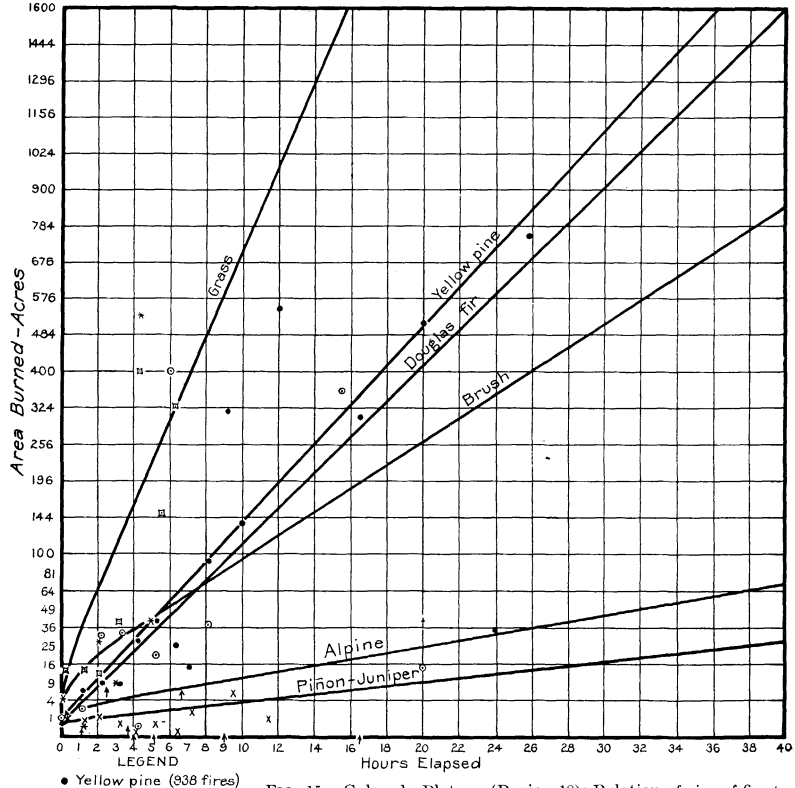

FIG. 15.—Colorado Plateau (Region 18): Relation of size of fire to time elapsed between discovery and attack

NOTE.—Data from Region 19 used also for Douglas fir, woodland, brush, and grass, and data from Region 20 for Douglas fir and alpine.

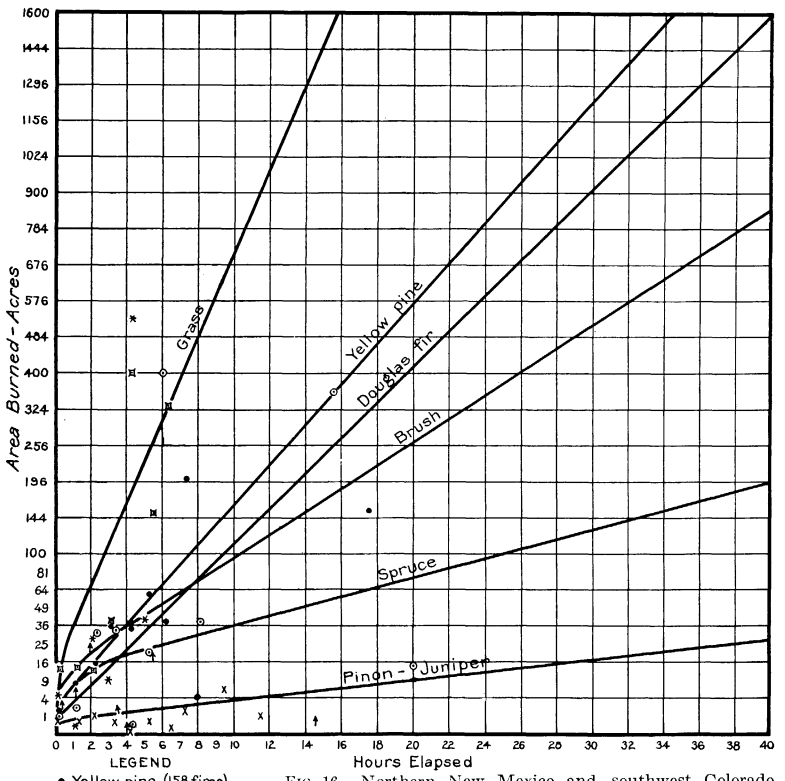

FIG. 16.—Northern New Mexico and southwest Colorado (Region 19): Relation of size of fire to time elapsed between discovery and attack

NOTE.—Data from Region 18 used also for brush, grass, Douglas fir, and woodland, and data from Region 20 for Douglas fir.

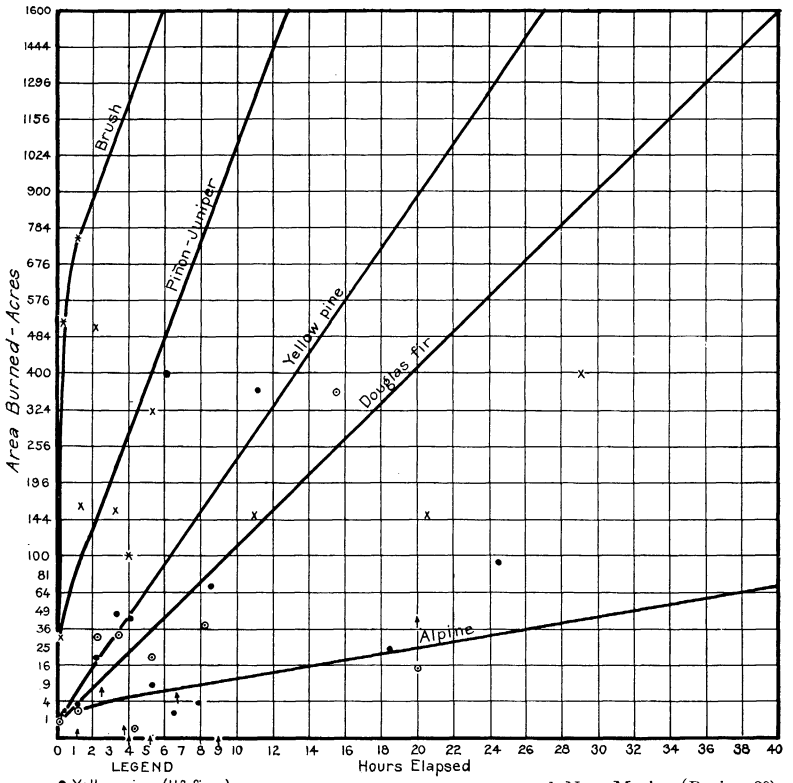

FIG. 17.—Southern Arizona and New Mexico (Region 20): Relation of size of fire to time elapsed between discovery and attack

NOTE.—Data from Region 18 also used for Douglas fir and alpine, and data from Region 19 for Douglas fir.

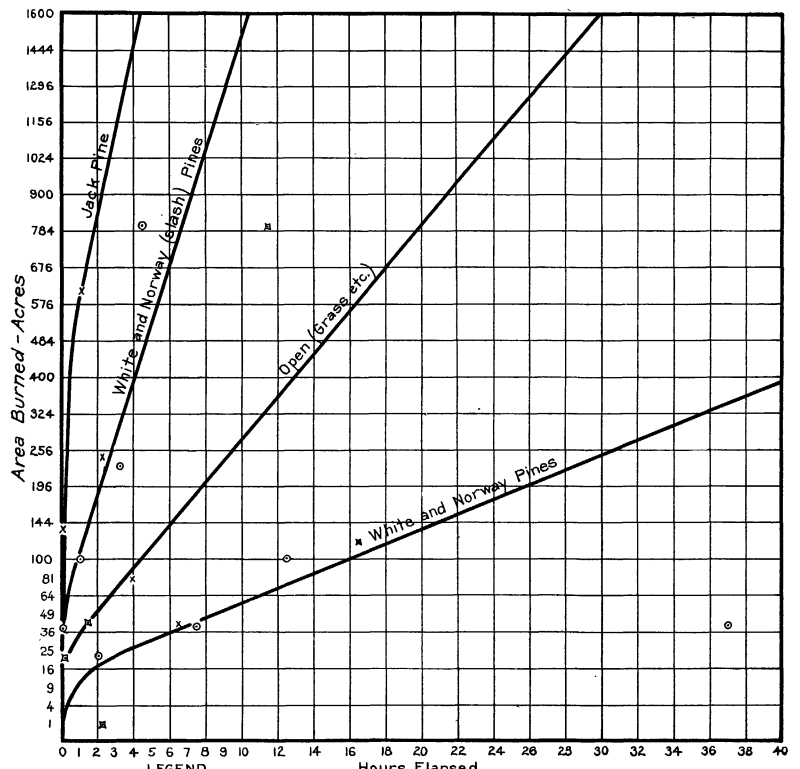

FIG. 18.—Lake States (Region 21): Relation of size of fire to time elapsed between discovery and attack

NOTE.—Not enough data for hardwoods and tamarack.

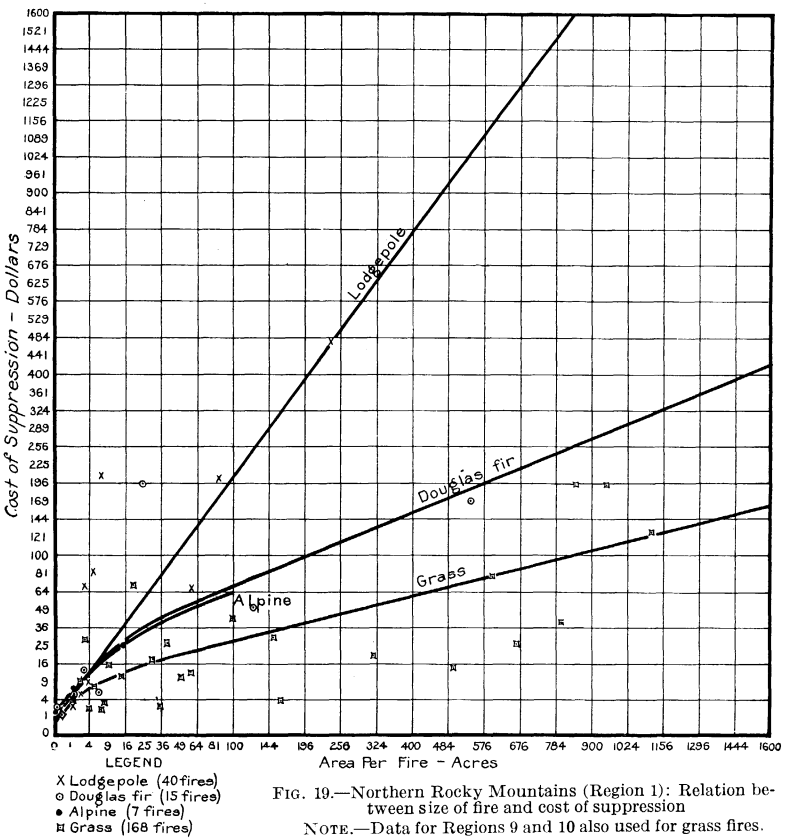

FIG. 19.—Northern Rocky Mountains (Region 1): Relation between size of fire and cost of suppression

NOTE.—Data for Regions 9 and 10 also used for grass fires.

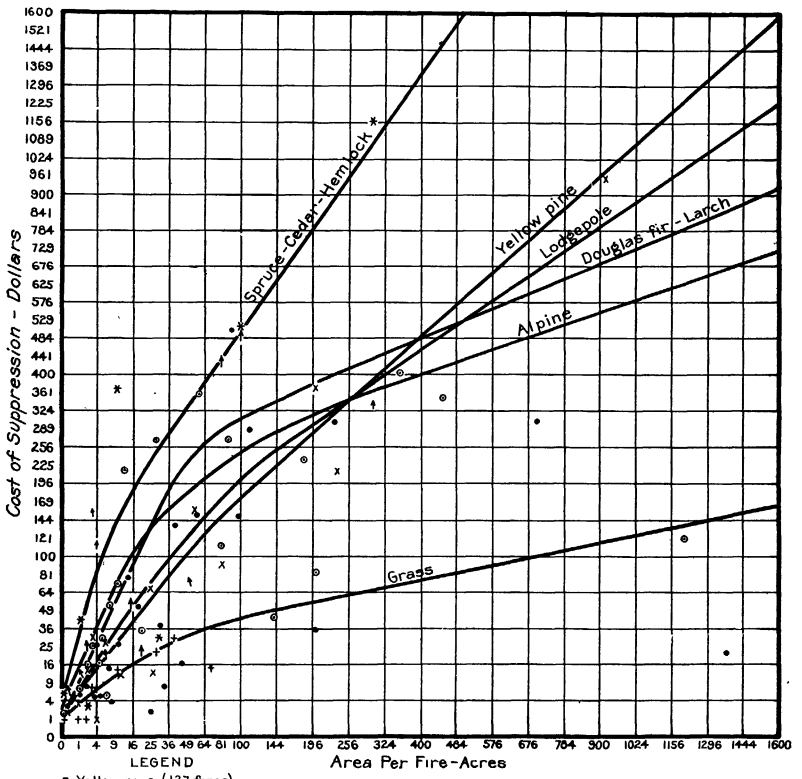

FIG. 20.—Western Montana (Region 2): Relation between size of fire and cost of suppression

NOTE.—Data for Region 3 used also for yellow pine, spruce-cedar-hemlock, alpine, and grass.

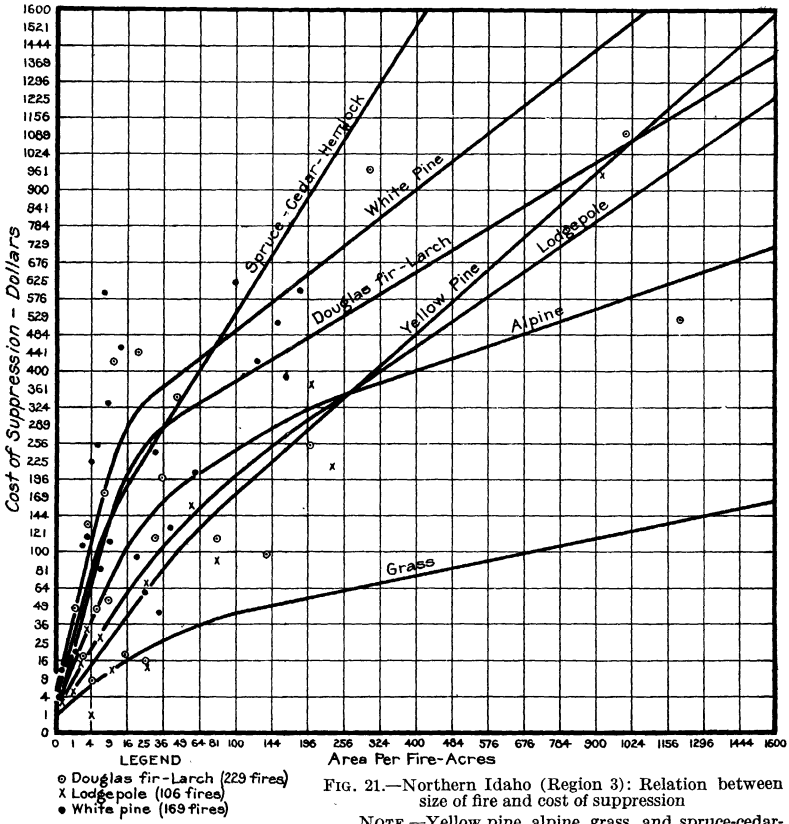

FIG. 21.—Northern Idaho (Region 3): Relation between size of fire and cost of suppression

NOTE.—Yellow pine, alpine, grass, and spruce-cedar-hemlock curves are identical with Western Montana curves. Lodgepole curve based chiefly on Western Montana data.

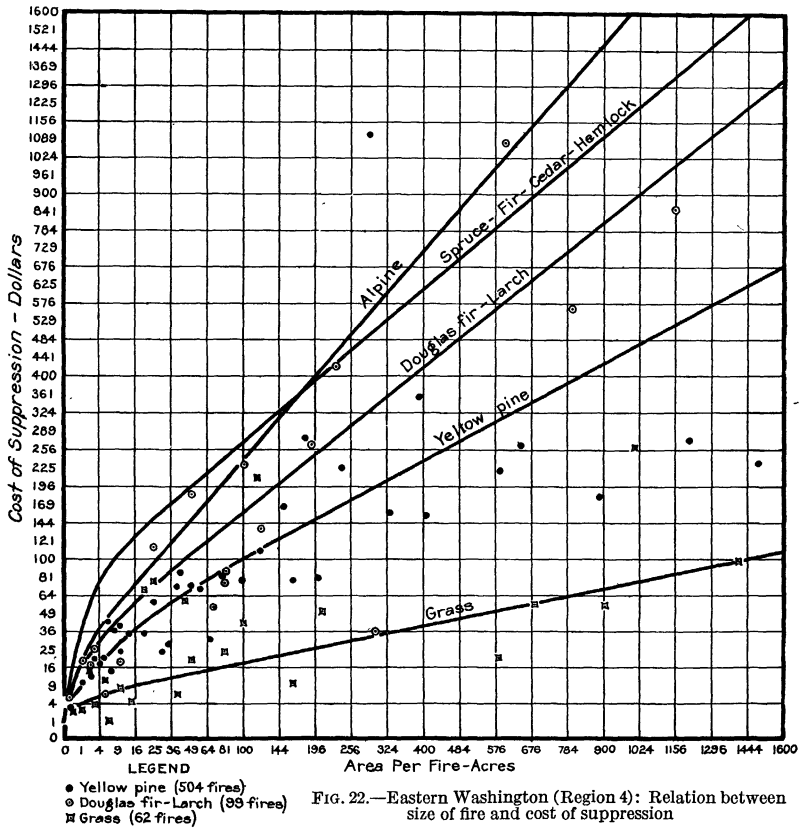

FIG. 22.—Eastern Washington (Region 4): Relation between size of fire and cost of suppression

NOTE.—Data for Region 8 also used for all types except Douglas fir-larch.

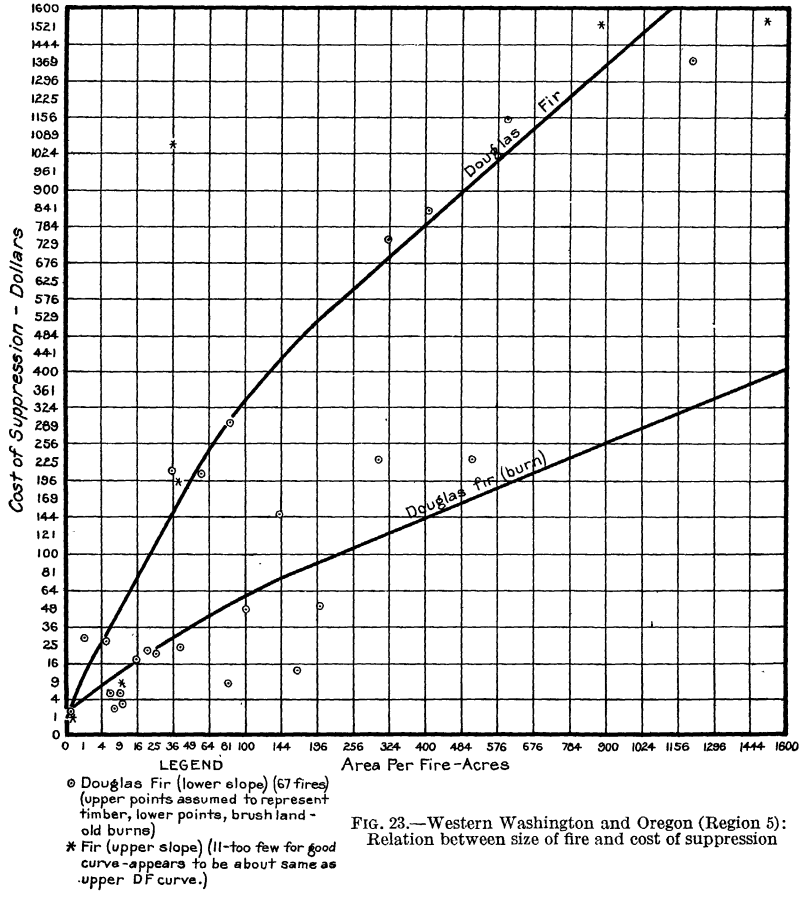

FIG. 23.—Western Washington and Oregon (Region 5): Relation between size of fire and cost of suppression

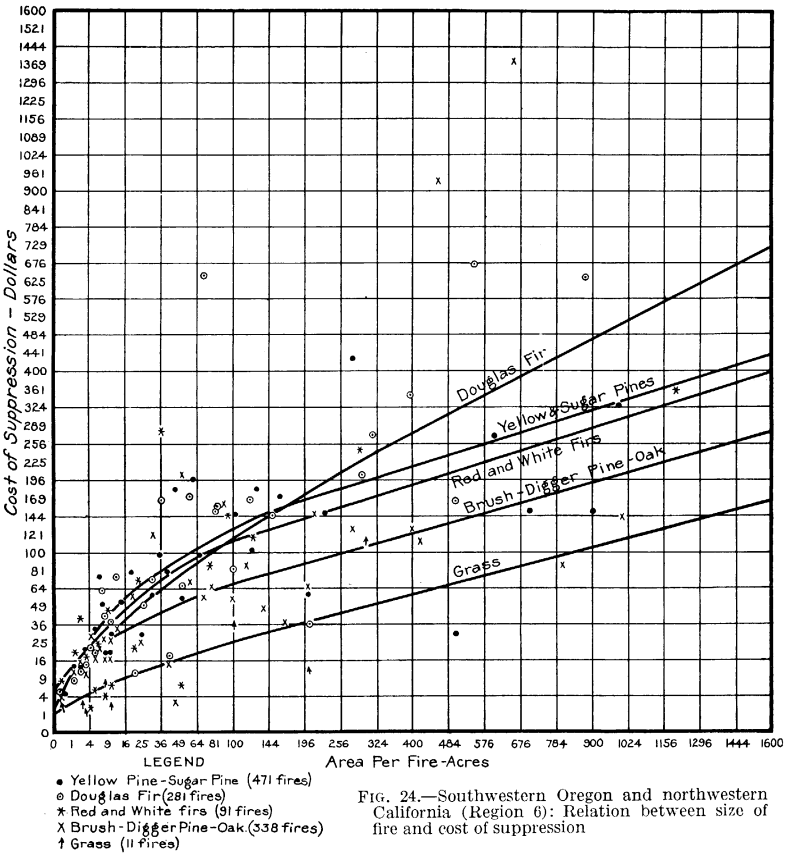

FIG. 24.—Southwestern Oregon and northwestern California (Region 6): Relation between size of fire and cost of suppression

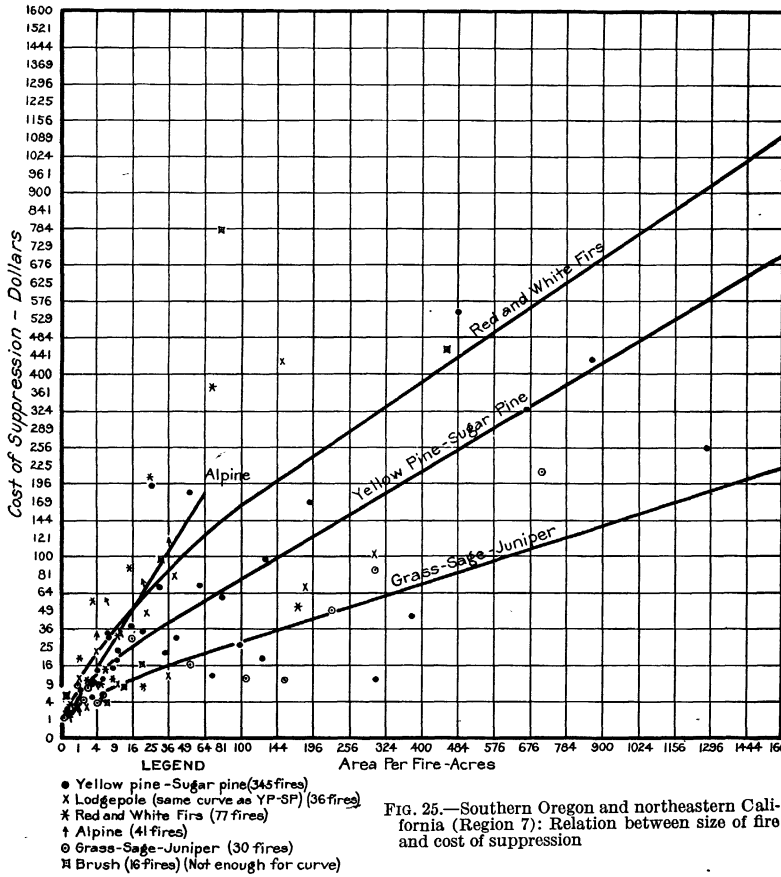

FIG. 25.—Southern Oregon and northeastern California (Region 7): Relation between size of fire and cost of suppression

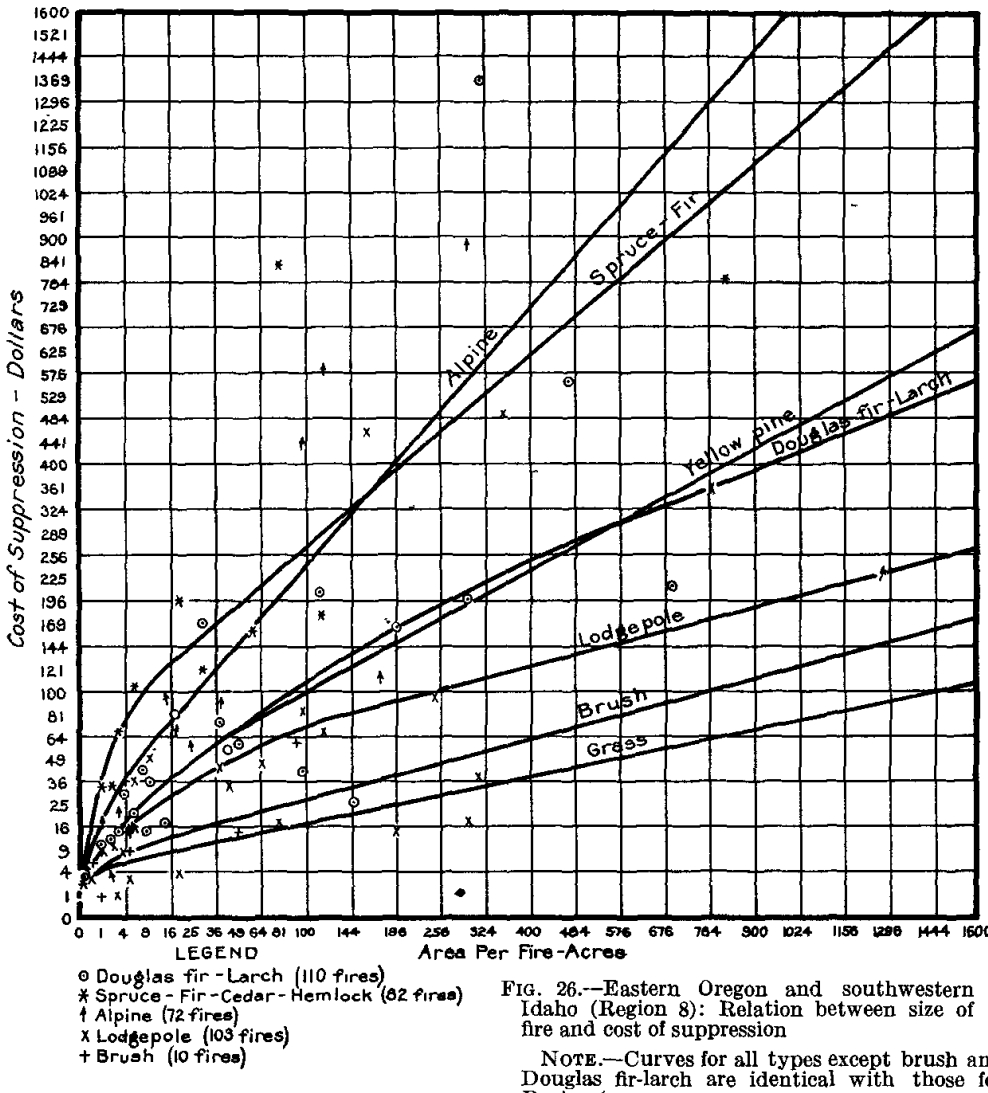

FIG. 26.—Eastern Oregon and southwestern Idaho (Region 8): Relation between size of fire and cost of suppression

NOTE.—Curves for all types except brush and Douglas fir-larch are identical with those for Region 4.

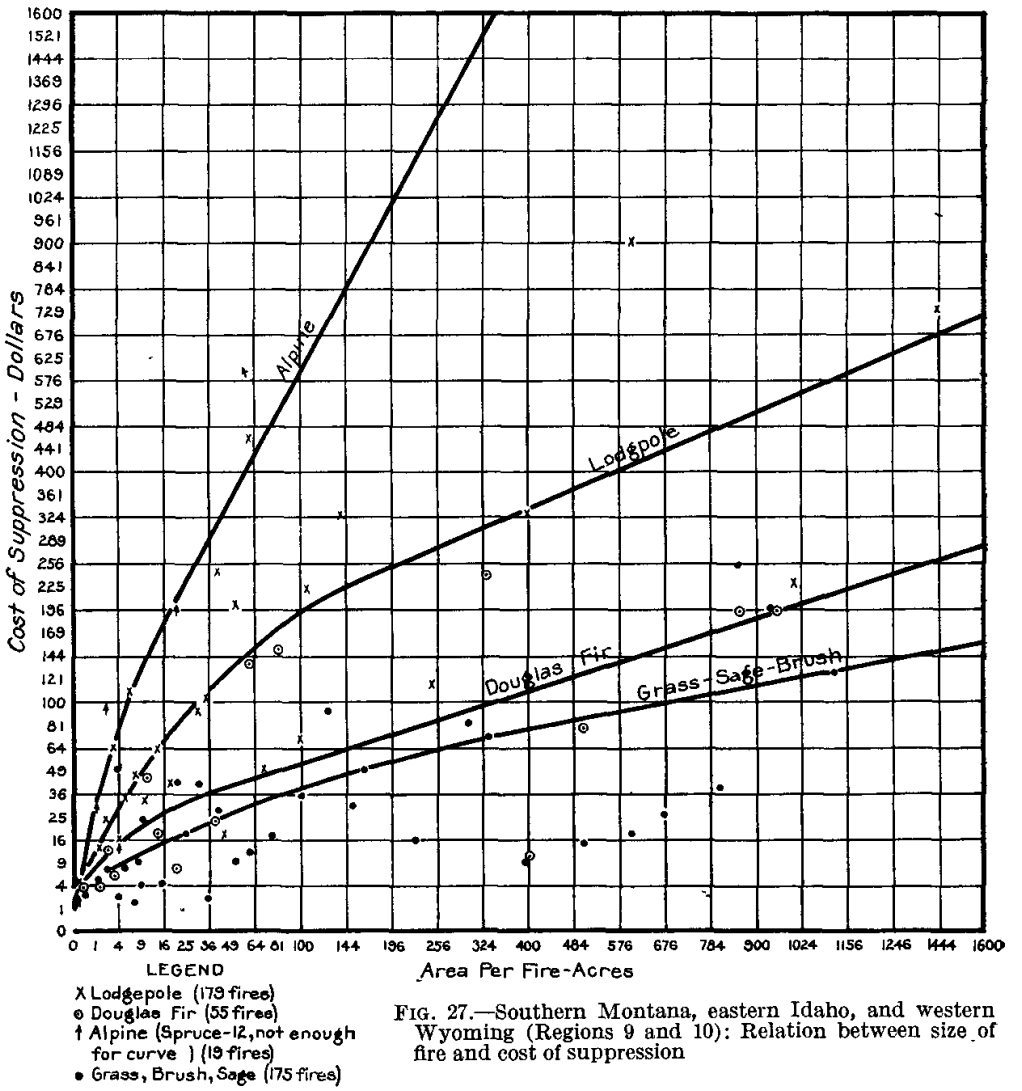

FIG. 27.—Southern Montana, eastern Idaho, and western Wyoming (Regions 9 and 10): Relation between size of fire and cost of suppression

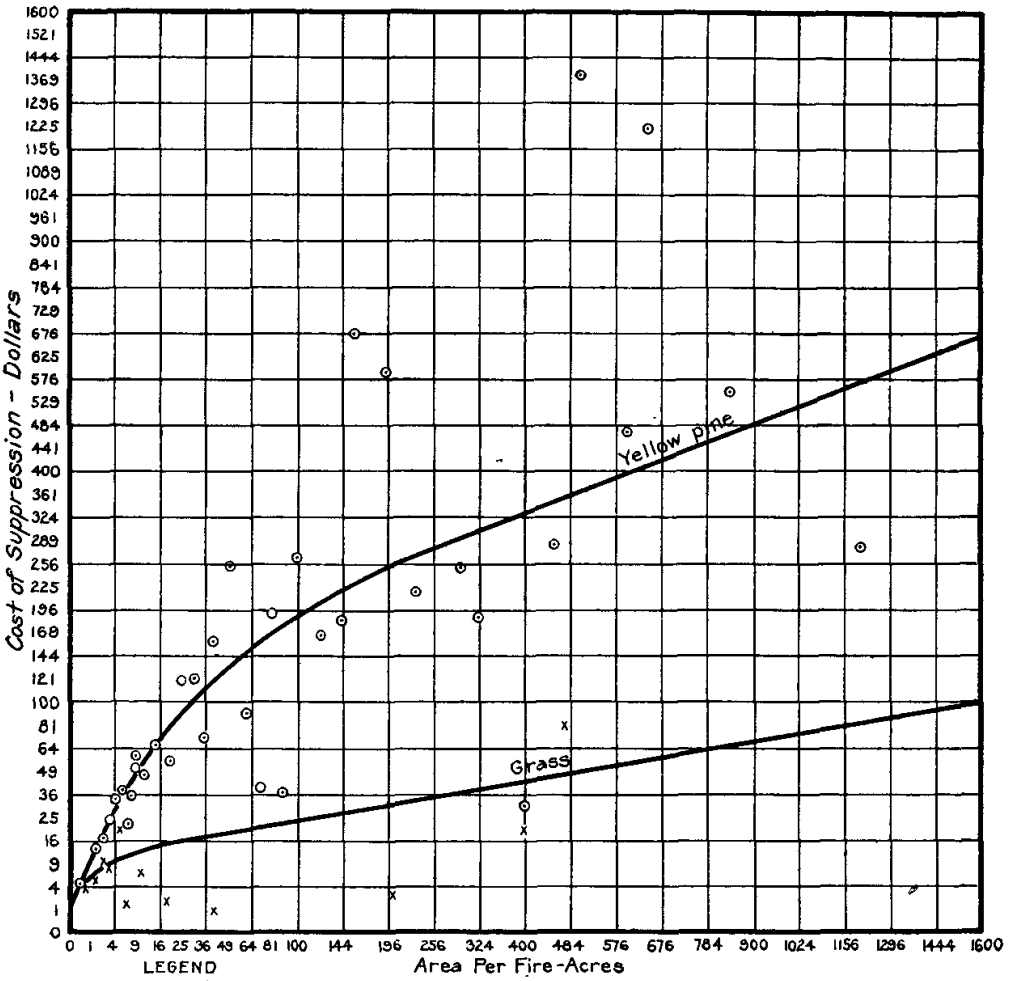

FIG. 28.—Black Hills and eastern Montana (Region 11): Relation between size of fire and cost of suppression

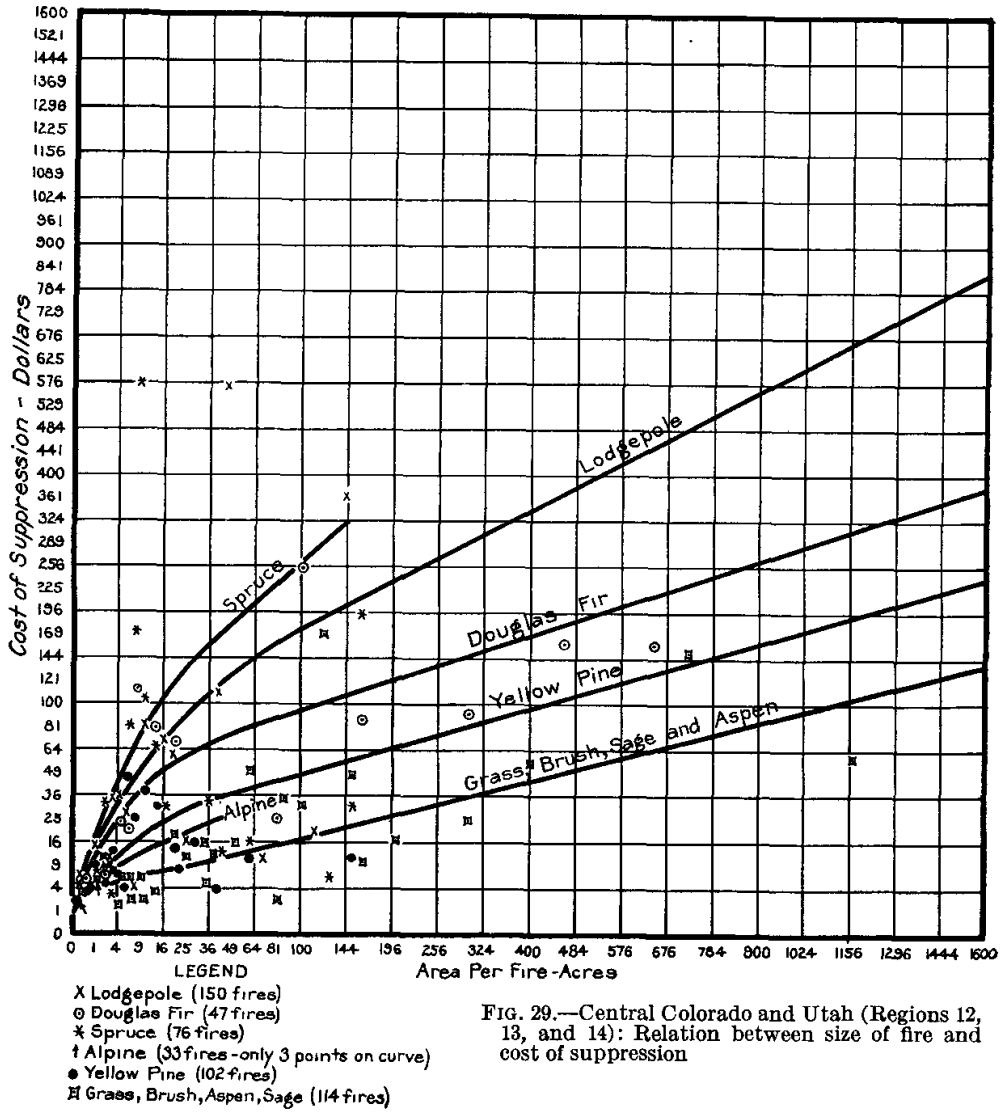

FIG. 29.—Central Colorado and Utah (Regions 12, 13, and 14): Relation between size of fire and cost of suppression

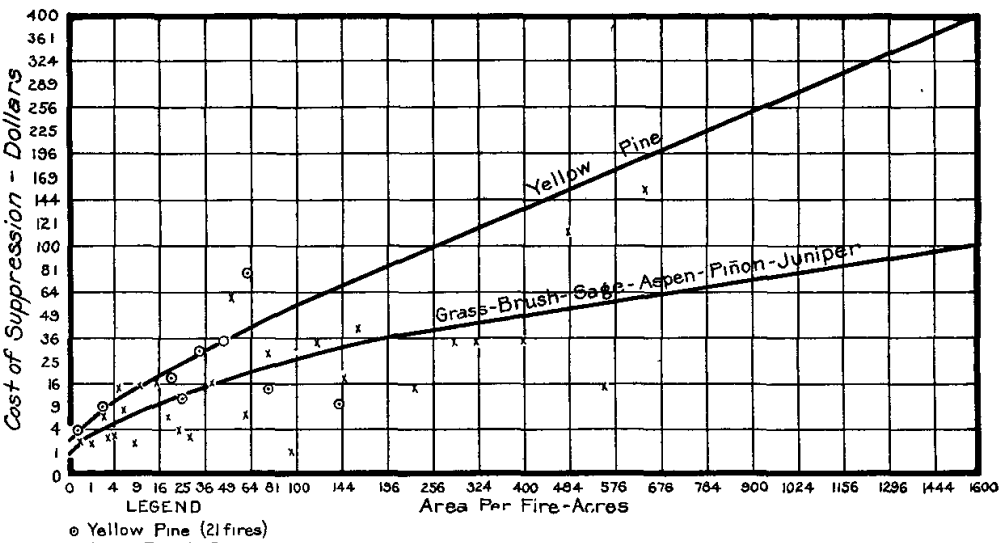

FIG. 30.—Nevada and southeastern California (Region 15): Relation between size of fire and cost of suppression

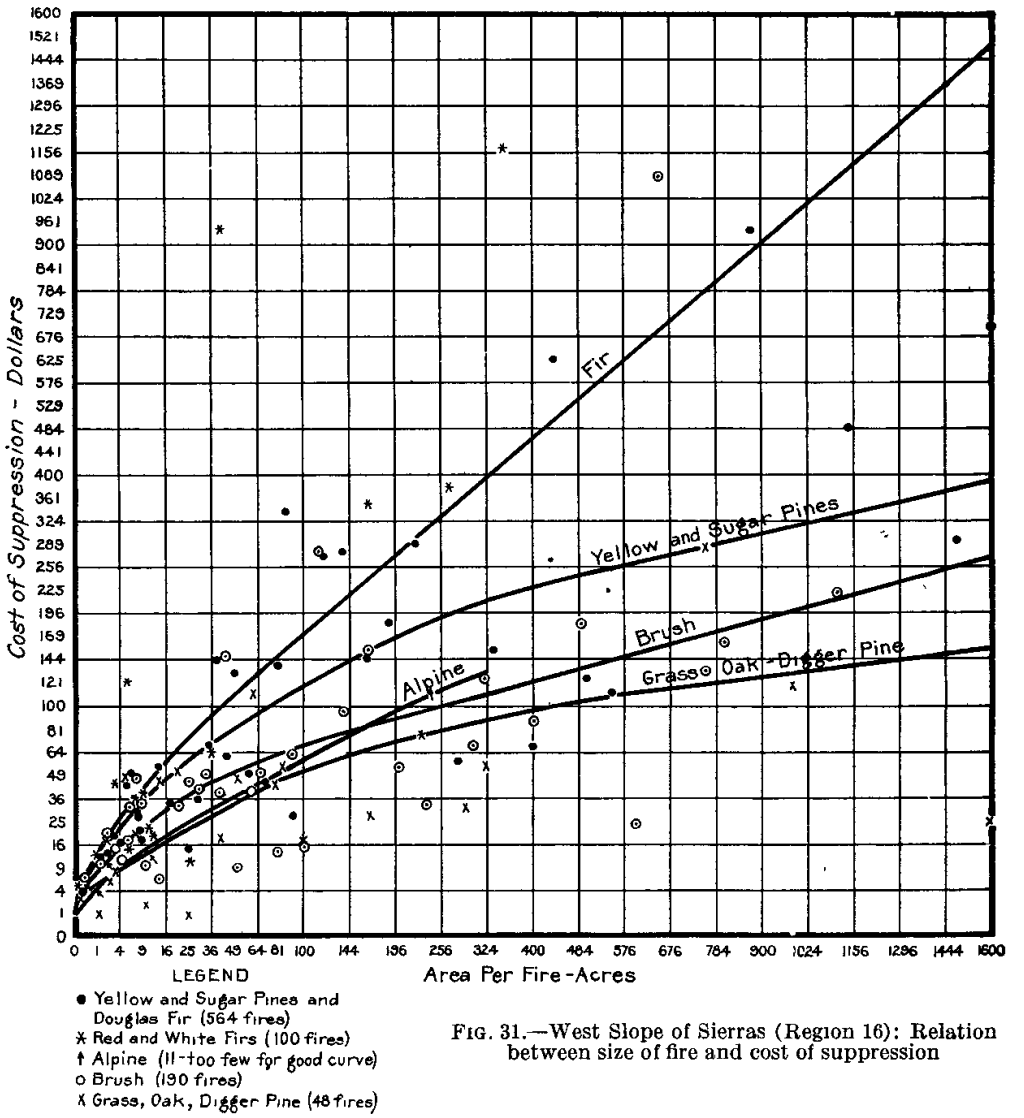

FIG. 31.—West Slope of Sierras (Region 16): Relation between size of fire and cost of suppression

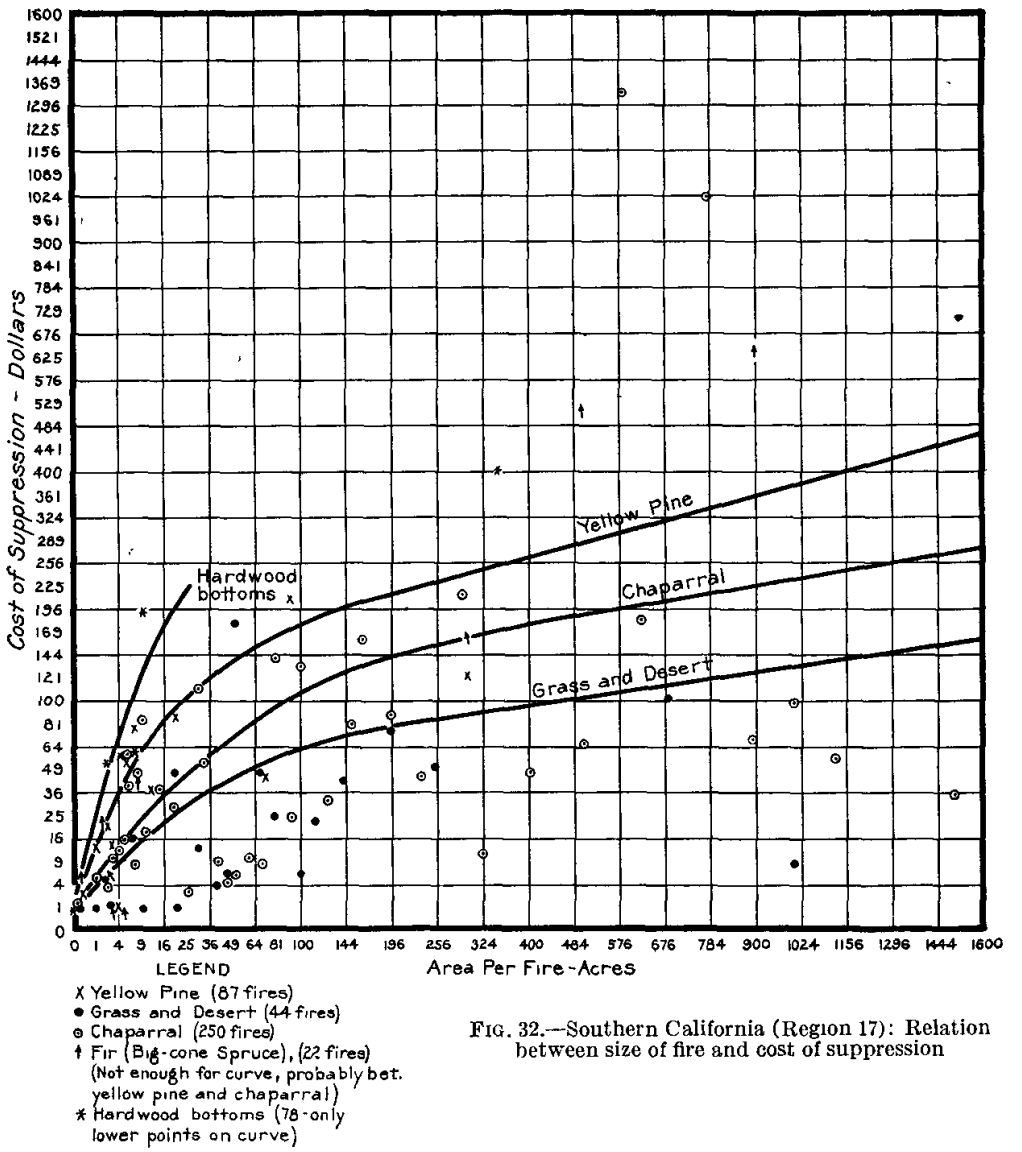

FIG. 32.—Southern California (Region 17): Relation between size of fire and cost of suppression

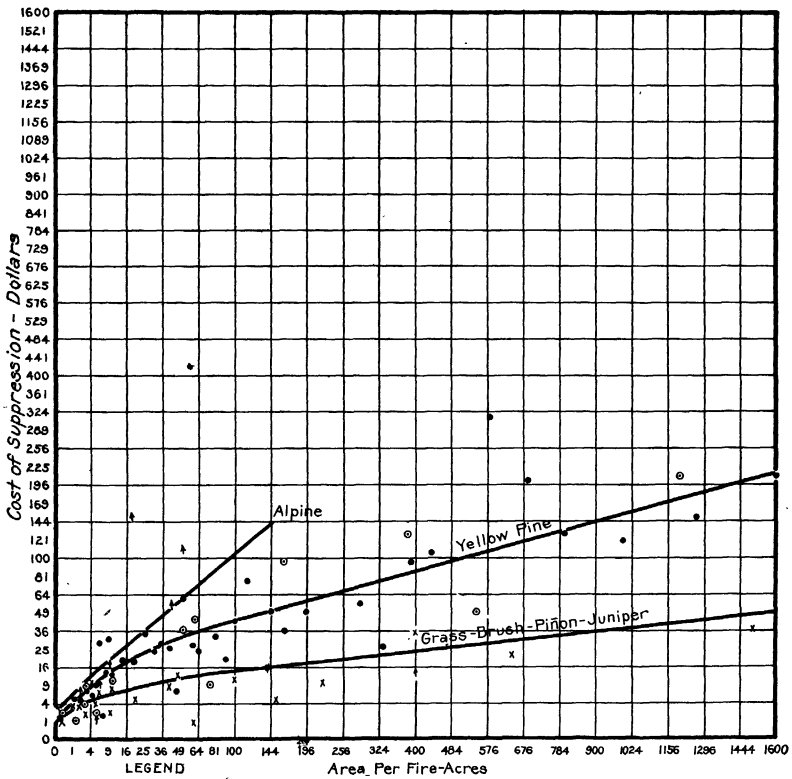

FIG. 33.—Northern Arizona and Western New Mexico (Region 18): Relation between size of fire and cost of suppression

NOTE.—Data for Region 20 included for alpine type.

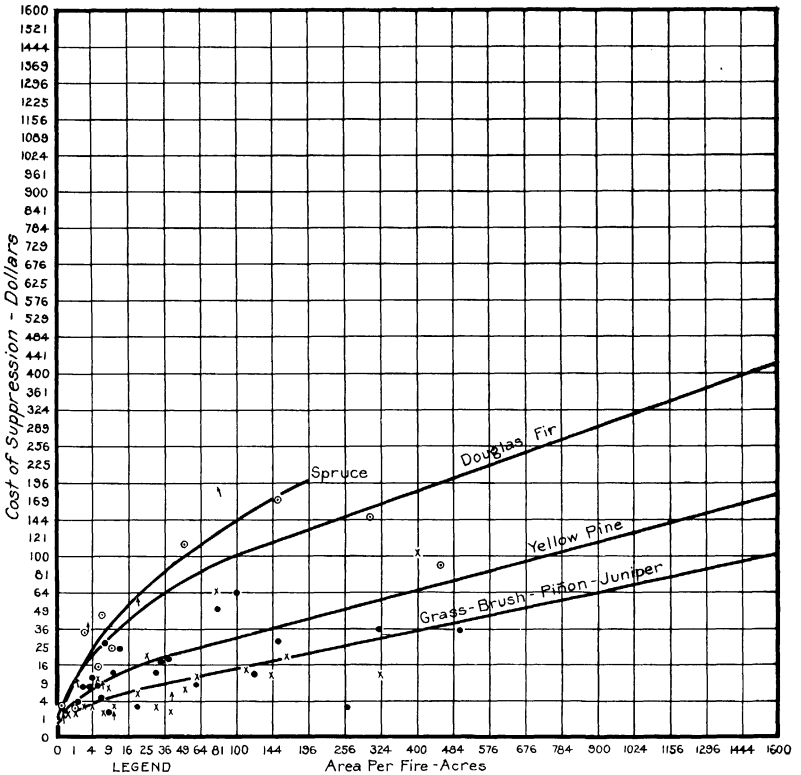

FIG. 34.—Northern New Mexico and southern Colorado (Region 19): Relation between size of fire and cost of suppression

NOTE.—Data for Region 20 included for Douglas fir.

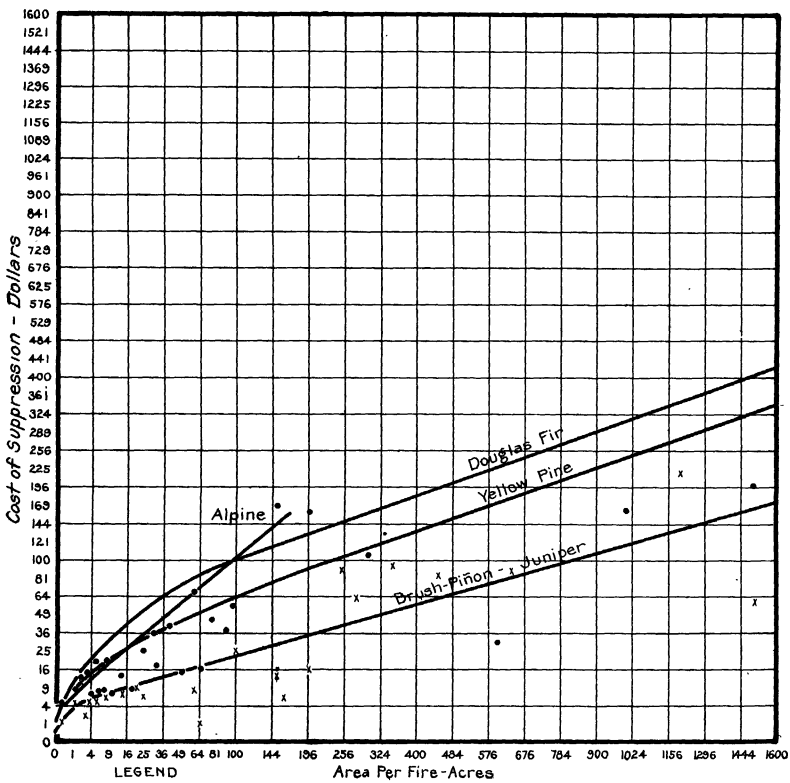

FIG. 35.—Southern Arizona and New Mexico (Region 20): Relation between size of fire and cost of suppression

NOTE.—Curve for Douglas fir identical with that for Region 19; alpine curve same as that for Region 18.

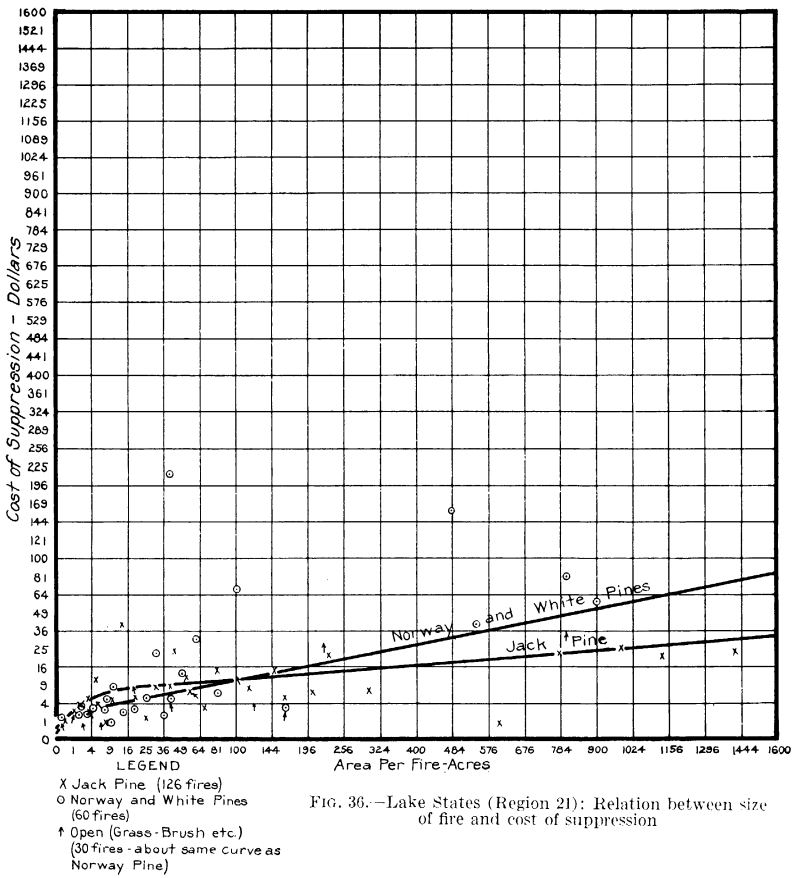

FIG. 36.—Lake States (Region 21): Relation between size of fire and cost of suppression

TABLE VI.—*Average costs of suppressing fires, according to time elapsed between detection and start of suppression work* [a]

REGION 2—WESTERN MONTANA, 1911–1915

Time elapsed (hours)	Forest types						
	Western yellow pine	Douglas fir and larch	Western white pine	Lodgepole pine	Spruce, hemlock, white fir	Subalpine	Open
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	11.00	15.00	42.00	10.00	12.00	11.00	12.00
1	16.00	25.00	69.00	14.00	14.00	15.00	17.00
2	27.00	48.00	92.00	19.00	17.00	19.00	24.00
3	34.00	72.00	110.00	24.00	19.00	21.00	29.00
4	40.00	88.00	130.00	26.00	21.00	22.00	33.00
5	46.00	102.00	155.00	28.00	24.00	24.00	36.00
6	52.00	115.00	175.00	35.00	26.00	26.00	39.00
7	58.00	130.00	200.00	50.00	29.00	27.00	42.00
8	64.00	145.00	230.00	62.00	32.00	29.00	45.00
9	72.00	165.00	250.00	72.00	36.00	35.00	46.00
10	80.00	185.00	270.00	81.00	40.00	58.00	49.00
12	96.00	215.00	295.00	100.00	49.00	88.00	52.00
15	120.00	255.00	325.00	130.00	59.00	110.00	59.00
20	155.00	290.00	360.00	185.00	81.00	135.00	71.00

REGION 3—NORTHERN IDAHO

Time elapsed (hours)	Forest types						
	Western yellow pine	Douglas fir and larch	Western white pine	Lodgepole pine	Spruce, fir, cedar, hemlock	Subalpine	Open
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	11.00	42.00	42.00	13.00	12.00	11.00	12.00
1	16.00	74.00	69.00	17.00	14.00	15.00	17.00
2	27.00	135.00	92.00	23.00	17.00	19.00	24.00
3	34.00	180.00	110.00	23.00	19.00	21.00	29.00
4	40.00	200.00	130.00	30.00	21.00	22.00	33.00
5	46.00	220.00	155.00	33.00	24.00	24.00	36.00
6	52.00	235.00	175.00	40.00	26.00	26.00	39.00
7	58.00	245.00	200.00	58.00	29.00	27.00	42.00
8	64.00	260.00	230.00	72.00	32.00	29.00	45.00
9	72.00	270.00	250.00	81.00	36.00	35.00	46.00
10	80.00	280.00	270.00	88.00	40.00	58.00	49.00
12	96.00	300.00	295.00	110.00	49.00	88.00	52.00
15	120.00	325.00	325.00	135.00	59.00	110.00	59.00
20	155.00	360.00	360.00	185.00	81.00	135.00	71.00

[a] Tables prepared for Regions 1, 5, 7, 9, 10, 11, 15, 18, and 20 are omitted because of the rather inadequate data on which they are based.

TABLE VI.—*Average costs of suppressing fires, according to time elapsed between detection and start of suppression work*—Continued

REGION 4—EASTERN WASHINGTON

Time elapsed (hours)	Forest types					
	Western yellow pine	Douglas fir and larch	Lodgepole pine	Spruce, cedar, white fir, hemlock	Subalpine	Open
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	15.00	19.00	13.00	25.00	11.00	16.00
1	20.00	25.00	14.00	36.00	15.00	19.00
2	29.00	30.00	15.00	48.00	20.00	22.00
3	38.00	36.00	18.00	55.00	25.00	26.00
4	49.00	44.00	24.00	64.00	26.00	29.00
5	59.00	58.00	27.00	68.00	27.00	33.00
6	69.00	76.00	30.00	73.00	28.00	37.00
7	79.00	105.00	33.00	78.00	29.00	42.00
8	90.00	135.00	35.00	83.00	30.00	48.00
9	100.00	180.00	37.00	88.00	31.00	53.00
10	115.00	220.00	41.00	94.00	32.00	58.00
12	135.00	325.00	46.00	100.00	42.00	72.00
15	175.00	510.00	54.00	110.00	62.00	92.00
20	250.00	925.00	69.00	125.00	98.00	130.00

REGION 6—SOUTHERN OREGON AND NORTHERN CALIFORNIA COAST RANGES

Time elapsed (hours)	Forest types						
	Western yellow and sugar pine	Douglas fir	Red and white fir	Subalpine [a]	Digger pine–oak	Brush	Grass
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	27.00	12.00	12.00	8.00	66.00	35.00	24.00
1	40.00	15.00	13.00	8.25	76.00	44.00	30.00
2	56.00	20.00	14.00	8.50	85.00	53.00	35.00
3	67.00	34.00	16.00	8.75	92.00	64.00	40.00
4	78.00	44.00	17.00	9.00	100.00	70.00	45.00
5	86.00	53.00	19.00	9.25	108.00	76.00	50.00
6	94.00	61.00	24.00	9.50	117.00	81.00	56.00
7	100.00	67.00	31.00	9.75	128.00	85.00	62.00
8	108.00	73.00	35.00	10.00	135.00	90.00	67.00
9	115.00	77.00	38.00	10.50	145.00	96.00	74.00
10	120.00	83.00	40.00	11.00	155.00	100.00	81.00
12	130.00	92.00	44.00	11.50	175.00	110.00	96.00
15	145.00	110.00	48.00	12.00	210.00	130.00	120.00
20	170.00	130.00	60.00	16.00	280.00	160.00	165.00

[a] Costs for subalpine are based on red fir curve.

TABLE VI.—*Average costs of suppressing fires, according to time elapsed between detection and start of suppression work*—Continued

REGION 8—EASTERN OREGON AND SOUTHWESTERN IDAHO

Time elapsed (hours)	Forest types						
	Western yellow pine	Douglas fir and larch	Lodgepole pine	Spruce and fir	Subalpine	Brush	Grass and sage
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	15.00	10.00	13.00	25.00	11.00	24.00	16.00
1	20.00	14.00	14.00	26.00	15.00	29.00	19.00
2	29.00	18.00	15.00	48.00	20.00	34.00	22.00
3	38.00	22.00	18.00	55.00	25.00	40.00	26.00
4	49.00	28.00	24.00	64.00	26.00	46.00	29.00
5	59.00	37.00	27.00	68.00	27.00	53.00	33.00
6	69.00	49.00	30.00	73.00	28.00	61.00	37.00
7	79.00	70.00	33.00	78.00	29.00	67.00	42.00
8	90.00	100.00	35.00	83.00	30.00	76.00	48.00
9	100.00	120.00	37.00	88.00	31.00	85.00	53.00
10	115.00	145.00	41.00	94.00	32.00	95.00	58.00
12	135.00	200.00	46.00	100.00	42.00	115.00	72.00
15	175.00	285.00	54.00	110.00	62.00	145.00	92.00
20	250.00	430.00	69.00	125.00	98.00	210.00	130.00

REGION 12—EASTERN COLORADO; REGION 13—NORTHWESTERN COLORADO AND SOUTHERN WYOMING; REGION 14—WASATCH AND UINTA RANGES (UTAH)[a]

Time elapsed (hours)	Forest types						
	Western yellow pine	Douglas fir	Lodgepole pine	Engelmann spruce	Subalpine	Woodland and aspen brush	Grass and sage
	Dolls.	*Dolls.*	*Dolls.*	*Dolls*	*Dolls.*	*Dolls.*	*Dolls.*
½	9.00	19.00	20.00	22.00	4.00	10.00	7.00
1	11.00	24.00	30.00	28.00	6.00	14.00	8.50
2	13.00	36.00	50.00	36.00	8.00	18.00	10.00
3	15.00	45.00	66.00	45.00	11.00	20.00	13.00
4	16.00	50.00	83.00	50.00	11.50	22.00	15.00
5	18.00	56.00	100.00	56.00	12.00	24.00	18.00
6	20.00	61.00	115.00	62.00	13.00	26.00	20.00
7	24.00	66.00	130.00	69.00	14.00	28.00	24.00
8	28.00	71.00	145.00	74.00	14.50	30.00	26.00
9	32.00	75.00	160.00	81.00	15.00	32.00	30.00
10	35.00	80.00	170.00	90.00	15.50	35.00	34.00
12	41.00	85.00	195.00	100.00	16.00	40.00	42.00
15	50.00	100.00	230.00	120.00	18.00	49.00	56.00
20	67.00	120.00	300.00	150.00	21.00	64.00	83.00

[a] These three regions combined in order to afford better basis for curves. They are fairly similar.

TABLE VI.—*Average costs of suppressing fires, according to time elapsed between detection and start of suppression work*—Continued

REGION 16—WEST SLOPE OF SIERRAS

Time elapsed (hours)	Forest types					
	Western yellow and sugar pines and Douglas fir	Red and white firs	Subalpine	Lodgepole[a] and knobcone pines	Digger pine–oak and grass	Brushfields
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	23.00	10.00	1.00	23.00	53.00	60.00
1	36.00	15.00	1.50	36.00	61.00	72.00
2	52.00	21.00	1.75	52.00	68.00	81.00
3	64.00	22.00	2.00	64.00	74.00	88.00
4	72.00	23.00	2.00	72.00	81.00	94.00
5	81.00	24.00	2.00	81.00	87.00	99.00
6	86.00	25.00	2.00	86.00	93.00	104.00
7	90.00	26.00	2.00	90.00	98.00	109.00
8	94.00	26.50	2.00	94.00	104.00	115.00
9	100.00	27.00	2.25	100.00	108.00	120.00
10	105.00	28.00	2.50	105.00	112.00	125.00
12	110.00	29.50	3.00	110.00	120.00	140.00
15	120.00	31.00	3.50	120.00	130.00	155.00
20	145.00	34.00	6.00	145.00	155.00	190.00

[a] Because of insufficient data for lodgepole type, figures for the yellow pine, sugar pine, and incense cedar type were used.

REGION 17—SOUTHERN CALIFORNIA

Time elapsed (hours)	Forest types					
	Western yellow and Jeffrey pine	Fir[a] and pine slopes	Subalpine[b]	Chaparral	Hardwood bottoms	Grass and sage
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	28.00	24.00	1.00	145.00	32.00	50.00
1	45.00	45.00	1.50	160.00	55.00	62.00
2	77.00	79.00	1.75	175.00	87.00	70.00
3	102.00	100.00	2.00	190.00	110.00	77.00
4	119.00	115.00	2.00	200.00	125.00	85.00
5	132.00	130.00	2.00	210.00	135.00	90.00
6	145.00	140.00	2.00	220.00	140.00	95.00
7	155.00	150.00	2.00	230.00	145.00	100.00
8	165.00	160.00	2.00	240.00	150.00	105.00
9	170.00	170.00	2.25	250.00	155.00	110.00
10	180.00	180.00	2.50	260.00	165.00	120.00
12	190.00	190.00	3.00	280.00	175.00	130.00
15	200.00	210.00	3.50	315.00	190.00	150.00
20	230.00	245.00	6.00	380.00	215.00	190.00

[a] Based on area from fir slope curve, and costs from chaparral curve.

[b] Based on figures for Region 16 (Sierras).

TABLE VI.—*Average costs of suppressing fires, according to time elapsed between detection and start of suppression work*—Continued

REGION 19—SOUTHWESTERN COLORADO AND NORTHERN NEW MEXICO

Time elapsed (hours)	Forest types						
	Western yellow pine	Douglas fir mixed	Spruce and subalpine	Lodgepole pine [a]	Pinon-juniper	Brush	Grass
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
½	7.50	13.00	25.00	20.00	1.75	5.00	7.00
1	9.50	18.00	34.00	30.00	2.00	6.00	9.00
2	14.00	28.00	47.00	50.00	2.15	7.00	12.00
3	17.00	40.00	53.00	66.00	2.30	8.00	16.00
4	20.00	50.00	59.00	83.00	2.45	9.00	20.00
5	23.00	61.00	65.00	100.00	2.60	10.00	25.00
6	26.00	72.00	69.00	115.00	2.80	11.00	30.00
7	29.00	81.00	72.00	130.00	3.00	12.00	35.00
8	32.50	90.00	77.00	145.00	3.25	13.00	41.00
9	36.00	99.00	81.00	160.00	3.50	14.00	46.00
10	39.50	106.00	85.00	170.00	3.75	15.00	54.00
12	47.00	120.00	94.00	195.00	4.00	17.00	67.00
15	59.00	145.00	104.00	230.00	4.25	20.00	94.00
20	83.00	190.00	123.00	300.00	5.00	27.00	145.00

[a] For lodgepole pine, figures for Region 13 were used.

REGION 21—LAKE STATES

Time elapsed (hours)	Forest types				
	Eastern white and red pine (green)	White and red pine (slash, etc.)	Jack pine (mostly slash)	Other timber (green) [a]	Open
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*
½	3.00	9.50	18.00	3.00	5.00
1	4.00	11.50	21.00	4.00	6.00
2	4.50	16.00	23.00	4.50	7.00
3	5.00	21.00	27.00	5.00	9.00
4	5.50	27.00	31.00	5.50	10.00
5	6.00	34.00	35.00	6.00	11.50
6	6.25	41.50	39.00	6.25	13.50
7	6.75	49.00	44.00	6.75	15.00
8	7.25	58.00	48.00	7.25	17.00
9	7.75	69.00	51.00	7.75	18.50
10	8.00	79.00	55.00	8.00	21.00
12	9.00	100.00	66.00	9.00	25.00
15	10.50	145.00	83.00	10.50	32.50
20	13.00	235.00	115.00	13.00	47.00

[a] Because of insufficient data for fires in other timber types (spruce, balsam, tamarack, hardwoods), the same figures were used as for white and Norway pine green.

AMOUNT OF DAMAGE DONE BY FIRES

Damage varies directly with area burned, and therefore may be expressed on an acre basis. The question of damage is the most difficult part of the whole problem, for several reasons. In the first place, no satisfactory method has yet been devised for putting money value on the less tangible elements of value present in a forest. Even the value of merchantable timber can be determined with a reasonable degree of accuracy only where such timber is so located as to be immediately saleable, and the value of the same timber varies more or less from year to year. In case of young growth, a number of complications enter which make it almost impossible to value it on a scientific basis, or rather, to determine the monetary loss in case of its destruction or injury by fire. The fire reports, in the majority of cases, entirely neglect to evaluate the damage to young growth, or estimate it so crudely and inconsistently that the figures are worthless. Damage to forage is ignored, not only because of the extreme paucity of data, but also because the existing data indicate that such damage is less than the probable error in estimating damage to timber. In studying the records of individual fires, then, it was decided to ignore the estimates of damage expressed in dollars, and to consider only the data as to quantity of damage expressed in board feet of timber and acres of reproduction. The fire records are particularly incomplete on these points, especially in regard to reproduction destroyed, but they represent all the information that can be readily obtained. For those fires within each type and subregion for which data were available regarding amount of damage, the average damage per acre burned over was ascertained. The figures given in Table VII are in each case averages for all burns in the given types, regardless of age class or density of stand, so should not be taken as indication of the amount of damage in mature well-stocked stands. For this reason the average amount of damage given for the mixed pine type of the Sierras, for instance, is less than the amount indicated by studies made in mature stands. It is important to know the relation between the quantities of timber and young growth present on the burned area before the fire and the amount destroyed—in other words, what the ratio of destruction is. Data on this point are even more fragmentary than those on the total amount of damage, but such as are available were compiled.

TABLE VII.—*Average amount of damage done by fires in different types and regions, 1911–1915*[a]

Type	Region	Timber destroyed		Young growth killed	
		Amount per acre	Percentage of stand	Percentage of burned area	Percentage of original stand
		Bd. ft.			
Yellow pine, including western yellow pine, sugar pine, incense cedar, and white fir mixture of California.	2, 3	695	14.9	56	83
	4	420	14.8	48	77
	6	860	12.4	46	63
	7	820	7.0	36	66
	8	950	8.4	70	93
	11	500	40.0	20	68
	12, 14	290	39.6	21	48
	15	385	8.3	44	88
	16	630	7.6	27	50
	17	560	6.7	44	58
	18, 19	100	4.4	26	47
	20	200	18.6	52	77
Douglas fir, including western larch and other mixtures.	1, 9, 10	775	79.6	56	67
	2	855	30.1	59	89
	3	1,290	47.0	87	97
	4	3,580	44.4	49	95
	5	1,630	45.3	64	82
	6	425	11.9	65	91
	8	1,895	70.1	29	56
	12, 13, 14, 15	195	25.5	33	92
	17	190	12.1	38	60
	18, 19, 20	530	23.1	23	32
Lodgepole pine	1, 9, 10, 15	1,180	80.8	48	83
	2, 3, 4, 5	320	39.4	83	84
	7, 8	585	65.4	36	81
	12, 13, 14, 19	2,090	96.8	72	99
Spruce and firs, including western hemlock and western red cedar except west of Cascades. (For Arizona, Colorado, Utah, and Nevada, the figures are for this type and subalpine combined).	1, 9, 10	1,685	99.9	16	100
	2, 3, 4	7,850	82.8	64	96
	5	5,000	100.0	48	100
	6	455	13.5	67	92
	7, 16	850	10.6	48	76
	8	1,445	19.5	28	84
	12, 13, 14, 15, 19	1,260	73.9	48	97
	18, 20	55	8.4	54	72
Western white pine	2, 3	3,860	84.7	33	96
Subalpine (figures doubtless include some merchantable spruce and fir stands in the Rocky Mountain Region.	1, 9, 10	3,985	80.7	99	100
	2, 3, 4, 5	1,670	65.1	28	66
	6, 7, 16, 17	130	12.1	19	37
	8	765	72.7	70	90
	12, 13, 14, 15, 19	1,260	73.9	48	97
	18, 20	55	8.4	54	72
Woodland.[b] Includes pinon-juniper and digger pine-oak. (Converted on basis 2 cords=1,000 bd. ft.)	6, 16	100	14.3	24	93
	7, 14, 15	305	39.3	6	70
	18, 19, 20	510	55.3	39	87
Brushland.[b] Includes woodland and aspen in some cases.	6, 7, 8, 16	110	9.0	8	77
	9, 10, 12, 13, 14, 15	160	No data	4	No data
	17	70	36.3	2	89
	18, 19, 20	10	.3	0	100
Grass and sage.[b] Includes brushland in regions where no separate figure is given for brush.	1, 9, 10	55	35.4	19	81
	2, 3, 4, 8	60	13.3	4	61
	6, 7, 16	10	1.2	0.4	12
	11	5	8.8	7	15
	12, 13, 14	75	79.3	1	100
	15	270	22.7	7	100
	17, 18, 19, 20	70	13.5	2	89
Hardwood	17	90	5.9	No data	
Eastern white pine–red (Norway) pine	21	60	3.0	18	99
Jack pine[c]	21	205	75.5	24	77

[a] Based on data in individual fire reports.

[b] Board foot figures for losses in woodland and open types are based on insufficient data and often probably too high. Percentages are based on fewer data than are board foot values.

[c] No data for other types in Lake States.

TABLE VI.—*Average costs of suppressing fires, according to time elapsed between detection and start of suppression work*—Continued

REGION 19—SOUTHWESTERN COLORADO AND NORTHERN NEW MEXICO

Time elapsed (hours)	Forest types						
	Western yellow pine	Douglas fir mixed	Spruce and subalpine	Lodgepole pine [a]	Pinon-juniper	Brush	Grass
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
½	7.50	13.00	25.00	20.00	1.75	5.00	7.00
1	9.50	18.00	34.00	30.00	2.00	6.00	9.00
2	14.00	28.00	47.00	50.00	2.15	7.00	12.00
3	17.00	40.00	53.00	66.00	2.30	8.00	16.00
4	20.00	50.00	59.00	83.00	2.45	9.00	20.00
5	23.00	61.00	65.00	100.00	2.60	10.00	25.00
6	26.00	72.00	69.00	115.00	2.80	11.00	30.00
7	29.00	81.00	72.00	130.00	3.00	12.00	35.00
8	32.50	90.00	77.00	145.00	3.25	13.00	41.00
9	36.00	99.00	81.00	160.00	3.50	14.00	46.00
10	39.50	106.00	85.00	170.00	3.75	15.00	54.00
12	47.00	120.00	94.00	195.00	4.00	17.00	67.00
15	59.00	145.00	104.00	230.00	4.25	20.00	94.00
20	83.00	190.00	123.00	300.00	5.00	27.00	145.00

[a] For lodgepole pine, figures for Region 13 were used.

REGION 21—LAKE STATES

Time elapsed (hours)	Forest types				
	Eastern white and red pine (green)	White and red pine (slash, etc.)	Jack pine (mostly slash)	Other timber (green) [a]	Open
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*
½	3.00	9.50	18.00	3.00	5.00
1	4.00	11.50	21.00	4.00	6.00
2	4.50	16.00	23.00	4.50	7.00
3	5.00	21.00	27.00	5.00	9.00
4	5.50	27.00	31.00	5.50	10.00
5	6.00	34.00	35.00	6.00	11.50
6	6.25	41.50	39.00	6.25	13.50
7	6.75	49.00	44.00	6.75	15.00
8	7.25	58.00	48.00	7.25	17.00
9	7.75	69.00	51.00	7.75	18.50
10	8.00	79.00	55.00	8.00	21.00
12	9.00	100.00	66.00	9.00	25.00
15	10.50	145.00	83.00	10.50	32.50
20	13.00	235.00	115.00	13.00	47.00

[a] Because of insufficient data for fires in other timber types (spruce, balsam, tamarack, hard-

AMOUNT OF DAMAGE DONE BY FIRES

Damage varies directly with area burned, and therefore may be expressed on an acre basis. The question of damage is the most difficult part of the whole problem, for several reasons. In the first place, no satisfactory method has yet been devised for putting money value on the less tangible elements of value present in a forest. Even the value of merchantable timber can be determined with a reasonable degree of accuracy only where such timber is so located as to be immediately saleable, and the value of the same timber varies more or less from year to year. In case of young growth, a number of complications enter which make it almost impossible to value it on a scientific basis, or rather, to determine the monetary loss in case of its destruction or injury by fire. The fire reports, in the majority of cases, entirely neglect to evaluate the damage to young growth, or estimate it so crudely and inconsistently that the figures are worthless. Damage to forage is ignored, not only because of the extreme paucity of data, but also because the existing data indicate that such damage is less than the probable error in estimating damage to timber. In studying the records of individual fires, then, it was decided to ignore the estimates of damage expressed in dollars, and to consider only the data as to quantity of damage expressed in board feet of timber and acres of reproduction. The fire records are particularly incomplete on these points, especially in regard to reproduction destroyed, but they represent all the information that can be readily obtained. For those fires within each type and subregion for which data were available regarding amount of damage, the average damage per acre burned over was ascertained. The figures given in Table VII are in each case averages for all burns in the given types, regardless of age class or density of stand, so should not be taken as indication of the amount of damage in mature well-stocked stands. For this reason the average amount of damage given for the mixed pine type of the Sierras, for instance, is less than the amount indicated by studies made in mature stands. It is important to know the relation between the quantities of timber and young growth present on the burned area before the fire and the amount destroyed—in other words, what the ratio of destruction is. Data on this point are even more fragmentary than those on the total amount

TIMBER VALUES.—For valuing damages in terms of money, it seems advisable to use general figures where averages are concerned, and not to attempt too great detail in the process. It is considered that practically the same loss is suffered in case of destruction of a given quantity of a given species in a given region, whether the particular stand destroyed is accessible to present logging operations, or whether it is less accessible and consequently of less immediate market value. To put a low estimate on the value of more remote timber would result in low estimates of liability, and therefore in less intensive protection and possible large losses of timber. This would defeat one of the important objects of the national forests, viz, to preserve the less accessible timber until it is needed by the country. Moreover, no one can tell what such stumpage may be worth by the time it becomes marketable. If a stand of timber is destroyed the loss is not merely the value of the timber as such, but includes also its value as part of the productive forest capital. The destruction of a million board feet, wherever located, reduces the forest capital and therefore the potential annual yield of the region.

For the purposes of this study, therefore, arbitrary stumpage values were taken, based largely on appraised or bid prices in large timber sales during the past several years, and supplemented by arbitrary estimates where such basis was lacking (Table VIII). In order to apply these figures in estimating damage in different forest types, which usually contain a mixture of species, composite values by types were set, based on assumed proportions of the different species in the mixture.

VALUE OF YOUNG GROWTH.—The problem of valuing young growth is a very complex one, and can be solved satisfactorily only after a great deal of intensive silvicultural research. Expectation values are purely theoretical, and basis for estimating them is lacking, since our knowledge of yields, rotations, costs of management, and even methods of management, is still almost nil. Cost values, according to standard formulae, based on any costs to which large-scale reforestation operations may be reduced, will in very many, perhaps most, cases give greater values for young growth than the present values of fully stocked stands of mature timber on the same sites.

Except for a few types and regions, reforestation costs fixed on the basis of past and present experience are far too high, and probably do not represent at all what the costs will be when

TABLE VIII.—*Basic stumpage values used for estimating damage done to merchantable timber, by species and types*

Species	Values [a]
Western yellow pine	$2 (2), $2.25 (3), $2.50 (4, 12, 14, 15, 18, 19), $2.75 (7, 8), $3 (6, 11, 16, 17, 20).
Sugar pine	$3.50 (6, 7), $4 (16). Norway pine, $4.50 (21).
White pine	Western $3 (2), $3.50 (4), $4 (3). Eastern, $5.50 (21).
Douglas fir	$1 (3), $1.25 (4, 6, 7, 8), $1.50 (1, 2, 12, 13, 16, 17), $1.75 (5, 9), $2 (10, 14, 15), $2.25 (18, 19, 20).
Western larch	$1.25 (3, 4, 8), $1.50 (2). Eastern larch, $2 (21).
Firs (Abies species)	$0.50 (1, 6, 7, 8, 9), $0.75 (2, 4, 5), $1 (3, 10, 12, 13), $1.25 (16), $1.50 (14, 15), $2 (19, 21), $2.25 (18, 20).
Spruce	$1 (8), $1.50 (1, 2, 5, 9), $1.75 (3, 4, 6, 12), $2 (10, 12, 14, 21), $2.25 (18, 19, 20).
Lodgepole pine	$1.50 (2), $1.75 (1, 9, 12), $2 (3, 4, 7, 8, 10, 13, 14, 15), $3 (6). Jack pine, $2 (21).
Western hemlock	$0.50 (5), $0.75 (4), $1 (3).
Cedar (incense and red)	$0.75 (6, IC), $1 (7, IC, 3, 4, RC), $1.25 (16, IC), $1.50 (2, RC), $2 (5, RC).
Aspen	$1 (12, 13, 14, 15).
Pinon-juniper, oak, etc. [b]	$0.25 (6, 7, 8), $0.30 (12), $0.40 (18, 19), $0.50 (14, 15, 16, 17, 20).

Type	Values [a]
Yellow pine, including sugar pine, etc.	$2 (2), $2.20 (12), $2.25 (3), $2.40 (8), $2.50 (4, 14, 15, 17, 18, 19), $2.60 (6), $2.70 (7), $3 (11, 16, 20).
Douglas fir, and larch—fir.	$1.40 (6, 8), $1.50 (1, 3, 4, 5, 12, 13), $1.75 (2, 9), $2 (10, 14, 15), $2.50 (18, 19, 20).
Lodgepole pine	$1.50 (2, 16), $1.60 (8, 9), $1.75 (1, 4, 7, 12), $2 (3, 6, 10, 13, 14, 15, 19). Jack pine $2 (21).
Spruce and fir, including hemlock, etc.	$0.75 (6, 7), $0.80 (8), $1 (5), $1.20 (9), $1.25 (4), $1.50 (2, 3, 13, 15, 16, 17), $1.60 (14), $1.75 (12), $2 (10), $2.25 (18, 19, 20). Eastern, $2 (21).
White pine	Western, $3.25 (2, 3), Eastern, $5 (21).
Subalpine	$0.50 (1, 2, 3, 4, 5, 6, 7, 8, 9, 16, 17), $1 (10, 12), $1.50 (15), $1.60 (14), $2.25 (18, 19, 20).
Hardwood	$1 (17), $1.50 (21).
Woodland	$0.50 (6, 7) (equivalent to $0.25 per cord). $1 (13, 14, 15, 16, 18, 19, 20).
Open	$0.50 (1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 13), $0.60 (12), $1 (14, 15, 16, 17, 18, 19, 20).

[a] Regions in parentheses.

[b] These prices are per cord.

proper methods have been worked out. However, costs are about the only tangible basis we have for valuing young stands.

In view of the many intangible values which can not be expressed in money, it seems fairly reasonable to use cost value for young growth as representing not only its value as potential timber but also the other forest values. This is on the theory that if the forest cover is to be maintained on a given site, it is worth at least what it would cost to put it there—if not for its timber value, then for other purposes, such as protection of watersheds. It seems quite possible that a portion of our Rocky Mountain forests will never yield enough timber to repay the costs of establishment and administration, unless timber values rise much higher than it seems reasonable to suppose. But because of their other values, which are of even greater importance, they will always be protected and maintained as forest. Cost of establishment as used here is not taken to mean the cost of growing the stand to maturity, or even to the age of that destroyed, but is merely the cost of getting young growth established. For use in figuring past losses, general values for the different types and regions were worked out by the following arbitrary method.[3]

Costs of replanting were set, based in part on results of planting operations on the national forests during a number of pre-war years, but mostly on arbitrary estimates of what replanting should cost if done immediately after a burn, and assuming that the proper technique had been developed (Table IX).

It was assumed that, taken by and large, one-half of the reproduction areas destroyed by fire will restock naturally within an average period of 10 years, and one-half not at all. Exceptions are lodgepole pine, jack pine, and the woodland types, of which it was assumed three-fourths will restock within 10 years and the rest not at all. Other exceptions are the western yellow pine type in the Great Basin and in the Southwest, and the scattered timber in the brush and grass types of all regions, of which it was assumed that but one-fourth will restock within 10 years.

The cost of restocking was then taken to be the cost of planting, plus compound interest at 3 per cent for 10 years. In case of destruction of young growth which will not restock naturally, the loss will be this figure; where natural restocking will take place the loss will be merely the 10 years' interest. This "rule-of-thumb" method gives the following results, "A" being area in acres and "C" the cost of planting per acre:

Where the entire area will restock naturally ..... 0.3439 AC, or 0.35 AC.
Where three-fourths of the area will restock naturally ..... .5939 AC, or 0.60 AC.
Where one-half of the area will restock naturally ..... .8439 AC, or 0.85 AC.
Where one-fourth of the area will restock naturally ..... 1.0939 AC, or 1.10 AC.

It is admitted that this method is not entirely scientific, but it is expected to give about as good a basis for valuing relative damage which has occurred over considerable areas and periods as we can get with the data available at present.

With the data described above (Tables VII, VIII, IX), the average monetary damage per acre was computed for the different types of forest and other cover within the several regions. (Table X.)

TABLE IX.—*Assumed costs of replanting, used as basis for estimating damage to young growth*

Forest type	Cost per acre to restock [a]
Western yellow pine, including sugar pine mixtures, etc.	$6 (3), $7 (2), $8.50 (11), $10 (1, 4, 6, 7, 8, 9, 10), $12 (12, 13, 16), $15 (14, 15, 17, 18, 19, 20).
Douglas fir, including western larch.	$6 (2), $7.50 (5, 6), $8 (3), $10 (1, 4, 7, 8, 9, 10, 12, 13, 16), $12 (18, 19, 20), $15 (14, 15), $20 (17).
White pine (W. and E.)	$5 (2), $6 (3), $6 (21). Norway pine, $6 (21).
Lodgepole pine	$8 (2, 3, 6), $10 (1, 4, 7, 8, 9, 10, 12, 13, 14, 15).
Jack pine	$10 (21).
Spruce	$5.50 (3), $6 (2), $6.50 (1, 9, 10), $8 (4, 7, 8), $10 (12, 13, 14, 15, 18, 19, 20).
Firs	$6 (2, 3, 21), $7.50 (4, 5, 6, 7, 8), $8 (16).
Subalpine	$6 (2, 3), $8 (4, 5, 6, 7, 8, 16), $10 (1, 9, 10, 12, 13, 14, 15).
Woodland	$5 (6, 12, 13, 14, 15, 16, 18, 19, 20).

[a] Regions in parentheses.

[3] A method for valuing young growth for use in making fire plans and in fire reports in the future is outlined in the discussion (pp. 759–760) on "Destructible values."

TABLE X.—*Average value of timber and young growth destroyed per acre burned over*

Region	Forest type								
	Western yellow pine and sugar pine	Douglas fir and larch	Lodge-pole pine	Spruce and firs	White pine	Sub-alpine	Wood-land	Brush	Grass
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1		5.92	4.95			10.40		[a] 0.29	0.29
2	4.75	4.45	4.63	14.97	14.20	2.24		.29	.29
3	4.36	8.03	4.79	14.65	14.20	2.24		.29	.29
4	5.13	9.44	5.54	13.97		2.80		.47	.47
5		6.61		8.12		3.86			
6	6.15	4.82	2.97	4.72		1.40	1.22	.78	.04
7	5.27		3.18	3.76		1.40	.33	.78	.04
8	8.23	5.12	3.10	5.12		5.28		.94	.47
9		6.12	4.77	2.90		10.40		[a] .30	[a] .30
10		6.31	5.24	4.25		12.39		[a] .30	[a] .30
11	2.95							.65	.65
12	3.37	3.10	7.98	6.29		3.01			.28
13		3.20	8.50	5.97			.28	.28	.15
14	4.20	4.68	12.10	6.10			1.68	.53	.53
15	8.22	8.83	5.24	5.97		5.97	.48	.68	1.18
16	4.59		2.68	4.64		1.40	.82	.99	.05
17	7.12	6.75				1.40	[b] .09	.51	.51
18	4.74	3.62		4.71		4.71	1.68	.34	.40
19	4.74	3.62	8.50	4.71		4.71	1.68	.34	.40
20	9.18	3.62		4.71		4.71	1.68	.34	.40
21			[c] 1.85	[d] 1.20	1.20		[e] 1.20	.10	[a] .10

[a] Estimated, data unsatisfactory.
[b] Hardwood bottoms.
[c] Jack pine.
[d] Spruce, balsam, tamarack, value estimated same as eastern white pine.
[e] Hardwoods, value estimated same as eastern white pine.

RATING THE LIABILITY

Rating of the liability of a given individual unit involves two different processes. One is the rating of the general liability, or the liability due to general risk fires. which may be considered as an average figure generally applicable to the entire area of a given type within one region. The other process is the rating of the special liability due to special risk fires, which can not be applied generally but will be different for each specific unit. In each of these cases the rating should include the total liability of each sort, i. e., the liability of loss, plus the suppression liability.

GENERAL LIABILITY—Since the general risk has been assumed to be spread fairly evenly over the whole extension of a given type within one region, the general liability will be uniform for equal areas of the type, provided they are subject to the same "hour control," no matter which individual forest unit within that region may be under consideration. This liability will be the product of the sum of probable average loss plus probable average suppression cost per fire for the given hour control, multiplied by the average number of fires per year per unit of area of the given type, and can be computed as follows:

1. Average sizes of fires for different hour-control periods are shown in Figures 4–18.

2. Average damage per acre burned over is found in Table X. The products of these two sets of figures give average damage per fire.

3. Average suppression costs per fire for different hour control periods are given in Table VI.

4. The average numbers of general risk fires per 1,000 acres of each type and region are given in Table XI.

5. The sums of damages and costs, found as outlined above, multiplied by number of fires, gives the general liability per 1,000 acres for each type and region according to different hour controls. These values are given in Table XII.[4]

[4] Tables were also prepared for regions 1, 5, 7, 9, 10, 11, 13, 14, 15, 18, and 20, but are omitted because of the rather inadequate data on which they are based.

TABLE XI.—*Average number of general risk fires on national forests per year per 1,000 acres, by regions and forest types, 1911–1915*

Region	Forest types								
	Yellow pine, etc.	Douglas fir, etc.	Lodge-pole pine	Fir, spruce, etc.	White pine	Sub-alpine	Wood-land	Brush	Grass and sage
1		0.00582	0.00541			0.00418		0.00522	0.00522
2	0.03146	.01015	.00766	0.00952		.00569		.01231	.01231
3	.04059	.02391	.01843	.03113	0.06294	.04644		.01989	.01989
4	.05188	.02441	.01956	.04806		.01859		.10937	.10937
5		.01077	.01378	.04203		.01378			
6	.07316	.10559		.11850		.04215	0.02857	.09584	.13636
7	.06667		.01774	.08955		.04706	.01048	.02179	.01405
8	.03645	.01548	.01359	.00451		.00993		.00601	.01333
9		.00630	.00813	.02326		.00327		.00907	.00907
10		.00420	.00456	.00347		.00071		.00462	.00462
11	.05227							.01724	.01724
12	.01281	.03077	.00682	.00239		.00252	.01149	.01149	.01149
13		.03333	.00926	.00385			.00077	.00077	.00627
14	.00485	.00306	.00162	.00393		.00393	.00061	.00402	.00402
15	.02186	.02326	.00980	.00256		.00256	.00102	.00221	.00495
16	.05064	.05064	.00601	.07692		.01119	.02817	.04112	.07752
17	.05952	.03604				.03846	[a].13194	.02531	[b].25641
18	[c].04252	.04252		.04252		.04252	.00767	.00133	.00133
19	[c].00717	.00717	.00435	.00717		.00717	.00421	.00200	.00200
20	[c].03806	.03806		.03806		.03806	.00374	.00361	.00361
21			[d].01842	.00475	.06250		[e].01081	.10000	.10000

[a] Hardwood bottoms.
[b] Doubtful.
[c] Same figure for all timber types, because no basis for separating them.
[d] Jack pine.
[e] Hardwood.

TABLE XII.—*Total general liability per 1,000 acres by control periods*

REGION 2—WESTERN MONTANA

Hour control	Forest types						
	Western yellow pine	Douglas fir and larch	Western white pine[a]	Lodgepole pine	Spruce and fir	Subalpine	Open
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	0.79	0.24	3.52	0.14	0.14	0.07	0.19
1	1.26	.44	6.10	.21	.17	.10	.27
2	2.33	.85	8.50	.31	.21	.12	.40
3	3.02	1.27	10.51	.40	.24	.14	.50
4	3.65	1.57	12.65	.43	.28	.15	.60
5	4.28	1.85	15.11	.46	.32	.16	.68
6	4.94	2.07	17.25	.59	.36	.17	.75
7	5.57	2.35	19.76	.91	.41	.18	.84
8	6.20	2.69	23.41	1.19	.47	.20	.92
9	7.05	3.04	25.55	1.40	.52	.24	.99
10	7.90	3.41	29.52	1.62	.59	.42	1.07
12	9.50	4.08	32.86	2.07	.75	.65	1.23
15	12.46	5.12	39.21	2.87	.92	.84	1.53
20	17.71	6.78	52.18	4.43	1.34	1.06	2.09

[a] Region 3 figures used for white pine type, because data for this region are insufficient.

TABLE XII.—*Total general liability per 1,000 acres by control periods*—Contd.

REGION 3—NORTHERN IDAHO

Hour control	Forest types						
	Western yellow pine	Douglas fir and larch	Western white pine	Lodgepole pine	Spruce, cedar, fir, hemlock	Subalpine	Grass and brush
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	0.97	1.39	3.52	0.42	0.43	0.56	0.30
1	1.54	2.54	6.10	.57	.56	.79	.44
2	2.87	4.76	8.50	.81	.68	1.02	.66
3	3.68	5.92	10.51	1.08	.81	1.11	.82
4	4.41	7.65	12.65	1.12	.90	1.21	.98
5	5.22	8.70	15.11	1.22	1.06	1.30	1.09
6	5.99	9.45	17.25	1.53	1.15	1.39	1.21
7	6.75	10.28	19.76	2.40	1.31	1.49	1.35
8	7.52	11.41	23.41	3.07	1.46	1.62	1.49
9	8.57	12.22	25.55	3.54	1.68	2.00	1.59
10	9.68	13.22	29.52	4.09	1.93	3.45	1.73
12	11.65	15.23	32.86	5.29	2.43	5.34	1.99
15	15.08	18.53	39.21	7.17	2.99	6.87	2.47
20	21.43	24.91	52.18	11.00	4.36	8.68	3.38

TABLE XII.—*Total general liability per 1,000 acres by control periods*—Contd.

REGION 4—EASTERN WASHINGTON

Hour control	Forest types: Western yellow pine	Douglas fir and larch	Lodgepole pine	Spruce fir, hemlock, cedar	Subalpine	Grass and brush
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	1. 56	0. 81	0. 59	1. 54	0. 22	5. 91
1	2. 39	1. 17	. 64	2. 40	. 32	7. 77
2	3. 71	1. 66	. 72	3. 32	. 45	10. 06
3	6. 48	2. 27	1. 00	3. 92	. 56	13. 12
4	9. 44	3. 15	1. 64	4. 62	. 59	15. 97
5	12. 92	5. 10	2. 05	5. 29	. 61	19. 58
6	16. 81	8. 08	2. 42	5. 87	. 63	23. 30
7	21. 37	13. 86	2. 82	6. 44	. 67	27. 67
8	26. 77	21. 72	3. 17	7. 35	. 69	32. 33
9	32. 32	32. 03	3. 66	8. 27	. 71	37. 41
10	38. 70	43. 40	4. 17	9. 23	. 74	42. 33
12	52. 24	72. 45	5. 36	10. 19	1. 04	54. 70
15	78. 28	129. 96	7. 12	12. 69	1. 73	72. 08
20	130. 05	264. 53	11. 11	16. 77	3. 27	116. 05

REGION 6—SOUTHERN OREGON AND NORTHERN CALIFORNIA COAST RANGES

Hour control	Forest types: Western yellow pine	Douglas fir	Red and white fir	Subalpine	Digger pine and oak	Brush	Grass
	Dolls.	*Dolls*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	3. 80	2. 32	1. 66	0. 34	5. 03	4. 79	3. 82
1	6. 51	3. 06	1. 90	. 34	6. 71	6. 80	4. 77
2	10. 83	4. 65	2. 25	. 38	8. 51	9. 29	5. 73
3	15. 22	9. 71	2. 61	. 38	10. 11	12. 08	6. 70
4	19. 68	14. 36	2. 84	. 38	11. 91	14. 57	7. 50
5	24. 29	19. 32	3. 32	. 42	13. 89	16. 96	8. 45
6	28. 90	23. 76	5. 10	. 42	16. 06	19. 36	9. 68
7	33. 43	28. 01	7. 58	. 42	18. 46	21. 56	10. 77
8	38. 04	31. 57	8. 89	. 42	20. 94	23. 96	11. 86
9	42. 58	34. 63	10. 07	. 46	23. 49	26. 36	13. 09
10	47. 04	38. 36	10. 90	. 46	26. 40	29. 04	14. 45
12	56. 33	44. 88	12. 44	. 51	32. 54	35. 17	17. 45
15	64. 45	56. 38	14. 70	. 55	42. 94	45. 33	22. 09
20	102. 42	77. 24	20. 50	. 76	63. 77	64. 70	31. 23

TABLE XII.—*Total general liability per 1,000 acres by control periods*—Contd.

REGION 8—EASTERN OREGON AND SOUTHWESTERN IDAHO

Hour control	Forest types: Western yellow pine	Douglas fir and Larch	Lodgepole pine	Spruce, fir, etc.	Subalpine	Brush	Grass
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	1. 45	0. 28	0. 30	0. 12	0. 13	0. 60	0. 72
1	2. 22	. 42	. 34	. 18	. 19	. 79	. 93
2	4. 05	. 55	. 37	. 24	. 27	1. 05	1. 23
3	6. 49	. 82	. 50	. 28	. 34	1. 37	1. 60
4	9. 59	1. 14	. 79	. 32	. 36	1. 69	1. 95
5	13. 27	1. 84	. 95	. 35	. 38	2. 07	2. 37
6	17. 50	2. 90	1. 13	. 38	. 40	2. 48	2. 84
7	22. 38	4. 97	1. 29	. 41	. 42	2. 95	3. 37
8	28. 17	7. 89	1. 44	. 45	. 44	3. 45	3. 96
9	34. 51	11. 36	1. 64	. 48	. 45	3. 99	4. 56
10	41. 08	15. 32	1. 86	. 52	. 48	4. 53	5. 16
12	55. 92	25. 28	2. 35	. 56	. 78	5. 83	6. 65
15	84. 38	44. 82	3. 10	. 65	1. 19	8. 05	9. 19
20	141. 10	89. 86	4. 73	. 79	2. 33	12. 45	14. 13

REGION 12—EASTERN COLORADO

Hour control	Forest types: Western yellow pine	Douglas fir	Lodgepole pine	Engelmann spruce	Subalpine	Grass and brush
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	0. 24	0. 86	0. 25	0. 08	0. 02	0. 18
1	. 31	1. 11	. 42	. 10	. 03	. 26
2	. 42	1. 88	. 83	. 13	. 05	. 38
3	. 50	2. 52	1. 21	. 17	. 07	. 47
4	. 55	3. 08	1. 71	. 19	. 08	. 56
5	. 67	3. 72	2. 31	. 22	. 09	. 67
6	. 78	4. 46	2. 90	. 25	. 11	. 77
7	1. 04	5. 26	3. 61	. 28	. 12	. 89
8	1. 39	6. 09	4. 36	. 31	. 13	1. 00
9	1. 79	6. 99	5. 22	. 35	. 14	1. 15
10	2. 21	8. 00	6. 05	. 39	. 15	1. 29
12	3. 20	10. 06	8. 13	. 46	. 16	1. 60
15	5. 05	13. 91	11. 63	. 60	. 21	2. 16
20	9. 49	21. 35	19. 19	. 84	. 28	3. 25

TABLE XII.—*Total general liability per 1,000 acres by control periods*—Contd.

REGION 16—WEST SLOPE OF SIERRAS

Hour control	Forest types: Western yellow and sugar pines	Red and white fir	Lodgepole pine	Subalpine	Digger pine and oak	Brush	Grass
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	2.08	0.92	0.20	0.01	3.80	6.43	4.50
1	4.15	1.69	.38	.01	4.85	7.76	5.27
2	7.04	2.54	.62	.02	5.97	9.88	5.97
3	9.72	2.77	.83	.02	7.04	11.62	6.59
4	12.26	2.92	1.03	.02	8.28	13.16	7.29
5	14.79	3.08	1.23	.02	9.61	14.45	7.91
6	16.66	3.23	1.37	.02	11.04	15.90	8.60
7	18.28	3.38	1.50	.02	12.34	17.62	9.23
8	19.65	3.46	1.60	.02	14.25	19.37	10.00
9	21.32	3.54	1.73	.02	15.97	21.05	10.54
10	22.99	3.69	1.86	.03	17.72	22.98	11.18
12	25.57	3.92	2.04	.03	20.47	27.22	12.35
15	30.74	4.15	2.33	.04	27.92	33.56	14.19
20	41.07	4.77	3.21	.09	41.32	46.77	18.22

REGION 17—SOUTHERN CALIFORNIA

Hour control	Forest types: Western yellow pine	Fir and pine slopes	Subalpine	Hardwoods	Chaparral	Grass,[a] etc.
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls*	*Dolls.*
½	2.92	3.31	0.04	4.22	6.25	21.28
1	5.24	7.62	.04	7.26	7.79	28.97
2	10.54	17.44	.08	11.34	9.47	36.15
3	16.25	25.51	.08	14.65	11.13	44.62
4	21.49	33.33	.08	16.62	12.68	54.62
5	26.90	41.19	.08	17.94	14.35	60.51
6	32.80	51.28	.08	18.60	16.02	76.67
7	38.45	62.57	.08	19.26	17.90	88.97
8	43.75	75.10	.08	19.92	20.00	102.82
9	48.28	87.60	.08	20.58	22.15	117.18
10	53.10	101.36	.11	21.62	24.28	134.10
12	62.14	132.11	.11	23.22	29.03	167.95
15	79.70	186.34	.15	25.33	37.21	229.49
20	115.42	298.27	.31	28.63	53.00	349.49

[a] Data on area very unsatisfactory; figures doubtless too high.

TABLE XII.—*Total general liability per 1,000 acres by control periods*—Contd.

REGION 19—SOUTHWESTERN COLORADO AND NORTHERN NEW MEXICO

Hour control	Forest types: Yellow pine	Douglas fir	Spruce and subalpine	Lodgepole pine	Pinon-juniper	Brush	Grass
	Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
½	0.19	0.13	0.32	0.16	0.01	0.02	0.03
1	.31	.21	.48	.28	.01	.02	.05
2	.60	.38	.61	.55	.02	.03	.08
3	.97	.65	.92	.80	.02	.03	.12
4	1.41	.93	1.06	1.14	.02	.04	.17
5	1.93	1.27	1.21	1.54	.03	.05	.23
6	2.53	1.66	1.32	1.94	.03	.06	.30
7	3.20	2.09	1.46	2.41	.03	.06	.38
8	3.98	2.57	1.60	2.92	.03	.07	.47
9	4.85	3.10	1.73	3.51	.04	.08	.57
10	5.72	3.66	1.86	4.07	.05	.09	.68
12	7.99	4.88	2.17	5.47	.05	.12	.92
15	11.81	7.27	2.60	7.84	.06	.16	1.37
20	21.41	12.27	3.41	12.95	.09	.23	2.29

REGION 21—LAKE STATES[a]

Hour control	Forest types: Eastern white and red pines	Jack pine	Spruce, balsam, tamarack	Hardwood	Open
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*
½	3.62	13.96	0.28	0.63	0.80
1	5.00	20.83	.38	.86	1.00
2	8.19	28.53	.62	1.42	1.20
3	12.12	37.97	.92	2.10	1.60
4	17.00	49.98	1.29	2.94	1.90
5	22.62	61.97	1.72	3.91	2.30
6	28.75	75.67	2.19	4.97	2.80
7	35.75	92.12	2.72	6.18	3.20
8	43.56	109.23	3.31	7.53	3.70
9	52.12	128.73	3.96	9.02	4.20
10	61.19	147.51	4.65	10.58	4.90
12	82.00	196.29	6.23	14.18	6.10
15	119.31	263.87	9.07	20.64	8.30
20	196.50	419.46	14.93	33.99	12.70

[a] All figures on areas very doubtful, and these values are therefore not very satisfactory.

To use these figures in estimating the general liability of a given forest unit it will be necessary to know the area and location of the different types of forest cover within the unit, and the hour-control that will be effected for all parts of the unit with the existing or proposed protective organization. Thus, the fire plan might show a forest in western Montana something like this:

Forest type	Area	Hour control	General liability
	Acres	*Hours*	*Dollars*
Western yellow pine	100,000	Less than 1	79.00
	50,000	2	116.50
	50,000	3	151.00
	50,000	4	182.50
Douglas fir	50,000	2	42.50
	100,000	4	157.00
	200,000	6	414.00
	50,000	12	204.00
Lodgepole pine	100,000	6	59.00
	50,000	8	59.50
Subalpine	50,000	10	21.00
	50,000	15	42.00
Total general liability for the forest			1,528.00

This means that, with the given amount of protection, the average annual loss plus suppression cost for general risk fires, for a period of years, ought to be about $1,500; some years might run above, others below this figure. It is hardly necessary to say that the example given is for a purely imaginary forest.

SPECIAL LIABILITY.—Rating of the special liability will be done in a slightly different way. It is not uniform for the whole area of a given type within a region, but is confined only to those parts of the type which are exposed to the fixed risks and varies for different units as the chance of occurrence of fires varies. In order to rate a unit it will be necessary to know what areas of each type are exposed to special risks, how many fires per year can be expected in each, and what hour control will be provided by the existing or proposed protection organization. The number of fires per year will be based on the average number which have occurred in that particular unit during a period of years, making due allowance for changes in the hazard, such as adoption of spark arresters or of fuel oil, or construction of effective fire lines along railroads. The special liability will then be the products of losses plus costs per fire for different hour control periods, found in the same way as described under general liability, multiplied by the number of special risk fires. For example, let us take the hypothetical western forest already described. We find that areas exposed to special risks are as follows:

Class of risk, forest type, and area	Hour control	Fires per year	Loss plus cost per fire	Product
Railroad fires:				
Yellow pine type—	*Hours*	*Number*	*Dollars*	*Dollars*
50,000 acres	Less than 1	25	25.25	631.25
20,000 acres	2	10	74.50	745.00
Douglas fir type—				
20,000 acres	2	5	83.60	418.00
Total liability due to railroad				1,794.25
Lumbering operations:				
Yellow pine type—				
25,000 acres	Less than 1	8	25.25	202.00
Douglas fir type—				
50,000 acres	2	7	83.60	585.20
Total liability due to lumbering				787.20
Total special liability				2,581.45

TOTAL GENERAL AND SPECIAL LIABILITY.—Having found the general and the special liabilities for the unit in the manner described, the total liability from all causes is their sum, or in the illustration given, $1,528 plus $2,581.45, or $4,109.45. It will be noticed that nowhere in this method of rating has any allowance been made for variations in the factor of efficiency. This appears to be justified for at least two reasons. The grouping together of the fires on several of the national forests and for periods of several years in studying the past records should have evened out differences in efficiency as far as past performance is concerned, and in figuring on future organizations we should assume these differences to grow no greater, and probably less.

LENGTH OF FIRE SEASON

The cost of maintaining a protective organization will be governed partly by the length of the period during which it must be effective. This of course depends upon the length of the danger period in the different units. The occurrence of general risk fires per unit of area (per 1,000,000 acres) in the different types and subregions, by 10-day periods, is shown in Table XIII. If it be assumed that the fire season, the period during which the protective organization should be effective, is marked by the period during which more than one fire per million acres occurs in each 10-day period, the fire seasons for the different types and regions will be found indicated under "Fire danger A" in each section of the table. A smaller number of fires per 10-day period ought to be handled effectively by the regular administrative organization, without seriously interfering with their other work. If the standard is set at some point greater than one per 10 days, it will cut down the fire seasons accordingly. (See "Fire danger B," Table XIII.)

TABLE XIII.—*Average number of general risk fires per year, per million acres, by 10-day periods* [a]

REGION 2—WESTERN MONTANA

Period	Number of fires, by forest types						
	Western yellow pine	Douglas fir and larch	Western white pine	Lodgepole pine	Spruce and fir	Subalpine	Grass and brush
Apr. 21–30				0.2			
May 1–10		0.1					0.6
11–20	0.2						
21–31		.1					
June 1–10	.2	.1					
11–20	.5	.2		0.1		0.2	
21–30	1.4	.8		.5		.2	.6
July 1–10	.2	.1		.2		.3	.6
11–20	2.5	.5		.3	0.6	.2	1.3
21–31	4.1	2.5		.7	2.5	.6	.6
Aug. 1–10	6.0	3.1	3.0	2.1	1.3	1.0	1.3
11–20	8.3	2.3		1.2		1.8	3.2
21–31	6.9	3.3		1.6	1.3	1.3	3.2
Sept. 1–10	1.6	.4		.8	1.3		.6
11–20	.9	.1		.1			.6
21–30	1.2	.1					.6
Oct. 1–10				.1			
11–20		.1					
21–31	.2						
Nov. 1–10							
11–20							
21–30		.1					
Danger periods A.[b]	June 21–30; July 11–Sept. 30.	July 21–Aug. 31.	Aug. 1–10.	Aug. 1–31.	July 21–Sept. 10.	Aug. 1–31.	July 11–20; Aug. 1–31.
Danger periods B.[b]	July 21–Aug. 31.	Aug. 1–31.	Aug. 1–10.	None.	None.	None.	Aug. 11–31.

[a] Tables were prepared also for Regions 1, 5, 7, 9, 10, 11, 13, 14, 15, 18, and 20, but are omitted because of the rather inadequate data on which they were based.

[b] Danger periods A are the periods during which one or more than one fire occurs in 10 days. Danger periods B are the periods within which three or more fires occur in 10 days, or two fires or more a week.

TABLE XIII.—*Average number of general risk fires per year, per million acres, by 10-day periods*—Continued

REGION 3—NORTHERN IDAHO

Period	Number of fires, by forest types						
	Western yellow pine	Douglas fir and larch	Western white pine	Lodge-pole pine	Spruce, hemlock, fir, cedar	Sub-alpine	Brush and grass
Apr. 11–20	0.9						
21–30							
May 1–10					0.8		
11–20		0.1	0.2				
21–31	.9						
June 1–10		.1	.4				
11–20		.3	.6				0.4
21–30	.9	.1	1.2		1.6		
July 1–10	.9	.2		0.9		0.6	
11–20		1.0	4.2	.9	1.6	1.7	.4
21–31	9.8	5.7	8.6	2.8	2.4	4.4	2.6
Aug. 1–10	6.2	3.2	13.0	6.6	7.2	3.8	1.8
11–20	8.0	4.4	13.2	5.6	6.4	12.9	5.7
21–31	16.9	5.3	17.0	2.8	4.0	10.2	4.8
Sept 1–10	8.0	1.7	4.2		4.8	2.6	1.3
11–20	1.8	.1	.6			.3	
21–30							.4
Danger periods A [b]	July 21–Sept. 20	July 11–Sept. 10	June 21–30; July 11–Sept. 10	July 21–Aug. 31	June 21–30; July 11–Sept. 10	July 11–Sept. 10	July 21–Sept. 10
Danger periods B [b]	July 21–Sept. 10	July 21–Aug. 31	July 11–Sept. 10	Aug. 1–20	Aug 1–Sept. 10	July 21–Aug. 31	Aug. 11–31

REGION 4—EASTERN WASHINGTON

Period	Number of fires, by forest types					
	Western yellow pine	Douglas fir and larch	Lodgepole pine	Spruce, hemlock, cedar, white fir	Sub-alpine	Grass and brush [c]
May 11–20	0.6					
21–31						
June 1–10	1.7	0.5				
11–20	2.8	.2		1.6		2.0
21–30	7.8	1.2	4.2	1.6	0.5	2.0
July 1–10	7.8	2.2	4.2	3.1	2.3	
11–20	6.2	2.7		2.3	.9	
21–31	17.4	4.9		8.6	9.2	2.0
Aug. 1–10	7.3	4.4	4.2	7.8	2.3	
11–20	6.2	4.4		11.7	1.4	2.0
21–31	11.8	5.9	12.6	18.7	.9	6.0
Sept. 1–10	6.7	1.9		3.9		6.0
11–20	3.9			1.6		
21–30	2.2			.8	.5	6.0
Oct. 1–10	2.8	.2				
11–20						2.0
21–31	.6					
Nov. 1–10	.6					
Danger periods A [b]	June 1–Oct. 10	June 21–Sept. 10	June 21–Aug 31	June 11–Sept. 20	July 1–Aug. 20	June 11–Oct. 20
Danger periods B [b]	June 21–Sept. 20	July 21–Aug. 31	Same as A.	July 1–Sept. 10	July 21–31	Aug. 21–Sept. 30

[b] Danger periods A are the periods during which one or more than one fire occurs in 10 days. Danger periods B are the periods within which three or more fires occur in 10 days, or two fires or more a week.
[c] Data on area of this type very unsatisfactory, therefore figures are little better than a guess.

TABLE XIII.—*Average number of general risk fires per year, per million acres, by 10-day periods*—Continued

REGION 6—SOUTHERN OREGON AND NORTHERN CALIFORNIA COAST RANGES

Period	Number of fires, by forest types							
	Western yellow pine	Western yellow and sugar pines	Douglas fir	Fir and lodge-pole	Sub-alpine	Digger pine and oak	Brush	Grass
Mar. 11–20		0.2						
21–31								
Apr. 1–10		.3						
11–20		.3					0.2	
21–30		.5						
May 1–10		.5	0.3				.2	
11–20	1.8	1.2	.8	0.7			.4	
21–31	1.0	1.9	.3	2.7		0.9	.6	
June 1–10	2.8	2.6	1.1	.7		.9	1.1	4.4
11–20	1.0	1.6		1.3			.4	
21–30		1.0	.3	.7			.6	
July 1–10	5.3	7.7	3.1	8.0		.9	4.4	13.2
11–20	3.9	6.1	6.2	4.0	3.9	2.8	3.2	13.2
21–31	7.4	9.5	7.8	7.4	3.9	.9	5.6	4.4
Aug. 1–10	6.8	4.7	4.8	3.3		11.4	8.9	8.8
11–20	4.2	9.1	8.1	10.7	3.9	.9	11.6	13.2
21–31	7.7	10.2	20.7	22.8	11.7	9.5	13.8	13.2
Sept. 1–10	1.8	4.6	5.9	1.3		2.8	4.4	4.4
11–20	1.8	2.1	2.2	2.0		1.9	8.4	
21–30	1.8	3.3	3.9	1.3		4.7	4.7	
Oct. 1–10	.4	3.3	2.8	4.0			6.8	
11–20	1.4	2.3	7.0	2.0			7.0	4.4
21–31	1.0	1.4	.6			.9	1.7	30.8
Nov 1–10	.4	.2					.6	
11–20	.4	.7						
21–30	1.4	.2					.8	
Danger periods A [b]	May 11–June 20; July 1–Sept 30; Oct. 11–31; Nov. 21–30	May 11–Oct. 31	June 1–10; July 1–Oct. 20	May 21–31; June 11–20; July 1–Oct. 20	July 11–31; Aug. 1–31	July 11–Sept 30	June 1–10; July 1–Oct. 31	June 1–10; July 1–Sept. 10; Oct. 11–31
Danger periods B [b]	July 1–Aug. 31	July 1–Sept. 10; Sept. 21–Oct. 10	July 1–Sept. 10; Sept. 21–30; Oct. 11–20	July 1–Aug. 31; Oct. 1–10	Same as A	Aug. 1–10; Aug. 21–31; Sept 21–30	July 1–Oct. 20	Same as A

REGION 8—EASTERN OREGON AND SOUTHWESTERN IDAHO

Period	Number of fires, by forest types						
	Western yellow pine	Douglas fir and larch	Lodge-pole pine	Spruce, white fir (cedar)	Subalpine	Brush	Grass and sage
Apr. 21–30	0.1						
May 1–10	.1						
11–20							
21–31	.3						
June 1–10							
11–20	.5						
21–30	.5		0.1				0.3
July 1–10	.5	0.1	.2		0.3		.7
11–20	1.2	.2	.6			1.0	1.3
21–31	3.6	1.5	1.9	0.5	.6		.7
Aug. 1–10	7.4	3.1	1.9	2.5	1.1	1.0	1.7
11–20	7.7	2.4	2.4	.5	2.2	2.0	1.7
21–31	6.9	2.9	1.9		1.9	1.0	3.0
Sept. 1–10	4.0	1.8	2.0		.8		2.3
11–20	.9	.9	.2	.5	.6		.7
21–30	.5	.3	.1		.5		
Oct. 1–10	.3		.3				
11–20	.1						
21–31	.1	.1	.1				
Nov. 1–10	.1						
Danger periods A [b]	July 11–Sept. 10	July 21–Sept. 10	July 21–Sept. 10	Aug. 1–10	Aug. 1–31	July 11–Aug. 31	July 11–Sept. 10
Danger periods B [b]	July 21–Sept 10	Aug. 1–10	None.	None.	None.	None.	Aug. 21–31

[b] Danger periods A are the periods during which one or more than one fire occurs in 10 days. Danger periods B are the periods within which three or more fires occur in 10 days, or two fires or more a week.

TABLE XIII.—*Average number of general risk fires per year, per million acres, by 10-day periods*—Continued

REGION 12—EASTERN COLORADO

Period	Number of fires, by forest types					
	Western yellow pine	Douglas fir	Lodgepole pine	Engelmann spruce	Subalpine	Grass and brush
Mar. 21–31						0.9
Apr. 1–10	0.2					
11–20				0.2		
21–30						
May 1–10	.2		0.4			
11–20						
21–31	1.2	3.1		.5		
June 1–10	.7		.4		4.0	
11–20	.5	3.1	.4	.2	4.0	.9
21–30	.9		1.3	.2	4.0	2.6
July 1–10	2.3	9.2	1.8	.2	8.0	.9
11–20	.9		.9			
21–31	.7	3.1	.4	.5		
Aug. 1–10	1.6	3.1	.9			.9
11–20	.7					.9
21–31	.7	6.1	.4		4.0	
Sept. 1–10	.7	3.1	1.3			
11–20	.5		.4			.9
21–30	.2		.4			
Oct. 1–10	.9	3.1				.9
11–20	.5	3.1				
21–31			.4	.2		
Nov. 1–10				.2		.9
11–20	.7		.4	.2		
21–30						.9
Danger periods A [b]	May 21–31; July 1–10; Aug. 1–10.	May 21–31; June 11–20; July 1–10; July 21–Aug. 10; Aug. 21–Sept. 10; Oct. 1–20.	June 21–July 10; Sept. 1–10.	None.	June 1–July 10; Aug 21–31.	June 21–30.
Danger periods B [b]	None.	Same as A.	None.	None.	Same as A.	None.

[b] Danger periods A are the periods during which one or more than one fire occurs in 10 days. Danger periods B are the periods within which three or more fires occur in 10 days, or two fires or more a week.

TABLE XIII.—*Average number of general risk fires per year, per million acres, by 10-day periods*—Continued

REGION 16—WEST SLOPE OF SIERRAS

Period	Number of fires, by forest types						
	Western yellow pine	Western yellow and sugar pines and Douglas fir	Red and white fir	Lodgepole pine and subalpine	Digger pine and oak	Brush	Grass
Feb. 21–28/29		0.5				0.2	
Mar. 1–10	0.3						
11–20	1.0	.1					
21–31							
Apr. 1–10							
11–20	.3						
21–30		.2					
May 1–10		.1					
11–20	.8	.2					1.7
21–31	1.3	.4			1.0	0.2	1.7
June 1–10	3.1	2.0	1.5		3.1	1.3	
11–20	4.2	1.3	3.0	0.3	3.1	.4	3.4
21–30	1.0	1.2		.6		.6	1.7
July 1–10	3.9	1.3	4.0			1.5	13.6
11–20	4.9	4.4	12.0	.3		4.4	8.5
21–31	7.0	4.5	7.0	.6	1.0	4.1	8.5
Aug. 1–10	9.4	3.9	8.5	.8	5.2	5.7	10.2
11–20	10.4	4.5	7.0	1.1	2.1	5.0	10.2
21–31	14.8	9.8	16.5	2.2	4.2	8.3	5.1
Sept. 1–10	5.2	4.1	6.5	.6	2.1	5.2	3.4
11–20	7.3	4.9	7.0	.6	3.1	5.2	1.7
21–30	12.0	3.3	6.5	.6	1.0	3.5	5.1
Oct. 1–10	4.7	1.7	3.0	.3		4.1	3.4
11–20	4.9	1.3	1.0		1.0	2.6	5.1
21–31	2.9	2.6			1.0	.9	
Nov 1–10	1.0	.6	.5				
11–20	.3					.2	1.7
21–30	.3	.2				.2	1.7
Dec. 1–10		.2					
11–20		.1					
Danger periods A.[b]	May 21–Nov. 10.	June 1–Oct. 31.	June 1–20; July 1–Oct. 20.	Aug. 11–31.	May 21–June 20; July 21–Sept. 30; Oct. 11–31.	June 1–10; July 1–Oct. 20.	May 11–31; June 11–Oct. 20; Nov. 11–31.
Danger periods B.[b]	June 1–20; July 1–Oct. 20.	July 11–Sept. 30.	June 11–20; July 1–Oct. 10.	None.	June 1–20; Aug. 1–10; 21–31; Sept. 11–20.	July 11–Oct. 10.	June 11–20; July 1–Sept. 10; Sept. 21–Oct. 20.

[b] Danger periods A are the periods during which one or more than one fire occurs in 10 days. Danger periods B are the periods within which three or more fires occur in 10 days, or two fires or more a week.

TABLE XIII.—*Average number of general risk fires per year, per million acres, by 10-day periods*—Continued

REGION 17—SOUTHERN CALIFORNIA

Periods	Number of fires, by forest types				
	Western yellow and Jeffrey pines	Fir and pine slopes	Hardwood bottoms	Chaparral	Grass and sage [d]
Jan. 1–10	0.6			0.2	
11–20					5.0
21–31				.1	
Feb. 1–10				.1	
11–20				.1	
21–28/29				.3	
Mar. 1–10					
11–20				.1	
21–31			1.4	.1	5.0
Apr. 1–10				.1	
11–20	0.6			.1	
21–30				.2	
May 1–10		1.8		.3	5.0
11–20	.6		2.8	.1	
21–31	2.4		1.4	.2	10.0
June 1–10	1.2		2.8	.2	5.0
11–20	1.8		7.0	.9	45.0
21–30	2.4	5.4	12.6	.8	25.0
July 1–10	1.8	1.8	14.0	1.5	20.0
11–20	5.4	1.8	5.6	1.5	15.0
21–31	6.0	3.6	2.8	3.2	50.0
Aug. 1–10	10.8	5.4	9.8	2.6	5.0
11–20	6.0	5.4	23.8	2.7	15.0
21–31	9.0	18.0	21.0	2.8	20.0
Sept. 1–10	4.8	12.6	22.4	1.7	25.0
11–20	7.8	7.2	5.6	2.0	20.0
21–30	1.8	1.8	1.4	2.0	5.0
Oct. 1–10	1.8		1.4	1.0	15.0
11–20	.6		2.8	2.1	15.0
21–31	1.8	1.8	4.2	1.0	25.0
Nov. 1–10	1.2		2.8	.8	20.0
11–20	1.2	3.6	2.8	.7	10.0
21–30	1.2		1.4	1.3	5.0
Dec. 1–10				.4	
11–20				.1	
21–31				.1	5.0
Danger periods A [b]	May 21–Oct. 10; Oct. 21–Nov. 30.	May 1–10; June 21–Sept. 30; Oct. 21–31; Nov. 11–20.	Mar. 21–31; May 11–Nov. 30.	July 1–Oct. 31; Nov. 21–30	Jan. 11–20; Mar. 21–31; May 1–Nov. 30; Dec. 21–31.
Danger periods B [b]	July 11–Sept. 20.	June 21–30; July 21–Sept. 20; Nov. 11–20.	June 11–Sept. 20; Oct. 21–31.	July 21–31.	Same as A

[b] Danger periods A are the periods during which one or more than one fire occurs in 10 days. Danger periods B are the periods within which three or more fires occur in 10 days, or two fires or more a week.
[d] Data on area very unsatisfactory, figures probably too high.

TABLE XIII.—*Average number of general risk fires per year, per million acres, by 10-day periods*—Continued

REGION 19—SOUTHWESTERN COLORADO AND NORTHERN NEW MEXICO [e]

Period	Number of fires, by forest types			
	Western yellow pine, Douglas fir, Engelmann spruce	Lodgepole pine	Pinon-juniper	Grass, brush, sage, and aspen
Mar. 1–10			0.4	
11–20				
21–31				
Apr. 1–10				
11–20				
21–30	0.2			
May 1–10	.2		.4	
11–20	.3		.7	0.3
21–31	.7			
June 1–10	.8		.7	.1
11–20	.4			.1
21–30	.8			.2
July 1–10	.6	0.9	.7	.1
11–20	.6			
21–31	.1			.1
Aug. 1–10	.2			.1
11–20	.5			.1
21–31	.5		.4	
Sept. 1–10	.1			
11–20	.1			
21–30	.2			.1
Oct. 1–10				.1
11–20	.2			
21–31	.4			.4
Nov. 1–10				
11–20	.1			.1
21–30	.3			.1

REGION 21—LAKE STATES [f]

Period	Number of fires, by forest types				
	Eastern white and red pines	Jack pine	Hardwoods	Tamarack and balsam	Open
Apr. 1–10	1.2				
11–20	2.5	1.5			6.7
21–30	13.7	3.7			13.3
May 1–10	3.7	.7			20.0
11–20	8.7	3.0	1.1		6.7
21–31	2.5	2.2	1.1		
June 1–10	5.0	1.1	4.3		
11–20	2.5	1.1	2.2		
21–30	1.2	1.5	1.1		6.7
July 1–10	1.2	.7	1.1		6.7
11–20	5.0	1.8	1.1		6.7
21–31	1.2				
Aug. 1–10		1.8			
11–20		.7		1.0	
21–31	1.2				6.7
Sept. 1–10	1.2	.4			6.7
11–20				1.0	
21–30					
Oct. 1–10		.7			6.7
11–20					
21–31		.4			
Danger periods A [b]	Apr. 1–July 31; Aug. 21–Sept. 10.	Apr. 11–30; May 11–June 30; July 11–20; Aug. 1–10.	May 11–July 20.	Aug. 11–20; Sept. 11–20.	Apr. 11–May 20; June 21–July 20; Aug. 21–Sept. 10; Oct. 1–10.
Danger periods B [b]	Apr. 21–May 20; June 1–10; July 11–20.	Apr. 21–30; May 11–20.	June 1–10.	None.	Same as A.

[b] Danger periods A are the periods during which one or more than one fire occurs in 10 days. Danger periods B are the periods within which three or more fires occur in 10 days, or two fires or more a week.

[e] No danger periods occurred in this region; that is to say, the average per 10 days was always less than one fire.

[f] Data on areas of all types very unsatisfactory; figures for numbers of fires in "open" probably much too high.

THE USE OF LIABILITY RATINGS IN FIRE PLANS

It is realized that the figures given in Tables VI to XIII are based on such incomplete data in many cases, perhaps in all, that they can not be used as absolute guides in allotting funds for primary protection. It does seem reasonable to believe, however, that figures worked out in this way can be so used, as soon as sufficient data accumulate to afford a basis for reliable figures on spread of fires, on suppression costs, and on the damage done in different types. It will also be desirable, perhaps, to have a more detailed classification of fires based not only on mere segregation by types, but also according to differences in the age of the stands, differences in quality of sites, and differences in characteristics with respect to inflammability.

Meanwhile, the figures given here may serve as valuable indicators in planning protection, provided they are not relied upon to too great an extent. In the first place, as fire plans for each of the national forests are worked out, showing the locations and areas of the different forest types classified according to the hour control now in effect, and ratings are made by the use of the tables, great differences in liabilities between different forests will undoubtedly appear. It will then be proper to examine more closely those forests whose liability is rated especially high and extremely low, to see whether or not more protection should be given the former.

Then, if the ratings could be relied upon absolutely, the justification of a suggested increase or decrease in protection could be determined by weighing its cost against the reduction or increase in total liability effected by such modification of the protection organization. Ratings based on the present data are not good enough to decide such questions, but should at any rate be suggestive.

A point which should be borne in mind is that it may not always be necessary to increase expenditures in order to increase the intensity of protection or to reduce the hour control. This may be accomplished on any forest unit in other ways, such as changing the distribution of personnel so as to locate men nearest to where the greatest number of fires will start, or nearest to where fires may be expected to spread most rapidly or be most destructive or costly to control, such as slashings, for instance. Nor do increased protection expenditures necessarily mean increased personnel, but the expenditure may be made in such a way as to reduce the hazard, by isolating special risks, or by removing especially hazardous conditions, such as logging slash, windfalls, or snags, or by improving communication.

MINIMUM REQUIREMENTS

It is believed that one exception should be made to the general principle of weighing costs against liabilities; that is, except in a very few places where it is certain that fires can be left without danger, enough protection should be provided during the danger season so that it will be possible to reach any part of every forest unit within 12 hours after a fire is discovered. The reason for this is that the law of averages is less dependable for longer elapsed periods, and even though averages may show comparatively low liabilities, it is more than likely that a considerable proportion of fires left for longer periods may do a great deal of damage or may prove very costly to control, or that they will spread from areas of low liability to areas where damage and costs will be much greater. A large proportion of the worst fires that have occurred on the national forests burned for more than 12 hours before they were attacked, and a considerable part of the total fire loss has been caused by such fires. For instance, nearly half of the total timber area burned during the five years studied, when the protective organization was not as well developed as it has subsequently become, is shown by the available records of elapsed time to have been burned over by fires which were not attacked until 12 hours or more after their discovery. (Tables XIV, XV, and XVI.)

TABLE XIV.—*Comparison of areas on which fires were attacked within 12 hours of discovery and those on which attack was later*

Region	Acreage of timber fires [a] by time of attack				Acreage of woodland and open fires by time of attack			
	Attack within 12 hours	Attack after 12 hours	Total burned	Percentage after 12 hours	Attack within 12 hours	Attack after 12 hours	Total burned	Per centage after 12 hours
	Acres	*Acres*	*Acres*	*Per cent*	*Acres*	*Acres*	*Acres*	*Per cent*
1	3,975	94	4,069	2	788	10	798	1
2	13,316	7,659	20,975	37	600	0	600	0
3	8,837	5,386	14,223	38	73	83	156	53
4	8,871	22,655	31,526	72	4,160	4,940	9,100	54
5	8,272	15,724	23,996	66				
6	17,477	7,154	24,631	29	22,274	7,573	29,847	25
7	6,940	12,168	19,108	64	11,295	0	11,295	0
8	8,961	27,264	36,225	75	2,948	4,600	7,548	61
9	5,901	813	6,714	12	3,894	161	4,055	4
10	6,083	1,471	7,554	19	12,438	7,968	20,406	39
11	26,657	827	27,484	3	2,506	200	2,706	7
12	1,484	0	1,484	0	96	20	116	17
13	2,602	451	3,053	15	1,566	361	1,927	19
14	21	80	101	79	1,070	1,282	2,352	54
15	487	153	640	24	12,706	60	12,766	0
16	29,084	4,565	33,649	14	67,567	10,281	77,848	13
17	6,228	590	6,818	9	147,539	6,617	154,156	4
18	17,294	32,090	49,384	65	8,578	87	8,665	1
19	3,058	648	3,706	17	2,287	0	2,287	0
20	8,514	670	9,184	7	8,893	555	9,448	6
21	[b]	[b]	[b]	[b]	66,593	15,149	81,742	19
Total	184,062	140,462	324,524	43	377,871	59,947	437,818	14

[a] Including subalpine type.

[b] Included in open.

TABLE XV.—*Number of fires by elapsed time groups, for general risk fires in all types*

Region	Total number of fires	Fires by hours elapsed from discovery to start of suppression work												
		Less than 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 15	15 to 20	More than 20
1	42	15	9	2	2	2	1		1	2	2	2	2	2
2	337	104	58	17	17	24	14	6	12	13	10	16	19	27
3	588	174	62	47	17	19	11	9	19	23	12	68	44	83
4	330	197	29	15	8	4	5	4	7	4	7	18	13	19
5	83	31	4	6	2		4	2	1	4	1	8	8	12
6	1,499	447	251	183	112	75	51	58	38	44	24	106	56	54
7	828	285	129	75	41	50	33	20	16	15	23	61	47	33
8	465	130	57	45	36	20	17	14	18	6	19	35	31	37
9	116	51	19	8	7	4	4		3	3	3	3	7	4
10	131	51	16	7	16	6	6	4	3	1	1	8	3	9
11	434	211	90	47	21	15	9	10	8	2	2	12	6	1
12	108	71	9	6	6	3	3	2	1	2	1	2	2	
13	108	56	19	6	8	3	1	2	4	1	1	2	1	4
14	25	11	6	2	2			1				1		2
15	73	27	12	12	3	4	2	1	3	1	4	1	1	2
16	1,385	669	223	135	79	52	20	25	15	17	20	77	27	26
17	745	557	78	22	21	18	6	9	6	5	4	10	3	6
18	1,096	496	154	129	85	52	27	23	17	10	11	38	30	24
19	235	114	40	22	18	10	5	3	4	1	3	6	5	4
20	197	76	43	17	16	8	9	4	1	4	1	7	4	7
21	149	105	13	8	9	1			1	1		5	3	3
Total	[a]8,974	3,878	1,321	811	526	370	228	197	178	159	149	486	312	359
Per cent	100	43.2	14.7	9.0	5.9	4.1	2.5	2.2	2.0	1.8	1.7	5.4	3.5	4.0

[a] Totals of Tables XV and XVI do not agree with Table I, because this table includes most of the fires on private land in and adjacent to the forests, on which data were available. On the other hand, Table I includes some fires not included here, because elapsed times were not given.

TABLE XVI.—*Number of fires by elapsed time groups, for special risk fires in all types*

Region	Total number of fires	Fires by hours elapsed from discovery to start of suppression work												
		Less than 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 15	15 to 20	More than 20
1	115	108	3	2	1							1		
2	337	291	24	3	4	2	1	1	2	1	4	1		3
3	202	153	20	6	5	1	3	2			2	7	2	1
4	42	22	6	2	1	2		3	2			2	1	1
5	24	17			1		2					1	1	2
6	82	66	8	2	2	1				1			2	
7	53	39	9	2	2	1								
8	24	17	3		2	1	1							
9	33	24	7	1		1								
10	33	14	4	3	2	1	1				2	3	1	2
11	175	131	25	9	3	2	2	1		1		1		
12	148	120	15	5	2	1	1		1		1	2		
13	91	62	16	7								2	3	1
14	8	4		1				1		1				1
15	12	5	2	2	1	2								
16	214	155	44	6	1	1	3		1			1		2
17	113	86	15	2	3		1	1	2	1	1	1		
18	155	138	13	1			1		1			1		
19	119	71	29	8	4	2		2		1		1		1
20	17	7	4	3	2									1
21	180	151	15	5	2	1		1	1		2	2		
Total [a]	2,177	1,681	262	70	38	19	16	12	10	6	12	26	10	15
Per cent	100	77.2	12.0	3.2	1.7	0.9	0.7	0.6	0.5	0.3	0.6	1.2	0.5	0.7

[a] See note (a), Table XV.

PRIVATE LANDS

For purposes of rating liabilities, no consideration has been given to values on private lands within or adjacent to forest boundaries, because the cost of protecting such values should be met by the owners. It may in some cases be desirable to protect timber values on private lands, because of the possibility of the land being acquired later by the public, through exchange or in some other way. In such cases, arrangements should be made whereby the owner pays the cost of protection either now or at the time when the land is transferred.

In computing special liabilities for any forest units, due allowance should of course be made for special risk fires originating on adjacent or included lands which if not controlled may spread to the protected lands. Fires starting on a railroad right of way running through a forest, for instance, are as much a source of danger to the forest as if the right of way were owned by the public. Where, however, the right of way is so isolated by fire lines or otherwise that no fires ever have escaped from it on to the protected lands, fires occurring on the railroad land would not be counted in computing the liability.

FIRE PLAN RECONNAISSANCE

To apply the method of rating liabilities outlined in the preceding pages, or any other method, for that matter, it will be necessary to make some kind of a survey of the lands and resources that are to be protected. For a preliminary rating, this can be done in a rather extensive way, without a great amount of detailed field work, but such a rating should be followed, eventually, by a more accurate and detailed one based upon an intensive survey. In the meantime, more accurate and complete records should be kept of all fires that occur, in order to afford a better basis for rating liabilities.

DATA TO BE OBTAINED

The survey, whether extensive or intensive, should result in the following information for each forest and protection unit (or ranger district):

1. A map, showing the location and extent of all areas of each class of risk, together with the hour control effective for each area, under the existing conditions. The amount of detail used in classification of risks will depend upon the intensity of the survey.

2. Statistical data regarding the areas subject to risk, classified as shown on the map. These data may be represented in tabular form, somewhat as follows:

A.—AREAS SUBJECT TO GENERAL RISK

Unit	Forest type	Age class	Risk class	Hour control			Quantity and value of timber and young growth		General liability factor	Total general liability
				Less than hour (acres)	1 to 2 hours (acres)	Etc. (acres)	Total	Per acre		

"General liability factors" are the factors for total liability per 1,000 acres, as already given in Table XII. With the data so far available there will be one uniform factor for each type in a given region, regardless of its age or risk class, but varying with hour control. When more detailed ratings can be made, it will be desirable to use different liability factors for stands of different ages and different relative risk. It will also be desirable to take into account the differences in quantities and values at stake, possibly by expressing liability of loss in terms of percentage of total values, instead of directly in dollars.

The preliminary reconnaissance need not show age classes or risk classes, since we have not the data necessary to rate them separately. It is obvious, however, that both costs of suppression and amounts of damage will vary rather widely with differences in age or risk class within a single type, and separate ratings should be made as soon as fire records with the necessary basic information accumulate. It is desirable to have information regarding the distribution of age classes and risk classes for use in planning protection, even though we can not yet rate liabilities in such detail. The classification as to hour control should be based on what is reasonably possible with the existing or proposed protective organization, taking into consideration location of personnel and means and speed of travel.

3. Special information should be given regarding areas of high liability, whether due to probability of occurrence of fires, to probability of rapid spread and of difficulty in suppression, or to probability of heavy damage because of the size of the area likely to burn over, or because of high destructible values. Such information should describe the reasons for the high liability, and, if possible, suggest means of reducing it.

SPECIFICATIONS FOR CLASSIFYING RISKS

The following specifications are suggested as a basis for the classification of areas indicated in the maps and tables described above. The limit of subdivision should be approximately 40 acres for the intensive survey, or 160 acres for an extensive one; or, in other words, no area should be distinguished on the map, or counted in preparing the tables, unless it is at least 40 or 160 acres, respectively, in extent. Smaller areas should be thrown with the neighboring ones. Exceptions to this rule may be made in the case of smaller areas of especially great liability.

FOREST TYPES.—To be classified on the basis of present cover, because that is what is being protected and what determines the hazard and liability. All areas which are fairly satisfactorily stocked with tree growth, no matter how small, should be classed with the

B.—AREAS SUBJECT TO SPECIAL RISKS

Number of fires per year per unit area of the type, for the given unit and cause [a]	Special liability factor	Total special liability (for this cause)

[a] The same data for each kind of special risk separately, as in A, except for the last two columns, for which should be substituted the last two columns of B.

type represented by those trees, and not with the type represented by the possibly more obvious cover, such as brush. In other words, brushfields which have a good stand of tree reproduction beneath the brush cover should be classed with the proper timber type, and not with "brush." In case of two-storied types, as conifers under aspen in some parts of the Great Basin region, the cover should be classed according to the species of chief economic or silvicultural importance. For instance, if such a stand is to be handled as an aspen forest, the conifers may be considered as underbrush, and the type be called "aspen." But if the conifers are to grow to maturity and become the chief crop, and the aspen represents only a temporary phase of the development of a conifer stand, then the cover should be designated as belonging to the proper conifer type. Strictly speaking, there should be classed as "subalpine" only the strictly noncommercial scrubby or scattered high altitude stands, although the ratings as developed in this study undoubtedly included some merchantable fir and spruce and probably some lodgepole pine stands as subalpine.

In general, the definitions of the different types will be about the same as those prescribed for use in timber surveys. In some cases, however, two or more of these types have been grouped together in the present study, and some of these groups may be allowed to stand even in working out more detailed ratings in the future. Others should be separated if possible. Such are the aspen type of the Central Rocky Mountains, now combined with other types; the Engelmann spruce and subalpine types, now combined in several regions; and the brush, grass, and woodland types, now thrown together in a number of cases. In some instances, where a type occurs over a limited area within a region, it has been combined with other types. Thus the limited areas of western yellow pine in the Northern Rocky Mountain region should be thrown in with the Douglas fir or lodgepole pine types.

AGE CLASSES.—Classification as to age should be based on the age of the major part of the stand; for instance, a very scattered stand of old seed trees, over a fairly well-stocked stand of reproduction, would be classed as reproduction; a stand composed of trees of several age classes, but with a large preponderance of mature trees, would be classed as mature. Not more than five age-classes should be recognized. These are:

1. Reproduction	Trees up to 4 inches d. b. h.
2. Small poles	Trees between 4 and 7 inches d. b. h.
3. Large poles	Trees between 8 and 11 inches d. b. h.
4. Young merchantable.	Trees 12 inches or more in d. b. h., up to the rotation age, or the age generally considered as representing maturity.
5. Mature and overmature.	

In addition to these five classes, a sixth class of stand should be recognized, viz: All-aged, where practically all ages are present in approximately equivalent proportions.

RISK CLASSES.—Each stand, after being classified according to type and age class, should be further classified according to the degree of risk involved. "Risk" is used here in the sense of inflammability and controllability, independent of the probability of fires starting or of the presence or absence of a protective organization. For the purpose of rating liabilities, three risk classes should be recognized, based on the susceptibility of the stand to fire. This susceptibility is determined by the fire resistance or inflammability of the component species and of the ground cover, and to some extent by topographic conditions, which favor or hinder rapid spread and destructiveness of fires, and make control work difficult or easy. These classes may be designated as low risk, average risk, and high risk, and should represent the relative risks as between stands of the same type and age class, but not between stands of different types. A stand of western yellow pine classed as "high risk" might not represent as great damage or cost as a "low risk" stand of western white pine, but it would represent a risk greater than the average for the yellow pine stands in the region concerned. Brief tentative specifications for the different risk classes follow.

LOW RISK

Reproduction.—Young trees scattered as individuals or in patches, with comparatively little brush or litter, or where the cover is grazed fairly close before the fire season, or where the inflammable ground cover as a whole—including tree reproduction, grass, weeds, brush, and litter—is not continuous, but is broken by numerous openings or patches of bare soil, rock, or less inflammable vegetation, (such as bear clover). On sheltered flats or moist bottoms, the cover may be more continuous.

Pole stands.—For larger poles, stands with comparatively little undergrowth or dead and down material, and with boles fairly clear of dead branches or moss. For smaller sizes of poles, broken stands with noninflammable openings. For all sizes, stands on sheltered flats and in moist situations.

Merchantable stands.—Comparatively open stands with clear boles, little undergrowth except grass and weeds, or tree reproduction less than 1 foot high, with few standing snags and little litter or débris. Trees not badly scarred at their bases, nor covered with dry moss or pitch. In mixed types, stands composed largely of the more fire resistant species of the mixture. In all-aged stands, those where older trees largely predominate. No deep continuous layer of duff. Stands on sheltered flats and on moist sites which in other situations might fall in a more hazardous class.

AVERAGE RISK

Reproduction.—Stands of fair density, with a fairly continuous cover of light herbage and scattered brush, with only a moderate amount of scattered débris, or with considerable litter entirely shaded and kept from drying out by a dense crown cover. Such stands on moist flats might be classed as low risk, and on steep slopes exposed to drying winds as high risk.

Pole stands.—Larger sizes, with some undergrowth and débris, or with average amount of dry lower branches. Smaller sizes, with comparatively little, or only patchy, inflammable ground cover.

Merchantable stands.—Stands with a fair amount of undergrowth, including tree reproduction, and with more or less débris, scattered standing snags, and more moss, low crowns, or dry lower branches. Stands with average proportions of the more inflammable species.

HIGH RISK

Reproduction.—Either open or dense stands, with heavy grass, dry during the fire season, or a continuous cover of brush and débris to carry fire. Stands on steep slopes and other sites exposed to drying winds. An extreme example of a "high risk" stand of reproduction or poles is found in the "jack-straw" burns common in many regions.

Pole stands.—The larger sizes, where there are large amounts of inflammable ground cover and débris, moss on stems, low inflammable crowns, standing snags, or on steep exposed sites. In mixed stands those with larger proportions of the less resistant species. The smaller poles, where there is a continuous cover of brush or inflammable débris, even if not especially great in quantity. Stands on steep slopes or most exposed situations, which on other sites might fall into the "average risk" class.

Merchantable stands.—Stands with large amounts of inflammable undergrowth or débris (such as logging slash), large numbers of standing snags, bases of trees badly fire-scarred, boles covered with dry branches or much dry moss or resinous bark. Stands with somewhat less inflammable material, where especially exposed to drying winds or on steep slopes. In mixed stands, those where the least resistant species are represented in large numbers; in all aged stands, those with a large proportion of the younger ages. Stands with a deep layer of duff or peat which dries out during the fire season.

DESTRUCTIBLE VALUES

Values should be tabulated as indicated, for individual stands. These values represent what would be lost in case of total destruction by fire, and include values of timber, both merchantable and young growth, of the forest capital (not including soil productivity), where that is involved, and of intangibles such as watershed protection. Forage value is omitted, unless it can be considered to be included in the figures given for the other values, for the reason already mentioned, viz, that destructible value of forage is generally so insignificant in comparison with the other values as to be less than the probable error in estimating the others. For the sake of simplifying calculations, therefore, it is left out.

In order that such values can be easily gotten at, and to insure that the values given shall be comparable as between different forest units and between different regions, and also in order that figures on damage during a series of years may be computed on the same basis and may therefore be possible of comparison—which is not the case with the records hitherto collected—it seems extremely desirable to establish standards, to be used uniformly, without the necessity of leaving very much to the individual judgments or guesses of reporting officers.

These standards should be as simple as is consistent with the purpose for which they are to be used, namely, to show relative values and relative damages as between stands of different species, of different ages, and in different regions. Moreover, they should be in such form as to enable the field men to work the values out without mathematical formulae. With these ideas in mind, standard values were worked out as outlined below.

VALUES OF MERCHANTABLE TIMBER

Merchantable timber, i.e., timber of merchantable size in "young merchantable," "mature," and "all-age" stands, should be valued on the basis of its species and volume, at fixed stumpage rates. For reasons already discussed, it seems advisable to use uniform rates for one species throughout a given region The values suggested have been given in Table VIII. Such scattered trees of merchantable size as may be found in "reproduction" and "pole" stands should not be given a timber value, because they generally would not be utilized for timber. No additional allowance is made for the capital value of merchantable stands, because, in general, natural reproduction will follow the destruction of such stands, if further fires and grazing are kept out. No value will be put on the timber, as such, in scrubby high-altitude subalpine stands that never will be utilized for timber production. Their value consists entirely of the intangible values for watershed protection and the like, and for mature stands will be the same as given in Table XVII for "large poles."

VALUES OF YOUNG GROWTH

The timber value of young growth depends upon its species and the stage of development which it has reached. This value is the value of the accrued net return on the capital value of the forest, for a number of years equal to the economic age of the stand. For natural stands, such as practically all of those on the national forests, it can be expressed by the formula:

$$V = Y \times \frac{1.0p^m - 1}{1.0p^n - 1}.$$

Here Y is the value of the final crop (for the sake of simplicity no allowance is made for intermediate returns from thinnings), $.0p$ is 3 per cent, m is the economic age of the stand, and n is the number of years in the rotation.

The value of Y depends upon the stumpage value per thousand board feet and the amount of timber that will be produced during a rotation. For the purpose of establishing standard values for young growth, arbitrary rotations and yields were used, with the stumpage rates given in Table VIII. Because we know very little about what rotations will actually be used for stands now below merchantable size, it seemed advisable for the present purpose to use a uniform rotation period of 100 years, regardless of forest type, in the regions where growth is moderately fast (regions 2, 3, 4, 5, 6, 7, 8, 16, and 17), and 150 years where it is slower (regions 1, 9, 10, 11, 12, 13, 14, 15, 18, 19, and 20). For the Lake States (region 21) a 70-year rotation was used.

In order that the field men may not have to estimate the ages of the stands, and to reduce the division into age classes to the simplest practicable terms, only three age classes of young growth are recognized, and these are expressed in terms of size, rather than of age. They are: Reproduction (stands below 4 inches d. b. h.); small poles (4 to 7 inches d. b. h.); and large poles (8 to 11 inches d. b. h.). In stands classed as "all-aged," young growth of all sizes will be lumped together. For computing values by the formula, the average ages of these size-classes were assumed to be: For 150-year rotation, 20, 40, and 70 years, respectively; for 100-year rotation, 15, 30, and 50 years; and for 70-year rotation, 10, 20, and 35 years.

Besides the timber, or product, value of young stands, there is their value as part of the forest capital. The destructible part of this value (aside from soil productivity, which will not be considered) is the cost of establishment. That is to say, when a new stand has been established on the burned area, the forest capital (but not the accumulated product) has been restored. If a destroyed stand is quickly replaced by natural reproduction, it is considered that no capital loss has been suffered; but where natural restocking does not follow, the capital loss, equal to cost of replanting, must be added to the product loss. Standard costs of planting have been given in Table IX. For the sake of simplicity and uniformity, it has been assumed that stands of young growth covering less than 10 acres, and also young growth of any area under merchantable stands or scattered through all-aged stands, will be replaced by seeding from the sides or from above if destroyed by fire, and that areas greater than 10 acres (except where mixed with older timber) will not restock naturally. Burns smaller than 10 acres, within more extensive stands of young growth, can not be depended upon to restock naturally within a reasonably short period; therefore damage in such cases will include the capital loss. Exceptions to the above assumption are: the western yellow pine in regions 14, 15, 18, 19, 20, where it was assumed that only one-half of the destroyed area will restock even in stands smaller than 10 acres; Douglas fir in the same regions, where it was assumed that only two-thirds of the destroyed area will restock in stands smaller than 10 acres; the woodland types in all regions, where only one-half will restock in stands under 10 acres in extent; lodgepole pine and jack pine stands of the "large pole" class, where it was assumed that half the burns will restock naturally even in stands larger than 10 acres; and the hardwood and aspen types in all regions, which will restock entirely, even on large burns.

INTANGIBLE VALUES

There appear to be no data upon which to base valuations of watershed protection, recreation values, or other similarly intangible benefits due to the presence of a forest cover, or to estimate what part of such values might be destroyed by a fire. It seems fairly reasonable to suppose that in most cases where reproduction will follow naturally almost immediately after the burn, the damage to such values is comparatively small; where such restocking will not take place, the damage estimates

already allow for the cost of restoring a stand by planting, which is probably considerably greater than the actual intangible loss. No additional value, therefore, has been allowed for "intangibles," except in the case of brushland and grassland, and subalpine areas that do not produce merchantable timber, and the southern California hardwood bottomlands type, that has small commercial value and a very great intangible value. For these types, arbitrary intangible values were assumed. Except in the case of the Southern California stream bottom type, it was also assumed that very little or no damage would be done to the intangible values by fires covering less than 40 acres. In this type, even small fires, if they destroy the cover, do considerable damage, even though natural restocking quickly follows, and the damage where stands of mature trees are destroyed is at least as great as for younger stands, regardless of the timber value.

TOTAL VALUES

The standard total destructible values per fully stocked acre of young growth of the different types and in the several regions have been given in Table XVII. For the use of field officers within a given region, these values are not as complicated as they may appear here, because any one officer will have to consider only the figures that apply to his particular region, and to the types which are found on his particular district.

TABLE XVII.—*Standard total destructible values of young growth*

Type	Region	Destructible value per well-stocked acre						
		Reproduction		Small poles		Large poles		Reproduction and poles in all aged stands
		Areas under 10 acres	10 acres and over	Under 10 acres	10 acres and over	Under 10 acres	10 acres and over	
		Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
Yellow pine, including western yellow pine-sugar pine mixtures in California.	1,9,10,11	0.60	9.10	1.65	10.15	5.00	13.50	2.00
	2	1.25	8.25	3.15	10.15	7.40	14.40	2.70
	3	1.40	7.40	3.50	9.50	8.35	14.35	3.00
	4	1.55	11.55	3.90	13.90	9.30	19.30	3.30
	6	2.40	12.40	6.10	16.10	14.50	24.50	5.20
	7	1.65	11.65	4.25	14.25	10.00	20.00	3.60
	8	1.45	11.45	3.75	13.75	8.90	18.90	3.20
	12, 13	.45	12.45	1.20	13.20	3.65	15.65	1.50
	14, 15	7.75	15.25	8.20	15.70	9.60	17.10	8.30
	16	2.75	14.75	7.05	19.05	16.70	28.70	6.00
	17	9.05	16.55	11.40	18.90	16.80	24.30	10.80
	18, 19	8.00	15.50	8.85	16.35	11.65	19.15	9.25
	20	8.10	15.60	9.15	16.65	12.50	20.00	9.50
Douglas fir, including western larch mixtures in the northwest, lower slope mixture on west coast, and bigcone spruce slopes in southern California.	1, 12, 13	.20	10.20	.60	10.60	1.90	11.90	.75
	2	1.05	7.05	2.75	8.75	6.60	12.60	2.30
	3	1.40	9.40	3.50	11.50	8.35	16.35	3.00
	4	1.40	11.40	3.50	13.50	8.35	18.35	3.00
	5	2.75	10.25	7.00	14.50	16.70	24.20	6.00
	6	2.55	10.05	6.55	14.05	15.50	23.00	5.60
	7, 8	.85	10.85	2.20	12.20	6.00	16.00	1.90
	9	.25	10.25	.70	10.70	2.20	12.20	.90
	10	.30	10.30	.80	10.80	2.50	12.50	1.00
	14, 15	5.30	15.30	5.80	15.80	7.50	17.50	6.00
	16	1.40	11.40	3.50	13.50	8.35	18.35	3.00
	17	10.90	20.90	12.35	22.35	15.60	25.60	12.00
	18, 19, 20	4.40	12.40	5.00	13.00	7.15	15.15	5.25
Lodgepole pine, including knobcone pine in California.	1, 12	.35	10.35	.95	10.95	2.95	7.95	1.20
	2, 16	.90	8.90	2.35	10.35	5.60	9.60	2.00
	3, 6	1.55	9.55	3.90	11.90	9.30	13.30	3.30
	4	1.05	11.05	2.75	12.75	6.60	11.60	2.30
	5	1.20	9.20	2.90	10.90	7.00	11.00	2.50
	7	1.40	11.40	3.40	13.40	8.15	13.15	2.90
	8	1.25	11.25	3.15	13.15	7.40	12.40	2.70
	9	.30	10.30	.85	10.85	2.70	7.70	1.10
	10, 13, 14, 15, 19	.40	10.40	1.05	11.05	3.30	8.30	1.30

TABLE XVII.—*Standard total destructible values of young growth*—Continued

Type	Region	Destructible value per well-stocked acre						
		Reproduction		Small poles		Large poles		Reproduction and poles in all aged stands
		Areas under 10 acres	10 acres and over	Under 10 acres	10 acres and over	Under 10 acres	10 acres and over	
		Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
Spruce and fir (not subalpine), including cedars and hemlock when not included in white pine or Douglas fir types.	1, 9	0.20	6.70	0.50	7.00	1.50	8.00	0.60
	2	.90	6.90	2.35	8.35	5.60	11.60	2.00
	3	1.40	7.40	3.50	9.50	8.35	14.35	3.00
	4	1.20	8.70	2.90	10.40	7.00	14.50	2.50
	5	1.25	8.75	3.15	10.65	7.40	14.90	2.70
	6	.90	8.40	2.35	9.85	5.60	13.10	2.00
	7	.70	8.20	1.75	9.25	4.20	11.70	1.50
	8	.50	8.00	1.25	8.75	3.00	10.50	1.10
	10	.30	6.80	.80	7.30	2.50	9.00	1.00
	12	.25	10.25	.70	10.70	2.20	12.20	.90
	13, 15	.20	10.20	.60	10.60	1.90	11.90	.75
	14	.25	10.25	.65	10.65	2.00	12.00	.80
	16	1.40	9.40	3.50	11.50	8.35	16.35	3.00
	18, 19, 20	.30	10.30	.90	10.90	2.85	12.85	1.10
	21	2.00	8.00	4.65	10.65	10.50	16.50	4.00
Western white pine	2	3.50	8.50	8.90	13.90	21.10	26.10	7.60
	3	4.50	10.50	11.45	17.45	27.15	33.15	9.75
Eastern white pine and Norway pine.	21	10.20	16.20	26.20	32.20	59.00	65.00	22.50
Jack pine	21	1.50	11.50	3.50	13.50	7.85	12.85	3.00
Hardwoods	17	20.00	20.00	20.00	20.00	20.00	20.00	5.00
	21	2.50	2.50	5.80	5.80	13.10	13.10	5.00
Subalpine, noncommercial high altitude type.	1, 9, 10, 12, 13, 14, 15, 18, 19, 20.	.....	10.10	.....	10.50	.....	11.00	.25
	4, 5, 6, 7, 8, 16.	.....	8.10	.....	8.50	.....	9.00	.25
	2, 3	.....	6.10	.....	6.50	.....	7.00	.25
	17	.....	15.10	.....	15.50	.....	16.00	.25
Aspen	All regions where of commercial value.	.60	.60	1.60	1.60	3.70	3.70	1.30
Woodland. Includes piñon-juniper, digger pine-oak, and similar types.	4, 7, 8	2.60	5.10	2.80	5.30	3.20	5.70	2.75
	6, 12, 13, 14, 15, 17, 18, 19, 20.	2.75	5.25	3.10	5.60	3.90	6.40	3.00
	16	2.95	5.45	3.70	6.20	5.30	7.80	3.50
Brush, not restocking with commercial species. Includes chaparral type and other brushfields.	1, 2, 3, 5, 9, 10, 11, 12, 13.	Uniform value $0.10 per acre (for areas greater than 40 acres).						
	4, 6, 7, 8, 16.	Uniform value $0.25 per acre (for areas greater than 40 acres).						
	14, 15, 18, 19.	Uniform value $0.50 per acre (for areas greater than 40 acres).						
	17	Uniform value $5.00 per acre (for areas greater than 40 acres).						
	20	Uniform value $2.00 per acre (for areas greater than 40 acres).						
Sagebrush and grassland	All regions.	Uniform value $0.05 per acre.						

FIRE RECORDS

To provide an accurate basis for future rating by the methods outlined in this report, or by any other scientific method, it is essential that accurate records be kept of all fires throughout the country. Since the value of such records varies directly with their completeness and accuracy—inaccurate records are but little more useful than none at all—it will be decidedly worth while to take considerable pains to see that they are made and kept in good shape. All reports on individual fires should be checked up by a competent supervisory officer to see that they give the information that is required to make them useful. For the purpose of rating hazards and liabilities, the reports for each protective organization should always give at least the following information; other data may be desired from time to time for administrative studies of various sorts:

1. Location of the fire.
2. Date and hour of the discovery of the fire (and of its start if known); of the start of work on it; when it was under control; when it was out.
3. Cause, in detail. For instance, if a camper fire, what kind of a camper—traveler, sheep-herder, campfire?
4. Cover. Forest type, age class, risk class.
5. Area burned, classified according to types, age, and risk classes, if more than one.
6. Destructible values on the burned area before the fire.
7. Losses—quantities (thousand feet by species, and fully stocked acres of young growth by types and age classes, if more than one) and values, according to standard figures.
8. Costs of suppression—itemized in such a way that that part of the cost chargeable to primary protection may be kept distinct from special fire-fighting costs.

In addition to the detailed individual reports on all fires, which may be transferred to tabulation sheets or punched cards for convenience in filing and future study, it is also desirable that sets of maps be kept up to date showing the character and values of the cover on the whole area, and the locations of all fires covered in the reports. Such maps should be on a fairly large scale, preferably one-half inch or one inch to the mile. The fire records should be made permanent, and those for any one organization should preferably be kept all together in one place.