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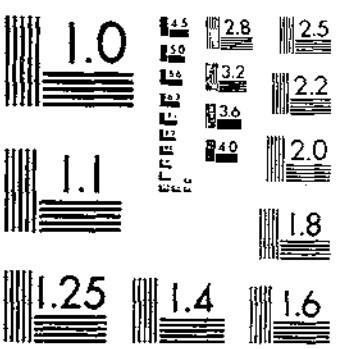

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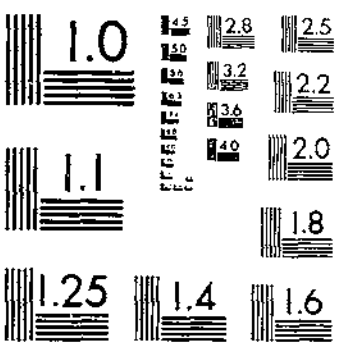

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TECHNICAL BULLETIN No. 551 FEBRUARY 1937

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

FOREST FIRE INSURANCE IN THE PACIFIC COAST STATES[1]

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[1] This study was conducted in 1930–34 while the author was assigned to the Pacific Northwest Forest Experiment Station at Portland, Oreg.; the assistance of the research staff of the station and of the California Forest and Range Experiment Station at Berkeley is hereby acknowledged. The author gratefully acknowledges valuable assistance from: The Board of Fire Underwriters of the Pacific; the Washington Surveying and Rating Bureau; the National Board of Fire Underwriters; the Oregon Forest Fire Association; the Washington Forest Fire Association; the California Forest Protective Association; the State Foresters of Oregon, Washington, and California; the National Fire Protection Association; the Weather Bureau; a number of members of the Forest Service, both in administration and research, and other individuals and organizations. The aggressive interest and active support given the study, particularly in the formative stages, by E. T. Allen, of the Western Forestry and Conservation Association, were indispensable in getting the work started. P. A. Herbert's excellent pioneering work in forest insurance investigation has been freely drawn upon. His help through suggestions and manuscript reading has been an important contribution.

INTRODUCTION

Forest fire insurance, or standing-timber insurance,[2] has attracted widespread attention for a long period of years. In Norway, Sweden, and Finland actual practice has met with conspicuous success. Somewhat less advance has been made in other European countries; and throughout most of the rest of the world, particularly in North America, there has been little or no practical accomplishment along this line.

General interest in the problem of practical forest fire insurance in the United States, which had been growing for about 25 years, resulted in 1924 in the inclusion in the Clarke-McNary Act of a provision for an inquiry into the subject as a Federal research activity. This report covers the accomplishments of that inquiry in its first broad field of study.

Funds for the study did not become available until the fall of 1929 and have at no time permitted more than an extremely small staff of workers. To spread the study over the whole country was manifestly impossible. The forest regions of the Pacific Coast States were therefore selected as offering the most profitable field for an inquiry thus limited. These regions include the Nation's greatest remaining reservoirs of timber—the Douglas fir forests of western Oregon and Washington, the ponderosa pine of the eastern portion of those States and of central Idaho and northeastern California, and the mingled sugar pine and ponderosa pine on the west slope of the Sierra Nevada.

The aims of the study were to determine as accurately as possible, where protection has been effective, what the conditions have been and now are with respect to fire losses as they might affect forest insurance, together with other pertinent factors of hazard rating, underwriting, policy provisions, and organization and administration; and to gain as clear an indication as possible of what might be done to provide forest owners with truly practical fire insurance.

The outcome of the inquiry is, in brief, a recommendation in favor of forest fire insurance in the Northwest as a feasible and profitable undertaking where proper precautions are observed. The normal loss expectation from ordinary fire occurrence averages 0.082 percent per year, but it is recommended that commercial forest fire insurance introduced in these regions be based on an average premium rate of 0.450 percent. As will be made clear in the subsequent pages, the wide spread between expectancy and premium is deemed essential to cover a number of factors which the insurer cannot afford to overlook, despite the strong inducement to good volume of insurance that would operate in a low premium rate level. With increased volume of business, bringing premium income well above a quarter-million dollars, rates could be materially reduced. Meanwhile, it is believed that the conservative rate here recommended would not prove prohibitive to the majority of large timber owners, and that the obvious benefits to the insured of even partial protection would make such insurance sufficiently attractive to assure its successful operation.

[2] Although this term has been in common usage in the United States it is not believed to be as satisfactory a designation as "forest fire insurance", particularly for purposes of this work in which a more comprehensively descriptive expression is desirable. The term "forest fire insurance" will therefore be used in this report. Property-damage insurance only is treated; no consideration is given to other forms providing indemnity for loss of use or profits, business interruption, or other economic values.

NEED FOR FOREST FIRE INSURANCE IN THE UNITED STATES

EXTENT AND VALUE OF PRIVATELY OWNED FORESTS

It is estimated that forest lands privately owned comprise four-fifths of the total area of such land remaining in the country, and that they carry more than 980 billion board feet of timber of merchantable size, about 1¾ billion cords of cordwood, and 90 million acres of fair to satisfactory small growth and reproduction. These figures include the farm woodlands (*17*),[3] which carry 12.5 percent of the privately owned merchantable timber, 38.5 percent of the cordwood, and 30.5 percent of the small growth and reproduction.

This privately owned forest property has been estimated to have a sound value of slightly more than $4,000,000,000 (*2*). It is believed that the farm woodlands account for about 20 percent of this value, leaving approximately $3,200,000,000 in other forms of private ownership.

PUBLIC VALUES INVOLVED

One of the major problems at present is that of reconciling the management of these privately owned forests with the requirements of sound public interest. It is highly desirable that their great public values be not further dissipated. Already a great deal of harm has been done in this respect. Forests are not inherently forms of wealth that can be utilized only once through liquidating conversion. They are adaptable to a form of management under which they will continue to produce their wealth indefinitely through regeneration and growth. The development of a condition under which forests will be managed with this end in view is a social necessity.

Such a concept of forest management implies long-time planning. It cannot be expected to materialize overnight, constituting as it does a radical departure from the traditional attitude toward the national resources. Meanwhile the Federal Government and many State and local governments are cooperating to aid the development of forestry on private lands. There may be forest land in private ownership at the present time that will not continue to be privately owned under such a regime. Some appears to be well suited to the practice of forestry as a private enterprise.

PRIVATE FOREST ENTERPRISE

The possibilities of timber growing as a business are not yet fully understood. Several controlling factors are involved, one of which is the relation of probable earnings to the safety of the investment. This relationship has not yet been definitely established. The academic principle involved is that, other things being equal, demanded returns vary inversely with the safety of the investment. With due allowance for errors in judgment on the one hand and superacumen on the other (the one accounting for losses and the other for abnormal gains), many investors desire to effect what they consider rational compromises between risk and return. The component of investment forces tends, of course, to equalize discounts in all fields, with that of forestry no exception.

[3] Italic numbers in parentheses refer to Literature Cited, p. 168.

It is probably safe to say that insurance serves its best purposes when (1) the discount factors are difficult to measure and (2) long-time ownerships are involved. At any rate, whether this is true or not, it appears that the business of tree growing ought to be made as free from risk to the investment as possible.

If the highest values, either public or private, are to be realized, methods that result in wasteful use or in the devastation of forest lands, such as too rapid and uncontrolled liquidation, must not be applied. One factor which encourages liquidation is the fear of loss from fire before the value can be realized. This is the point of direct interest to this study. If the fear of loss from fire can be removed, the influence of at least one adverse factor will have been minimized. Forest fire insurance can help to do this.

Whether or not forest fire insurance is destined to be of importance as an element of the actual practice of forestry, there is an obvious opportunity for it to render an important service in the program of correction of existing economic maladjustment in the timber industry itself. The financing of the timber business has always been relatively difficult because of the liability on forest values arising from the possibility of unrecoverable loss. Since the conduct of the business inevitably involves more or less timber ownership, there has been no way of avoiding this liability. Its effects have been various, but a perennial shortage of working capital is perhaps the most striking. The statement that the availability of practical forest fire insurance would make forests more valuable may seem overacademic. Nevertheless there is reason to believe that such an effect might be felt.

In any event, timber owners themselves and financial authorities familiar with forest finance have expressed belief that the credit positions of timber owners could be materially improved by the application of fire insurance to their properties. Obviously there would be no advantage in eliminating one liability by incurring a greater one, as would be the case if the cost of the insurance were too high. This is a direct function of the aggregate rate of loss, the determination of which is one of the major purposes of this study.

PRACTICAL FOREST FIRE INSURANCE FACILITIES LACKING

Although some forest insurance is being offered and written in this country, it has not reached the stage of true practicality. The infinitesimal portion of the forest value that is insured definitely establishes this assertion. It is indeed doubtful whether there is any other class of property, destructible by fire, for which fire insurance facilities are so lacking.

This lack raises two questions: (1) Why does the present condition exist, and (2) is it possible to correct it? The present situation is unquestionably inimical to the application of good forestry practice on private land.

DEVELOPMENT OF FOREST FIRE PROTECTION FAVORABLE TO INSURANCE

Prior to 1900 very little protection was given to forests in any part of the country. Since that time, however, owing mainly to a general

awakening of public interest, there has been a rapid development of organized protection.

This development has advanced further in some parts of the country than it has in others and, in a relative sense, it is still lagging somewhat in most of the Southern States. Saying that the protection afforded practically all of the private forest property in the North and West compares very favorably with the protection given other forms of property is by no means a misstatement. Forest fire protection in these parts of the country is, at the present time, intelligent, experienced, systematic, and effective. It can be improved and unquestionably will be. Meanwhile it is effecting a definite control on forest-property losses.

The dependability of present-day protection is without doubt the greatest single factor making for a condition under which forest fire insurance becomes a practical possibility.

PRINCIPLES OF FIRE INSURANCE APPLICABLE TO FOREST PROPERTIES

PROVISION FOR INDEMNITY FOR FORTUITOUS ECONOMIC LOSS

The fundamental principle of insurance is indemnity. In simple language, an insurance policy is a contract between an insurer, as party of the first part, and an insured (or assured), as party of the second part, under which the first agrees to make good to the second any loss or damage that may result from the action of some destructive agency or agencies named.

Two essential features of the fire contract stand out above all others (*1*), namely:

1. It is a contract of indemnity and does not contemplate that the insured shall reap a profit as a result of the damage or destruction of his goods by fire.

2. It is a personal contract insuring the person and not the goods.

A lengthy discussion here of the accepted principles of insurance is not necessary, since there is available a large mass of material on the subject with citations of legal decisions. Suffice it to say that, in order for the terms of the contract to be carried out, the assured must have a legal insurable interest in the insured property and damage must have resulted as a consequence of the accidental operation of the agency insured against. The fulfilling of the contract terms comprises an attempt on the part of the insurer to repay to the assured the equivalent of his insured loss to the exact extent that it is possible to determine it—no more and no less.

Obviously all action by both parties must be in good faith. The operation of the destructive agency must be wholly fortuitous so far as the assured is concerned. There must be no concealing of facts nor deliberate inciting of the destructive agency directly or indirectly. It is obviously essential that the insurer protect himself by providing for the voidance of the contract when and if violations of these principles are proved.

NOT A BET OR WAGER

Neither can the insurance contract partake of the character of a bet or wager. This is specifically prohibited by law in many if not

in all States. Whether legal or not, such an agreement would obviously be unworkable. The only eventuality on which a legitimate bet can be placed is one over which neither party has any control. The owner of a piece of property can always exert an adverse control on the occurrence of fire that cannot be balanced by favorable control by the insurer.

NOT A SUBSTITUTE FOR BUT A SUPPLEMENT TO PROTECTION

Neither is fire insurance, as is often believed, a substitute for fire protection. This would allow, if permitted, a slackening in the protective effort that would result in an increase in total loss. Fire insurance, by its inherent nature, cannot function that way. All it can do is to supplement effective protection, carrying on from protection's point of diminishing returns and completing the job of protecting the financial investment.

The only direct effect that insurance may be said to have on the protective effort itself is that it does alter somewhat the point of diminishing returns. Briefly stated, the possibility generally exists of applying a small portion of what would otherwise be protection expense to the payment of premium for insurance and still leaving a condition entirely satisfactory to the insurer. Whatever may prove to be the true point of diminishing returns, the real function of insurance is merely to absorb the residual hazard that is left when protection has done all it can do economically. This principle is not upset by the fact that insurance is sometimes placed where organized public protection is not supplied—in many rural and farm communities, for example.

The actual function of insurance is, in this respect, to lift responsibility for effective protection from the shoulders of the owner and to place it on those of the insurance carrier. Throughout this discussion reference is made to organized public or semipublic protection. Private protection, undertaken solely by the owner, is a matter of individual agreement between the two parties, but the ultimate responsibility for its effectiveness is still assumed by the insurer. It is inevitable that it should be so. The insurer is the one who will lose if protection weakens. The influence exerted on the efficiency of city and town fire departments by the insurance companies and their associated organizations is very great.

Insurance introduces a systematic, technical, and vigorous effort to maintain effective protection. This is a recognized function of insurance activity, along with indemnity payment. That the owner who does not insure also enjoys this benefit is merely one of many as yet unsolved social problems. It does not argue insurance out of the picture.

The major benefits of insurance accrue only to those who actually subscribe to it. Insurance eliminates an element of uncertainty and replaces it with a definitely known and budgetable annual expense. This is its great accomplishment in an economic system based upon the principle of private enterprise in which the safety of the investment becomes an increasingly important consideration. Insurance plays one of the leading parts in this development.

THE POLICY CONTRACT

GENERAL PRINCIPLES AND PROVISIONS

An insurance policy, then, is a contract of indemnity providing that the insurer will reimburse the insured for any loss he may incur as a result of the action of any destructive agency or agencies insured against. The insurer must, under the terms of the policy, pay indemnity up to the full amount of the loss unless the insured has failed to avail himself of his opportunity for full-value insurance, unless full-value insurance is not accepted by the insurer, or unless the terms of the policy have been violated.

Unfortunately it is necessary for the insurer to insist on some contract provisions that make for safety against bad faith and even deliberate fraud. His best refuge is, of course, provision for the voidance of the agreement if it is demonstrated that the insured has violated the terms.

As a general principle, it is desirable that the fire-insurance contract, like other contracts, be as simple as possible. Considerations of safety have, however, in North America at least, gradually brought about the introduction of complications in the policy. Many authorities believe that insurers would do better in the end to simplify the policy and place their trust mainly in the fairness of the courts, as insurers do in England. There is no question but that the very complication of the policy in its present usual form often works to the disadvantage of the insurer. Since the provisions evidently protect him more effectively than the insured, juries are sometimes unduly prejudiced against the companies.

However, until reforms are made, the existing policy forms will have to be used in forest fire insurance as they are for other properties. The policy form is regulated by State law. Not all States use the same forms and there is some variation in the interpretation and application of insurance principles. In any given State, however, the policy contract used must be the one prescribed.

Since the territory under discussion lies in four States, four policy forms will have to be used. In each of these States the legal form is based on the so-called "New York standard form" and the significant wordings do not vary materially.

The writing of forest-property insurance will be accomplished by attaching to these policy forms riders which make the coverage specific as desired. It is with the wording of these riders that this study is particularly concerned. The wording is mainly a matter of agreement between the two parties of the contract, subject to the approval of the State authorities. It is most likely that they will serve satisfactorily when they are drawn through the joint action of the companies, the prospective assureds, the insurance commissioners, rating specialists, adjusters, and experienced attorneys.

In order merely to have a starting point, suggestions for these forms are included in this report. It is not intended to imply that they should be adopted for actual use in exactly their present form. Thorough study and discussion are suggested before forms are adopted for actual use. Possibly, though, a short discussion of the considerations that have prompted the writer to suggest these forms will not be out of place at this point.

Two provisions that seem to stand out as essential above all others are: Some application of the principle of coinsurance, and a partial-value stipulation.

THE COINSURANCE PRINCIPLE

With respect to coinsurance it is impossible to arrive at an equitable rating system without some means of keeping the collection of premium and the payment of losses on the same basis. To be sure, the principle of coinsurance is not universally applied even yet—we insure our houses and furniture on a flat-rate basis. This is no argument against coinsurance, however, and in the forests, where specific rating will be the invariable rule, and where hazards vary through wide ranges, success will be much more likely if the coinsurance principle is applied.

It is desirable to explain the coinsurance principle at some length, since it is not well understood by the public at large. Its purpose is simply to put the collection of premium and the payment of losses on the same basis. If all losses were total there would be no need for coinsurance because the collection of premium and the payment of losses would always be on the same basis automatically. For example, assume that a piece of property is actually worth $10,000 and that the fire-insurance rate on it is 50 cents per $100 of value. It will then cost the owner $50 to insure it to full value, $25 to insure it for one-half its value, and $12.50 to insure it for one-quarter of its value. If the property then becomes a total loss the ratio of indemnity to premium received is the same no matter how much insurance was carried, as illustrated in the first section of table 1.

TABLE 1.—*Ratio of premium to loss percent under total loss, and under partial loss with flat-rate premium and with 100 percent coinsurance*

TOTAL LOSS BASIS WITH FLAT RATE PREMIUM

Insurance carried (dollars)	Premium received	Loss paid	Ratio of premium to loss
	Dollars	*Dollars*	*Percent*
10,000	50.00	10,000	0.5
5,000	25.00	5,000	.5
2,500	12.50	2,500	.5

$1,000 LOSS BASIS WITH FLAT RATE PREMIUM

10,000	50.00	1,000	5.00
5,000	25.00	1,000	2.50
2,500	12.50	1,000	1.25

$1,000 LOSS BASIS WITH 100 PERCENT COINSURANCE RATE

10,000	50.00	1,000	5
5,000	25.00	500	5
2,500	12.50	250	5

For comparison, assume the same property, insured as above, to be damaged to the extent of $1,000 only. The three amounts of insurance then compare as shown in the second section of table 1.

In the second case, where the loss was only $1,000, it cost the assured four times as much to buy indemnity when he insured to full value as it did when he only carried insurance to one-quarter of the value, and yet he was no better indemnified for his loss. In fact, he could have been as well indemnified if he had only carried $1,000 insurance at a cost of $5. To be sure, he could only have been indemnified for half of his loss if it had happened to amount to $2,000 while he was only carrying $1,000 of insurance; but partial losses are the general rule except where protection is totally absent, and he might figure that $1,000 was about all that there was any great likelihood of his losing at one time and that he would rather gamble on the difference than pay the extra premium.

The exercising of this option would, however, introduce an unknown into the calculations of the insurance carrier that it could never possibly avoid. Since the face value of the policy furnishes the only figure with which to integrate the rate in order to calculate the premium, and since the premium must, on the average, bear a relation to the loss cost, some means is required of effecting a harmony between the amounts insured and the values at risk. The burning ratio is always a function of the value at risk and can never be correlated with the disorganized figure that would result from the exercising of the judgment of a lot of property owners as to how much insurance they ought to carry to cover their probable losses.

The application of the coinsurance principle does this and is apparently the only possible means of effecting this desirable end. The coinsurance clause asks the assured to carry an amount of insurance equal to a certain percentage of his value and to assume his own liability to the extent that he fails to do so. Obviously the insurer can afford to offer the assured an inducement to carry a higher proportion of insurance to value by making the rate lower.

Suppose, in the example cited, it is a condition of the contract that the assured agrees to carry insurance to the extent of 100 percent of the value. Then, to avoid being a coinsurer, he must carry $10,000 of insurance. In substance, the coinsurance clause states that the insurer is liable for no greater proportion of any loss than the amount of insurance bears to 100 percent of the value.

Under this condition, with the same three amounts of insurance and a $1,000 loss, the results would be as shown in the last section of table 1.

If only one-half the required amount of insurance is carried, then only one-half of any loss is paid instead of the full amount of all partial losses up to the face of the policy. But the ratio of premium to loss is again stabilized, as it would be if all losses were total.

In practice, the insurers ordinarily establish flat rates and coinsurance rates also—the latter at varying reductions below the flat rates according to the percentage of coinsurance specified. Suppose, for example, that the actual burning ratio of the class of property in which the above-cited case falls is 0.25 percent. This means that for each $100 of value there will be an average loss each year of 25 cents worth. That is, the loss cost is 25 cents. In order to pay losses in the class and maintain solvency, then, the insurer must charge a rate of 25 cents, expenses for the moment ignored.

Without coinsurance, a 25-cent rate will be satisfactory if, and only if, all assureds carry full insurance to value. Suppose, for example, they feel that their chances of losing more than 75 percent are so small that they do not care to incur the expense of insuring the other 25 percent. On $1,000,000 of liability, then, only $750,000 of insurance will be carried, producing $1,875 in premium. The loss cost will still be $2,500, because enough insurance is being carried to cover all the loss, and the insurer will lose $625. The flat rate, therefore, if owners are going to carry insurance to only 75 percent of the value, must be 33⅓ cents instead of 25 cents. If they carry only 50 percent of insurance to value the rate must be 50 cents. These figures, however, while illustrative, are not quite a true picture, because once in a while a protected property does become a total loss and the final loss cost, of course, includes these total losses. If, on a flat-rate basis, a loss is total and only partial insurance is carried, the insurer's loss is less than if full insurance is carried with a 100-percent coinsurance clause. Thus, if the owners, on a flat-rate basis, only carried insurance to half of their values, the rate would not have to be quite twice the 100-percent coinsurance rate for the insurer to get out even.

Introducing the coinsurance principle is, manifestly, eminently fair to both parties. It is hoped that this discussion has made this fact plain. Coinsurance combines maximum protection and minimum cost for the assured with mathematical soundness for the insurer. It eliminates the uncertainty as to the ratio of premium to loss cost and results in a condition under which all policyholders pay in proportion to the extent to which they are relieved of liability. Relief of liability is the commodity traded in.

In Oregon, rider forms attached to policies covering on specifically rated properties carry the following clause:

AVERAGE CLAUSE: It is expressly stipulated and made a condition of the contract that, in event of loss, this company shall be liable for no greater proportion thereof than the amount hereby insured bears to percent (%) of the actual value of the property described herein at the time when such loss shall happen, nor for more than the proportion which this policy bears to the total insurance thereon.

Washington policies, under similar circumstances, carry the following clause:

REDUCED RATE AVERAGE CLAUSE: In consideration of the reduced rate at which, and the form under which this policy is written, it is expressly stipulated and made a condition of the contract that, in the event of loss, this Company shall be liable for no greater proportion thereof than the amount hereby insured bears to percent (%) of the actual value of the property described herein at the time when such loss shall happen, nor for more than the proportion which this policy bears to the total insurance thereon.

Either of these clauses introduces the principle of coinsurance into the contract. The last phrase of each only protects the individual insurer against having to pay more than his proportionate share of the loss when other insurers have liability jointly with him. The major portion of the clause is an agreement between the insurer and the assured that, if a certain proportion of insurance to value is not maintained, the assured will assume a proportion of his losses to the extent that he fails to carry insurance as agreed.

Similar clauses will, of necessity, be included in the riders to be attached to policies covering on forest properties in the territory.

PARTIAL VALUE LIMITATION

All experimentally introduced insurance needs extra safeguards in the early stages. As actual experience is gained it is possible to modify these and often eventually to eliminate them altogether. A substantial factor of safety in the rating schedule has already been suggested as one of these safeguards. It is believed that another, the introduction of which will be highly desirable, is a partial value clause, so called, under which the insurer declines to assume more than proportionate liability. By this is meant that provision is suggested whereby owners of forest properties can, in any event, be only partially reimbursed for their losses. This is on the principle that half a loaf is better than none and that, until knowledge of the true characteristics of forest insurance is acquired through actual practice, a needed control can be maintained by such an application better than by any other known method.

It is suggested that a clause be inserted stipulating that in any event the insurer accepts liability only to the extent of 75 percent of the value of the property insured. It would be incumbent on the assured then to ascertain how much insurance would represent three-quarters of his value and to limit the face of his policy to that amount. There would be no object in his carrying more insurance, because three-quarters of the value is the limit of liability accepted by the insurer in any event.

A sample of one form of partial value clause which has been used in the past is:

THREE-QUARTER CLAUSE: It is understood and agreed to be a condition of this insurance, that, in the event of loss or damage by fire to the property insured under this policy, this company shall not be liable for an amount greater than three-quarters of the actual cash value of each item of property covered by this policy at the location and as of the time immediately preceding such loss or damage; and in the event of additional insurance, then this company shall be liable for its proportion only of three-quarters of such cash value of each item insured not exceeding the amount insured on each such item. Total insurance is hereby permitted for and limited to three-quarters of the cash value of the property herein described and to be concurrent herewith.

CONJOINT USE OF 100-PERCENT COINSURANCE AND THREE-QUARTER VALUE CLAUSES

The writer's suggestion is that the form adopted for use in forest fire insurance carry, in substance, the above three-quarter value clause together with an average clause calling for insurance to 100 percent of the value. The conjoint use of these two seemingly contradictory clauses would be highly desirable during the experimental stages of writing. While they seem to be contradictory, the actual intention is for the assured to carry only 75-percent insurance. The 100-percent average clause is inserted in order to provide that no losses shall be indemnified at more than three-quarters of their amount.

For illustration, assume that a forest property had a sound value of $100,000 and has been damaged to the extent of $60,000. By the terms of the average clause it should have been insured for $100,000, but, because of the three-quarters value clause, has actually been insured for only $75,000. This is the correct amount that the assured should have been carrying. The average clause, however, states

that the insurer is liable for no greater proportion of any loss than the proportion which the insurance carried bears to the total value. Since this is a ratio of three-quarters, the insurer is liable only for three-quarters of all losses, in this case for the amount of $45,000. This is figured as follows:

$$\text{Indemnity} = \text{loss} \times \frac{\text{amount of insurance carried}}{\text{amount of insurance named in average clause}}$$

Thus, in this case:

$$\text{Indemnity} = \$60{,}000 \times \frac{\$75{,}000}{\$100{,}000} = \$60{,}000 \times \tfrac{3}{4} = \$45{,}000.$$

Since the premium paid was also reduced by 25 percent compared to what the assured would have paid if he had carried full insurance, he has suffered no actual injustice. The insurer has merely declined to insure him for more than three-quarters of the amount of his losses and has charged him accordingly for the service.

If, in the above case, a 75-percent average clause had been used with the three-quarters value clause, the company would have had to pay the assured $60,000 as indemnity for his loss. For example, the average clause only asks the assured to carry $75,000. If he was carrying this amount at the time of the loss the indemnity is figured as follows:

$$\text{Indemnity} = \text{loss} \times \frac{\text{insurance carried}}{\text{insurance required}}$$

in this case,

$$\$60{,}000 \times \frac{\$75{,}000}{\$75{,}000} = \$60{,}000.$$

Here the insurer would be defeated in his purpose of paying only to the extent of three-quarters of all losses and his actuarial base would be distorted adversely just as if flat rates were used.

The purpose of suggesting this modification in the offering of fire insurance on timber properties is merely to provide an additional safeguard during the experimental stage of development, when a number of questions will not have been answered. They can only be answered through observation of actual practice. The most important of these questions is, How much business can be done and how well can it be spread? Through the answer to this question determinations can be made of the actual effects of possible losses from single fires and, consequently, to what extent liability can safely be concentrated. A given number of properties, partly insured, give a better opportunity for the operation of the law of averages, resources of the insurers considered, than do the same number of properties fully insured.

After a time it would be hoped that the partial value limit could be discarded. Some scaling down of the coinsurance requirement would also be desirable when it could be justified by experience. The ideal form would probably call for only 80 percent of insurance to value and would carry no partial value limitation. Consistently successful operation under the plan suggested would undoubtedly bring this about in time.

DRY-SEASON CLAUSE

The insurance of forest properties will call for the use of one clause that is almost wholly unique. This is the so-called dry-season clause. The necessity for it is imposed by the fact that practically all of the hazard occurs during only a relatively short period instead of all the year round, as is the case with most properties.

To be sure, no owner can ever be certain that his forest property will not be damaged in any month of the year and policies will always be written to run through full-year terms. An assured, of course, always has the option of canceling his insurance at any time that he desires during the life of the policy. If, therefore, no provision were made to prevent, owners could insure at the beginning of the hazardous season, carry their insurance through 3 or 4 months, and then cancel, thus obtaining cover against practically the whole of the annual hazard at slightly less than or exactly half the full annual premium by the customary short-rate cancellation system.

Since the loss cost on which the insurers must base their premium rates is necessarily based on the full calendar year, some provision must be made for absorbing the premium during the months when the hazard is most acute, or at least for the greater part of this period. This is most satisfactorily accomplished by inserting a clause which specifies a certain portion of the year as the hazardous season and allocates the major portion of the annual premium to this period. Such a clause has already been drawn up and reads:

DRY-SEASON CLAUSE: It is understood and agreed that the premium rate named in this policy includes a charge equal to 80 percent of the annual premium for the additional hazard incurred during the dry season, and it is a part of the consideration of this policy, and the basis upon which the rate is fixed that in case of cancellation by the assured the return premium shall be calculated at the customary short rates of the difference between the dry season charge and the full premium charged.

It is understood and agreed that the dry season hereinabove referred to shall be any part of the months of April, May, June, July, August, September, October, and November.

By the use of this clause truly equitable conditions are provided. Assume, for example, that an assured waits until June 1 before insuring because the spring has been wet, and cancels on September 1 because heavy rains have come at that time. He has carried insurance for 3 months out of the dry season of 8 months. By the terms of the agreement, since he has carried insurance during a portion of the dry season, he is entitled only to a return premium figured on the basis of 20 percent of the annual premium. The short rate for 3 months is 40 percent. He is thus entitled to receive as return premium 60 percent of 20 percent, or 12 percent of the total annual premium. Most assureds prefer to carry insurance through the balance of the year, on the chance that some departure from the normal may cause them to suffer out-of-season losses, rather than to take back this small return premium. This clause should therefore produce the desired effect of inducing the assureds to carry their insurance through the full policy year.

AVERAGE-DISTRIBUTION CLAUSE

There is one other clause that, evidently, in modified form, should be given general application to forest-property insurance. This is the so-called average-distribution clause. When more than one building is insured under one stipulated amount the provision introduced by this clause is essential to workable insurance. This clause says, in one of its forms:

AVERAGE-DISTRIBUTION CLAUSE: It is understood and agreed that in event of loss, this insurance shall attach to each of the buildings described herein, in the exact proportion that the value of each building shall bear to the value of all such buildings at the time of fire.

Without such a clause as this there could be no application of the coinsurance principle when one building of a group insured together is damaged. In the forests a great many individual acres, and very often a number of individual tracts, will be insured under one stipulated amount of value. Some of these acres will inevitably carry more or better growth than others. Without some regulatory stipulation it would many times be practically impossible to determine whether the individual acres burned were adequately covered by insurance. For example, the damage may have occurred in a portion of a tract which runs 75,000 board feet of first-quality timber to the acre. The average of the whole may be 50,000 feet of second-quality timber, and there may be a considerable acreage of third-quality timber running only 25,000 feet to the acre. Since the average is 50,000 feet of second quality, worth, say, 75 cents per thousand, the average per-acre value is $37.50. This is the basis of value on which the tract should be insured. If there are 1,000 acres, the face of the policy should be $37,500. Obviously, if the damage happened to come in the 75,000-feet-per-acre portion, where the quality was high and the per-acre value, say, $75, the assured would not like to be told that $37.50 per acre was all he could collect. Conversely, if the loss came in the light stand of low quality, worth only in the neighborhood of $12.50 per acre, the insurer would resist payment of $37.50. In order to avoid misunderstandings, however, previous provision needs to be made in the contract.

So far as the writer knows, no clause has been designed that exactly fulfills the requirements here noted. Forest fire insurance that has been written has ordinarily carried a clause stipulating a per-acre limit indemity value but nothing further. It does not appear that this quite meets the needs. The use of a clause reading substantially as follows is therefore suggested:

AVERAGE-DISTRIBUTION CLAUSE: It is understood and agreed that, in event of loss, this insurance shall attach to each and every acre of the property described herein, in the exact proportion that the value of each acre shall bear to the value of the whole property at the time of fire, quality and density of stand, and logging facility considered.

In no event shall this policy be liable for more than $ per acre, nor more than $ per MBF.

In the subsequent discussion of loss adjustment it is suggested that the general principle be adopted of having all losses adjusted by arbitrators. The requirement here discussed illustrates one of the reasons for this recommendation. It is not intended to imply that a complete appraisal of the whole property should be made on the ground, solely for the purpose of adjusting a loss on a part of it.

The evidence supplied by cruise data that will ordinarily be available should be accepted by the insurer for purposes of applying this clause.

MISCELLANEOUS CLAUSES

A number of other stipulations appear to be needed, but it will probably suffice merely to name them here without detailed discussion.

The policy should state clearly the exact location of the property and the owner's interest, whether clear ownership or with a mortgage. If there is a mortgagee interest, provision should be made for paying indemnity direct to the mortgagee according to his interest. Provision should be made for the payment of indemnity for the difference between the amount of damage and the salvage value only. Other insurance should be permitted up to the amount to which insurance is limited by the partial-value clause.

The species of trees intended to be insured should be stated in the policy, no insurance to attach to other species. A photostat copy of the application submitted by the assured should be attached to the policy, and the form should include a statement of agreement that the assured warrants the statements made in the application to be true, the policy to be voided if this is not the case.

Provision should be made for a limitation in the lapse of time between the occurrence of the loss and the making of the adjustment. It is suggested that this give the insurer until November 1 of the year following the year of the loss, since it will occasionally happen that attempts at adjustment prior to that time will result in excessive expense.

Warranty terms may be desirable, making provision for reduction of the rate where additional protection features of any kind are maintained by the assured in accordance with specified standards. These may comprise additional equipment, patrols, or other preventive and protective measures.

A clause exempting the insurer from the payment of indemnity for very small losses will probably be desired; and, lastly, the terms of policies should be limited to 1 year.

This last provision is made because conditions often change materially in the course of a year as they affect forest-fire hazard and warranties made by an assured might not hold the next year, with consequent unsatisfactory insurance conditions.

Toward the end of the report some specific suggestions are included for the wording of policy rider and application forms for use in forest fire insurance writing in the various forest regions in the territory. Because of differences in conditions in the separate regions, better results will be achieved if modifications are made in the forms.

TYPES OF INSURANCE CARRIERS

STOCK, MUTUAL, AND RECIPROCAL COMPANIES AND LLOYDS ASSOCIATIONS

There are four main types of organization through the application of which fire insurance has been conducted as a private endeavor. So far as is known there have been no attempts of any importance in North America to handle fire insurance as a State or Federal activity.

These four types of insurance carriers have been very well described and commented upon elsewhere, and quotation will be resorted to here in covering this phase of the present report.

Ketcham and Ketcham-Kirk (*5*) differentiate between two of the main types of fire-insurance companies as those organized for profit to the organizers and those without profit. They describe these types as follows:

> The former of these are called stock companies, and the latter mutual companies. Stock companies are required to have a cash capital in order to guarantee the carrying out of their contracts. * * * Dividends are declared from the surplus of the company after making provision for the payment of all claims and putting aside the necessary reserves.
>
> The primitive insurance organizations were purely mutual. This class of companies is not organized for profit and the policyholders share equitably in the surplus of the company. They have no capital stock and frequently no deposit for contingencies, consequently mutual fire-insurance companies have been unable to withstand a series of heavy losses. * * * However some mutuals transacting business on the class and perpetual plans have charged an adequate rate, maintained an unearned premium reserve, met their obligations promptly, set aside large reserves for unexpected losses, and are among the most stable institutions in the world.
>
> Mutual companies may be classified into farm mutuals, city and village mutuals, and class mutuals. * * * The third transact an interstate business accepting only one or more lines of risks and limit their business to special lines such as laundries, hardware and implements, mills, factories, etc.

Riegel and Loman (*13, pp. 45, 47*) have written very good short descriptions of the other two main types of carriers:

> Reciprocals.—The reciprocal organization is, in one sense, a development of the mutual idea. Here the various policyholders are, as in the mutual, both insured and insurers. The active head of the organization, however, is an attorney in fact who has been given authority to conduct the affairs of the organization through powers of attorney conferred upon him by the various members. The actual management is subject to his control, with only such limitations as are provided for by the terms of the organization and the written powers of attorney. As compensation the attorney in fact receives usually a percenage of the gross premiums, ranging from 25 to 40 percent, out of which he pays the management expenses. Out of the remainder the losses and loss expenses are paid, and the residue is returned to the policyholders as dividends.
>
> Lloyds associations.—The most prominent association of this type is Lloyds of London, which has served as a model for similar organizations. The Lloyds association is an association of individual underwriters, each of whom becomes personally liable for the amount of insurance for which he subscribes. It is, therefore, insurance written by individuals, as contrasted with insurance written by companies or associations. Usually one individual is not responsible for the fulfillment of the obligation of others. * * * The value of the policies depends upon the underwriters who subscribe to them.

Obviously each of these different forms of fire-insurance carriers possesses some advantages, practical or theoretical, not participated in by the others. The question of their relative final merit is, however, to a very considerable extent, controversial. If the test is in the volume of business done, then the stock companies have much the best of the argument because they handle far and away the greater proportion of fire business done in North America. Some mutuals have, on the other hand, enjoyed phenomenal success, and there has been a great deal of insurance, in the aggregate, satisfactorily placed with Lloyds associations. In some special cases reciprocals have functioned with entire success for long periods of time, so that their permanent stability seems to be practically as well assured as does that of the other forms.

If truly adequate fire-insurance facilities are to be provided for the owners of forest properties, the carrier organization will have to have great strength. It will be of very little use to offer insurance limited to small amounts subject to loss from single fires.

If a stock-company basis should be adopted, this requirement could be fulfilled by the organization of a pool or pools to handle the business to which a number of companies would subscribe in varying amounts as they desired, probably more or less in proportion to their resources.

Very great strength could be developed if stock fire companies could be induced to undertake forest-insurance business.

It would appear that the most likely method of application of the mutual idea would be a building up from mutual organizations already in existence, though, if increased resources were required, new mutual companies might be organized. In any event it would be quite essential that affiliations be maintained so that a pool or reinsurance basis could be held to. It is probably doubtful whether as great strength could ordinarily be developed in mutual companies as in stock organizations.

The reciprocal form has evidently met with success where single classes with unique technical problems have been involved. A number of strong and well-managed reciprocals, reinsuring each other, might be able to write forest insurance successfully.

Whether or not Lloyds associations, either new ones or those already in existence, would be particularly well adapted to direct writing, there is little question but that they might be of value as reinsurers. This type of organization also seems particularly well adapted to "excess cover lines", so called—a modification of the reinsurance principle whereby liability up to a certain amount is assumed by the direct writing company, the excess being assumed by another.

There has been no serious attempt in this country to develop State or Federal participation in the fire-insurance business, and it would appear that, so far as forest insurance is concerned, no strong demand for public participation is likely. Such a demand could only be expected if a strong desire for the cover were not met by insurance organizations of the ordinary type.

Whatever form of insurance organization undertakes the forest-insurance business, the main essential of success will be technical soundness.

Careful selection of risks, frequent inspections covering a fairly large percentage of the liability, attention to the character of the assured and to proper appraisal and valuation, a good distribution of liability supplemented by intelligent reinsurance, and evidence of a sympathetic attitude toward the owners, coupled with strictly honest dealings, will be the primary requirements of successful operation.

POSSIBLE DEVELOPMENT OF FOREST-INSURANCE ORGANIZATIONS FROM PROTECTIVE ASSOCIATIONS

A few years ago the suggestion was made that the existing forest-protective associations might eventually evolve into forest fire

insurance organizations. While this might conceivably be looked upon as a possibility, there would be danger of failure unless some fundamental principles were observed. One of these is that better final results are produced if the insurance and the protection are supplied by separate organizations. The postulate that one man cannot satisfactorily serve two masters applies. One organization attempting to supply both protection and insurance would be too seriously torn by opposing interests. Its position in resisting pressure to diminish the protective effort in the interests of decreased expense would be weak. Satisfactory strength in this respect is apparently only achieved by the application of pressure by independent insurance carriers who threaten increased rates or the refusal of insurance unless proper protection standards are maintained. Experience has effectively taught that joint protection and insurance organizations are unable to apply this essential force.

Diplomatically, also, such joint organizations are in weak positions when the time for loss adjustments comes. An independent insurer is entirely free from imputation of liability for the extent of the loss. A joint insurance-protection organization is not. That is, dissatisfaction, argument, and litigation can always be expected when such organizations attempt to adjust losses, because of the possibility that the assured can contend that there was negligence on the part of the insurer-protector with consequent confusing of the real questions and undue possibility of the establishment of excessive claims.

Insurance carriers might conceivably evolve out of the protective organizations, but if they do their set-up should be entirely independent, financially and administratively. There should be no intermixture of the financial assets of the insurance carriers and the protective organizations, and no overlapping of duties and responsibilities of the administering personnel.

PRACTICAL CONSIDERATIONS IN THE APPLICATION OF FOREST FIRE INSURANCE

SELECTION OF RISKS

The forest insurance underwriter is sure that there are some items of property that he would, for one reason or another, prefer not to insure. His experience has convinced him that certain subclasses of property are subject to conditions that seem to make them unfitted to the application of insurance. He wants a set of standards by which he can identify such properties so that he can exercise intelligent selection or, at least, apply the necessary extra safeguards. This factor of selection is an undesirable but apparently essential element of insurance, at least in its present stage of development. There are reasons for believing that it will always be a factor. In any event it appears that its application in forest fire insurance will be necessary for some time to come.

VALUES SUBJECT TO LOSS FROM A SINGLE FIRE

There is also one factor in fire insurance, not directly connected with the rating problem but of great importance to underwriters, namely, the amount of value subject to loss from a single fire. This

factor does influence rating to some extent, especially as indicating the distances over which exposures must be recognized, but its major significance is the effect that a single fire might have on a carrier, which must be compensated by proper distribution of liability among carriers. In other words, no one carrier can assume more than a certain amount of liability in one place. Distribution must be effected both internally and externally regardless of other considerations. It is plain that in forests, which often extend practically unbroken for long distances, this is a very important consideration.

MORAL HAZARD

There is one element of fire-insurance underwriting that has, so far, not been given detailed mention. This is the moral hazard. There is no need to remind fire underwriters of this, their archenemy. In fact, the author has heard timbermen themselves express doubt whether a forest fire insurance undertaking could succeed in the face of the moral hazard it would encounter.

It is freely granted that the probable effects of this hazard upon forest fire insurance cannot be foretold. Even in ordinary fire insurance, in which extensive experience has been accumulated, accurate measurements of it are impossible. All that is known is that it takes an appreciable toll in the face of strong preventive efforts. Undoubtedly forest fire insurance will produce some deliberate fire loss. As in other forms of fire underwriting continual care will be the best safeguard. Moral hazard arises from a small but unscrupulous minority of owners, who are, unfortunately, capable of doing much damage. The author holds the opinion, based on his general knowledge of and experience with timber owners, that moral hazard will not, in itself, constitute a barrier to successful forest fire insurance. P. A. Herbert (in a letter to the author) says:

> I believe a cross-section of the owners of forest lands would present a better [moral] risk than the average store or dwelling owner. The forest property owners in the timberland regions, I really believe, have a higher moral integrity by and large than the million fly-by-night small businesses that are now adequately covered by insurance. It takes more capital, more foresight, and more patience to invest in forest property than it does to operate a clothing store or a multitude of other business ventures.

Insurance underwriters may take issue with the statement that the million fly-by-night small businesses are adequately covered by insurance, at least if they can help it. The fact remains that the fly-by-night element does not invest in forest property, and the moral-hazard status of forests is helped at least to that extent.

To what extent this favorable factor is balanced by unfavorable factors pertaining to forest ownership, only time and actual experience can indicate. The general factor of safety incorporated in the suggested method of premium collection is intended to cover this indeterminate factor along with others. When and to what extent it can be abrogated is an inseparable function of actual experience.

FOREST VALUATION FOR FOREST FIRE INSURANCE PURPOSES

Some students of forest fire insurance have expressed the opinion that the proper valuation of forest properties for insurance purposes will present one of the greatest difficulties that have to be overcome.

It is undeniably true that it is a highly complicated subject, that there is too little real understanding of the underlying principles of sound valuation among a large number of the people who are directly concerned with it, and that consequently a somewhat unsatisfactory condition exists throughout the country.

It is clear that an accurate knowledge of the essential principles of forest valuation will be a necessary prerequisite to any successful fire-insurance undertaking. The final application will be made through the medium of dollars and cents. The general principles with which underwriters are already familiar will apply with equal force in the woods as elsewhere.

ACTUAL SOUND VALUE THE BASIS OF POLICY WRITING AND INDEMNITY

Overpayment of indemnities must be consistently avoided, but loss payments must be equitable and actually fulfill their function of providing relief from loss. Adjusters and underwriters must both be familiar with sound bases of adjustment. It is not only essential that adjusters be able to adjudge true amounts of losses, but policy contracts must be so designed that equitable but not excessive losses are payable under them. The actual value must always form the basis of underwriting and adjustment practice.

It is not possible, therefore, to assume arbitrary values—so much per acre, for instance, to be paid in case of damage by fire. The extent, intensity, and actual financial value of the damage must always constitute the basis of indemnity. This basis must, furthermore, be foreseen when the policy is written and must dictate its terms insofar as the amounts stated are concerned.

Full property-damage insurance is said by careful students seldom to be the cause of moral-hazard losses. True moral hazard mainly arises through the assured's indifference as to whether his property is damaged or even from his actual desire to liquidate by this means. Where only full cover is maintained other factors usually still operate to make the assured prefer not have a loss. Overinsurance, however, occasionally creates the impression, apparently, that a profit can be made out of a fire. Any great amount of overinsurance is therefore likely to produce an excessive number of losses and should accordingly be vigorously combatted. Obviously overinsurance cannot be avoided unless underwriters are able to identify true values.

Property on which fire insurance is mainly being written today falls into two major classes: Buildings and contents of buildings. There are very few items of property which are not, at least potentially, either buildings or contents. Nevertheless there are a number of classes of property which are not buildings but which are often insured in an out-of-doors status. Lumber, pulpwood, hay, and grain are examples. These items partake essentially of the character of contents of buildings rather than of buildings, since they are primarily movable and are hence essentially stocks of goods.

The governing principle in the insurance of these stocks of goods against property damage is that the carrier is only obligated to replace them after the loss. Thus the indemnity is an amount sufficient to put back into the assured's premises another stock of goods of like kind, quality, and amount. The market is quite definitely

established in the majority of cases and fluctuations do not disturb the principle involved. It is to be noted, though, that this market is the one in which the assured buys goods, not the one in which he sells. Thus proper indemnity is based not on the assured's selling price but on the cost to him.

In the case of buildings, the proper basis of indemnity is established on the principle of replacement less depreciation. It is not assumed that the assured is entitled to new for old at no expense to himself. There is here, of course, no established market to fall back on and adjustments must be made on the basis of appraisals. The assumption of the indemnity is the provision of the assured with another building with a value equal to the one destroyed.

SPECIAL FEATURES OF FOREST VALUATION

The insurance of forest properties will be somewhat unique and will involve a technique new in some respects but with no modification of essential principles. Forests are not analogous to buildings in that they cannot be reconstructed after a fire. Neither are they exactly like stocks of goods, in that they are not movable and cannot be replaced on the assured's premises (except perhaps in the case of very young artificial plantations). In their insurance aspects, however, they resemble stocks of goods more than anything else. When we speak of the insurance of forests we really mean the insurance of actual or potential forest products on the stump. It is these forest products that have a tangible insurable value for which there is an economic need of insurance protection.

These actual and potential forest products are really the stock in trade of the timber industry and, even though many times it would be difficult or impossible to buy other standing timber that would exactly match the destroyed timber, nevertheless an adjustment, for purposes of this study, must be assumed on the basis of what it would cost to buy such timber if it were available.

It can be expected that on occasion assureds will urge special values for their particular tracts because loss of timber has necessitated shutting down or moving their plants. These extra losses are not, however, elements of property damage but of loss of use, business interruption, or loss of profits, and the special forms of insurance to cover them are ordinarily obtainable. This report is confined to the various aspects of property insurance. Use and occupancy, business interruption, and profits insurance will not be discussed.

There are two main classes of forest property: Merchantable timber and naturally grown second growth or reproduction (unmerchantable timber). There is also a third class which is so far of minor importance in this country, though as time goes on its importance may increase. This is the class of artificial plantations, which occupies a somewhat unique position with respect to its insurance possibilities and the technique required to cover it.

In the Douglas fir region merchantable timber is mainly derived from trees 20 inches or more in diameter at breast height. While under practical conditions a degree of merchantability is recognized for stands of trees smaller than this, in some specially favored cases, the needs of this discussion will be met if only the larger sizes are

discussed. This is the class of timber ordinarily considered merchantable by the established lumber industry. In portions of the pine regions trees somewhat smaller have been regarded as merchantable. In the future, whether or not a tree of a given size is considered merchantable will depend mainly on local conditions as they are affected by the market and by the methods of logging and forest management that are being applied.

The most universal expression used in connection with timber values is the word "stumpage." Unfortunately, this word is not uniformly applied. Trade practices vary in different parts of the country with consequent varying connotations for stumpage. Whatever the local variations may be, however, stumpage always applies to the value in the tree as it stands in the woods unsevered from the stump. It may mean the consideration paid for the right to cut the tree and remove the logs immediately. It may imply a consideration paid for the right reserved to cut at some time in the future, which is a very different thing. Or, it may simply be a figure derived by dividing the total price or assumed value of a tract by the estimated quantity of timber on it, reducing the total to terms of unit values.

No real progress in discussion can be made without some more or less arbitrary narrowing of the definition of stumpage. The most logical method is to adopt a term that has already come into use in connection with other economic investigations in the industry. This is "stumpage conversion", the stumpage-conversion value being the value for immediate operation and manufacture.

In this connection it is important to observe that the word "immediate" is of special significance. The privilege of removing a tree at some later time is not as valuable as the privilege of removing it now, other conditions remaining the same. In practice, of course, other conditions usually do not remain quite the same, but the direction and amount of change are uncertain. Meanwhile some definite liabilities are incurred, such as taxes and interest on the money tied up and the indefinite liability of contingent risk of loss or damage. Therefore, mature, or nearly mature, timber bought for future conversion has a less definitely demonstrable value than timber which is to be converted at once.

Obviously, then, since much of the timber in the Pacific coast territory can be liquidated through conversion only at some future time, it is difficult to assign a definite value to it, and speculative opinion must rule. The point chiefly worthy of note is that sound speculative opinion will be guided, not by the amount of the cumulated capital investment, but by the combined effect of probable conversion values and probable length of time prior to actual conversion.

While it is true that physical change may increase rather than offset the liabilities incurred during the waiting period, nevertheless, in the past, an intangible-asset factor has strengthened the position of the timber owner, at least in part. This is the gradual rise that has taken place in log values and consequently in stumpage-conversion values.

Throughout the history of the industry in the West the locations of the log markets have been practically stationary. Convertible timber has, on the other hand, steadily retreated from these markets as successive zones have been entered and, in turn, cut out. In spite

of the gradually increased cost of log production that has resulted from going farther and into less favorable operating chances, average stumpage-conversion values have increased because of an increasing differential between delivered log prices and log-delivery costs. Between 1900 and 1926 this increase in stumpage-conversion values in the Douglas fir region amounted to an average of 14 cents per year (*6*). The true values of given tracts that have remained unoperated have increased at a more rapid rate than this. By true values is meant the actual sound values, not speculative or transitory values.

Whether this same trend will continue in the future, no one can definitely tell. Authoritative opinion on the point is somewhat controversial. Whether or not it does is of academic interest only, so far as this discussion is concerned, as will be explained. It is nevertheless important that underwriters and adjusters understand clearly that these trends have operated in the past, in order that they may have a basis for intelligent guidance in their judgment of values that are derived from future conversion prospects only.

That the tendency during the past for stumpage-conversion values to increase is of academic interest only is due to the absence of any certainty as to whether it will continue in the future. This uncertainty of the future makes some discounting of past experience desirable. Such discounts are sometimes, however, not heavy enough, with the result that speculative values are distorted upward. At the time of any given loss in a speculative property, the indemnity must be made on the basis of the speculative value that is supported by the weight of opinion at the time. Since the carrier is obligated to provide the assured with means to acquire another equally desirable property immediately, it must pay him an indemnity that is in line with the speculative values prevailing at the time. These values will be dictated by the consensus of opinion of the men who are actually engaged in ownership and acquisition. Underwriters and adjusters will accordingly always be obliged to base their practice on actual prices prevailing, subject to such improvement as a complete understanding of underlying principles enables them to make.

The author's preference, as a forester, would be to discuss this matter of forest valuation from the point of view of forests as continuously producing rather than as liquid properties. Forest insurance will of necessity be a wholly practical undertaking and, as such, must follow rather than initiate developments. The existence of insurance will, in itself, be an aid to the development of better forest practices. Proponents of forest insurance will, it is hoped, continue to be proponents of improvement in forestry methods. Meanwhile, the present discussion must adhere to existing conditions. There is no reason to believe that any great difficulty would be encountered in adapting insurance-valuation practice to forests actually under sustained-yield management where proper indemnity would be a measure of the actual growing-stock value. Such a condition will not exist in practice, of course, until most forests are actually valued that way.

Underwriters and adjusters can expect to encounter three main classes of insurable interests in timber, in addition to the ubiquitous mortgagee interest which needs no special attention. These are represented by: (1) Nonoperating owners of both timber and land;

(2) operating owners of both timber and land; and (3) operating owners of timber only.

In the first class come all those who have made investments in timberlands for speculative profits only and who hold it for liquidation through en bloc sale or piecemeal stumpage conversion. They do not intend to do any logging themselves in any event, and will effect stumpage conversion, if at all, through sale to an operator. The governing principles of insurance valuation of such properties have already been discussed. Valuations based on speculative opinion must be the rule.

Class 2 includes all the lumber manufacturers who own timber in connection with their operations and such loggers as may have actually bought timber properties outright, land fee and all. These owners have bought en bloc and are, in effect, selling piecemeal. Since they are actually operating, their properties must inevitably be equipped with operating facilities. Their liquidation prospects, therefore, are predictable with reasonable definiteness. There has been a distinct lessening of the influence of the speculative element which is, after all, mainly inherent in the uncertainty as to how soon it may be possible to liquidate the property or, at least, to make it begin to produce some cash income. Such an owner cannot be satisfied by the payment of an indemnity that will enable him only to buy timber that cannot be made operable or liquidable without a new advance of capital, since the capital advance already made, whether deliberate or fortuitous, has been reflected in an actual enhancement in the value of the timber affected.

If the owner of 10,000,000 feet of timber has installed spur trackage through it at a cost of $10,000 he has enhanced the value of the timber at the rate of $1 per 1,000 feet. If this were not true the expenditure in trackage would have been thrown away. In any event, then, when timber that is under actual operation is destroyed, the unrecoverable capital advance that has been made against it is a proper item of property damage and must be reimbursed in the indemnity.

This enhancement is not, however, a sum over and above the stumpage-conversion value but is a part of it. Proper indemnity will be arrived at by adding the unrecoverable capital advance to the proper depletion reserve requirement, and will be the sum of these two figures only.

This owner's market, in which he buys timber, is the market in which timber tracts are sold en bloc, as has been stated. His settled business policy is, or should be if he intends to stay in business and keep sound accounts, to reserve out of each year's cutting receipts, a sum capable of purchasing in the en bloc market, that year, a quantity of standing timber equal to the amount cut. From the insurance point of view it makes no difference whether he is a "cut-out and get-out" operator. His actual property loss is always what it would cost the insurance carrier, buying as he has bought, to provide him with other timber equally ready for immediate operation (i. e., with operating capital advance made).

Figure 1 is a diagrammatic presentation of a complete lumber manufacturing undertaking which owns a supply of timber sufficient for 20 years. Average values and costs per 1,000 board feet for

a 5-year period, as reported by the West Coast Lumbermen's Association, are given for the purpose of clear illustration. If, in this case, the first year's cut is lost just after the operating capital advance has been made it will still be possible to move into the second year's cutting area and substitute that for the first. There are, then, only 19 years of operation ahead instead of 20. No allowance needs to be made for the expense of taking up track and moving equipment because that would have had to be done anyway. The opportunity of obtaining a cash reserve for depletion out of the first year's cut has, however, been irrevocably lost. This is a true liability on the insurance carrier. Likewise the true capital advance for operating the first year's cut has been irrevocably lost and is a liability on the carrier since it is an element of actual property value in the timber. Loss of time in making the change is, however, an element of business interruption and cannot be indemnified under property-damage insurance. In fact it is questionable whether there is any

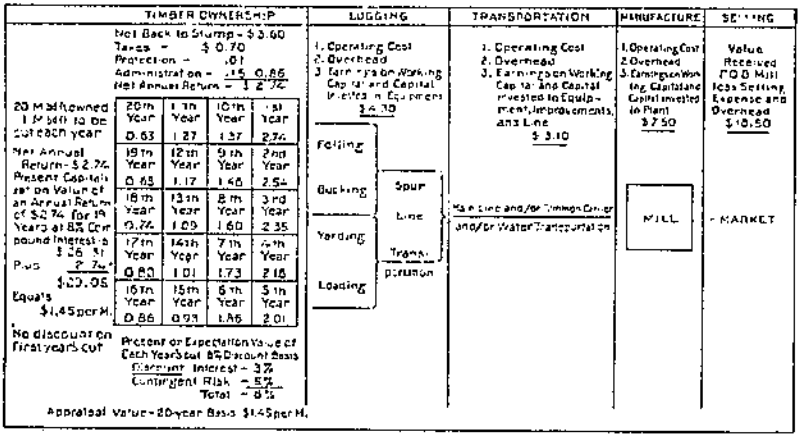

FIGURE 1.—Diagram of appraisal of a timber property under operation. Basis, 1,000 board feet; 20-year cut, stumpage price assumed paid in advance each year.

loss here, since the change would have had to be made in any event.

Class 3 includes mainly loggers who have paid timberland owners in advance for cutting rights. Ordinarily only a 1-year supply of timber will be involved, though there may be exceptions to this. Timber owners of this class will ordinarily be doing business in a market in which unit prices paid are higher than they are in classes 1 and 2. This is because these owners are mainly piecemeal buyers who risk no capital investment against returns in future years. Those who do buy only a 1-year supply at a time will be found to be paying full stumpage-conversion prices, and proper indemnity for them will be this figure plus the unrecoverable capital advance they may have made, as is explained under class 2. Owners of this class will recover, as proper indemnity, higher unit values than will owners in the other two classes, and should carry correspondingly more insurance under their policies.

This seemingly paradoxical situation is easily explained when it is realized that insurance does not protect the thing itself but the property interest. Thus differences in classes of ownership demand

differences in insurance cover and indemnity. Take, for example, any random article, as a piece of furniture. For insurance purposes it is worth, to the manufacturer, what it has cost him to make it; to the wholesaler, what it costs him to buy it from the manufacturer; to the retailer, what it costs from the wholesaler; and to the householder, what he has to pay the retailer for it. Here, then, are four different insurable values for the same piece of property. Similarly there are at least three different bases of valuation of standing merchantable timber, depending on who owns it. The analogy is not precise, but the principle is probably sufficiently well established.

Individual cases will be encountered in practice in which the unrecoverable capital advance has not been made by the owner but is in the form of an improvement, public or private, which has bestowed upon the timber a differential advantage that is wholly fortuitous. It may be a public highway on which truck logging is economically feasible, or it may be a sawmill erected primarily to manufacture other timber but willing to buy the timber in question. After loss of timber so located, unless the insurance carrier indemnifies the owner with liberality sufficient to enable him to procure other timber equally ready for sale on the same terms, it has not indemnified him adequately.

It is only meant here to emphasize that any unrecoverable capital advance, whether deliberate or fortuitous, is an entirely proper element of property value, since it imparts to the timber a differential advantage not enjoyed by other timber against which such an advance has not been made.

As has been stated, the most common interpretation of the term "merchantable" is an expression of size of the tree. Trees smaller than 20 inches in diameter are not ordinarily considered to be merchantable by the established lumber industry in much of the territory under discussion. When "unmerchantable timber" is referred to, therefore, stands of trees mainly smaller than this are implied. In actual practice no hard and fast line can be drawn, because there have existed in times past, in some localities, recognizable stumpage-conversion markets for the larger sizes of unmerchantable timber for saw-timber purposes. A certain value can also be said to be realizable from small trees for fuel where only short hauls to market are involved.

THE PROBLEM OF VALUATION OF UNMERCHANTABLE GROWTH

Except on certain unfavorable growing sites, mainly in mountain or seacoast areas, stands of trees generally smaller than 20 inches in diameter are second growth. In the aggregate there is a large amount of this type of timber growth scattered throughout the territory here considered. The amount to which any present value could be said to attach for saw timber or fuel purposes is, however, a small part of the total. By far the greater portion derives what value it has from the prospect that it will one day become truly merchantable in the ordinary sense of the word. Its present value depends on estimates as to when it will become merchantable and marketable.

The small portion that can be called marketable today can be insured like timber of merchantable size according to the class of ownership and situation with respect to operating. Because there is still

so much timber already of merchantable size, little interest has as yet developed in the ownership of second-growth stands and speculative opinion has not established anything like adequate value indexes. The smaller the sizes of the trees considered the more this is true, and it will undoubtedly be a long time before there can be said to be any real market for small reproduction.

Forestry cannot function without young trees, and if private owners are to practice forestry they must own young trees. If forest insurance is to function as an integral element of private forestry, it must attempt to devise a means whereby second growth and reproduction can be insured with success and satisfaction to both parties to the contract. As private forestry develops it will be reasonable to expect that the keenest demand for forest insurance will be for second-growth stands partly because losses will be wholly unrecoverable through salvage and partly because of the long time that one owner must hold any single unit area.

In the absence of any better basis for valuation the suggestion has been made that indemnity might be paid for losses in second growth and reproduction as determined by what they actually cost the owner in money paid out. This would normally be represented by a sum arrived at by adding to the purchase price, if any, the annual and periodic payments for taxes, protection, administration, or other maintenance costs, with allowance for reasonable compound interest cumulation. Ordinarily no purchase price would be involved. Much of the second growth and reproduction privately owned today is the gratuitous result of the natural restocking of areas previously cut or burned. It could accordingly be expected that the cumulated maintenance expenses with interest would comprise the total basis of value in the majority of cases.

The reforestation laws of Oregon and Washington reduce annual taxes on this form of property to a minimum. Classification is provided for, after which a tax of about 5 cents per acre is collected. If 5 cents per acre per year is allowed for protection (probably an ample amount), and 3 cents for incidentals, the total is 13 cents per acre per year. Allowing compound interest at 3½ percent, then, cumulated capital investments would amount to the following at various stages of growth:

	Per acre
At 20 years of age	$3.67
At 40 years of age	10.98
At 60 years of age	25.55
At 80 years of age	54.50

Allowing the cost at 80 years to expand to $77.55 per acre, that is, adding slightly more than another 0.5 percent, would cover the cost of fire insurance for the whole period on the basis of average premiums suggested in this report. With a yield of 50,000 board feet of timber products, a not unreasonable expectation for much of the land in the fir region, a unit conversion value of $1.55 would liquidate this cumulation. Land that will not justify such an annual expense either ought not to be held, or means should be devised for maintaining it at less expense. All that is intended here, in any event, is to illustrate the principle of the cumulative annual expense as a method of valuation of immature growth.

From the insurance point of view, of course, it might result in the owner's always having more money tied up than he would require to buy another property equally valuable to him with consequent encouragement of the moral hazard. To this the only answer is that it might conceivably be found, in actual practice, that the manner suggested is the most practical method of appraising these values. After all, moral hazard is not increased if the insured owner still prefers not to have a loss and sincerely cooperates in the protection of his property.

Underwriters and adjusters must necessarily know something of prices at which various classes and types of unmerchantable timber are actually changing hands. Whether it would be found that values indicated by these prices would be badly out of line with values indicated by cumulated expenses it is very difficult now to guess. Much will depend on future developments in forest practice and policy.

It may be that before long other and more direct methods of appraising the values of unmerchantable stands may become practicable, or may be so even now, in some cases. The method proposed above is only intended to serve where no better basis is available.

It is too early yet to make more than these indefinite suggestions for the valuation of unmerchantable timber, second growth, and reproduction. Each separate case will have to be considered on its individual merits when the application or report of loss comes in. Quality, location, speculative value, and capital investment tied up will all have to be given due consideration. The usual underwriting factors of reputation, policy, and financial standing of the owner will also play their parts. In insurance, and especially in fire insurance, there is no escape from consideration of the personal element. Underwriters are many times loath to accept liability on property of acceptable physical hazard and definite insurable value solely on the ground of uncertainty as to the integrity, moral responsibility, or financial security of the owner. Conversely, they are in principle, and entirely properly, disposed toward liberality in the acceptance of liability subject to greater physical hazard or less definite value if the assured's integrity, moral responsibility, and financial security are unquestioned. They want to feel that, in spite of his insurance protection, the assured will still prefer not to have a loss. It would appear that this consideration will be an inevitable factor in the insurance of unmerchantable timber.

ARTIFICIAL FOREST PLANTATIONS

In view of the activity already developing in the establishment of privately owned artificial forest plantations, some consideration should be given to the principles of valuation that may be involved in them, since if forest insurance becomes a fact there will undoubtedly be some demand for cover for plantations.

It can be believed that there will be no great danger in adopting the principle of insuring newly established artificial plantations on the basis of their cost (or a figure approximately what they should have cost if, for any reason, the actual cost was excessive). The very fact of their establishment can, with very few exceptions, be taken as an indication of the integrity, moral responsibility, and financial security of the owners.

The capital investment in a plantation inevitably increases as time goes on, since it produces no income but absorbs lost interest on its cost and items of annual expense for maintenance and protection. In practice it might be suggested that this increase could be, at least in part, allowed for by more or less arbitrary agreement, always bearing in mind that sooner or later a plantation is indistinguishable from a naturally grown stand.

Possibly it would be sufficient to cover only the cost of planting for the first 5 years, thereafter making moderate allowance for increasing capital investment in the form of percentage additions so long as the plantation remained in the hands of the original owner who did the planting. Increased care will be necessary in the insurance of purchased or inherited plantations because of the change that is wrought in the personal element. It is also a recognized fact that under ordinary conditions several years would have to elapse before there would be any probability that a plantation could be sold for even as much as its original cost.

No plantation has an intrinsic value greater than that possessed by any stand of natural reproduction equally good and equally well situated. The only basis for a separate classification is in the personal element. If this is borne in mind the insurance of plantations can probably be kept on solid ground. There would inevitably come a time in the life of any successful plantation when its insurance status would be the same as that of natural growth, regardless of any other consideration. The essence of the problem is to scale the increase of value with the increase of age correctly for insurance purposes. Actual insurance practice will furnish the best guide to definite principles. Meanwhile conservative values must be the rule.

As a part of the national forestry program, forest fire insurance will fail in its purpose if it does not provide for insurance on stands of second growth and reproduction. As a practical business undertaking it is restrained by the necessity of adhering to sound principles. It will inevitably fail if insurances are written and indemnities paid on the basis of too high values. It will not necessarily fail if too low values are used, provided premium charges are reduced accordingly and the property owners are not misled as to the ratio between full values and the insurance protection.

It may be desirable to provide for this safety factor through the use of a partial-value clause, at least during the experimental stages of actual writing. This provision is discussed in detail elsewhere in this report.

NEED FOR CONTINUOUS STUDY

It is not believed that this report should go beyond this point in the discussion of forest values. Any more detailed work might easily very soon become obsolete. Detailed studies of values should go on concurrently with the development of actual insurance, each individual case being given special attention. During the early stages, particularly, very careful study should be made, including attention to sound values of second growth and reproduction and the costs of establishing artificial plantations. Probably at least one man should devote all of his time to it, keeping himself closely informed through all possible channels and personally reviewing each application and daily report.

The problem of forest valuation for fire-insurance purposes will be a difficult one and will require very careful attention. It should not, however, be insurmountable, and there will still be plenty of opportunity for insurance to function and perform a highly useful service in this field.

ADJUSTMENT OF LOSSES IN FOREST FIRE INSURANCE

Speed in loss adjustment where all conditions surrounding the loss are beyond question is one of the principal competitive elements of the fire-insurance business. To have adjusters examine the loss quickly and to get payment into the hands of the assured as soon as possible after proofs have been accepted are settled policies of the business. Agents and companies like to gain reputations as quick settlers, believing, probably not without basis, that their competitive position is thus strengthened.

There can be no objection to this practice if the equity of loss adjustment is not impaired by it. It is really small consolation to an indemnified assured to realize that he got his money quickly if he also realizes that the loss was greater than the amount for which he settled. It is always possible that a quick adjustment may be an erroneous one, bad from the company's point of view if payment is too high and bad for the assured if it is too low.

DELAYED ADJUSTMENT DESIRABLE

The peculiar conditions prevailing with respect to forest fire insurance will make rapid loss adjustment practically impossible. This is due to the almost general fact that it is not possible to tell what the damage has been until a considerable time after the fire. Trees often require a year or more to show definitely whether or not they have been damaged or killed by a fire. It will be the best practice to delay damage appraisal until it may be definitely determined whether any individual tree is damaged or undamaged, alive or dead.

It is undoubtedly safe to say that there will be no difficulty whatever, in any event, in appraising damage in the Pacific coast territory at the end of the next growing season succeeding the date of the fire. Thus losses from fires occurring in 1934 would not be finally adjusted until the fall of 1935, whether they were spring, summer, or fall fires.

Where damage is confined to young plantations or natural reproduction, this wait will not always be imperative, but it should be the rule if the trees involved are more than 15 or 20 feet high.

TECHNIQUE AND POLICY OF APPRAISAL AND ADJUSTMENT

Any experienced timber cruiser who is familiar with the cruising technique of the region can make satisfactory damage appraisals with very little supplementary instruction.

It is essential to know what the quantity and quality of the immediately liquidable or speculatively held timber was prior to the damage, and the quantity and quality of that remaining. Accurate determination of the area burned is essential. Mapping work must, of course, make accurate location with respect to the legal survey, in order that

proper check may be made with the coverage in the policy and the assured's title.

Where speculatively held timber is lost there will often be no immediate prospects of salvage, and the index of the indemnity is the full amount of the timber killed or damaged. Title to the damaged portion of the timber passes to the carrier who has paid the indemnity, so that he may get what benefit may be derived from future salvage possibilities.

The damage in immediately liquidable timber is the difference between its value prior to the fire and the salvage value after. There is always some loss due to degrade and increased breakage, which increases during the time between the fire and the time of cutting for salvage. As this period lengthens, the effects of decay and other deterioration will increase the total amount of damage. These losses are more serious in hemlock, spruce, and pine than in Douglas fir. The killing of mature cedar by fire, unless the wood is burned, constitutes a still less severe loss, since cedar does not decay as rapidly as most other woods.

In adjusting losses on timber near active logging operations, which would be cut within a few years in any event, the adjuster must always endeavor to persuade the assured to modify his cutting plan so far as he can without undue expense, so that the salvage realization may be as large as possible. If an owner is uninsured he will always try to salvage his burned timber as quickly as possible. The existence of insurance protection should not cause this practice to be modified. The adjuster should not endeavor to enforce salvage in a manner different from that which the assured would have adopted without insurance; but, on the other hand, slackness on the part of the assured should not be allowed. The standards of salvage must be the same whether or not insurance protection is maintained.

There is no need here to go into the details of the technique of determining volume of timber per acre where timber of merchantable sizes is involved. For purposes of estimating damage to unmerchantable stands where small-sized trees are involved, the use of the so-called stocked quadrat system (*4*) is recommended. The adjustment of losses in second-growth and reproduction stands can be expected to present a number of problems. To attempt to enumerate them here or to advise the adjuster how to deal with the assured, or vice versa, would be an impossible task. The problems will have to be recognized as they come up and solved by agreement, one special case at a time, always bearing in mind the principles of good insurance.

When the extent of the damage in thousands of feet of timber or acres of young growth has been determined, there still remains the necessity of assigning proper unit values in terms of dollars before the indemnity payment can be made.

The principles governing forest valuation for fire-insurance purposes have been discussed. It should be mentioned here, however, that there is one activity connected with loss adjustments that does not need to be delayed but can sometimes be taken up soon after the fire. This is the agreement as to unit values which can be made between the assured and the adjuster at any convenient time. If, for example, an assured reports a fire on his property, an adjuster can

visit him at any time, and after study and conference, sign an agreement with him as to the unit values involved. Then, as soon as the extent of the damage is determined through the field cruising, the indemnity can be figured and the loss paid.

The practice of basing adjustments on "woods run" or "camp run" should be closely adhered to. It is to be noted that although the assured sells logs, he buys trees, so that, while quality must of necessity be taken into consideration and the proportions of the total volume in no. 1, no. 2, and no. 3 logs admitted as an indication of quality, nevertheless the terms of the policy presuppose the reimbursement of the owner in standing trees, and an average should always be struck before making the final calculation. If agreement can be reached between the assured and the adjuster as to the average quality of the damaged timber, the unit value can be established prior to the determination of the extent of the damage. The evidence contained in previously made cruise reports may be acceptable. The assured's own records of actual cutting on adjacent areas may give sufficient indication, or there may be other ways of arriving at this information.

If, however, no basis for agreement as to quality exists prior to the production of figures by an adjustment cruise of the burned area, the agreement as to extent of damage and unit values involved will have to be made simultaneously. It will probably always be necessary for the estimator of the extent of damage also to determine the qualities involved, even if for no more than a rough check.

It will unquestionably be essential that representatives of both parties be included in the damage-cruising party. Whether they should invariably be invested with the power of arbitrators and should, between themselves, choose a third, it is not at present possible to state. There are some very apparent advantages, however, in such practice. Unless the assured and the adjuster contemplate doing the actual field cruising work themselves and agreeing as they go, it would appear that two cruises would be necessary, one for the assured and one for the carrier. This duplication could be avoided by the appointment of one cruising party with power of arbitration, its findings to be binding on both parties. If this appears to be a somewhat harsh policy, it can be argued in justification that many losses now go to arbitration before they are settled and the adjustment of losses in standing timber will many times possess very unique characteristics. A truly economical method of procedure will sometimes be difficult to achieve. In Norway all forest fire loss adjustments are invariably referred to arbitrators as a matter of principle.

It is realized that this discussion of the problem of adjustment of forest property losses is brief. Nevertheless it is not felt that a more detailed discussion would be justified here. The great multiplicity of possibilities makes an accurate prediction of exact practice in specific cases impossible. The general principles outlined above will probably be found applicable. Experience and practice may very likely disclose other general principles now unknown.

THE FOREST FIRE INSURANCE STUDY

BASIC CONSIDERATIONS

The study of insurance conditions in an almost entirely new field, in which practically no insurance is in force, faces some baffling problems. There is no experience to use as a guide; no precedents have been established. Furthermore, in the forests, present-day conditions have existed for only a relatively short time and the statistical base is accordingly narrow. Hence the statistical data must be as accurate as it is humanly possible to make them, available time and funds considered.

Without question, the first information that an underwriter would want to have is the loss cost, or how much, in all probability, will be lost, damaged, or destroyed out of a given amount of property. The loss cost is directly dependent on the so-called burning ratio. If, out of a total value of $1,000,000, property to the value of $1,000 is lost, the burning ratio is 0.1 percent, and the loss cost is 10 cents per thousand dollars of value.

Next, the experienced underwriter requires specific knowledge concerning hazard factors, their nature and influences, and the range between the lowest and the highest hazards of individual property units. Most important of all he must have an idea as to how much business can probably be done in the class and to what extent liability can be spread, or to what extent the law of averages will operate. As has already been stated, the best aid to a large volume of business and a wide spread of liability is an accurate and equitable premium rate schedule. Other things being equal, it is mainly through such a device that the insurance can be made equally attractive to all owners regardless of relative hazard. An accurate rating schedule furthermore enables the insurance carrier to pay losses on the basis upon which it collects premium. This desideratum can be achieved in no other way.

This imposes the necessity of knowing what influences bear on the loss cost through variable hazard conditions. The best measure of insurance loss costs is the broad insurance experience of the past, properly analyzed and expressed; but, having access to no such data, it is necessary in this study to base the estimate of probable future loss costs on the past experience of timber and forest properties as a whole. It is highly desirable to produce a schedule of rates that will make insurance equally attractive to all owners whether their hazards are high or low. In fact, unless premium is charged at a rate that expresses to a practical extent the relative hazard incurred, no material success can be achieved. Insurance based on a flat premium charge expressing the grand average of hazard would be foredoomed to failure. All the owners of properties with low hazards would refuse to insure at what would be for them excessive costs, whereas the premium rate would be most attractive to all owners of properties of more than average hazard. The result would be the collection of premium on the basis of the average and the payment of losses on the basis of the worst only, and success would be impossible.

It is fully realized that an estimate of future insurance loss costs derived wholly from a study of the experience of uninsured proper-

ties would necessarily be fallacious at least so far as the end result is concerned. The very introduction of insurance will produce distortions. The only recourse is the application of an arbitrary safety factor to be used through an experimental period until it is possible to make corrections from actual experience.

While the possible end result is subject to distortion, many internal effects are entirely independent of the factor of insurance and can be studied in uninsured properties with equal facility and accuracy up to the limit of the adequacy of obtainable data. All effects of the elements of relative physical hazard operate with complete impartiality on insured and uninsured properties, whether causative and starting fires or contributive and affecting their seriousness. Thus, if adequate data are obtainable, an estimate of hazard, and consequently of probable loss cost, can be made that will be actuarially correct in its internal relative expressions, insurance or no insurance. The conduct of this inquiry has been guided by the recognition of this fact. The findings are based on an analysis and classification of the comprehensive fire experience of forest properties in the territory for a 10-year period in a manner that painstaking preliminary study indicated to be best adapted to the requirements.

A study of the experience of 20 years would be, other things being equal, distinctly preferable and productive of more authoritative conclusions. Under existing conditions, however, this is not practicable. The forest fire loss data for the years previous to about 1920 are not sufficiently reliable for intensive study. At about that time fire reports were brought to something like the standard of accuracy and completeness required for actuarial use. The practice of the study has been based on the policy that it is better to depend mainly on fewer but more reliable data. The fire records for the decade 1911 to 1920, therefore, were only examined extensively for a determination of their general indications.

THE ORDINARY FORM OF FIRE-INSURANCE EXPERIMENTATION

In ordinary practice many serious difficulties are encountered in connection with the experimental introduction of a new form of insurance cover. In the field of fire insurance, at least, it has been customary when a demand seemed to be arising for a hitherto unknown type of protection to conduct the research through the medium of experimental writing. In order that this may be done, of course, some preliminary study must be made to determine probable loss costs, hazard influences, spread of liability, and volume of premium income. On the strength of such a preliminary inquiry, which is ordinarily quite extensive in character, a tentative system of rates and rating, including what are believed to be at least adequate factors of safety, is issued. Using this rating system, together with what seem to be necessary policy contract stipulations, the attempt is then made to obtain as much desirable business as possible, the idea being that as business is done and experience gained, the required refinements and corrections can be made.

In theory, this method of developing a new type of insurance cover is sound. It has, however, two major shortcomings. The first of these is the length of time required to bring the system to approximate perfection. This is because it depends for its supply of experi-

ence data only on the business actually transacted. Since it always requires a period of years to build up a class of business, the statistical base is certain to be relatively narrow for a considerable time so that new combinations of circumstances, hitherto unknown, are continually being encountered. The uncertainty as to whether these circumstances are normal or abnormal is sure to have a disquieting effect on the underwriters and to interfere with the opportunity afforded the class of business to demonstrate its real character. It is argued that, the basis of insurance being the law of averages, no real indication can be had of possibilities until the extent of the demand is known, the operation of the law requiring volume. If volume is not obtainable success cannot be achieved.

The second of these is the uncertainties surrounding new ventures, impelling the experimenting underwriters to demand a factor of safety between premium income and estimated loss costs large enough to give promise of covering the unknown contingencies. This has the effect of creating rates that are often relatively so high that it is difficult to persuade the owners to buy the insurance, particularly if they believe their hazard is overestimated by the rate. Liability limits, imposed as safeguards, also often detract from the desirability of the cover. The experience on much of the best business is thus lost and the statistics gathered by the insurers indicate the class as worse than it actually is. Ordinarily, if the class is large enough, a working practice, satisfactory to both sides, eventually develops. Fire and theft insurance for automobiles is a conspicuous example of the successful working of this method. Various forms of insurance against hazards arising from aviation, inland marine insurance, and forest fire insurance can be cited as experimental forms now in various stages of development through the application of this method.

No particular issue is taken here with the established practice of experimental underwriting except as to the time involved. It is the writer's belief that in the case of forest fire insurance a particularly long time would be required for this method to produce a truly adequate and practical form of cover. It would probably be almost impossible to find a class of property inherently so poorly adapted, for a number of reasons, to this method of study. Forest properties for one thing appear to violate, in almost all of their characteristics, most of the established principles of fire underwriters.

Another reason why the present practice of experimental underwriting is not applicable to forest property is that the profit margin of forestry practice is now so small that a high insurance premium, such as is required in experimental underwriting, wipes out too much of it. Most experimental underwriting develops when the business itself is in an experimental stage and when possible profits are large, permitting the payment of relatively high insurance premiums.

It therefore seems entirely proper to approach the research into forest fire insurance in what practically amounts to a reverse order. In other words, it appears that an opportunity exists to get the statistics first and to launch the business afterward, if it appears justified. So far as the writer knows, this study embodies the first comprehensive attempt to apply this method. It is hoped that indications as to its general merits may be brought out.

METHOD OF DEVELOPMENT OF STATISTICAL DETAIL

It has been stated that somewhat over a decade ago the keeping of forest fire records in the territory studied was brought to a standard commensurate with that of actuarial practice. While the original research that has been carried on in connection with this inquiry indicates this to be a fact, it is also nevertheless true that these records say very little as to details. Since, however, they are authoritative as to the sum total of the loss experienced they do give an all-important starting point.

Since these records do not tell enough of the story, other means of obtaining more information had to be devised. The work of the inquiry has accordingly comprised a number of phases directed toward (1) verifying the accuracy of the existing records and (2) obtaining, analyzing, and interpreting a volume of supplementary data making possible a number of highly essential refinements. The original data gave an almost bare but authoritative indication of the average loss cost. The refinements desired are those which make possible a proper gradation of the premium rate through all the varying degrees of hazard, so that each individual owner may be asked to pay premium in practical proportion to the actual hazard to his property.

The exact methods of collecting, analyzing, and interpreting supplementary data for the purpose of refining and clarifying the hazard-rating process are described in detail on subsequent pages. Broadly speaking, the phases of detailed study cover five major subdivisions of the inquiry as follows: (1) Verification of the accuracy of the existing records; (2) study of the influences of the contributive physical hazards; (3) study of the influences of the causative hazards; (4) study of the influences of climatic conditions; and (5) study of the influence of the organized protective effort. While these last two factors are, to be sure, inherently elements of contributive hazard they are nevertheless sufficiently distinctive to merit separate mention. The inquiry into either one of them is a study by itself.

A study of hazard and, consequently, of possible rates and rating systems, although it does not constitute a complete insurance study, is, nevertheless the keynote. On its conclusions depends the essential decision of the general practicability or impracticability of the whole project. While no amount of abstract research can, in the absence of actual practice, give a definitely final answer, the evidence produced by the abstract inquiry here reported clearly indicates a justification for early promotion of actual writing as soon as it appears that the forest owners are disposed toward giving reasonably adequate support.

FOREST REGIONS COVERED

GENERAL DESCRIPTION

The Pacific coast territory is conceived as embracing primarily the forested portions of the three Pacific Coast States, Washington, Oregon, and California. Four distinct forest regions are recognized (fig. 2). Since the northern ponderosa pine region extends from eastern Oregon into central Idaho with perfect continuity of silvic and economic conditions, this portion of the so-called Inland Empire is also included.

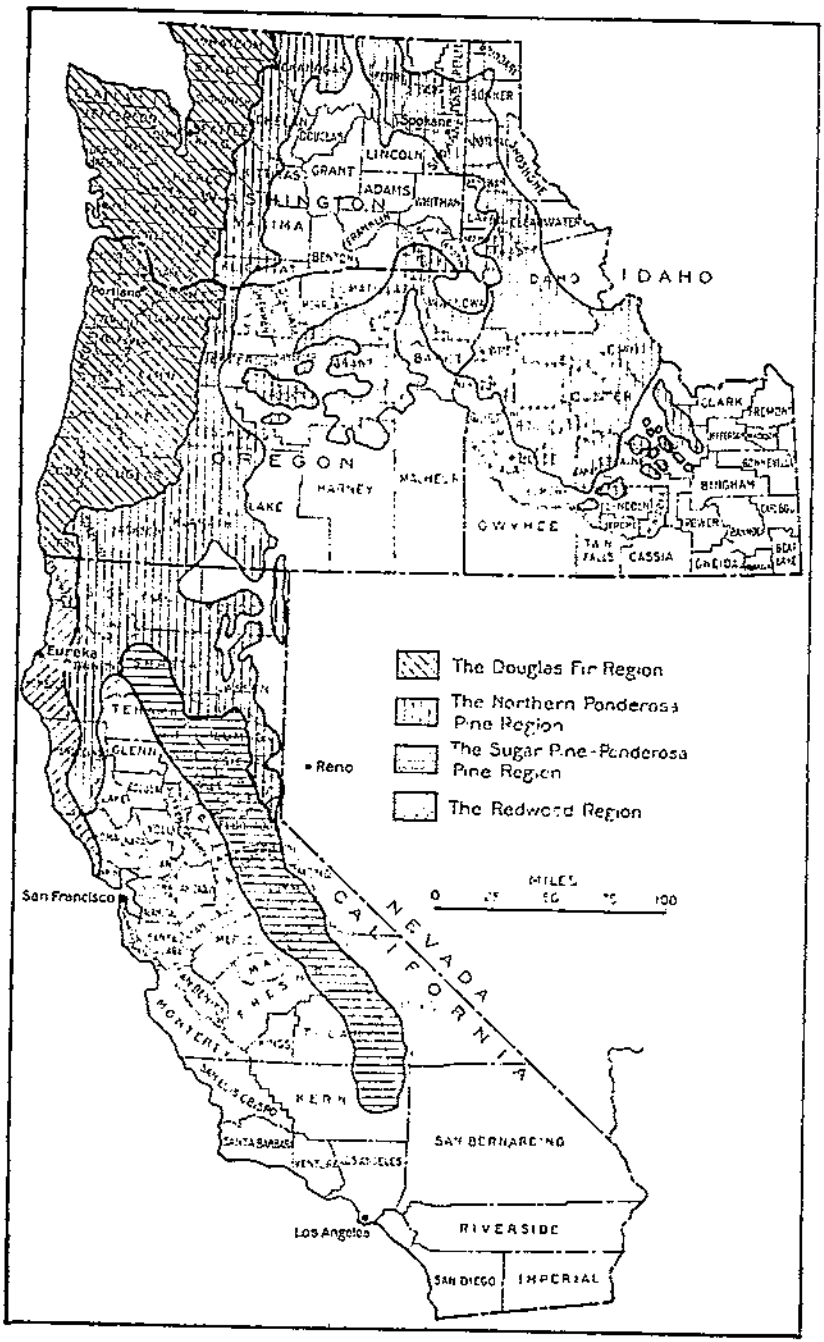

FIGURE 2.—Map of the Western States showing the location of the four forest regions studied.

From the point of view of the available standing timber supply of the United States the regions covered by this current phase of the study are the most important. It is estimated, in fact, that they contain approximately two-thirds of all of the privately owned merchantable timber in the country. In addition there are extensive national-forest and other publicly owned lands that carry timber potentially available for the Nation's timber industry. This industry is heavily concentrated in the northwestern portion of the country, particularly in Oregon and Washington.

It is understood, of course, that in some instances the lines of demarcation between regions are not clear-cut. This is especially true in northern Washington and in the territory embracing southwestern Oregon and northwestern California. In northern Washington there is a very large area east of the Cascades in which there is a coniferous mixture that is neither properly characteristic of the Douglas fir region nor of the ponderosa pine region. Near the Oregon-California line, and extending for considerable distances on each side in the Siskiyou Mountain region is a transition belt involving a mixture of the trees of all four regions without conditions typical of any one of them. It is believed that detailed study of these nontypical and transition belts would not be justified—that all that is required are analyses of the climatic conditions and the degree of protection afforded them. An arbitrary division, allocating portions to the contiguous established regions, has been made, which, it is believed, works no serious inequities on the insurers either in these belts or in the typical portions of the regions.

What is said here with respect to the transition belts is also true of the redwood region, with some additional considerations. In the first place, to the forest fire insurance study, the redwood region is really only a modified form of the Douglas fir region, similar, in many respects, to the Port Orford cedar belt. Redwood really occurs in what amounts to a special type in a territory that does not otherwise depart importantly from the Oregon coast portion of the Douglas fir region. Within the confines of the redwood region there is a great deal of Douglas fir, western hemlock, Sitka spruce, and other fir-region species.

The mature redwood itself is characterized by a very low susceptibility from the point of view of insurance in that it is very rarely killed by fire. It is susceptible to fire damage through cat-facing and occasional burning down, as are all species, but this sort of injury is not well adapted to the application of the insurance principle. Furthermore a killed redwood tree, even lying on the ground, is of very little less value for conversion than a live one unless it happens to be affected by a subsequent fire. On the whole, the possibility of serious fire loss in mature redwood timber is not sufficient to create any material demand for insurance cover.

Immature redwood, at least in the earlier stages, is subject to fire damage like any other species. That is, depending on conditions at the time of burning, it may be partially or totally destroyed. This is also true of the accompanying species in both the immature and merchantable stages. There is not in the redwood region, however, a sufficient quantity of timber or a sufficiently wide departure from conditions found in the other regions to justify any detailed study of causative and contributive hazards. Such insurance as may be

required can safely be written on the basis of what is known of these factors in the Douglas fir region. The only specific requirements for the redwood region are detailed climatic designations and a protection survey. In actual underwriting, of course, specific areas of prohibitive hazard arising from excessive incendiarism or combinations of other causative hazards may be considered. For a detailed discussion of fire in the redwood region see Fritz (*3*).

The general locations of the four silvic and economic forest regions covered by this study are shown in figure 2. In many respects, and particularly from the viewpoint of the forest insurance study, the sugar pine-ponderosa pine region differs very little from the ponderosa pine region. It is, in actuality, essentially a continuation of this region with a few rather minor modifications caused by climate and soil. While recognizing a distinction between east side and west side, the Forest Service administration has nevertheless always spoken merely of the "California pine region", making no differentiation of a fundamental character. As evidence of the similarity of fire conditions, Show and Kotok (*16*) find the hour-control requirements to be identical in the two portions of the region.

The significance of this to the forest fire insurance study is that, except for the few modifications, there is no justification for conducting a separate study of the sugar-pine region. Coupled with this consideration is the fact that the private ownership of timber and the extent of development of the timber industries are relatively small in this region compared to these factors in the other two regions. For these reasons a much less intensive study has been indicated and the work here has accordingly been done with a view to applying extensively the findings of the ponderosa pine region, merely being sure that the significant departures were identified and adequately measured.

THE DOUGLAS FIR REGION

The Douglas fir region lies in the portions of the States of Oregon and Washington west of the crest of the Cascade Range. Since the character of timber growth changes toward the south as the Siskiyou Mountains are entered, corresponding more nearly to the northern California type, Jackson and Josephine Counties in southern Oregon have not been considered as being in the Douglas fir region for purposes of this study but are included in the ponderosa pine region.

Socially this region is one of the newest in the country. A hundred years ago settlement and economic development had not begun. What the region is now, socially, politically, and economically, it has become since 1840, practically speaking. In 1930 the region had, according to the census, a population of 1,807,883, of which 774,215, or 42.8 percent, was credited to the three cities of Seattle, Portland, and Tacoma.

For its livelihood this population is dependent mainly on the wood-using industries, other manufacturing (mostly light), and agriculture. Nearly 50 percent of the primary income of the region comes from the forest industries. Climatic and soil conditions conspire to make entirely probable the continuation of this situation.

Without going too deeply into speculation on the region's probable economic future, it may be mentioned that, on large areas of land giving apparently no great promise for agricultural development,

good timber could be grown at a rate of nearly 1,000 board feet per acre per annum. This is a possible source of income that should not be neglected.

The ownership of forest land in the region is divided as follows:[4]

On the basis of acreage:	*Acres*	*Percent*
Privately owned	13,837,281	52.1
National forests	8,934,069	33.7
Other public	3,780,980	14.2
Total	26,552,330	100

On the basis of merchantable-sized timber:	*Million feet*	*Percent*
Privately owned	262,066	49.7
National forests	188,235	35.7
Other public	76,854	14.6
Total	527,155	100

About half of the timberland and half of the timber in the region are in private ownership. Before the privately owned lands were cut into, they carried much heavier stands of timber per acre than the publicly owned lands, most of which are in national forests. In spite of the fact that they have been cut more heavily, the private timberlands still carry only slightly less than the same average stand per acre as the public lands. In general, the private lands are superior in geographic location and timber-growing capacity, since they are for the greater part at lower elevations, where the soil is better and timber markets are closer.

Timber growth in the Douglas fir region is exceptionally heavy, in both stand per acre and size of trees. Individual acres have been known to carry as much as 200,000 board feet of timber, though the average for the region, for the area now in merchantable timber, is almost exactly 40,000. Authentic records have been made of trees 15 feet in diameter at breast height, and heights up to 325 feet have been officially recorded. Operated timber probably averages close to 3½ feet in diameter breast high and 175 feet in total height.

It is estimated that 61 percent of the timber in the region is Douglas fir (*9*). The minor species are western hemlock, mountain hemlock, western red cedar, Sitka spruce, silver fir, noble fir, lowland white fir, and Port Orford cedar, with a sprinkling of western white pine and Engelmann spruce at the higher elevations. There are a number of other species, but with one exception, that of Oregon (red) alder, they are not of great commercial importance. The alder is used to a considerable extent in furniture manufacture in the region.

The value of Douglas fir for construction and general utility lumber is widely recognized. Western hemlock, while also utilized as lumber, probably attains its highest value as pulp material. Both of the spruces furnish excellent lumber and pulp, but because of its limited occurrence in the region the Engelmann spruce is of no very great importance.

The heavy stands of timber, the large sizes of the trees, and the practically pure conifer type of the forests have brought about a unique system of logging. The use of heavy power logging as it has largely been practiced, with its inevitable production of large quan-

[4] Figures from the Forest Survey, Forest Service, Jan. 1, 1933.

tities of heavy debris, together with the system of clear cutting which has so far been the general rule, have, however, resulted in forest devastation that presents a serious social problem.

Because of the great accumulation of debris and the very serious fire hazard that exists if this debris is allowed to remain after cutting, it has become the practice to broadcast-burn the cut-over lands. In fact, slash burning, so-called, is required by law in both States. In general, the practical effects of this burning are to reduce somewhat the amount of debris on the ground and to destroy very effectively any small trees that may have escaped destruction in the logging process but which might have helped to bring a second growth of timber onto the land. The slash fire never consumes the logging debris entirely, though usually, if it is successful, it does reduce the current fire hazard very considerably. This intentional burning is conducted under the direction of authorized State fire wardens at times when the danger of loss of control is at the minimum compatible with obtaining a reasonably effective burn.

While a considerable amount of logged-off land remains a waste of brush and ferns for long periods after logging, nevertheless considerable areas do begin to restock sooner or later. When these areas escape fire during the early years of regrowth, they develop stands of second-growth timber. There is in the aggregate a large amount of land in the region covered with trees of various sizes, ages, and densities, which do not qualify at present as merchantable but which will reach that status eventually.

The land area in the region which can properly be designated as essentially forest land can be divided into five main classifications: Coniferous merchantable timber, coniferous second growth (and reproduction), hardwoods, noncommercial forest, and unrestocked cut or burned areas. The forest survey (January 1933) estimated these five classes to occupy the land as follows:

	Acres
Coniferous merchantable timber	13,270,922
Coniferous second growth and reproduction	6,588,869
Hardwood forest	749,836
Noncommercial forest	2,067,652
Deforested burn or cut over	3,869,051
Total	26,552,330

Climatically it would be difficult to find a region anywhere in the world better suited to the growing of trees, the outstanding characteristics of the region being moisture and mildness. Making allowance for some local variations—the climate naturally tending to become warmer and drier toward the south and away from the ocean—probably the best general index of climate is afforded by Portland, lying approximately midway of both axes of the region and having the equable year-round temperature, the long growing period, and the relative abundance of rainfall illustrated by the following data:

Normal annual precipitation	inches	41.62
Normal period between killing frosts (Mar. 15 to Nov. 20)	days	251
Norman mean annual temperature	° F.	53.1
Normal mean summer temperature	do	65.3
Normal mean winter temperature	do	40.9

There are locally wide departures from some of these figures within the region. At some points, for example, the normal pre-

cipitation is well over 100 inches per year while at others it is less than 30. Mean annual temperatures are affected more by elevation than by latitude, broadly speaking, though on the west side of the Coast Range, cool air moving in off the ocean in summer gives points on the coast lower mean annual temperatures than they otherwise would have.

Since, however, the portion of the region lying west of the crest of the Coast Range has a typical marine climate with normally mild winter temperatures, and a consequent very long period between killing frosts, it is admirably adapted to tree growth. It is, furthermore, mainly in this section that the high precipitations occur, and there is also a great deal of fog, even through the summer, so that the forest is typically a wet forest and correspondingly dense and luxuriant.

Wind often has an adverse effect on tree growth, and destructive windstorms are definite matters of record in the Douglas fir region. Along the immediate ocean front, on the sides of the Columbia Gorge, and at points high in the mountains, protracted strong winds affect tree form adversely. In 1921 there occurred the so-called "Olympic blow-down", a hurricane that swept over an area 75 by 25 miles and blew down timber estimated at 4½ billion board feet. Since that time there have been occasional serious wind losses in various parts of the region. Although the wind hazard is undoubtedly an important factor and should not be minimized, the condition is by no means prohibitive to the successful practice of forestry. At the same time, a properly developed system of wind-loss insurance would doubtless serve a useful purpose.

Most of the land area of the region lies in the basin running north and south between the Cascades and the Coast Range. This latter range terminates at its northern end in the Olympics on the Olympic Peninsula. The region is bisected approximately by the Columbia River which flows through both mountain ranges. Timber growth of merchantable size extends across the summits of practically the entire Coast Range. In the Cascades the upper limit of timber of merchantable size and quality is approximately at the 4,000-foot level, somewhat higher toward the south and correspondingly lower toward the north.

In spite of the normally heavy precipitation throughout most of the region the forest fire problem has always been serious. This is mainly because all of the precipitation comes, roughly, in 9 months of the year, while in the other 3 practically drought conditions prevail. This situation is aggravated, from the fire point of view, by the tendency to low relative humidities during the warmer portions of the year.

In the Douglas fir region the period of greatest hazard ordinarily begins about the middle of June and continues with constantly increasing severity until rains come in the fall, which is ordinarily sometime in September. Occasionally early spring conditions may be favorable to the inception and spread of fire, and it sometimes happens that rains do not come in September, so that this month occasionally sees heavy losses.

A dry fall is more serious than a dry spring, because in the spring green timber and dense second growth have not yet lost enough of the moisture absorbed through the winter to be in danger of burning

and only the more open areas will burn. When the fall is dry a dangerous hazard is produced, because the summer drought has already effected a drying out of all classes of growth which, if continued through September, may produce a serious cumulative effect.

Since all but about 5 percent of the fires in the region are caused by human agencies, it is reasonable to expect that as population increases and transportation facilities improve the number of forest fires will increase, and this assumption is well borne out by the records. The problem of public education in forest fire prevention is one that cannot be neglected with safety to the public interest. That fire damage does not increase in proportion to the increase in the number of fires is wholly due to the effectiveness of the forest fire-protection organizations. While the number of fires has been increasing these organizations have been at least holding losses approximately level, if not actually decreasing them when long periods are considered.

The keeping of accurate records has not yet continued long enough for true trends in this respect to be discernible in the face of climatic variation from year to year. Furthermore, the result is dependent on a number of factors that are very difficult to measure. For one thing, the protective forces are gaining in experience, efficiency of organization, and legal support. For another, research is making available facts not previously known. On the whole, it is gratifying to one who has studied the situation in detail to observe the general effectiveness and morale of the protective forces. There is still room for improvement and for getting more for the protection dollar, and further preventive measures will undoubtedly be devised; but, on the whole, the protective effort can be taken as a definite and reasonably measurable factor in forest fire control and loss reduction.

THE PONDEROSA PINE REGION

Socially and economically, the northern ponderosa pine region, like the Douglas fir region, is relatively young. A hundred years ago it had barely begun to be the abode of white men. Its real career, in this respect, began with the general westward expansion of "empire", which got strongly under way soon after 1840. Its economic development has not been so largely dominated by the forest-products industries as has that of the Douglas fir region. While lumber production here has come to be recognized as an important potential source of income, particularly within the past 20 years, it has not, and probably will not, come to account for as large a portion of the total income as is the case west of the Cascades.

This is caused, in part at least, by the fact that the major portion of the land area of the region is not naturally forest land. Having, for the greater part, a semi-arid climate, the region is largely characterized by sagebrush desert, the forest areas occupying only the higher, more moist sites. Roughly, the region as defined (fig. 1) covers an area of approximately 203,600 square miles, of which only approximately 80,700, or almost exactly 40 percent, are natural forest land. Partly because of the effect of natural site, moreover, and possibly because of the effects of past fires, not all of this forest area is of commercial importance. Some of the natural forest types carry practically no ponderosa pine, the only species of real com-

mercial importance at the present time. No accurate data are available as to the proportionate extent of these noncommercial types, but it is undoubtedly safe to estimate that they occupy from one-third to one-half of the total forest area. Only about 20 to 25 percent of the total area of the region, then, is occupied by commercially important timberland.

The land of the region which carries no forest growth whatever is utilized partly for stock grazing, partly for dry farming, so-called, and partly for agriculture under irrigation.

The Mississippi Valley is the principal market for lumber from this region, absorbing approximately one-half of the total produced (*7*). Most of the remainder is consumed within the region itself, only a small portion going to other Western States and the Atlantic coast. This dependence on rail shipment is an important factor in the economics of the lumber industry in the region and of the other industries as well. The results of its effect on local development are plainly apparent.

The importance of the forest-products industries relative to industry as a whole will probably continue to be less in the ponderosa pine region than in the Douglas fir region, partly for reasons indicated above and partly because of other factors. One of the latter is the much greater proportion of public ownership of forest land. Another is the more limited capacity of the land with respect to annual production of timber, an important consideration in sound, long-run forestry practice.

Commercial forest-land ownership is divided as follows, according to figures compiled by the Forest Service in 1931:

On the basis of acreage:	*Acres*	*Percent*
Privately owned	10,348,000	31.8
National forests	17,511,000	53.8
Other public	4,693,000	14.4
Total	32,552,000	100.0
On the basis of merchantable-sized timber:	***Million board feet***	***Percent***
Privately owned	93,270	40.4
National forests	113,791	49.2
Other public	24,127	10.4
Total	231,197	100.0

According to the same estimate, 70 percent of the timber is ponderosa pine. The minor species are Douglas fir, white fir, western larch, lodgepole pine, Engelmann spruce, and western white pine, with local occurrence of incense cedar and sugar pine. The western juniper is very common, but is of no great commercial importance. A few deciduous species, among which cotton wood predominates, also occur, mainly along stream bottoms. These cannot properly be said, however, to be forest species, nor the areas in which they grow to be true forest land.

Ponderosa pine attains a maximum size of 8 feet in diameter and 230 feet in height, but the average size of mature trees in the commercial stands of Oregon is about 3½ feet in diameter and 110 feet in height (*11*). Power logging with heavy equipment has never been the general rule in the ponderosa pine region as it has been in the Douglas fir region, chiefly because of the lighter yield per acre,

the more open character of the stand, and less rugged topography. Until recent years yarding to logging railroads was done mostly with horses, but lately the use of tractors has become general. Some companies are now logging extensively with motor trucks as a substitute for railroads.

The legal requirement that logging slash be disposed of by burning is effective in most of the ponderosa pine region as it is in the Douglas fir region. Because of the lighter stand of timber, however, the problem of slash burning without complete destruction of the forest growth is less difficult than it is in the fir region, and better silvicultural practice, without modification of existing logging methods, can be more easily applied (*10*). The chief result of this condition is that a considerably higher proportion of cut-over land carries advance-growth reproduction, even under present conditions. In the future it is highly probable that material improvements will be made in this respect on all classes of land. Mainly for this reason, the forest problem of the ponderosa pine region is not so much a problem of forest devastation, in the strict sense, as it is in the fir region. In many places, to be sure, the reversion of cut-over lands to brush types has in the past partaken virtually of the character of devastation, and logging practices still in effect in some localities tend to cause such reversion. Nevertheless, the modifications of current practice necessary to bring needed improvements involve less drastic innovations than is the case in the fir region.

According to figures compiled by the Forest Service in 1931, the total forest land of the region was, in 1930, divided as follows:

	Acres	Percent
Merchantable timber (and old-growth cordwood)	24,613,000	75.6
Second growth and/or reproduction	7,231,000	22.2
Unstocked cut-over or burned areas	708,000	2.2
Total	32,552,000	100.0

Physically the region is largely a high plateau varying in elevation between 3,500 and 5,000 feet with distinct mountain systems locally distributed, in parts of which elevations of 8,000 to 10,000 feet are attained. Forests cover most, but not all, of the higher areas, and in some portions, notably the eastern slopes of the Cascades, descend practically to the bases of the foothills.

In its essential features the climate in all parts of the region is much the same, being characterized by scanty rainfall, wide ranges in temperature, low relative humidity, rapid evaporation, and abundant sunshine. There are, however, some marked local differences in temperature and precipitation, because of the topography. The strong insolation in the plateau districts promotes active convectional currents, and these in turn tend to increase the velocity of the surface winds, which in the daytime are apt to be strong. The conditions are reversed at night, when the air is usually calm and cool. Except in winter, rainfall is largely associated with thunderstorms, and there are occasional cloudbursts. Tornadoes, however, are almost unknown.

Summer temperatures of 119° F. and winter temperatures of −47° are matters of record. There are large areas in which the average annual precipitation is less than 10 inches, too little to support forest growth, while some established weather stations have recorded aver-

age annual rainfalls of more than 44 inches. Undoubtedly some parts receive an average of more than 50 inches of rain per year.

In the mountains a large part of the annual precipitation is in the form of snow, some places getting as much, on the average, as 275 inches. The average snowfall for the whole region is about 50 inches. The heaviest precipitation is in the winter months, but there is a secondary maximum in May and June that in some localities is the principal maximum. Only 6 percent of the moisture falls in July and August.

Length of growing season is difficult to express, but periods between killing frosts vary between approximately 44 and 226 days. Elevation is a stronger determining factor than latitude. Since forests occur only at the higher elevations they are subject to shorter growing seasons. Undoubtedly this factor of length of growing season is important in limiting the rate of tree growth, though it is probably secondary to the volume of rainfall in this respect, in most localities.[5]

As might logically be expected from the climatic conditions described, the ponderosa pine region presents a serious forest fire problem. Precipitation during the summer is not sufficient to maintain negative hazard conditions. Ordinarily the season of positive hazard begins between June 15 and July 1 and lasts until some time in September.

Light rain and low humidity favor the development of fire, but on the other hand they are adverse to the growth of vegetation of all sorts, so that a sort of balance is preserved. The aggregate forest fire hazard in this region is considerably less, therefore, in comparison with that of the fir region, than relative climatic conditions alone would indicate.

The idea has been widely held that, while the ponderosa pine type is definitely subject to fire, the mature stands are not ordinarily susceptible to serious injury because of the predominating tendency for fires in them to stay on the ground. The data collected in the current study do not, however, support this belief. Detailed discussion of this phenomenon will not be entered into here, but there can be little doubt that one of the chief factors contributing to the tendency for fire to crown in the region is the prevalence of strong winds due to insolational convection, as already mentioned. These winds are general and exert their greatest influence during the afternoon, when relative humidity is lowest. At least 80 percent of the fire loss of merchantable timber takes place between 1 and 7 p. m. Being relatively high country, however, the region is characterized by wide diurnal ranges of temperature during the fire season. The depression of the temperature at night, accompanied by fairly constant absolute humidity, causes a very material rise in relative humidity, which is an extremely important factor of fire behavior. Many times fires which at 3 p. m. were raging crown fires are brought under complete control during the very early morning hours. Consequently the importance of night fire fighting is very great, and experienced firemen habitually base their strategy on a knowledge of local manifestations of this general rule.

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[5] Figures and remarks on climatic conditions are taken mainly from Summary of the Climatological Data for the United States by Sections (*18*). Eastern Oregon is reasonably representative of the region as a whole.

The chief factor bringing the end of the fire season in the fall is often not so much an increase in the amount of precipitation as a general lowering of the average daily temperature, with consequent raising of the minimum relative humidity and a decrease in air movement due to lessened convection.

Lightning is an extremely important cause of fire in the pine region, accounting, in the average, for about 50 percent of all fires. In this respect the region contrasts sharply with the fir region, where lightning causes only approximately 6½ percent of the fires on private lands. If it were not for this elemental cause of fire, there is no question but that the aggregate loss cost would show markedly the benefit of the sparser population with its accompanying reduction in the relative number of man-caused fires. This condition of natural fire inception inevitably raises the relative importance of suppression organization as compared to public education. That is, there is very little reason to suppose that any considerable economies could ever be effected in protection expense because of improvement in the attitude of the public, as is the case in some other forest regions.

As will be explained in detail further on, aggreggate normal loss costs in the pine region outrun those in the fir region in the ratio of nearly 4 to 1. It would appear that the main hope of reducing this aggregate lies in a general strengthening of the protective organization for earlier detection and quicker, stronger attack, so that strong afternoon runs can be reduced in number. The possibilities in this respect and the probable economic point of diminishing returns, that is, the point of balance between protection expense and results, are still subjects of active and intensive research. It is too early yet to tell to what extent or in what way further improvements will be made.

THE SUGAR PINE–PONDEROSA PINE REGION

The sugar pine-ponderosa pine region (fig. 2) became famous in 1849, but not because of its forest growth. This is the portion of California that supported an important gold-producing industry for more than 50 years. That industry has given it a colorful history and has had profound and far-reaching effects on its development and social character.

The gold-mining industry exercised an important influence on the forests of the region, particularly along its western side where the population was principally concentrated. Demand for mine timbers and fuel wood, as well as for construction lumber, brought about heavy cutting. The miners are also believed to have been very active forest burners, both through carelessness and intention. The result is that the whole western portion of the region and to a less extent the central and eastern portions exhibit at the present time plain evidences of the effects of this occupation with its resulting forest use and misuse. Large areas, formerly forest, are now brush fields which, because of their high fire hazard, repeatedly burn at sufficiently frequent intervals to prevent their reverting to their natural forest condition. There are nevertheless large areas of second-growth timber, mainly ponderosa pine, coming in on cut-over and burned areas.

Compared to the Douglas fir and ponderosa pine regions, the sugar pine region is distinctly localized. Unlike them, also, it is through-

out its full extent natural forest land, without breaks such as the Willamette Valley in the fir region and the sagebrush deserts in the ponderosa pine region. Mainly, this region occupies the lower and middle slopes of the west side of the Sierra Nevada from somewhat south of the Oregon line southward to the Mohave Desert. The commercial area is bounded on the west by a belt of woodland and chaparral type which covers the foothills east of the Sacramento and San Joaquin Valleys and on the east by the fir and subalpine types of the higher Sierra. Roughly, it occurs between 2,000 and 6,000 feet in elevation, somewhat lower toward the north and higher toward the south.

Commercial timber occurs mainly in two principal types, the ponderosa pine type and the "mixed-conifer type", so-called. It also extends slightly into the lower portions of the fir type. The ponderosa pine type occupies the lower slopes, principally between about 2,000 and 3,200 feet. It tends toward being a pure stand of ponderosa pine but carries, over much of the area, in varying degrees of mixture, oak, incense cedar, and Douglas fir, with, along the lower (western) limits, some digger pine. Toward the upper (eastern) limits sugar pine begins to appear.

The mixed-conifer type carries sugar pine, ponderosa pine, incense cedar, Douglas fir, and white fir. Toward the upper limits Jeffrey pine occurs locally. There is some oak, though this tends to occur as a separate type rather than in mixture. The mixed-conifer type extends mainly from about 3,200 feet up to 6,000 feet in the middle latitude of the region.

Creek bottoms in both types often carry considerable stands of Oregon alder and some maple. Both types are characterized by a rather general occurrence of various species of *Ceanothus*, manzanita, bear clover, and other relatively inflammable shrubby growths.

The big tree occurs in the mixed-conifer type but with very limited and local distribution. Economically this tree is of no importance and has no effect on fire hazard.

To a limited extent commercial sugar pine of economic importance extends upward into the fir type, which consists principally of a mixture of red and white fir, with some Jeffrey pine. The better red and white fir trees in this type are sometimes cut for commercial purposes. For a more complete description of types and fire behavior see Show and Kotok (*15*).

Aside from mining, of which a few active projects still remain, and stock grazing, there are no major economic activities east of the small ranch belt on the west side that do not involve actual forest exploitation. The timber industry centers around the exploitation of the sugar pine, an excellent commercial species yielding very high-grade lumber, well adapted to a number of specialized uses. In normal times it brings a good price and stumpage values are considerably higher than are those of Douglas fir and ponderosa pine, in spite of higher logging and transportation costs due to the relatively more difficult topography of the sugar pine region.

While the timber industry is of less importance among economic activities in California than in Oregon and Washington, it is nevertheless of major importance there. For example, more wages are paid

by the lumber and timber-products industry in California than by any other single manufacturing industry. In 1929 the industry was second in number of wage earners employed. The sugar pine region is very important as a producer of real income for the State. From it, timber products are shipped all over the United States, particularly to Atlantic coast points.

Physically, the sugar pine region is difficult for logging and lumber transportation, which are consequently expensive and can be made possible only through the solution of perplexing engineering problems. The topography is featured by steep and rugged river and creek canyons and by great differences in elevation within short distances. The main line of the Southern Pacific Railway between Sacramento and Reno, which intersects the region approximately a third of its length from the north end, is the only common-carrier line that offers transportation facilities within the limits of the region proper. Consequently lumber manufacturers are in many cases obliged to put in their own railroad lines all the way from the timber in the mountains to the common-carrier shipping points in the valleys. The distances and the differences in elevation make construction of these lines and transportation over them expensive. The result is the manufacturing is not done at towns in the valleys, as is the common practice in the fir and ponderosa pine regions, but at sawmill towns established for that sole purpose high up in the mountains.

The State has constructed a number of excellent highways through and over the mountains, so that at favorable locations truck logging is economical and is practiced to some extent. Up to the present, however, small-mill manufacturing has not become important.

Until recently, logging has been done mainly with heavy power equipment similar to that used extensively in the fir region. With the development and improved adaptation of tractors, however, the practice of logging with them has been gaining steadily in favor, until it appears now that the days of the donkey engine are distinctly numbered. Many of the operators have already abandoned them except for use on ground that has to be logged uphill. It is probable that within a very few years a donkey engine will be a rarity in the region. This development is looked on with favor by foresters, because tractor logging not only leaves the forest in much better condition for the second crop but is much less hazardous with respect to fire.

Silvically the region is well adapted to improved forestry practice. Selective logging that leaves a considerable portion of the stand and much advance-growth reproduction is economical for the logger and productive of an excellent growing stock without any serious threat of domination by inferior species. There is already a considerable area of logged-off land that bears very fine growth that will mature economically within 25 or 30 years.

This whole region is one of relatively rapid tree growth, in this respect resembling the fir region more than the ponderosa pine region proper. The average growth rate of ponderosa pine, for example, is, in the sugar pine region, almost twice what it is in the ponderosa pine region. This is mainly due to better climatic conditions, particularly the more abundant precipitation mainly in the form of very

heavy snowfall, depths of more than 10 feet being not at all unusual. This creates very favorable growing conditions even though practically no precipitation is received through the growing season.

Normal precipitation is very light between May 1 and November 1, so that by early summer and throughout the balance of the rainless season the ground surface is very dry, inevitably favoring the inception and spread of fire. Physically these forests are considerably more susceptible to rapid and serious fire than are those of the ponderosa pine region, because of the characteristically greater volume and density of undergrowth. In this respect there is a closer resemblance to the forests of the fir region.

Nevertheless, the fire problem is far from being prohibitive, because the physical adversity is heavily balanced by three favorable conditions. The first of these is the relative rarity of strong winds; insolational convection does not affect this region seriously. The second is the relatively frequent occurrence of a humid southwest wind. Not all southwest winds during the fire season bring higher relative humidities, but it is normal for the wind to come from this quarter with sufficient frequency and duration, and to carry sufficient atmospheric moisture, to effect an appreciable amelioration of the climatic hazard. The third and most important factor is topography. In the sugar pine region the peculiar condition of universal steepness and ruggedness curiously effects a beneficial rather than an adverse condition. The fact that there is almost no level ground, the canyons running up on both sides to very narrow ridges, gives the region a great abundance of natural firebreaks. Since cool, still nights are the rule, good opportunities are frequently presented to stop fires on the ridges during the night. The working of crews at night is consequently of great importance, as it is in the ponderosa pine region, and the accepted technique of fire fighting is based on this understanding. The size and apparent seriousness of fires that can be brought under control in one night by comparatively small crews are a surprise to one whose conceptions are based on observations in the other regions.

This should not be taken as an indication that the fire problem is not serious or that forest fire insurance is not needed. In the aggregate, losses are just as great as they are in the other two regions. Young growth especially is subject to a very considerable hazard if current losses can be taken as an indication. This is particularly true along the western edge where the forest is adjacent to the woodland type and exposed to the small-rancher inception hazard. The woodland type is a prolific fire breeder because of the particularly inflammable character of the grass which forms the ground cover.

Along the west side of the region there are a few extensive privately owned areas. Elsewhere the ownerships are so intermingled that no large portions stand out as primarily either publicly or privately owned, as is the case in the other two regions. The reasons for this are homesteading, extensive railroad grants, and the establishment, after the surveys were completed, of patents on many scattered parcels through the activity of various interests subsidiary to the mining industry. In this region, therefore, the bulk of the privately owned land is within the national-forest boundaries instead of outside as is more common in the other regions.

This mixture of ownerships and lack of continuity of private lands has had an important effect on the development of protective administration. Private and State administration of protection are almost entirely absent, the Forest Service being almost the sole protection agency. This does not mean that the fundamental set-up is different. Private owners are required to furnish protection, and the Clarke-McNary principle is applied. The State law provides for taxation to cover the cost of protection not directly defrayed, but the funds are actually disbursed by the Forest Service through cooperative agreements. This arrangement has a number of favorable features. Duplication of effort and division of responsibility are reduced to a minimum, and the spread of the protection effort is much more uniform than it would probably otherwise be.

According to figures compiled by the Forest Service in 1931, the ownership of forest land in the region, not including farm woodlands, is as follows:

On the basis of acreage:	*Acres*	*Percent*
Privately owned	2,691,000	35.4
National forests	4,824,000	63.5
Other public lands	84,000	1.1
Total	7,599,000	100.0

On the basis of merchantable timber:	*Million board feet*	*Percent*
Privately owned	54,032	44.5
National forests	66,676	54.9
Other public lands	713	0.6
Total	121,421	100.0

Of the privately owned merchantable timber, only about 31 billion feet can be called actually commercial according to present-day standards. At an average depletion value of $2 per thousand, which is probably sufficiently conservative, there can be said to be in the region an insurable value of nearly $62,000,000. This is a small figure compared with the privately owned values in the fir and ponderosa pine regions, but it is of sufficient importance to justify some special attention. When forest fire insurance is actually offered on a practical basis, there should be a considerable amount of cover in this region.

A demand here for cover for immature growth, also, should materialize relatively early if present trends in forest ownership and management continue. Natural reproduction of cut-over lands is not difficult to obtain, and growth conditions are notably favorable to private forestry. At present the privately owned lands that are actually forested can be classified as follows:

	Acres	*Percent*
Merchantable timber	2,252,000	83.7
Second growth and/or reproduction	439,000	16.3
Total	2,691,000	100.0

No figure is given for unstocked land because the unstocked areas are practically entirely embraced within the extensive brush fields and are consequently of little interest to private owners. An area now in brush is of no concern to this study whether the condition is of recent origin or has existed through a period of years.

MAJOR FEATURES OF METHOD

At the outset it was realized that one of the major requirements was the identification and evaluation of all the factors of hazard involved in practical rating and underwriting. This requirement includes (1) determination of the extent and character of losses; (2) identification, evaluation, and classification of hazard factors; (3) determination of indications as to values actually subject to loss from single fires; and (4) estimating of the quantity of business that can be done with adherence to the required rating and underwriting principles when these have been laid down.

The inquiry utilized all available data from all privately owned lands, obtaining the widest possible statistical base in this ownership class. The major disadvantage arises from the lack of certainty that the conclusions will apply accurately to the properties that will actually be insured. This consideration, together with the moral hazard, inevitably takes the study, insofar as its final conclusions are concerned, quite definitely out of the field of precise science. There is no help for this. Provision for the lack can only be made through the introduction of some factors of safety in rating and underwriting and, as a final phase of the inquiry, by an exhaustive study of probable demand. It is essential that the factors of safety be applied with intelligence and without imposing prohibitive conditions.

For the determination of the general extent of losses a mass of data covering the experience of 10 years was embodied in the individual fire reports of the local wardens and rangers. It was early recognized that if these records were reasonably accurate they could be made to form the base upon which the essential structure of statistical data could be built. The method actually adopted was founded upon this principle.

The first direct activity of the study, therefore, that partook of the character of original research was the collection in the field of a quantity of loss data that could be used, among other things, to check the accuracy of the existing data. This field-analysis phase of the study is described in detail further on. Checking the accuracy of the data already available was not its sole function. It also gave valuable insight into fire behavior and the identification of hazard factors. The conclusions of the study have been substantially strengthened by the results obtained.

In order, also, to provide adequate insight into the range of relative hazard and the factors accounting for it, other supplementary data had to be obtained. The collection and study of these data, all bearing on the problem of rating, was undertaken through four additional phases of the inquiry, as follows:

1. The contributive-hazard study: This phase comprised mainly the collection of data more specific in character than any already in existence, and their analysis, making possible the correlation of hazard with the essential contributive physical factors. Contributive hazards are those which affect the extent and seriousness of the loss once the fire is started.

2. The causative-hazard study: It was possible to make this study without recourse to any additional data, since the original fire reports contained the required information. This study correlates the occurrence of fire with its causes and makes possible the correct rating of individual property hazards of this type.

3. The climatic study: For this study additional data had to be collected. The climatic hazard is actually a contributive hazard, but is so individual that its separate consideration is required.

4. The protection study: The purpose of this study is the determination of proper allowance for the variation in the effectiveness of the protective effort. Some properties are better protected than others. Substandard protection constitutes a contributive hazard which calls for separate consideration.

The processes adopted for study of each of these phases are described in detail further on, along with descriptions of the phases relating to elements of the problem other than rating.

Briefly stated, the hazard-rating phases of the study are directed toward (1) the identification of the factors of hazard that are of practical significance, (2) their arrangement in classes, and (3) the assignment of proper weights to them. These determinations are matters of burning ratio under varying conditions. In order that burning ratio may be expressed, it is, of course, necessary to know not only how much timber has been burned but also how much there is altogether. Knowing that a certain quantity in a given class has been burned is entirely inconclusive until the extent of the class is known. The sources of this information are described in the detailed discussions immediately following.

Conditions affecting hazards, the form and extent of statistical material, and adaptable methods of study are different in the separate forest regions. The modifications of method accordingly called for are described herein.

THE DOUGLAS FIR REGION

Careful consideration indicated the undesirability, in the fir region, of including experience on the national forests. If this could have been included, the statistical base could have been considerably broadened in some respects but not to the extent that would at first appear. The conditions existing in the national forests in the region are, for the greater part, quite different from those in the privately owned forests. There is no probability that the national forests will be insured. The advantage, therefore, that would be gained by studying national-forest experience would be more than offset by the disadvantages that would be entailed in effecting the essential sortings and corrections necessary to make the data fit. All the national-forest data would have to be thorough analyzed, and only a relatively small portion would be usable. The somewhat arbitrary and questionable corrections that would have to be applied even to the usable portions would largely vitiate their value.

In the Douglas fir region there are already basic data for the determination of the quantities and areas at risk from which to develop burning ratios. Another economic study provided for under the Clarke-McNary law, the Nation-wide forest survey, has been applied in detail to this region. This is an intensive inquiry into the amount, character, and occurrence of forest land and forest growth. The figures that it is producing are all that the forest fire insurance study requires for integration of its loss figures to indicate burning ratios throughout the whole range of hazard. Without the benefit of the survey's results, the insurance-study figures could not have

been as authoritative as they are. The importance of this integration and the methods used will be made clear.

THE PONDEROSA PINE REGION

In the ponderosa pine region data were collected from both privately owned and national forest lands, since in this region no great differences exist, physically or otherwise, between the two classes of land. While estimates of aggregate loss cost were based wholly on figures taken from private lands, both classes of ownership were utilized in taking measurements of internal variations, providing thereby a greater breadth of the statistical base and correspondingly sounder conclusions.

Were it not for the fact that protection is, to a very considerable extent, separately administered, there would be no reason for making any distinction whatever between the two main classes of ownership. In the pine region no direct help from the survey was forthcoming, and the process of integration was consequently considerably modified.

The method of approach and application was as follows: Detailed field analyses were made, as a check on the reports of protective organizations and also to give accurate indications of the influences of the factors of relative hazard (after their identification and the selection of such as it might be practicable to use). Then the corrected loss figures were integrated into such timber-estimate (total exposure) figures as were available and broken down into classes as accurately as possible, in order that various relative hazards might be expressed with approximate clarity. Separate adjustment factors were applied to the basic data in the two ownership classes.

The point worthy of emphasis here is that the measurement of absolute hazard comes from the privately owned lands only, while expressions of relative hazard come from measurements made on both private and national-forest lands. Internal break-downs are so nearly identical on the two classes of ownership that the widening of the statistical base thus produced is a valuable consideration.

The protection study in the pine region consisted of the making of only such modifications in the grading schedule as seemed to make it better applicable to regional conditions.

THE SUGAR PINE-PONDEROSA PINE REGION

Although only 10 percent of the privately owned forest land in the territory covered by this study is in the sugar pine-ponderosa pine region, carrying only 13 percent of the timber volume, higher unit stumpage values raise its relative economic importance to something like 21 percent of the total merchantable value. This is shown by the following comparison of estimated private merchantable timber values (in round numbers) of the three regions:

		Percent
Douglas fir region	$263,000,000	47.9
Ponderosa pine region	170,000,000	31.0
Sugar pine region	116,000,000	21.1
Total	549,000,000	100.0

In spite of this relationship the intensity of study given the other regions would not be justified in the sugar pine region because of the strong resemblance that the region bears to the ponderosa pine region. There can be no question of the practical adaptability of very similar methods of rating and underwriting in the two regions. In fact, as has been stated, the sugar pine region is more properly a part of the ponderosa pine region, with a few variations, than it is a separate region.

Preliminary discussions with men in California who are intimately familiar with the California forests both east and west of the mountains, particularly with respect to fire, confirmed this conclusion.

Another important factor in this decision was the large amount of intensive fire investigation work that has been done in the sugar pine region by Show and Kotok (*14*, *15*, *16*), extending over a long period of years.

Although no original field work was conducted in the sugar pine region, the writer spent 10 days examining the forests in order to confirm by observation their similarity to those of the ponderosa pine region and the few points of difference. He also examined extensively two recently burned areas and two representative logging operations. This trip covered the central and most typical portion of the region, which lies between North Fork, headquarters of the Sierra National Forest, and Quincy, headquarters of the Plumas Forest.

During the past 3 or 4 years the fire record in this region has been very good, too good, in fact, for the purposes of this study had it been necessary to get original data. A careful combing of the records disclosed only a few fires of any consequence in the mixed-conifer type from which salvage had not been effected to the detriment of the collection of data. Not enough damaged area was available at the time of the study to provide a statistical base. Even if evidence not contained in the works of Show and Kotok or produced by this study in the ponderosa pine region were believed essential, it would have been very difficult, if not impossible, to get it. Opportunities to gather data in the ponderosa pine type of the sugar pine region were available, but to do so was not believed justified, since sufficient applicable data had already been collected in the ponderosa pine region proper.

The logical conclusion from these considerations was that most of the actual application of forest fire insurance in the sugar pine region could be based on findings made in the ponderosa pine region. No separate causative and contributive hazard studies were made. Such modifications as were obviously necessary are fully discussed in the sections on causative and contributive hazards in the region. Protection grading is not sufficiently different in principle or application in this region to require more than a few modifications. This subject also is discussed in a later section.

A separate climatic study was, of course, required and was the only one involving the use of data that constituted a completely separate work for this region. The method used was almost identical with that used in the ponderosa pine region.

THE DETAILED FIELD ANALYSIS

GENERAL CONSIDERATIONS

The basic data for this whole study come in part from the individual fire reports furnished by the local fire wardens for the 10-year period 1921 to 1930, inclusive, as summarized in the annual reports of the State foresters, and in part from the fire records of the Forest Service.

Figure 3 shows one of the forms on which the fire wardens' reports were made. It is apparent that the information furnished does not wholly meet the needs of such a study as this. Not only is more detail desirable but, as was realized early in the process, some means of providing a subsidiary check on the accuracy of the reports is necessary. Carrying the study directly into the field and making a detailed field analysis would satisfactorily further both of these objects. Furthermore, it would thus be possible to obtain an adequate background of practical knowledge of forest fire losses—an important consideration. Study of actual salvage probabilities, the peculiarities of fire behavior, and the identification of practical hazard factors would be facilitated by the collection and analysis of original field data. Detailed field-analysis work was accordingly designed and undertaken.

It was, of necessity, confined to a limited number of burned areas which had to be so selected as to yield the greatest possible volume of usable data. This involved establishing a limit in size of individual burned area below which the work would not go and spreading the work over as wide a range of territory as possible so as to include all local conditions. As already explained, the work was confined to the Douglas fir and ponderosa pine regions.

The general plan was based on a concept of what would constitute practical damage determination for loss adjustment under actual forest fire insurance. This involved the determination of the location and extent of the burned area, the forest types affected, and the extent of damage in each type. Standard timber-cruising technique was employed with such modifications as would improve the data for the special purpose intended, and both the field work and computations from the data were done by experienced timber cruisers. The conclusions can therefore be taken as authoritative. The estimates of fire damage obtained are comparable in every respect with the figures that would have been obtained had the burned properties been insured and the work done as a basis for loss adjustment.

In addition to the extent and type of damage, determination was also made of the volumes and areas left undamaged though actually subjected to the influences of the fire in question. Extensive areas of merchantable timber were found that had been burned over and left practically unharmed. This was also true of some few stands of second growth. The data collected indicate, however, that stands less than approximately 25 feet in height can rarely be burned over without suffering heavy damage. Small trees are less fire-resistant, generally speaking, than larger ones, yet it cannot be taken as certain that all small trees on a burned area will be killed. Sometimes partial damage is suffered when such stands are burned. The extent of killing is dependent on a number of

Revised Form A

REPORT OF FIRE

IN _____ COUNTY No. _____

NAME OF FIRE _____ (See definitions on back.)

CAUSE _____

DISCOVERED BY _____ REPORTED TO ME BY _____

TIME	Month	Date	Hour (a. m. or p. m.)	LOCATION
Discovered				SEC. _____ T _____ R _____
Reported to me				CLASS (Mark with X)
Work Begun				A (under ¼ A)
Under Control				B (¼–10 A)
Work Finished				C (over 10 A)

AREA BURNED	Cutover	Burned-over	Reproduction	Total
*Potential Forest Lands				
*Merchantable Timber Lands	(*See definitions on back)			
*Other Lands				

Total Area Burned _____

Note: If merchantable timber area was Yellow Pine, give, in addition to above merchantable timber area, acreage of ground fire killing reproduction.

_____ ACRES

Damage

Merchantable Timber . M-Bd. Ft. _____ Value _____ % Salvable _____

Logs . . . . . M-Bd. Ft. _____ Value _____ % Salvable _____

Logging Equipment . _____ Value _____

Damage to Settlers . . _____ Value _____

ESTIMATED COST	Association	State	Federal	Individual	Total
	$	$	$	$	$
Extra Labor					
Supplies, Board, Etc.					
Transportation					
Total	$	$	$	$	$

NUMBER EXTRA MEN EMPLOYED _____

LAND OWNED BY _____

RANGE OF RELATIVE HUMIDITY DURING FIRE—FROM _____ % TO _____ %

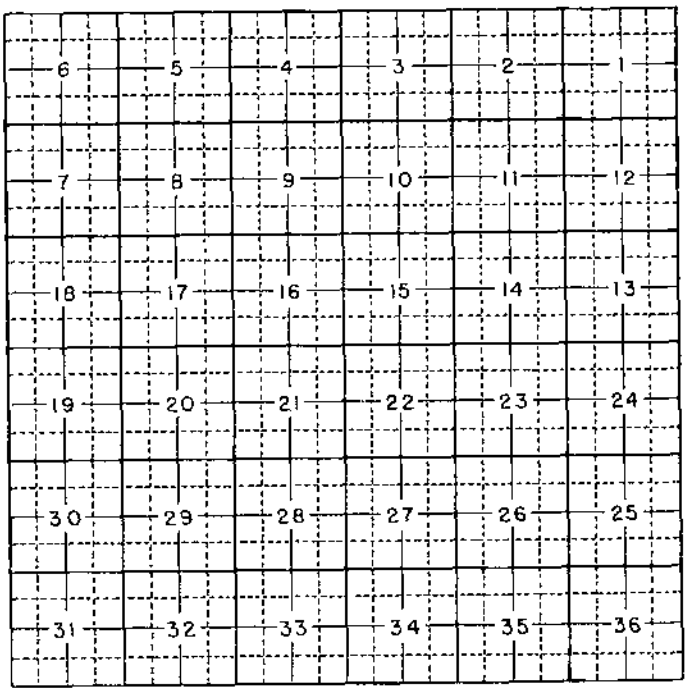
SIGNED _____ FIRE WARDEN

DATE _____, 19____

A

FIGURE 3.—Fire wardens' report form: A, Front.

Township_____ Range_____



Remarks_____

DEFINITIONS

POTENTIAL FOREST LAND—Includes all land other than merchantable timber land which is reforesting or which should and will produce forest crops if fire is kept out.

OTHER LAND—Includes nonforest land which requires forest protection.

CAUSES—All fire should be listed under one of the following: Lightning, Railroads, Campers, Smokers, Brush Burning, Incendiary, Lumbering, Miscellaneous.

INSTRUCTIONS FOR MAKING OUT REPORT

A report must be made for each fire, large or small. If there is not room on the form for full information regarding a fire submit additional details in a letter. Always indicate on the township plat where the fire is located and if possible show the area burned over. If the burned area runs into two townships use a township plat form to complete the map and attach this to the fire report.

Under "Estimated Cost" include costs for supplies, board, and transportation of all men for whom such costs are paid. Labor of regular men should not, however, be included.

Under "Damage to Property" specify amounts and value of different kinds of standing timber or logs destroyed and the approximate percentage of the total amount destroyed which will be salvable. After "Logging Equipment" or damage to settlers state kinds and amounts of property destroyed, such as rods of fence, number of feet of cable, etc., together with its approximate value.

B

FIGURE 3.—Fire wardens' report form: *B*, Reverse.

variable factors, including the kind and amount of debris on the ground, the character of the herbaceous and shrubby growth with which the reproduction is mixed, the topography, and the weather conditions at the time of the fire.

Merchantable timber was estimated by the sample-plot method. Straight cruise lines were run through the area on hand compass courses and ¼-acre circular sample plots taken every 5 chains. Standard practice called for running the cruise lines at ¼-mile intervals, though modifications were made in this practice where, in the cruiser's judgment, a practical compromise between accuracy and expense called for them. In general, the distance between the parallel cruise lines was determined by the size of the area burned, 10 chains apart on areas of less than 200 acres, ¼ mile on areas of 200 to 5,000 acres, and ½ mile apart on larger tracts. Satisfactory estimates of some areas were made possible by the running of only one cruise line approximately through the middle. Figure 4 shows how

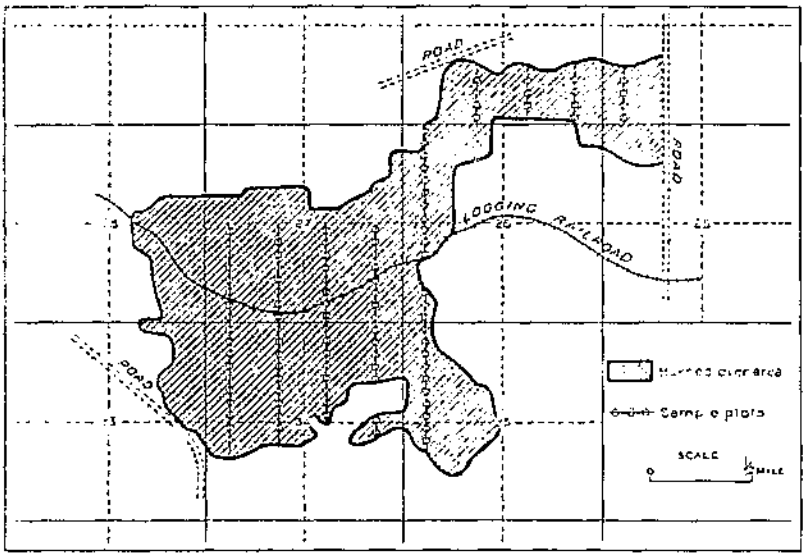


FIGURE 4.—Map of burned area as located by detailed field-analysis work, showing method of running cruise lines and locating sample plots.

the cruise lines were laid out and the sample plots taken on one of the burned areas studied in the course of the field analysis.

Merchantable trees were tallied on the quarter-acre plots by species, diameter at breast height (d.b.h.), and condition with respect to the fire in question, i. e., whether or not they were killed by it, the only distinction recognized being that between survival as a live tree and complete killing. The introduction of other tree-damaging factors produces insufficient control of the data. Butt injury by surface fire (cat-facing), for example, cannot be measured from one ground cruise. There is no way of knowing what the cat-face looked like just before the fire. If a tree had obviously fallen as a result of the fire it was tallied as dead (killed by the fire). Standing trees presenting such an appearance as to make their ultimate life or death questionable were tallied according to the cruiser's best judgment.

Even a year or two after the fire it is sometimes difficult to tell with certainty whether a tree will survive. Errors here are, however, compensating.

Heights were taken care of by making, for each burned area cruised, measurements for each species with the Abney level, enough being taken to insure the construction of an authoritative curve. After completion of the field work, estimates were made in the office by the use of accepted volume tables and acreage figures obtained by planimetering maps of the burned areas made in the field.

For map construction, notes were made as the cruising work progressed, one of the main requirements being accurate representation of the shapes and sizes of the burned areas analyzed. Full notes were also taken, as the work in the field proceeded, on all conditions that might possibly develop as important hazard factors. In order that the possibility of omissions might be reduced to the minimum, full notes were made on topography, condition with respect to brush and/or undergrowth, grass, site quality, age of trees, density, timber quality, apparent recent history of the area, and any other data believed to be of possible importance. Some of these were recorded as map data; others were put in as notes on the tally sheet.

The maps, when completed, showed the outlines of the burned areas and their subdivisions by forest types, age classes, and character of burn—that is, whether essentially surface or crown. The determination of this latter distinction was ordinarily not difficult, though occasionally fires burn as a sort of combination of the two, continuing to crown in spots and in relatively small areas. It is not possible to map such an area in detail in the course of ordinary cruising work, but to facilitate accurate estimating an arbitrary standard had to be established. If more than one-half the trees on a unit area had been killed and there was unmistakable evidence of at least some crowning, the area was designated as having been crown-burned. If fewer than half of the trees had been killed it was designated as surface-burned, even though some evidence might exist that the fire crowned occasionally. Of course, extensive areas were encountered in the course of the work on which it was unmistakably clear that the fire had been a continuous raging crown fire from which practically no trees had escaped alive. Modification of this practice was necessary in stands carrying large proportions of hemlock, spruce, or true firs, all of which are easily killed by surface fire.

Immature growth, particularly in the smaller sizes, seldom escapes very serious damage if it is subjected to any kind of fire, since in these smaller trees, with their lower branches near the ground, the fire is almost certain to reach and travel along through the crowns. Even if this does not occur, the burning of the duff and undergrowth usually develops sufficient heat to scorch the cambium layer through the relatively thin bark of the young trees. This is apart from the faculty, possessed to some extent by dense stands of larger young growth in the Douglas fir region, of resisting burning because of their ability to retain moisture for long periods. When, as occasionally happens, these stands do burn, the loss is almost certain to be practically total.

Loss appraisal in unmerchantable stands involves a principle somewhat different from that applying to merchantable stands. Actual

wood volume is not of primary importance. These stands can best be designated as worth so much per acre, depending on location, species, tree sizes, and densities. Data in these stands were accordingly collected by the "stocked quadrat method", so-called. This system has been developed to meet the need presented by these smaller stands. It has been described elsewhere (*4*).

A slight modification had to be made in this system to make it fit the requirements of the damage study. A distinction was needed between damaged and undamaged trees (trees killed by the fire and trees still alive after it), so provision had to be made for recording both. The data, as collected, give an accurate picture of conditions prior to the fire and the condition afterward. The difference is the fire damage. In this study quadrats were taken every 2½ chains on the cruise lines, or 32 quadrats to the mile of line. A more detailed description of this special application is given further on.

IN THE DOUGLAS FIR REGION

In order to achieve compliance with the requirement of wide distribution of sampling in the Douglas fir region, the following counties were selected for study: In Oregon—Clatsop, Tillamook, Clackamas, Marion, Lane, Linn, and Coos; in Washington—Skagit, Snohomish, Grays Harbor, and Cowlitz (fig. 5).

The actual work was confined to the effects of fires of 200 acres or more which were reported as having done damage to timber, second growth, or reproduction. In Cowlitz County, however, all burned areas of more than 200 acres were examined, whether or not they were reported as including damaged timber or reproduction. This exception was made in order to answer the question whether some fires not so reported did not in fact damage young growth.

Detailed analysis of a burned area was not attempted more than 3 years after a fire, since the evidence becomes too obscure after that period. In Clatsop, Tillamook, Clackamas, Marion, and Linn Counties all burned areas of the size prescribed for study that resulted from fires occurring during the seasons of 1928 and 1929 were investigated. This work was done in the fall of 1930, when it was too early to study the 1930 burns and too late for truly practical work on those of 1927. The data for the other five counties were, however, collected during the spring and summer of 1931 when it was possible to analyze the 1930 burned areas, and advantage was taken then of the opportunity for collection of data for this additional year in these counties.

It is axiomatic, of course, that clear differentiation must be made between merchantable timber and second growth or reproduction. Before the work had progressed far, it was evident that hazard and economic considerations both demanded provision for further distinctions not allowed by such general classifications.

It was obvious that if the establishment of classes for insurance purposes could be made to conform to the classification adopted by the forest survey the work of integration would be simplified. These classes are:

Class DA. Stands where the majority of the volume is in trees over 40 inches d. b. h. (overmature timber).

Class DB. Stands where the majority of the volume is in trees 20 to 40 inches d. b. h. (old-growth, fine-grained timber).

Class DC. Stands where the majority of the volume is in trees 20 to 40 inches d. b. h. (young-growth, coarse-grained timber).

Class DD. Stands in which most of the volume is in trees 6 to 20 inches d. b. h.

Class DE. Stands in which most of the trees are 6 inches and under in diameter.

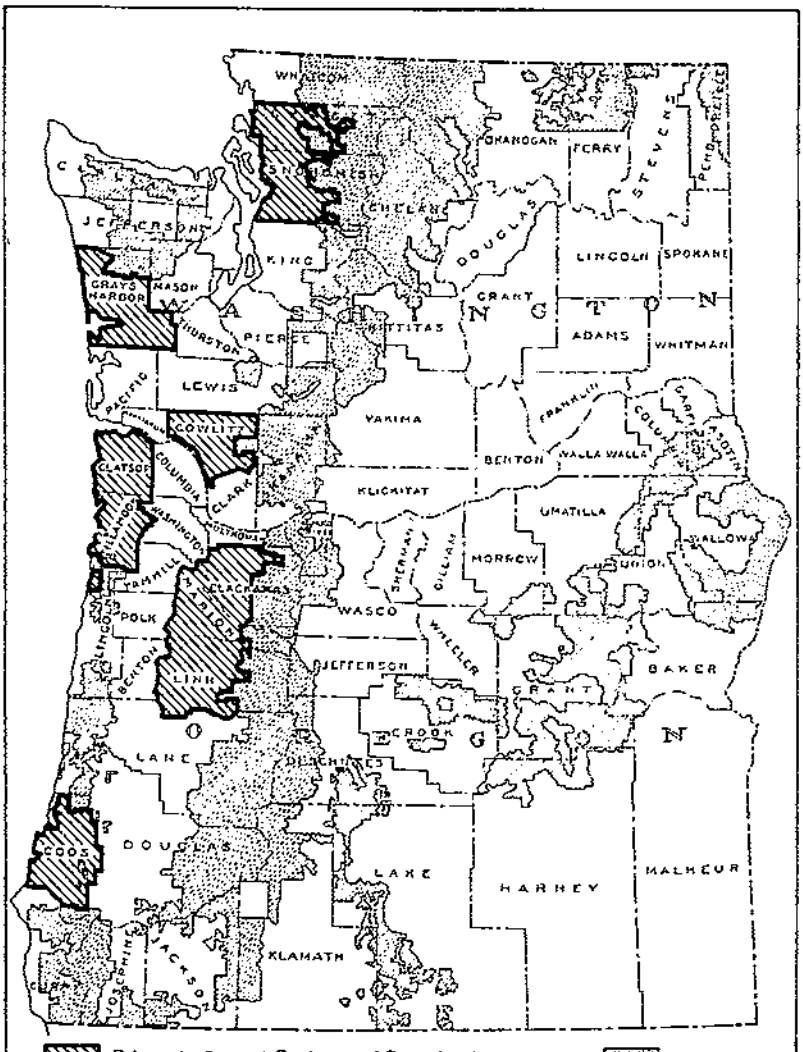


FIGURE 5.—Map showing privately owned portions of counties in the Douglas fir region in which detailed field analyses of burned areas were made.

It was decided that there was no advantage in distinguishing between classes DB and DC, and they were therefore combined into one

class of 20- to 40-inch trees. It was very apparent, though, that class DE includes extremely wide ranges of fire hazard. Accordingly another class was established within this class, the division point being placed at 25 feet in height. This is the height at which most restocking stands close in and a great lessening in hazard is effected.

The data collected in the field for the insurance study were accordingly grouped into five major classes, as follows:

Class A. Stands of trees mostly over 40 inches d. b. h.
Class B. Stands of trees mostly 20 to 40 inches d. b. h.
Class C. Stands of trees mostly 6 to 20 inches d. b. h.
Class D. Stands of trees mostly 25 feet high to 6 inches d. b. h.
Class E. Stands of trees mostly less than 25 feet high.

Two of these classes, then, are composed mainly of timber of merchantable size, and three of second growth and reproduction. In the field work no account was taken of trees less than 3 feet in height, since these cannot be regarded as having any economic or insurable value at the present time. The adherence to the subdivision of merchantable timber into two classes was based on the belief that there is a distinct difference between them in hazard. Data subsequently collected have substantiated this belief. All the evidence, in fact, indicates that this classification is admirably suited to the needs of forest rating and underwriting.

Since the basic data give figures for only two general classes, merchantable timber and reproduction, the break-down into three more classes could be effected only by the collection of additional data. One means of accomplishing this is described in the discussion of contributive hazards. The field analyses, however, shed some light on this break-down.

These field analyses in the Douglas fir region covered 69 separate burned areas. Counties in which damage was extraordinarily heavy were deliberately chosen for the field analysis work. Twenty-two areas were found to include no damage to timber, second growth, or reproduction. The data actually used came, therefore, from only 47 of the areas analyzed. Most of the 22 undamaged areas were in Cowlitz County, where every burned tract of the prescribed size was examined for the sole purpose of testing the accuracy of the original reports in this respect. The total area examined was 132,955 acres, 97,039 of which carried no trees prior to being burned over. Only 35,916 acres, or 27 percent, were therefore potentially insurable. This area was distributed between the five established classes as follows:

	Acres burned
Class A. More than 40 inches d. b. h.	11,453
Class B. 20 to 40 inches d. b. h.	5,587
Class C. 6 to 20 inches d. b. h.	8,694
Class D. 25 feet high to 6 inches d. b. h.	360
Class E. Less than 25 feet high	9,822
Total	35,916

With respect to this distribution it must be observed that (1) the statistical base from which it is obtained is relatively narrow; (2) because the basic data (all the fires in the whole region as gathered by the State foresters) give a broad statistical base for separating the merchantable timber from the second growth and reproduction.

the above figures are useful only within these two major divisions; and (3) because of the factor of partial damage, a knowledge of gross area burned over is of minor importance.

Because of the narrow statistical base these figures must not be considered as absolutely accurate. Nevertheless, the method of collection was relatively intensive: and, furthermore, the data collected by means of supplementary individual fire reports furnish the same information on a much wider base, with less intensiveness in the collection. The data from the two sources are comparable, so that between them an approximately correct break-down is a possibility.

The separation of the figures for merchantable and unmerchantable timber indicated by the basic data is the one actually used in the study. The great breadth of the base dictates this. The figures collected by the study itself are only intended to effect a further break-down within the figures given in the original data. Thus the merchantable timber is broken down into two classes and the reproduction into three, the primary separation (between merchantable and reproduction) being as indicated by the original fire reports.

The difficulty introduced by the factor of partial damage is overcome in the case of merchantable timber by basing all figures used on board-foot estimates of actual damage. In developing loss figures for unmerchantable stands, net areas on which losses occurred are arrived at by discounting the gross areas burned over in accordance with the actual damage incurred. Damage in these stands runs all the way from total loss to none at all. Acceptable figures for the expression of hazard for each class are obtained by computing a weighted average of all the varying percents of kill within the class. This is expressed as "net area lost."

Table 2 shows how actual losses, indicated by the field-analysis figures and worked up by this method, appear.

TABLE 2.—*Actual losses, by classes, with allowance for partial damage*

Class	Killed or area lost		Class	Killed or area lost	
	M board feet	Percent		Acres	Percent
Merchantable timber before salvage:			Unmerchantable timber:		
Class A	437,366	88.6	Class C	2,374	24.3
Class B	56,451	11.4	Class D	324	3.3
			Class E	7,073	72.4
Total	493,817	100.0	Total	9,771	100.0

The figure of net area lost for class C was obtained by working through cubic-foot volumes rather than tree counts. Not only is this a more accurate method of expressing the true damage in this relatively large size class, but since the forest survey is taking data in the class in cubic feet, integration for the expression of loss cost is facilitated. This does not in any sense vitiate the value of the acreage expression, which is essential in the complete interpretation of the data.

Criticism of the above break-down on the ground of an inadequate statistical base is entirely justified. The answer is that the above

figures are given for illustration only; for final conclusions they were harmonized with those obtained from the supplementary individual reports. Nevertheless it cannot be denied that when the effects of 47 fires are examined and it is found that of the unmerchantable timber area burned 72 percent was in class E and only 3 percent in class D, a variable is suggested that demands attention.

Probably the most significant contribution of the field-analysis phase to the study as a whole was through its check on the validity of the basic data embodied in the original fire reports. This was made, of course, by comparing the final totals for the 47 burned areas, as produced by the field analyses, with the figures for the identical areas given in the wardens' reports. Table 3 summarizes these comparisons.

TABLE 3.—*Comparison of aggregate loss on 47 burned areas as estimated by wardens with actual loss as determined by field analysis*

Source of data	Merchantable timber		Area of unmerchantable timber burned
	Area burned	Volume killed	
	Acres	*M board feet*	*Acres*
Wardens' reports	16,340	356,968	14,750
Field analyses	17,040	493,817	18,876
Excess of actual over reported damage	4.0	27.5	28.0
..... *Percent*			

The significant figures with respect to merchantable timber are those for volume killed. Since the field analyses covered a very considerable number of fires and volume of timber killed, and since ground was covered within the local districts of a large number of wardens, the correction factor of 27.5 percent increase was taken as authoritative and was applied to the original data. The summary of the wardens' reports obtained by combining the compilations in the annual reports of the two State foresters indicates an average annual gross loss of 181,346,000 feet, board measure, of merchantable timber. Increasing this figure by 27.5 percent gives 231,216,000 feet, board measure, as the adjusted figure for use in hazard rating.

Similarly, the wardens' average estimate of 19,362 acres of reproduction (unmerchantable timber) burned over per year was increased by 28 percent to 24,783 acres for the statistical purposes of the insurance study.

The estimated annual average of 231,216,000 feet, board measure, of merchantable timber killed is not, however, the final expression of damage, since much of this is ordinarily salvaged. With due allowance for depreciation between the time of the fire and the time of salvage, it was estimated that 44.2 percent of the 493,817,000 feet, board measure, killed on the areas analyzed would actually be salvaged. Unless salvage was, however, under way or definitely planned for, no allowance was made. Reducing the average annual amount of merchantable timber killed by 44.2 percent gives a net-volume-lost figure of 129,019,000 feet, board measure. This is taken as the truly significant figure of loss cost of merchantable timber in the region.

It will be noted, however, that this figure of 129,019,000 board feet is the summary of two of the timber classes established for rating purposes, namely, classes A and B. Table 4 indicates that this figure should be broken down in the ratio of 88.6 percent to class A and 11.4 percent to class B. This would be an acceptable break-down if the salvage probabilities of the two classes were the same. This is not, however, believed to be the case. Careful inquiry indicates that, generally speaking, the salvage prospects of class A are, roughly, twice as good as they are for class B, which contains smaller and often poorer timber.

Introducing allowance, therefore, for this variable in the ratio of 2 to 1 raises the final ratio of class B from 11.4 percent to 15.6 percent, leaving 84.4 percent as the ratio of class A to the total. This process is illustrated in table 4.

TABLE 4.—*Damage and salvage of merchantable timber by classes*

Class	Gross volume killed, M board feet	Volume salvaged		Net volume lost	
		M board feet	Percent	M board feet	Percent
A	204,857	96,019	46.9	108,838	84.4
B	26,359	6,178	23.4	20,181	15.6
Total	231,216	102,197	44.2	129,019	100.0

The process of breaking down the figure of 24,783 acres, representing the corrected estimate of the annual average area of unmerchantable timber burned over, into its three constituent classes and introducing further correction for the factor of partial loss is illustrated in table 5.

TABLE 5.—*Computation of net area of unmerchantable timber lost, by classes*

Class	Sample gross area burned [1]	Breakdown of total [2]	Actual gross area burned [3]	Partial loss averages [3]	Net area loss [4]	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
C	8,694	46.1	11,425	27.3	3,119	24.3
D	360	1.9	471	90.0	424	3.3
E	9,822	52.0	12,887	72.0	9,279	72.4
Total	18,876	100.0	24,783	51.7	12,822	100.0

[1] From field analysis.
[2] Class acreages derived by applying percents in column 3 to total of 24,783 acres.
[3] Partial loss percents from field analysis.
[4] Application of percents in column 5 to column 4.

The figures in the last column in table 5 would be highly significant, as indicating the relative distribution of damage between the three unmerchantable classes, if the statistical base were broader. As it is, they do carry some weight, which has been given recognition in rating. Nevertheless, the distribution adopted as finally authoritative was determined by a deductive process which gave weight also

to the distribution indicated by the analytical study of the supplementary individual fire reports covering a total of 866 burned areas. The description of this combination of the data from the two sources and the deductions drawn are included elsewhere in the report.

IN THE PONDEROSA PINE REGION

The field-analysis work in the ponderosa pine region covered 32 separate burned areas with an aggregate gross area burned of 33,367 acres. On 29,721 acres merchantable growth was present and 29,410 acres carried second growth (reproduction). The major portion of the area analyzed carried both classes of growth.

The objectives of the field-analysis phase in the ponderosa pine region were identical with those in the Douglas fir region, but differences in silvical and economic conditions made some changes in the conduct of the work advisable.

In the fir region, because of the current practice of broadcast slash burning, immature or unmerchantable growth standing under timber is practically certain to become a total loss when the overgrowth is logged. Therefore, merchantable timber and reproduction (and/or second growth) could never be considered as occurring on the same ground. If a unit area in the fir region has merchantable timber on it, this is the only element of insurable value to be considered. In the pine region this condition does not hold. Although in the past it was common practice here also to destroy practically all advance growth in the process of logging, in recent years sweeping changes in logging and slash-disposal methods have resulted in saving a considerable part of the advance growth. In this region, therefore, studies of damage to merchantable timber included measurements of damage to second growth or reproduction on the same ground. Every acre analyzed in the field work in the pine region was measured for damage both to merchantable timber and/or to all trees below merchantable size, down to 1 foot in height, wherever either or both classes of trees were present on the ground.

Merchantable timber was estimated in the same manner as in the Douglas fir region, except that the lower limit of merchantability was taken at 12 instead of 20 inches d. b. h. Trees this size and larger were tallied on the ¼-acre plots by species, diameter, and condition with respect to the fire in question. As in the fir region, the only distinctions recognized were survival as a live tree and complete killing. As the work proceeded in the field full notes were taken on all conditions that might possibly develop as important hazard factors.

Notes on the effects of fires on reproduction and second growth were made through use of the stocked-quadrat system already mentioned. In the pine region it is important to know what species compose the advance growth on the ground. In some places, even under practically pure stands of mature pine, the advance growth is composed mainly of other species. It is necessary, therefore, in recording by quadrats, to tally the reproduction count of each species separately and, also, to record the component result. To tally by separate species only would in some cases indicate full stocking when

there were blank quadrats. This condition is illustrated by the sample field-note form reproduced in figure 6.

CONDITION AFTER FIRE BY SPECIES, SEPARATELY AND COMBINED

Quadrat group (no)	SPECIES												All species	
	Pine		Fir		Larch									
	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead
1	1	1	0	2	2	0							2	2
2	2	1	1	0	0	0							2	1
3	0	2	0	1	0	2							0	2
4	0	0	0	0	0	0							0	0
5	2	1	1	2	3	1							3	1

FIGURE 6.—Form for stocked-quadrat field notes. Each group in the first column is composed of four quadrats.

It will be noted that in group 1 there still remain enough quadrats bearing live trees, all species together, to represent three-quarter stocking. Yet in the last column, the notation is made that, as a group, the quadrats are only one-half stocked. This means that one of the quadrats carries both live pine and live larch, two quadrats now bearing no live trees at all. This last notation makes it possible to tell what the aggregate stocking was.

In the quadrat field notes, records are also made of the average and maximum heights by species and by the total of all species. This makes possible the development of such correlations between size and extent of killing as may exist and also indicates the residual value after the fire, which depends not only on the number of trees left alive but also on their size.

Figure 7 shows the form on which the figures from the field data were entered for the office work-up. No radical departure from fir-region methods is introduced, and the items for which provision is made are largely self-explanatory. Correlation of damage with forest type is allowed for by the use of separate forms, as indicated at the top of the sheet, though in this respect no variation was found that justified distinction in practical hazard rating.

Substantially negative results were obtained in some other cases, as for example that of the separation of merchantable timber into age (size) classes and unmerchantable timber with respect to whether or not it stood under overgrowth. Field observation could not be relied upon to indicate whether stands of reproduction under merchantable-sized timber are more or less subject to fire than similar stands in the open, and resort to statistical method was necessary.

The final conclusion was that the only factors essential to practical schedule rating in the region are (1) size; (2) whether mer-

chantable or unmerchantable; (3) density; (4) condition as to unburned logging slash, heavy brush, and dead or dying timber; and (5) proximity to the desert fringe. Statistics on dead or dying timber were wholly lacking, but rationalized provision for this potentially important factor is incorporated in the rate schedule.

INDIVIDUAL FIRE SUMMARY

By Types

Name of Fire _____ County _____ Year _____

Gross Area _____ Acres

Type _____

Hazard factor	Net loss	
	Merchantable timber	Reproduction
	M feet b. m.	*Acres*
Total damage		
Age:		
350 years plus		
150 to 349 years		
Less than 150 years		
Heavy density		
Moderate density		
Light density		
Heavy brush		
Grass		
Unburned slash		
No special hazard		
Steep slopes		
Moderate slopes		
Level land		
Within 1 mile of desert		
More than 1 mile from desert		
Under merchantable timber		
Not under merchantable timber		

Acres crown burned:
Acres surface burned:

	Killed	Unkilled
M feet board measure killed by surface fires:		
Ponderosa pine		
Fir		
Lodgepole pine		
Larch		
Incense cedar		
Engelmann spruce		
Sugar pine		

Figure 7.—Form for entering figures from field notes for office computation.

Up to this point the discussion has been mainly directed toward the internal break-downs which indicate variations in relative hazard. As has been stated, however, one of the principal purposes of the field work was to establish a check on the measure of absolute hazard, which is the all-important starting point. As in the fir region the basic data for this come from the 10-year records, kept by the protective organizations and recapitulated and published by the coordinating heads. Since forest fire insurance will apply only to private lands, the measure of absolute hazard should be taken only on private lands. Therefore, for this purpose all data from the national forests were dropped, the summaries of the State foresters, corrected as indicated by the comparison of the wardens' reports with the results of the field analyses, supplying all the data used. Correction factors were developed simply by comparing the aggregate losses for the burned areas worked on, as reported by the wardens, with aggregate losses for the same fires as indicated by the field-analysis estimates, the latter being taken as correct. In the Oregon and Washington portion of the pine region the reported area of merchantable timber burned was thus decreased by 27.2 percent; the area of reproduction and second growth lost was increased by 34.8 percent; the merchantable timber volume lost, gross before salvage, was increased by 94.8 percent; and the merchantable timber volume, net after salvage, was increased by exactly 100 percent. This means that, in the portion of the region covered by the field analysis, just twice as much timber is being lost, net, as is indicated by the published data.

In determining absolute hazard for the pine region, the same principles were applied as in the fir region. That is, it is believed that the best general expression for immature stands is that which comes from the use of the so-called "net-acres-lost" figure derived from a combination of the gross area burned and the percentage of kill, regardless of the distribution of the remaining live trees. In these stands fires often exhibit all of a number of variable phenomena of partial damage. Cases of no damage or of total loss are easy to handle. Partial damage may, however, take such a large number of forms, each of which would call for separate consideration in loss adjustment, that, for rate-schedule purposes, the best expression of the average is that obtained by the method suggested.

All of the data for salvage also came from the field-analysis work. As the burned areas were analyzed, careful observations were made to determine whether any organized salvage of merchantable timber had taken place after the fire of which orderly records would be available, and whether there had been subsequent slash burning. If unorganized salvage appeared to have taken place, or if there had apparently been slash burning, the area was not worked on. If it developed on inquiry that salvage figures would be available, the area was worked in the usual way and the salvage figures were obtained and added in. In a few cases, where salvage had been effected for saw logs but for one reason or another the figures could not be obtained, an estimate of salvage was made in the field from the stumps.

The inquiry into the question of salvage disclosed that, on the privately owned lands included in the detailed field analysis, 39 per-

cent by volume of the killed merchantable timber was salvaged. This makes no allowance for loss from degrade, reliable figures for which could not be obtained. It has, furthermore, to be taken into consideration that, at the particular time that the field analysis was made, no particularly large private burned area was available, though relatively large fires are definite matters of record. The larger the fire the less the likelihood of complete salvage. With these considerations in mind, the decision was made to introduce into the calculations a general salvage allowance of 25 percent. It appears that, on a value basis, this is about all that can reasonably be expected in the long run under present conditions.

It will be noted that use is not made in the rating schedule of all the variables studied. This is because correlations sufficiently significant or demonstrable with respect to them were not developed by the analysis. Simplicity and facility of use are highly desirable characteristics of all rating schedules. Unless, therefore, variables with relatively sharp definition show up they are better ignored and their influences spread equally.

The fact that fewer definite correlations could be established in the ponderosa pine region than in the Douglas fir region accounts for the proposal, for this region, of a shorter and simpler rating schedule.

THE CONTRIBUTIVE FOREST FIRE HAZARDS

Once a causative agent has operated its influence is finished. All consequences of a fire from then on are due to the influences of the contributive hazards; in other words, the special conditions surrounding and affecting the small initial flame. These conditions depend upon the physical make-up of the forest area involved, the weather, and the effectiveness of the protective organization. These major elements of contributive hazard are here discussed.

PHYSICAL HAZARDS

It is first necessary to identify the physical factors susceptible to accurate measurement. These are determined from the recorded findings of forest-fire research, from discussion with fire wardens, and executives of the protective agencies concerning their specific problems of actual fire fighting, and from direct observation of the effects of fire under a variety of physical conditions in the field.

The investigation so conducted, revealed the existence of a number of physical hazards of major importance, the influences of which are measurable in actual practice. It is always recognized that some factors must be ignored because their measurement involves an undue complication and excessive work that would outweigh the advantages derived. The expense of doing business would be unwarrantably increased. The factors of physical hazard essential to this inquiry are:

1. The average size of the trees composing the insured stand.
2. The density of the stand.
3. The composition of the stand by species of trees.
4. The occurrence of unburned logging slash; of fern, brush, grass, or desert areas; and of lands recently cut over (carrying a growth of weeds).
5. The occurrence of snags in or near the insured stand.

6. The character of the topography, i. e., whether or not a considerable portion of the insured stand is on sloping ground.

The use of these factors in rating is exactly analogous to the use of construction factors in rating buildings and inflammability and destructibility factors in rating the contents of buildings. There is even a class that can be designated as introducing the "special hazards", so-called, group 4 in the above list, which includes, as the worst special hazard, logging slash.

These physical contributive hazards having been identified, they must be included in the rating schedule, on a basis of their relative values. That is, proper charges must be entered. This involves a determination of the loss costs or burning ratios that have resulted under their influences. The purpose here is to explain the process by which this was accomplished. This can best be done by discussing in detail the method of conducting the work in the separate forest regions.

IN THE DOUGLAS FIR REGION

Most of the data on which the study of physical contributive hazards in the fir region was based were obtained from the local wardens. Following is a sample of the form on which the information was furnished:

[Front of form]

SUPPLEMENTARY INDIVIDUAL FIRE REPORT

OREGON AND WASHINGTON WEST OF CASCADES

For fires which burned 50 acres or more, _____ 1926 to 1930 inclusive:

_____ County Number _____ Year _____

Name of fire _____ Time: Month _____ Date _____

Cause _____ Discovered _____

Discovered by _____ Work finished _____

Location: Sec. ___ Tp. ___ Range ___

NOTE TO WARDEN.—Please fill with figures or checks ( ) from your knowledge of the fire as many of the spaces below as necessary to give the best information as to what actually occurred.

1. Of the total area burned, about how many acres were in:

Type A: Stands averaging more than 40 inches d.b.h. _____ acres.
Type B: Stands averaging 20 inches to 40 inches d.b.h. _____ acres.
Type C: Stands averaging 6 inches to 20 inches d.b.h. _____ acres.
Type D: Stands averaging less than 6 inches d.b.h. but over 25 feet high _____ acres.
Type E: Stands averaging less than 25 feet high _____ acres.
Unburned slash _____ acres.
Fern, brush, or grass _____ acres.
Recent cut-overs (slash previously burned) _____ acres.
Other land _____ acres.

2. About what percent of the stand was killed in (make check mark):

Type A (stands averaging 40 inches d.b.h. and larger):
0 to 25%, _____; 25 to 75%, _____; 75 to 100%, _____
Type B (stands averaging 20 inches to 40 inches d.b.h.):
0 to 25%, _____; 25 to 75%, _____; 75 to 100%, _____
Type C (stands averaging 6 inches to 20 inches d.b.h.):
0 to 25%, _____; 25 to 75%, _____; 75 to 100%, _____
Type D (stands averaging 25 feet high to 6 inches d.b.h.):
0 to 25%, _____; 25 to 75%, _____; 75 to 100%, _____
Type E (stands averaging less than 25 feet high):
0 to 25%, _____; 25 to 75%, _____; 75 to 100%, _____

[Reverse of form]

3. What was the density of the stand in (make check mark):
   Type A (stands averaging 40 inches d.b.h. and larger):
   Heavy, _____; moderate, _____; light, _____.
   Type B (stands averaging 20 inches to 40 inches d.b.h.):
   Heavy, _____; moderate, _____; light, _____.
   Type C (stands averaging 6 inches to 20 inches d.b.h.):
   Heavy, _____; moderate, _____; light, _____.
   Type D (stands averaging 25 feet high to 6 inches d.b.h.):
   Heavy, _____; moderate, _____; light, _____.
   Type E (stands averaging less than 25 feet high):
   Heavy, _____; moderate, _____; light, _____.
4. Before the fire what was the approximate percentage of species (by volume) (give figures):

	Douglas fir	Hemlock	Cedar	Spruce
In burned portion of —				
Type A (40 inches and over)				
Type B (20 inches to 40 inches)				
Type C (6 inches to 20 inches)				
Type D (25 feet to 6 inches)				
Type E (under 25 feet)				

5. The fire spread (check whichever was true):
   From unburned slash to merchantable timber _____
   second growth, _____; neither, _____
   From fern, brush, or grass to merchantable timber _____
   second growth, _____; neither, _____
   From recent cut-overs (slash previously burned) to merchantable timber, _____; second growth, _____; neither, _____
6. Did this fire crown? _____. If so, in which stand (check)?
   Type A_____; Type B_____; Type C_____; Type D_____; Type E_____.
   On how many acres did it crown (give approximate figures)? _____.
7. Did snags make this fire harder to control (check): Yes_____. No_____.
8. Was the land mostly steep _____ Moderate _____ Level _____
9. Were portable pumps used? _____. If so, were they effective? _____
   If not used please state why _____
   Date: _____

_____,
(Signature of warden)

A larger volume of data would have been desirable, but it was not believed practicable to ask the wardens to remember more than 5 years back nor to recall the details of smaller fires. As it was, this campaign for additional data was extremely successful. Before sending out of forms the headings were all filled out from the existing records so that each separate form referred to an individual fire. The warden was simply asked to supply supplementary information on each. Every questionnaire sent out was returned properly filled out. Thus additional information was obtained on approximately 1,500 fires, of which 866 damaged potentially insurable growth.

Reference to the report form will disclose that the wardens were asked to furnish data for five established classes of growth according to the sizes of the trees. This classification corresponds to the first break-down made in the rating of buildings by dividing them into classes according to construction types, as frame, brick, or fire-resistive. Just as the fire experience of buildings can be directly correlated with types of construction, the fire experience of forests in this region can be directly correlated with these size classes. There is an element of contributive hazard inherent in the stand itself that is best expressed by the sizes of the trees composing it.

The adoption of the specific points of division between the classes, largely dictated by the fact that the forest survey recognizes almost identical classes in its work, is discussed elsewhere.

The closest approach that can be made statistically to indicating conditions as they would be if other things were equal, without unduly narrowing the statistical base, is through lumping all the figures for all the fires within each class. All other variables are thus given maximum opportunity to compensate each other.

The class enjoying the lowest burning ratio is taken as the standard. The other classes are charged, for class alone, according to the extent to which their burning ratios exceed that of the standard.

The next requirement is to establish the essential break-downs within the classes according to the other recognized variables. Uniform variation is not found in the different classes. The effect of density is, for example, not only more pronounced in some classes than in others, but the order of variation actually reverses itself. This consideration accounts for the separate collection of the data by classes, a separation that was maintained all through the analytical work.

The effect of stand composition is mainly a factor of susceptibility, so-called. Susceptibility factors do not affect the spread or intensity of the fire itself, but they do affect the consequences of the fire through the degree of resistance exerted by the specific property affected. Mature Douglas fir is an example of low susceptibility. Unless a fire crowns, the majority of Douglas firs in a stand of merchantable size will ordinarily escape being killed and the net damage will be relatively low. Western hemlock, on the other hand, being characteristically thin-barked, is easily killed by ordinary surface fires. The susceptibility of a forest is thus a direct factor of the proportion of hemlock in the stand in relation to Douglas fir. The higher the percentage of hemlock the higher must be the portion of the rate that allows for increased susceptibility. Sitka spruce is also a thin-barked species with high susceptibility.

Another factor of susceptibility is the rate of deterioration after death. Salvage possibilities are directly dependent on this factor, which varies considerably among different species. It is so low in Douglas fir that economical salvage is possible for relatively long periods after death. Hemlock and spruce deteriorate more rapidly through the effects of insect and fungus activity and thus present less favorable salvage prospects.

The collected data gave indications of the correlation between the composition of burned stands and the extent of killing and thus produced a means of measuring this factor of susceptibility.

By analyzing the data indicating the conditions on the land from which fire was communicated to the timber—whether unburned slash, a growth of fern, brush, or grass, or weeds on recently cut-over land—a correlation of damage was possible with exposure to these special hazards operating from land directly adjacent.

A snag can be defined for hazard rating as the remains of any dead tree over 12 inches in diameter and 25 feet high that is not overtopped by immediately surrounding trees. Snags may be mixed in with the trees of the insured stand or may carry fire to it from afar. Being very easily ignited, holding the fire high in the air, and scattering brands freely, they are very definite contributive hazards. The best indication of their contributive effect that it is possible to get is obtained by correlating the damage done by fires reported as being influenced by them with the estimated quantity of timber in the region that is mixed with them or adjacent to them. Snags are recognized as a hazard factor in the rating schedule when there are 10 or more per acre on an area 50 acres or more in extent, provided, in a stand of second growth, that the majority of the snags are taller than the majority of the trees. Such a stand must, of course, be sufficiently dense to make its classification as second growth justifiable. A few scattered trees growing among snags, brush, and ferns have no practical effect on hazard.

The intensity with which a fire will burn, the speed of its spread, its resistance to control, and its tendency to crown are all affected by the degree of slope of the ground. Steepness is an adverse hazard factor for which an appropriate charge must be made in the rating schedule. The amount of this charge is, of course, indicated by the correlation between the extent of damage done and the corresponding volume of timber on ground of different degrees of steepness. Three slope classes have been recognized for practical purposes—level, which includes slopes up to 10 percent; moderate, including slopes between 10 and 40 percent; and steep, which includes all slopes over 40 percent.

The different degrees of hazard that can be produced by varying occurrences of the factors mentioned are well-nigh numberless. Trying to allow for all of them would manifestly produce unnecessary complication and unwieldiness. It is plainly evident, for example, that a snag area, in terms of hazard, is one thing when it is directly contiguous to an area of forest and another when it is a quarter of a mile away. It may very likely, however, even at a quarter of a mile or more away, increase the hazard of the forest. So far the practical handling of the matter is not too difficult. A charge is made for the more distant snag area that is something less than the charge for the directly contiguous area. The intervening type, however, may exert an influence that increases or decreases the hazard effect through a range of several degrees. At this point in rating the law of diminishing returns begins to make itself felt.

The policy followed in the construction of the rating schedule has been that of providing for every degree of hazard for which it is practical to allow. Actual experience will undoubtedly reveal points at which the system here recommended should be modified; the schedules that will be in use after 10 years of practical experience are sure to differ considerably from those here suggested.

IN THE PONDEROSA PINE REGION

In the ponderosa pine region the use of supplementary data was dispensed with and the internal break-down was based entirely on the field-analysis data. This was possible partly through the guidance afforded by the supplementary data collected in the fir region. Also, it was apparent early in the study in the pine region that physical-hazard factors are fewer here and the range of their effects is narrower than in the fir region. Some of them are the same in both regions, notably density, exposure to slash, and exposure to heavy brush. A factor peculiar to the pine region is proximity to the desert edge.

The tabular form on which field data were summarized has already been mentioned (p. —). In the work in this region composition variables were allowed for by making two separate tabulations on the form (fig. 7), one for the ponderosa pine type and another for all other types. Most of the latter are forms of the so-called north-slope types in which ponderosa pine is largely absent, the stands being mainly composed of the Douglas and true firs, larch, and Englemann spruce. Little interest in insurance on these types is to be expected, at least in the near future; but it was believed advisable to include the findings in this study in the event that some underwriting should be called for later.

No attempt has been made to analyze the lodgepole pine type. Only a small area of this type is privately owned, its commercial importance is slight, and there is no reason to suppose that any material demand will arise for insurance on forest values in it.

The variable of composition is further measured by the figures entered at the bottom of the form (fig. 7) showing the relative amounts by species killed by surface fires. This is to indicate the relative susceptibilities of the species. As has been stated, this can be shown only by the effects of surface fires, since crown fires ordinarily kill all species indiscriminately. Provision is made on the form for expressing the evidence presented as to the probability of the development of crown fire in the respective types.

Snags are not important as hazard factors in the pine region and are not taken into account in the relative hazard set-up. For one thing, great areas bearing practically nothing but snags are almost unknown in the region and, for another, a snag is a far less menacing hazard in the pine region than in the Douglas fir region.

Ponderosa pine, unlike Douglas fir, degrades rapidly after approximately 6 months, unless the winter season intervenes. At best, profitable salvage cannot ordinarily be expected after a year or so. This involves a corresponding allowance in the susceptibility charge.

IN THE SUGAR PINE-PONDEROSA PINE REGION

The application of charges for contributive hazards in the sugar pine region follows closely the principles established in the ponderosa pine region, such modifications as are made being based on the findings of Show and Kotok (*14*, *15*, *16*) and of the fire research of the California Forest Experiment Station. The subject will be presented in detail in the discussion of the construction of the rate

schedule. Only a few of the more obvious points of distinction will be touched upon here.

Although in the sugar pine region there is no exposure to sage-brush desert, exposure to woodland and chaparral along the lower edge of the ponderosa pine type corresponds to this very closely. Here fires gain headway easily and sweep into the timber type on broad fronts, considerably increasing the hazard in the border areas. Careful extensive study indicates that the inclusion in the schedule of a rationalized charge for this exposure, equal in amount and applied in the same way as the desert-edge charge in the ponderosa pine region, is entirely justified.

In the sugar pine region no differentiation will be made for adverse terrain, because practically all of the forest is in rugged country so that allowance for it as a variable would be unjustifiable. Spreading the influence of the factor over all policyholders equally will effect a more equitable premium collection.

The same is true of the brush fields contiguous to the commercial mixed-conifer type and in places in contact with the ponderosa pine type not exposed to the chaparral areas proper. Because the distribution of this brush is almost universal, and its effects are sometimes felt far into the timber exposed to it, differentiation with respect to it would involve undue complication and be likely to introduce difficulty and controversy.

The setting of rates and the collection of premiums in the sugar pine region will be relatively very simple because of the elimination of these recognized factors of variation without the introduction of any new ones.

THE CLIMATIC HAZARD

Weather inevitably influences the spread of fire and therefore constitutes a contributive hazard. If climate is uniform locally, no attention need be paid to it. It becomes of importance when its local variations are sufficiently great to demand recognition by a practical rating undertaking.

The National Board of Fire Underwriters, in cooperation with the Weather Bureau, has made a chart of the whole country, on which are expressed various grades of a number of climatic-hazard factors for the purpose of determining proper climatic grades of cities, towns, and communities. The established principle is the same, although many of the factors used are of no interest in forest work because of fundamental differences in their action on forests as compared to that on buildings. Snow, for example, can never exert any but a favorable influence on forest fire hazard, although in town it impedes fire protection. These considerations, with others, made it necessary for this inquiry to conduct an entirely original study of climate.

What is desired is mainly an indication of the actual variation, in practical terms, of the influence of the climate on the net hazard, careful preliminary inquiry having indicated clearly that such influence is of sufficient importance to require inclusion in practical forest fire rating schedules. It is the completely isolated influence that is required in the "all-other-things-being-equal" sense, provision being made in the schedules for allowance for other variables.

The actual purpose is the subdivision of the territory into zones within each of which the climatic conditions, as they influence forest fire hazard, are approximately the same, each zone, however, being different from the others.

It was evident early in the study that the proposed inquiry could be made only through use of weather data. The collection of forest fire data had not included enough weather statistics for this purpose. Furthermore, the effects of fire are so largely the result of combinations of influences that the separate factor of climate could never be isolated in such data. The inquiry was accordingly directed toward an analysis and interpretation of the weather records, the findings to be applied to the rating process by an empirical method. This method meets the requirements of the insurance study in that it supplies a means of so recognizing and evaluating variations in climatic hazard that insurance rating cannot go far wrong during the experimental stage. Data gathered in the course of practical application will, of course, serve as a basis for improvement and refinement.

Climate itself, as a component effect, cannot be measured and expressed in absolute terms. Scientific observation is limited to the field of the measurable constituent elements, of which the following can probably be safely taken as of chief importance in relation to forest fire hazard anywhere:

Precipitation.—The total number of inches of rainfall during a year or period.

Periods without precipitation.—A drought is here defined as a period during which no measurable precipitation was recorded. Traces did not break droughts. Falls of one-hundredth of an inch did.

Days of low relative humidity.—By a day of low relative humidity is meant a day on which a relative-humidity reading is below an arbitrarily chosen point.

Minimum relative humidity.—The average of the low points of relative humidity recorded during a year or period.

Evaporation.—The average rate at which water is found to evaporate according to standard measurements over a period of time.

Air movement (wind).—The average for a year or period of the speed and volume of air movement according to standard measurements.

Air temperature.—The mean, mean maximum, and mean minimum temperatures recorded during a year or period.

An eighth element, lightning storms, is a direct causative hazard and as such has no place in the climatic-hazard study.

With respect to air temperature, it is at present difficult to discern the actual facts. Air temperature, evaporation, air movement, and relative humidity are all so intricately interdependent and there is such a dearth of truly indicative data that the time does not appear ripe for any practical application of this factor.

Of the others, two, wind and evaporation, must be left out because of insufficient data. It is very likely true that if sufficient wind data were available, relative variations with respect to this element could be designated. That is, it is probable that some sections are more subject to adverse wind conditions through long periods than

are others. All that can be done for the present, however, is to leave wind out of statistical consideration. If it ought to be made an element of differentiation, it is hoped the fact will be brought out by actual forest fire insurance experience and improved wind records. It is safe to say now that by spreading the wind hazard equally over all, no great discrimination will be shown any individual property owner. It simply means that one possible refinement is now being omitted that it may be desirable to introduce at some future time.

With respect to evaporation the same things may be said, but more emphatically. No data are available through which the correlation between location and evaporation can be shown.

Of the four remaining climatic elements—precipitation, drought, days of low relative humidity, and degree of low relative humidity—all could be used in the Douglas fir region because of the quantity and character of data obtainable there. In the two pine regions and the redwood region this was not possible, as will be made clear in the subsequent discussions of the climatic hazard in each region. It appeared that length of drought should be considered with respect both to the average and to the maximum, the latter corresponding to the long practically rainless periods that are normal through the middle of the summer.

When the influence of climate on forest fire hazard is under consideration, the essential factors are those that prevail during the so-called fire season as it may be recognized in any specific locality or region. This is, of course, the drier and warmer portion of the year. While the climatic conditions that prevail during the wetter and colder portion of the year do have some influence on the fire season, especially the early weeks, it nevertheless often happens that favorable winter conditions are completely neutralized by seriously adverse spring conditions. The normal fire season begins somewhat earlier and ends somewhat later toward the south and is correspondingly shorter toward the north. In order that complication might be avoided in the use of the data, the adoption of a uniform fire season was required. It was decided, after careful consideration, that all requirements would be best complied with by calling the fire season in the territory the 7-month period between April 1 and November 1.

The data were collected mainly through the helpful cooperation of the United States Weather Bureau, the actual work of original transcription having been done in Weather Bureau offices and with the help and guidance of members of the Weather Bureau staff. The discussion of the process and results can probably be best presented region by region.

IN THE DOUGLAS FIR REGION

The precipitation and relative humidity data were taken from the records of 141 stations in the portions of Oregon and Washington lying west of the crest of the Cascades. Of these stations, 70 had precipitation data only, 55 had relative humidity data only, and 16 had both. Geographic distribution of the stations was fairly satisfactory, with the possible exception of data on both relative humidity and precipitation on the Olympic Peninsula, in the mountains of

the Coast Range, and in portions of Lane and Douglas Counties, and data on precipitation in the Cascades. As it is, the data in these sections carry somewhat more weight in fact than they appear to do.

No attempt was made to collect data for years previous to 1921. This limit was placed because (1) the period 1921 to 1930, inclusive, was studied from the fire records, and (2) weather stations were relatively scarce prior to 1921. A wide geographic distribution of stations is preferable to long-time records.

Of the 86 stations furnishing precipitation data, 57 gave data for the past 10 years, and the rest for periods varying from 5 to 9 years. These differences permit some distortion to creep into the zonal averages, but this was compensated for by the obvious advantages of using all the data possible. The alternatives of reducing all stations to a 5-year basis or throwing out stations in localities already weak in data seemed equally undesirable.

Until comparatively recently the collection of relative humidity data has been systematically undertaken at only a few stations. In order, therefore, to achieve any semblance of conformity which would obviate the introduction of entirely unallowable distortions, it has been necessary to confine the use of relative humidity data to the months of July, August, and September for the years 1928, 1929, and 1930. With respect to relative humidity, therefore, all stations have been put on exactly the same basis. A longer period would, of course, make the results more conclusive, but this could be obtained only through sacrifice of most of the stations, making adequate geographic distribution impossible. Since no obvious contradictions have shown up in the data employed, it can be assumed that present findings may be adopted as safe for these initial promulgations.

As has been indicated, what is ultimately desired is a map of the region which will show, in a practical manner, zones of variation in climatic conditions that can be interpreted in terms of variations in fire hazard as influenced by the local or zonal climatic conditions. It is desired to set up as standard the zone in which conditions are the best prevailing anywhere in the region. In this zone no charge will be incorporated into the rating schedule for climatic contribution to hazard. It is then desired to delineate other zones with reasonably determinable adverse climatic factors that can be translated into proper charges to allow for less favorable hazard conditions. Wherever the effect of climate is felt there can be no question but that there is a correlation between its variations and variations in forest fire hazard. By the establishment of zones, provision is made for the proper expression of this variable at the appropriate place in the rating schedule.

The indications were that practical requirements would best be met by the establishment of five zones in the region. More would make this phase of rating too complicated; fewer would not quite allow for variations indicated by the data.

After the data had been transcribed from the annual reports and the original records in the Weather Bureau offices, they were summarized and the summary figures were entered on a master sheet. Extreme ranges between individual stations in variation of the five elements studied are given in table 6.

TABLE 6.—*Extreme variations of climatic factors in the Douglas fir region*

Element		Seasonal average	
		Maximum	Minimum
Precipitation	inches	41.4	6.9
Mean drought period	days	10.1	4.2
Maximum drought period	do.	67.5	17.4
Days below 35 percent relative humidity	number	68.0	.3
Average low relative humidity	percent	53.6	16.0

Variations such as these cannot be ignored in forest fire insurance rating, even though zonal averages modify them materially.

The first question that presents itself in attempting to combine the figures for the individual elements into one expression for climate as a whole is that of weights. The second is that the precipitation and relative humidity data come from different stations. A painstaking and exhaustive study revealed no authoritative justification for varying the weight assignments of the constituent elements, at least until more enlightenment is obtained from future studies, particularly of more specifically adapted data. Equal weights were accordingly assigned and the five elements combined simultaneously.

As a means of combining the precipitation data and the relative humidity data from different stations a separate map was made for each of the three precipitation elements and the two relative-humidity elements (figs. 8 to 12), each of the elements being graded in five intensity classes. On each map grading was done, except that for volume of precipitation, by grouping the stations whose figures fell between the points obtained by dividing the total ranges into fifths. For volume of precipitation all stations with seasonal precipitations of 25 inches or more were placed in the best class and the remaining stations graded by dividing the remainder of the range into four parts.

The combination of these five maps into one final map for indicating the zones of variation in the component climatic conditions was effected by the use of carefully located coordinate points. If, for instance, a coordinate point was found to fall in zone 1 on each individual element map it was colored on the final map to indicate it as a point in zone 1. If the same coordinate point fell into a number of different zones on the individual element maps, the zone numbers were averaged. Thus a point which fell into zones 1, 3, 1, 3, and 2, went on to the final map in the color representing zone 2.

The possible range from 5 to 25 thus obtained was divided arbitrarily into five classes, as follows:

Zone 1—5 to 7, inclusive.
Zone 2—8 to 12, inclusive.
Zone 3—13 to 17, inclusive.
Zone 4—18 to 22, inclusive.
Zone 5—23 to 25, inclusive.

It was found that one station or coordinate point may fall into any of the different zones with respect to each of the elements. Thus a station may be in zone 1 for number of days below 35 percent relative humidity and in zone 5 for precipitation. Port Townsend

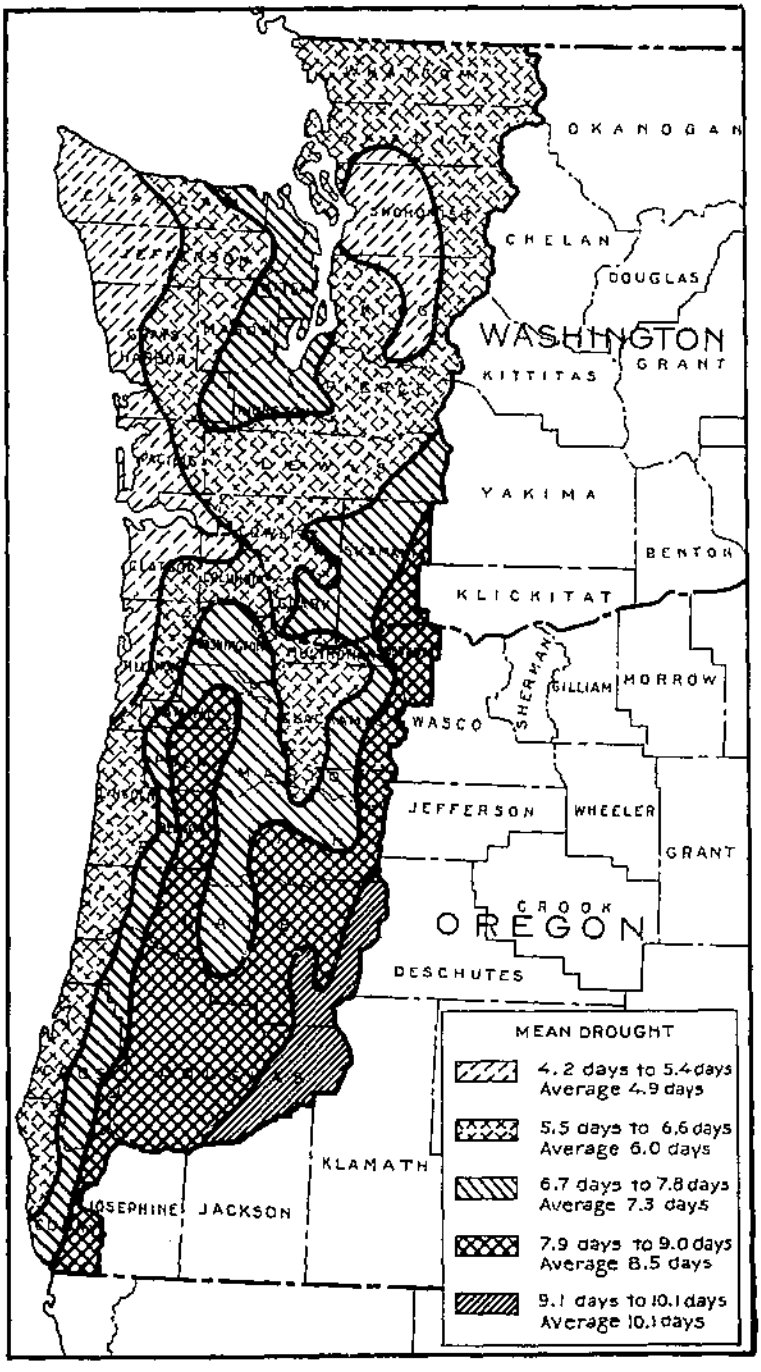


FIGURE 8.—Zoning of the Douglas fir region according to mean drought periods, April through October 1921–30.

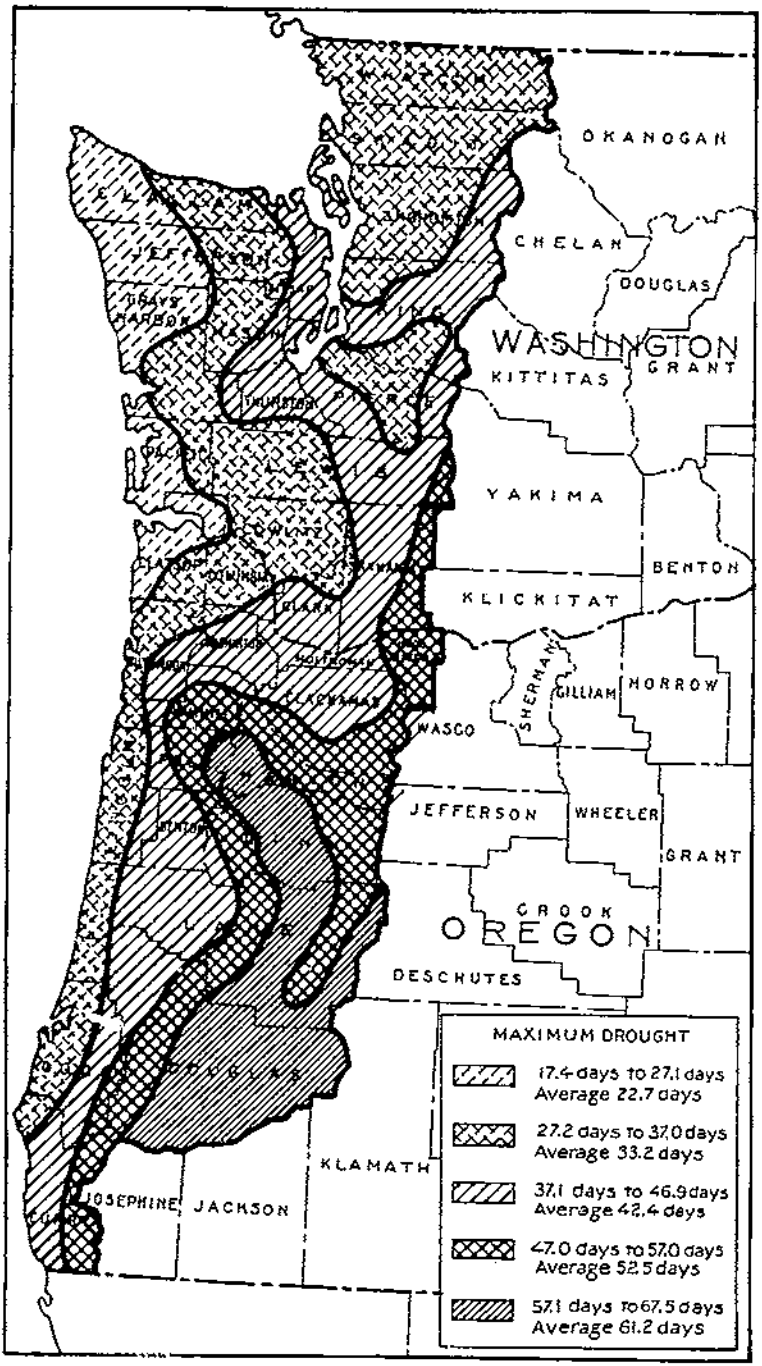


FIGURE 9.—Zoning of the Douglas fir region according to maximum drought periods, April through October 1921–30.

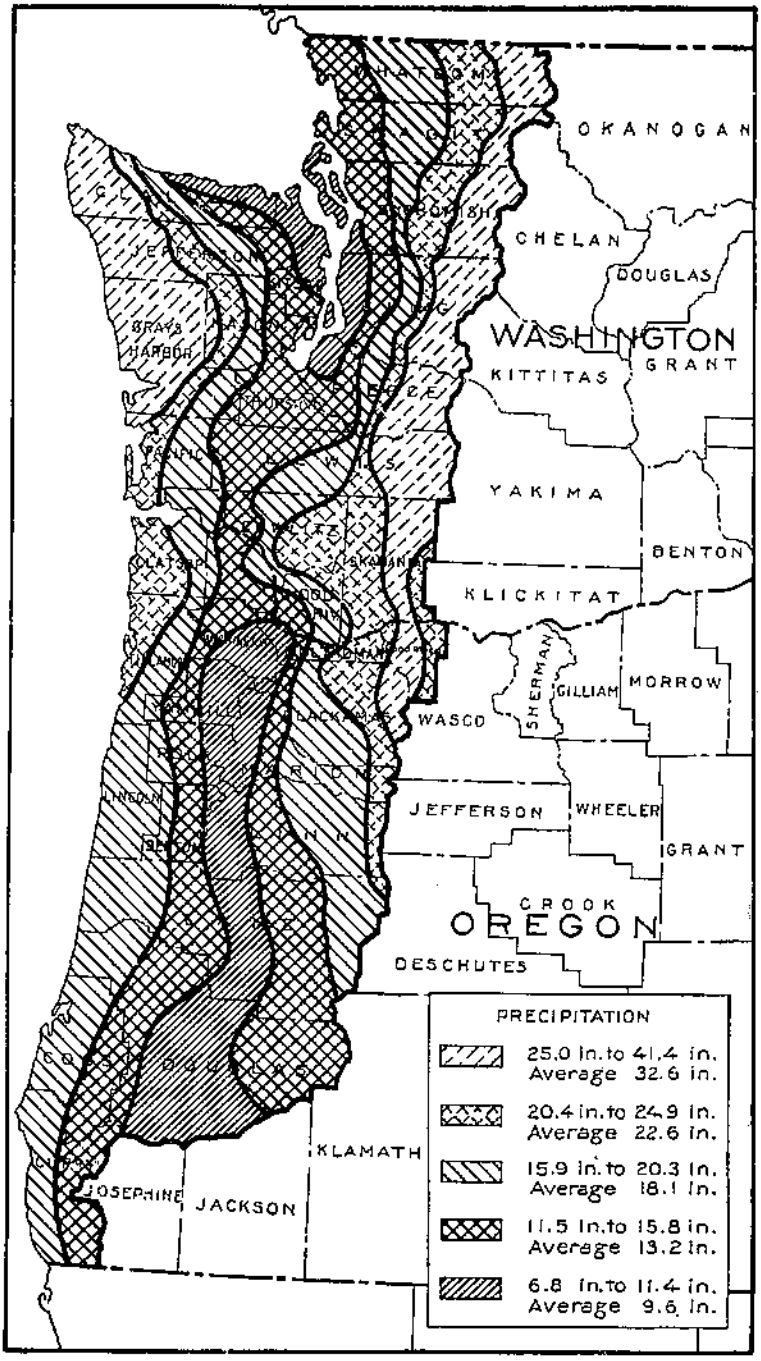


FIGURE 10.—Zoning of the Douglas fir region according to amount of precipitation, April through October 1921–30.

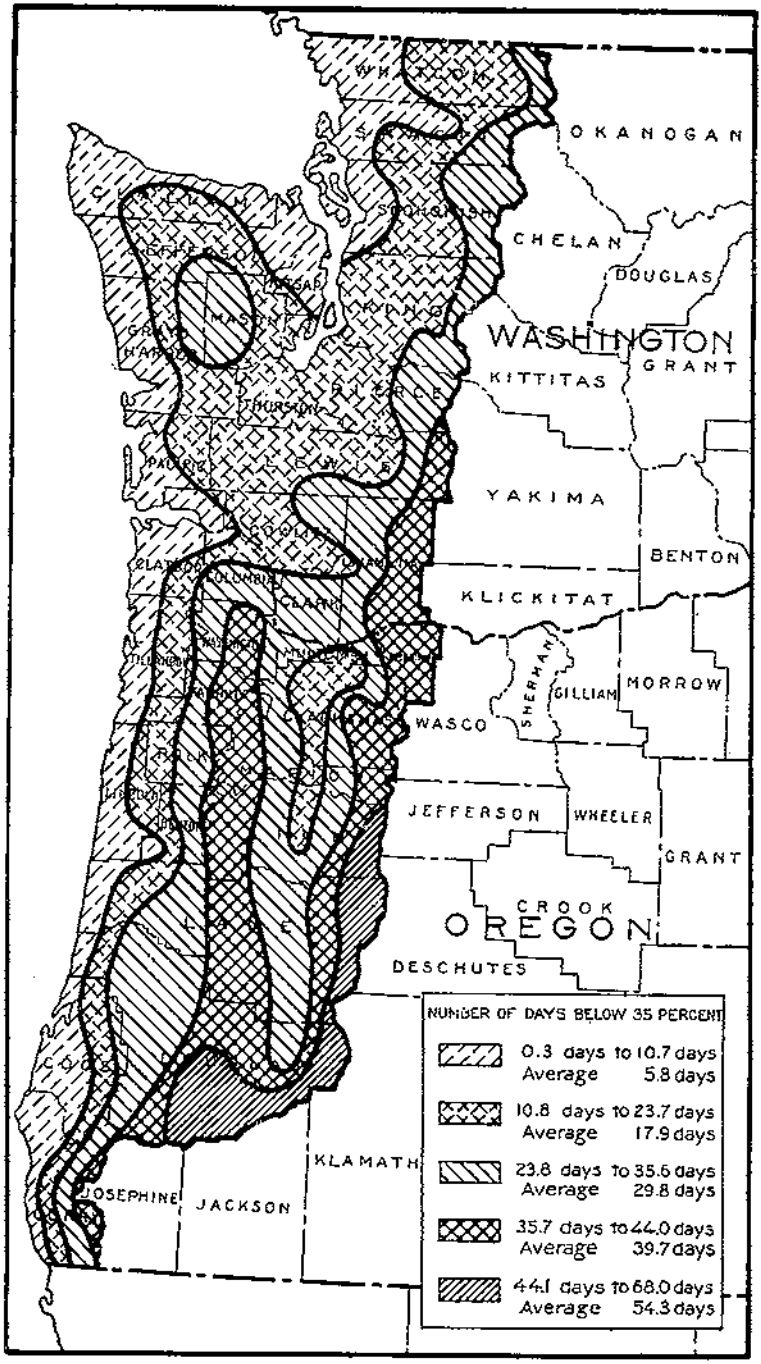


FIGURE 11.—Zoning of the Douglas fir region according to the number of days on which the relative humidity fell below 35 percent during July, August, and September 1928, 1929, and 1930.

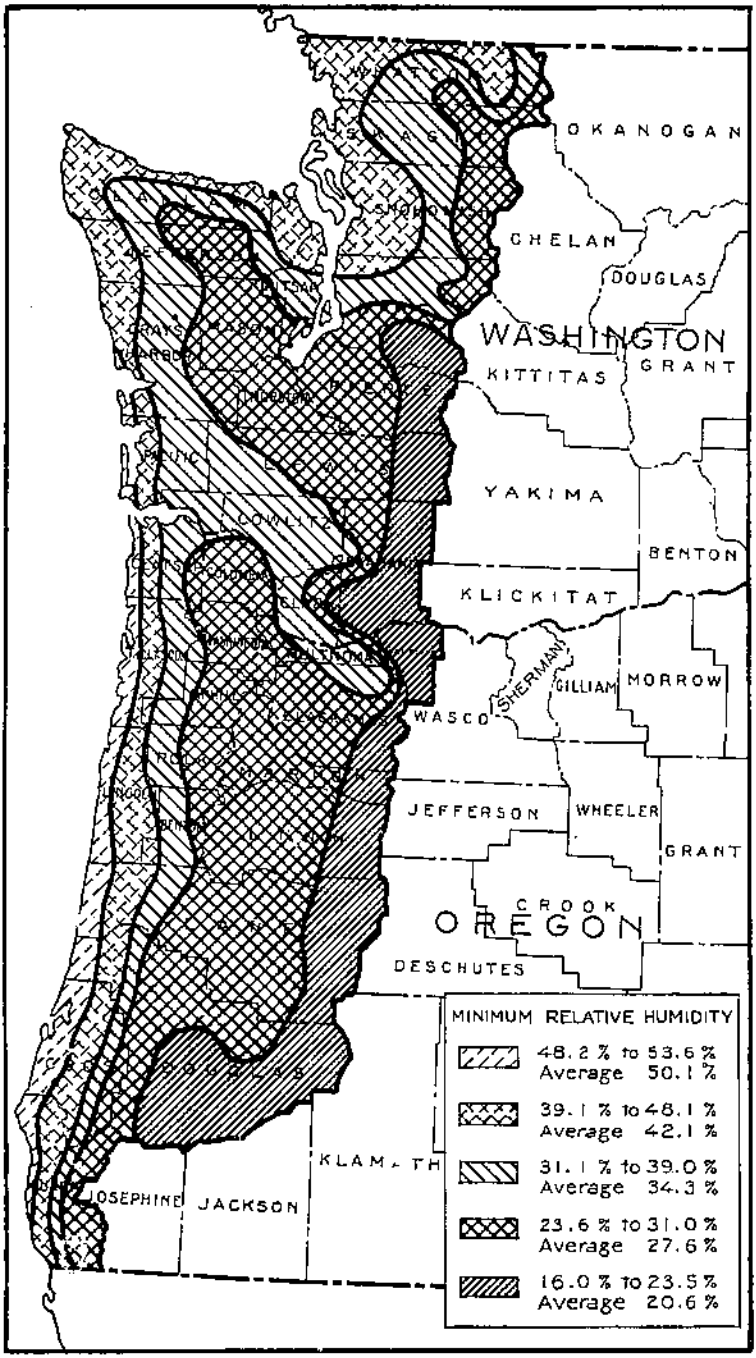


FIGURE 12.—Zoning of the Douglas fir region according to minimum relative humidities during July, August, and September 1928, 1929, and 1930.

is an actual case illustrating this possibility. Due consideration, however, makes clear the fact that this need cause no concern. While there is undoubtedly, in the main, a correlation between the elements, it is locally very seriously upset by topographic and other features. Port Townsend's precipitation deficiency is accounted for by its location to the northeast of the Olympic Mountains, which cause very heavy precipitation from the southwest winds on the windward side and very light precipitation on the lee side. Nothing interferes, however, with the opportunity afforded the waters of the San Juan Straits and Puget Sound to keep Port Townsend's relative humidity high. Similar local influences are at work in other places to prevent points from falling into the same zones with respect to each individual element.

Good conditions with respect to one element inevitably tend to neutralize bad conditions introduced by another element. This method of combination makes allowance for this fact, and acceptable and usable conclusions as to the final climatic component are thus produced. Various cut-and-try methods, assigning different weights and using different systems of combination, all gave very similar results, and the conclusion has accordingly been reached that the method adopted meets the requirements satisfactorily.

The final climatic map thus constructed (fig. 13) divides the region into the five zones, by area, as follows:

Zone 1—5.3 percent of the region.
Zone 2—27.6 percent of the region.
Zone 3—35.6 percent of the region.
Zone 4—24.4 percent of the region.
Zone 5—7.1 percent of the region.

The zones do not by any means divide the region into equal fifths by area, but they do perform the required function of grouping properties with approximately equal climatic conditions. Even if one zone had covered only 1 percent of the region, it would have been allowed to stand had it appeared that properties within it were affected by conditions different from those existing elsewhere.

After the five zones had been delineated on the final forest fire map of the region, the stations were located on the same map in order to show accurately into which zone each station falls. The figures for all the stations in each zone were then averaged. These averages are shown in table 7.

TABLE 7.—*Averages of climatic factors in the Douglas fir region, by zones*

	Seasonal precipitation	Mean drought period	Maximum drought period	Relative humidity below 35 percent	Low relative humidity
Zone no.:	*Inches*	*Days*	*Days*	*Days*	*Percent*
1	27.9	4.8	23.2	8.5	38.8
2	19.4	5.9	35.3	12.7	37.2
3	15.0	6.4	40.7	22.0	29.9
4	12.5	7.9	54.2	36.9	24.5
5	8.7	8.1	61.1	48.9	25.2

The general though unsteady tendency toward worse conditions under each element between zone 1 and zone 5, as shown in table 7,

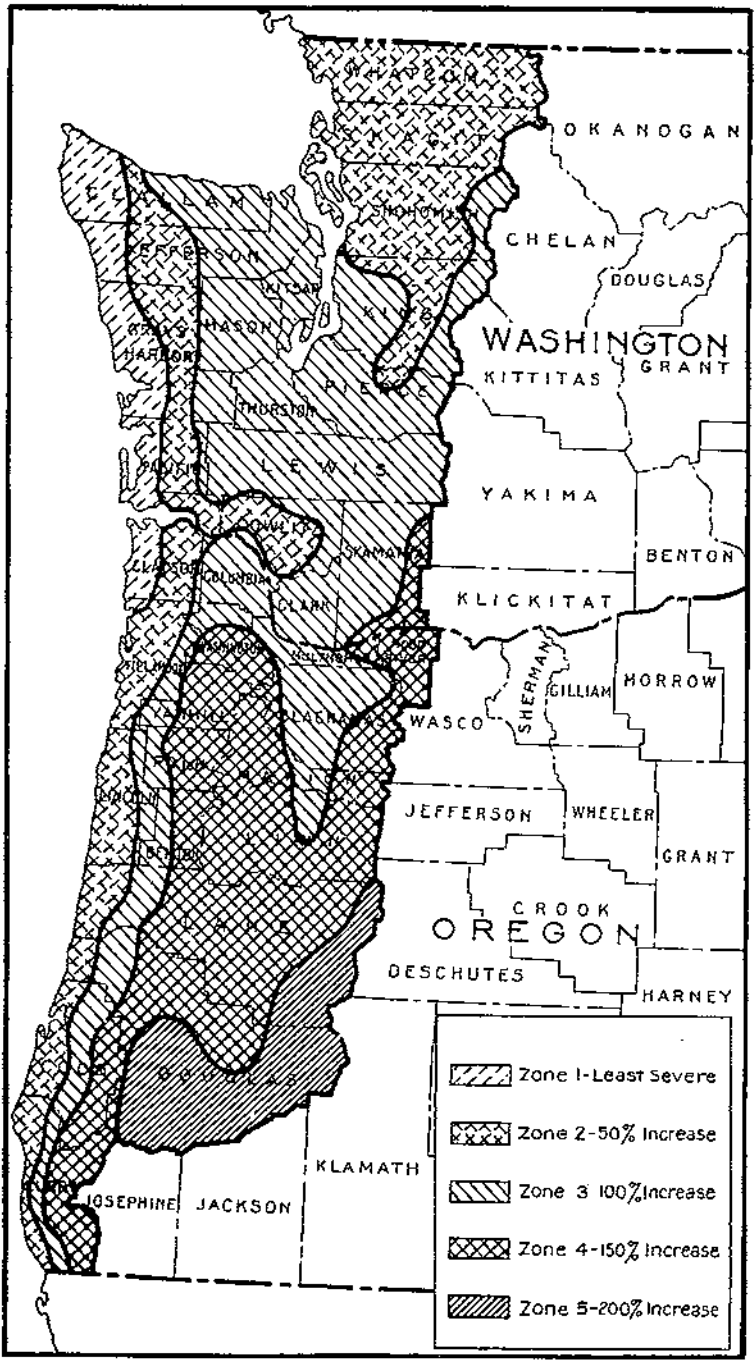


FIGURE 13.—Final forest fire climate chart combining the five elements shown in figures 8, 9, 10, 11, and 12.

is noteworthy. In table 8 zone 1 is taken as the standard, and the percentages given are for the increase in unfavorableness over conditions existing in that zone. Another column is added in which the average percentage increase is shown.

TABLE 8.—*Percentage increase in severity of climatic factors in zones 1 to 5 of the Douglas fir region*

	Seasonal precipitation	Mean drought period	Maximum drought period	Number of days below 35 percent relative humidity	Low relative humidity	Average
Zone no.:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1						
2	44	23	52	49	4	34
3	79	33	75	166	30	77
4	123	65	134	334	58	143
5	221	69	163	475	54	196

The figures in the last column of table 8 are an expression of the increase in climatic severity of the various zones over that of zone 1 from the standpoint of influence on forest fire hazard. For practical purposes, however, it will be advisable to smooth out the figures. The final average figures show an irregular progression, as illustrated below:

From zone 1 to zone 2, a difference of 34 percent.
From zone 2 to zone 3, a difference of 43 percent.
From zone 3 to zone 4, a difference of 66 percent.
From zone 4 to zone 5, a difference of 53 percent.

The mean difference is, roughly, 50 percent, or a difference of 200 percent between zones 1 and 5. Thus zone 5 is three times as bad as zone 1.

Deficiency charges made in the other zones to allow for the hazard increases above those of zone 1 have not been applied throughout on a percentage basis. Tests by direct application being impossible, it was decided that flat deficiency charges in cents promised the best workable basis, applying the percentage increase for climatic severity, as this study determined it, to the regional basis rate of 2½ cents.

All properties in zone 2 therefore take a climatic deficiency charge of 1¼ cents, in zone 3 of 2½ cents, and so on. Until actual practice is begun and direct observation made possible, it is believed that this is an entirely feasible method of application.

The adoption of this method will apparently provide for equitable recognition of the effects of climatic deficiency. It can be easily understood that the occurrence of highly inflammable herbage in the forests of the Douglas fir region varies directly with the climatic factors favorable to fire protection—the more moisture, the more brush and weeds. The worst physical hazard is in a forest ordinarily moist but temporarily dry. This treatment of the figures recognizes this fact and will, it is now believed, effect, on the whole, a more equitable measurement of the climatic hazard than any method so far suggested.

IN THE PONDEROSA PINE REGION

As has been stated, the essential climatic features of the northern ponderosa pine region are scanty rainfall, wide temperature range, low relative humidity, strong winds, rapid evaporation, and abundant sunshine—all of which tend unquestionably toward bad fire-hazard conditions, which generally prevail from before the first of July until sometime in September.

In this region, unfortunately, properly distributed data are lacking for evaporation, wind, and temperature in the forest. Even the available figures for precipitation and relative humidity are deficient in geographic distribution and method of collection. This deficiency arises partly from imperfect collection technique and partly from the fact that, up to the present, local variations have not been an important consideration in fire-weather measurement.

The present conclusion with respect to this phase of the study is, accordingly, to present no data bearing on internal local variations in the region. The subject must be left with the statement that the question has been as carefully investigated as the existing data permit, but that no convincing or authoritative conclusion could be reached.

This implies that for the immediate future, at least, the ponderosa pine region must be treated, for forest fire insurance rate making, as a single climatic unit or zone. If this works hardship on certain assureds, a differentiation based on inconclusive data might produce even greater inequities.

There are two possible ways of looking at the problem of the grading of hazard in any separate region. One is the complete isolation of the region and the development of an entirely independent grading and rating schedule. The other is the carrying forward from region to region of such indications and principles as may be applicable with or without supportable modification. It is the author's conviction that the best result is obtained by a combination of these two processes, that is, by doing as much as is possible with the region alone, then trying to rate hazard in it by a process of carrying over the rate structure of another region with proper differential modification, and finally harmonizing the two results. This is the method that has been used in this work.

In working out this system it is necessary that some approximate measurement be made of the differentials in all the factors common to both regions involved (in this case the Douglas fir and the ponderosa pine regions). An expression is therefore required of the point which the forest-fire climate of the ponderosa pine region attains in the scale developed for the fir region.

It appears from general observation and the available data that every locality in the ponderosa pine region has worse forest-fire climate than the worst zone in the Douglas fir region, despite the fact that such a hot, dry climate reduces the vegetable matter for fuel and therefore the inflammability of the forest.

With the aid of some permissible rationalization, a practical and usable basis may be built up on the following considerations: (1) The climate of the fir region is essentially insular and subject to influences not felt in the typically continental climate of the pine region; (2) the climatic elements in the continental climate run, without doubt, more closely parallel than they do in the insular belt

where peculiar physiographic features set up conflicting influences; and (3) the measurement of one element is therefore a better indication of climate as a whole in the pine region than in the fir region.

For something like an adequate basis of comparison, use may be made of volume of precipitation, which happens to be the one element of which reasonably reliable measurement has been possible. Precipitation data are available from 91 stations in California, Oregon, Washington, and Idaho, all either in or directly on the border of forested areas. An average of these data is 7.07 inches and this can be accepted as a reasonably accurate expression of the mean seasonal precipitation of the region. This is 20.83 inches less than the standard of 27.90 inches in the Douglas fir region (table 7), a deficiency of 294, or, roundly, 300 percent. On the basis of the smoothed-out increases adopted for use in the fir region the whole ponderosa pine region can reasonably be taken as zone 7 on the Douglas fir scale.

This grading system is presented entirely on its own merits, not at all as a perfect scientific finding. The writer will be the last to defend it against better proposals or designations having sounder statistical or rational support.

IN THE SUGAR PINE–PONDEROSA PINE REGION

The climatic study of the sugar pine region is, like that of the ponderosa pine region, less detailed than that of the Douglas fir region. Relative humidity data from a few widely scattered stations or from valley or high mountain points are too unrepresentative and unreliable for use. No alternative exists but to make as much as possible, for the present, of the existing precipitation data, letting the rest go until such time as more comprehensive records become available. The similarity in trend of the curve of fire-season precipitation to that of the final climate, as developed in the fir region, is used to establish a system of zones in the sugar pine region (fig. 14).

Though in other phases of the study, typical portions of the three major regions may furnish the guidance necessary in the minor portions, climate is a hazard factor for which general principles cannot be established. Its local characteristics must be discovered in every region, major or minor, in which underwriting may be undertaken.

Since all portions of the Pacific coast territory offer possibilities of successful underwriting, it is necessary to study climate as intensively as possible everywhere. A map is desired which will show the climatic grading of every acre of forest land.

Six of the seven standard zones already adopted are found in California, though the ranges of the second and third are limited to small areas along the coast at the extreme north end of the State (in the redwood region).

Figure 14 shows the zonation of the forested portions of the Pacific Coast States, including California, as indicated by the climatic phase of the inquiry. This classification is not presented as final; at best it is only a means to more equitable rating and underwriting than would be possible by any other method known at present. The ignoring of climate, charging all policy holders equally in this respect would unquestionably be less equitable.

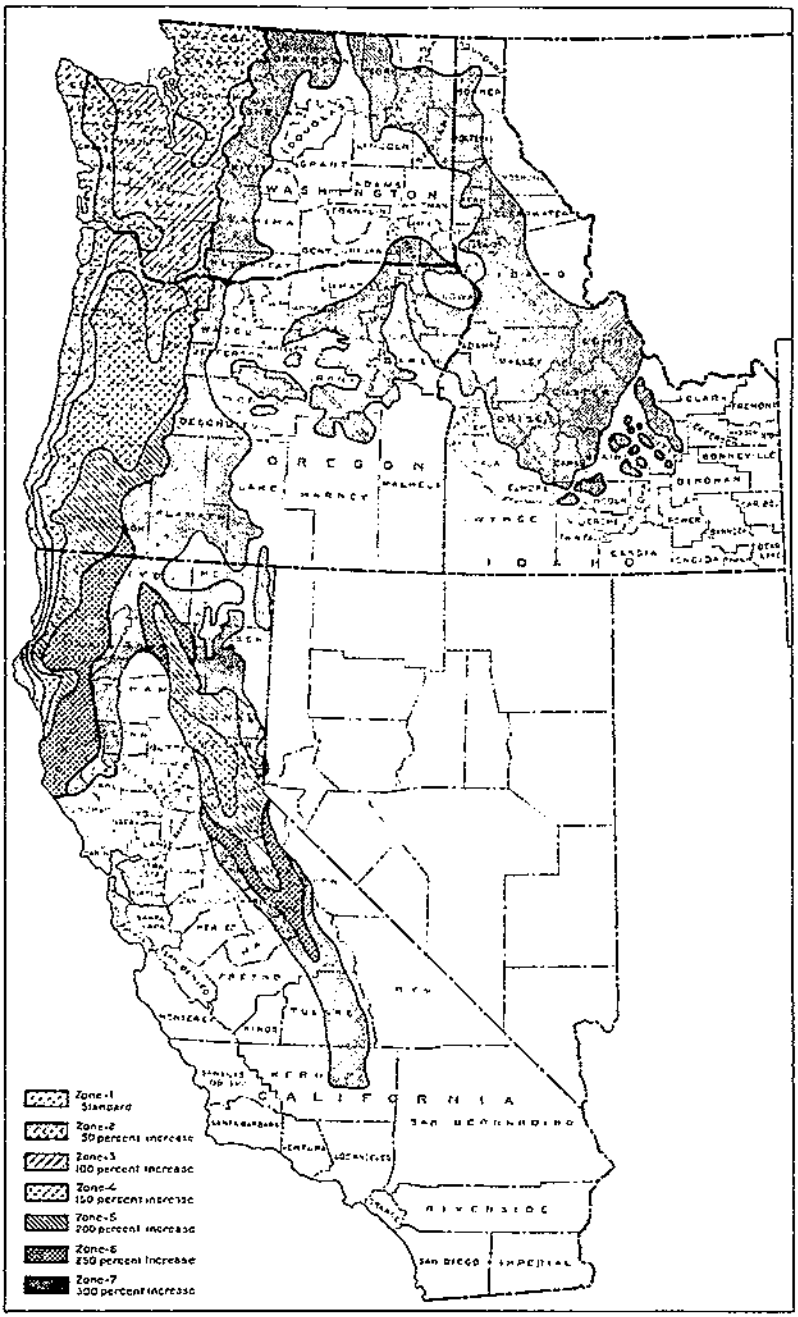


FIGURE 14.—Climatic zones in the forested portions of the Pacific Coast States.

As will be seen in figure 14, the sugar pine region itself thus divides into four zones, 4, 5, 6, and 7, with 7, the largest zone, occupying the whole southern end, and a relatively small area of zone 4 on the west slope of the north-central Sierra.

These differentiations are based on normal fire-season precipitations as recorded by the United States Weather Bureau for 70 stations in or close to the commercial forest areas being studied. Periods of observation vary between 5 and 69 years, the average for all stations being 26.8 years. Thirty-four of the stations have records of less than average length, but only 20 have records of less than 15 years. All but 14 records run through 1932 without breaks.

It is realized that the disparity in periods of observation introduces errors due to cyclic variation, but it is believed better to accept this error than to attempt a zonal differentiation on the small number of stations that could otherwise be used. The greater rationalization that would be necessitated by that method would probably produce still greater errors.

The normal fire season throughout most of the sugar pine region is somewhat longer than in the other two regions, extending roughly through November. Most of the portion at lower elevations—that is, the ponderosa pine type—is also normally subject to fire in March. Fires may occur here, in fact, in any month of the year.

Normal seasonal precipitation, as shown by the records used, varies between 3.17 inches at Lemon Cove and 19.59 inches at Crescent City. On the basis of this range of variation of 16.42 inches a somewhat rationalized zonation is drawn, dividing the range into six zones in such a way that average zonal precipitations of zones 2, 3, 4, and 5 approximately equal the figures for these zones established by the climatic study of the Douglas fir region. These figures, it will be remembered, progressed through the zones in approximate increases of 50 percent per zone, giving zone 5 an increase over zone 1 (the standard) of 200 percent. By this scale zone 6 should accordingly show an increase of 250 percent and zone 7 of 300.

CLIMATIC ZONING OF THE PACIFIC COAST TERRITORY

The final conclusion in the climatic study of the ponderosa pine region was, for the present at least, to group the whole area into one zone. The normal seasonal precipitation average of 7.07 inches indicates a general increase in severity of climatic conditions over the standard of 294 percent, very close to the arbitrarily established standard of 300 percent.

Table 9 shows the old averages of the zones together with the new averages as they now appear with the figures from the west-side California stations added in.

The percentage increases in column 4 follow closely enough the arbitrarily adopted increases of 50 percent per zone. In view of the data and the needs of the study this is as close a compromise as it was possible to devise. It is, moreover, an entirely legitimate one and, as has been stated, a basis for rating and underwriting that is an improvement over what could have been done had no climatic studies been made. With the collection of more data as time goes on, together with general improvement in collection technique, it will unquestionably be possible to improve the climatic zonation and

strengthen its authority. This will be particularly true when statistics from actual forest insurance practice begin to accumulate.

TABLE 9.—*Old and new average seasonal precipitations in the Pacific Coast States*

	Old average seasonal precipitation	New average seasonal precipitation	Percentage of increase in climatic severity of new averages over zone 1 (standard)
Zone:	*Inches*	*Inches*	*Percent*
1	[1] 27.88	27.88	
2	[1] 19.37	19.33	44
3	[1] 15.59	15.61	70
4	[1] 12.54	12.60	120
5	[1] 8.73	9.63	190
6	[2]	7.88	254
7	[3] 7.07	6.68	317

[1] From climatic study of Douglas fir region.
[2] None. Not previously shown.
[3] From climatic study of ponderosa pine region.

Preliminary rating and underwriting practice in the forested portion of California west of the crest of the Sierra Nevada can be based upon the use of an atlas similar to the one that has been made for the Douglas fir region. In this atlas the zone boundaries are made to follow the nearest major survey boundary, that is, township or range line, or center line of a township. For a work of this kind there is no need to refine to the extent of using section lines. Figure 14 is presented as the basis on which such an atlas can be made.

EFFECTIVENESS OF PROTECTION[6]

Other things being equal, fire damage will vary inversely with the effectiveness of the protective organization. Since the loss figures on which the rating practice here suggested is based were all obtained under conditions where protection is a factor, and since all other pertinent variables are allowed for at other points in the schedule, all that is required for an equitably rated expression of protection is a basis for comparison on absolute terms. Some of the elements of variation in protective effort are subject to direct expression in absolute terms as manpower per unit of area, amount and kind of equipment, miles of roads and trails, and so on. Some elements are matters of judgment, as physical and mental ability of the personnel and general morale. These latter items can be estimated and graded on the basis of study, both by direct observation and observation of past performance as indicated by the fire records.

When preliminary plans were being drawn up for the conduct of this phase of the insurance study it was discovered that the Board of Fire Underwriters of the Pacific had had a similar problem to solve only a few years previously in connection with the rural pro-

[6] This section was prepared in collaboration with E. H. MacDaniels, forest inspector, North Pacific Region, in charge of Clarke-McNary law administration in cooperative fire protection in Oregon and Washington, and J. H. Price, assistant regional forester in charge of fire control in the California National Forest Region.

tection districts being organized in California. Although an entirely new schedule had to be devised to fit the requirements of grading forest-protection districts, it was possible to get excellent help and suggestions from the form that had been developed for the rural districts.

Some differences exist between ordinary fire protection and forest fire protection that impose the necessity of differences in conceptions and approaches. As an example, fire-department men in rural communities devote part of their time throughout the year to fire work, whereas members of forest-protection organizations, broadly speaking, devote all of their time for a part of the year to forest fire work. The regularity with which drills and meetings are held, the evidence of morale furnished by the records of attendance, and the training work done, are indicative of the rating of a rural department with respect to personnel. Forest fire organizations do not hold drills and meetings. The work is of a more direct and constant nature while the fire season is on. The grading of personnel, therefore, requires the measurement of the personal traits of the men composing the force. The efforts of those men are individual in character. When not actually engaged in fighting fire they are detailed individually for prevention and preparedness work. In actual fire fighting they operate as foremen over the temporarily hired crews of laborers brought in to fight specific fires. In the forest-protection grading schedule, therefore, the men on the force are graded individually.

There are three main types of direct forest-protection administration on private land in the territory: Voluntary associations cooperating with the State foresters; complete jurisdiction of the State foresters; and protection by the Forest Service. In all cases responsibility rests ultimately with the State forester. Local administration is by districts, usually roughly concurrent with the counties.

The grading of protection districts involves a thorough inquiry into all conditions that influence the effectiveness of the organization, as well as a study of the organization's record in the file of fire reports. From these it is possible to determine with practical accuracy whether the organization's past performance has been as good as could reasonably be expected, all factors considered.

The grading of some of the factors of forest fire protection is properly the expression of the inspector's judgment. A careful study of the proposed grading schedules will make this clear. Obviously there is no help for this situation, and no harm is necessarily caused by it. If a reasonably good expression of the standard requirements is achieved and the inspector really knows the principles of protection and the conditions in the district he is grading, an entirely satisfactory result is possible. The objective is, of course, the establishment of practical standards of protection and provision for the orderly measurement of deficiencies.

IN THE DOUGLAS FIR REGION

About the time the need arose in the forest fire insurance study for devising a method of grading protective organizations, the Clarke-

McNary administration[7] had perceived a need for something of the kind in connection with its own work, a yardstick by which to measure and express the relative effectiveness of district organizations.

The form suggested for a grading schedule for the protective districts of the Douglas fir region follows: On the results of the inspection of protective organizations and determination of whether reasonable requirements are being met, depend decisions as to the allotments to individual units from the Federal Government's cooperative fund. The grading schedule here presented was prepared with the benefit of the knowledge and experience inevitably gained through such work, and it is confidently believed that it will meet the requirements of introductory practice. As actual insurance experience is gained it may, of course, be improved.

Schedule for Grading Forest Fire Protection in Forest-Protection Districts

This schedule is to be applied only in districts organized under the State law and under the jurisdiction of the State forester. A map of the district must be provided showing exact boundaries, township, range, and section lines.

Standards

GENERAL STRENGTH OF ASSOCIATION: For full credit not over 50 percent of the forest property within the limits of the district should be protected on the tax-roll basis; that is, at least 50 percent should be voluntarily protected through association membership. Not over 10 percent of the forest property in the district should be delinquent in the payment of property taxes. The extent to which support will be forthcoming from the parent organization should be considered under this item; also the independent financial resources of the association members and other forest-property owners in the district.

DETECTION: For full credit for detection all points in the district should be within 6 miles of an official lookout station, or covered by daily patrol, or within 1 mile of an occupied habitation with telephone connections to district headquarters.

COMMUNICATION: Dependable telephone service required from chief to all members of force and lookout stations, and to all parts of the district. Condition as well as completeness to be considered.

TRANSPORTATION: Not less than 75 percent of the area of the district should be within 1 mile of a road or trail. Each member of the force should be equipped with means of transportation suitable to his unit and duties. Ownership is immaterial. Constant availability is the essential factor. The protective organization should own and keep at a central and convenient location cars or trucks, or both, with an aggregate capacity of not less than 10 men with the customary equipment and tools. Consideration should be given to the availability of pack animals and equipment including number and amount, condition, and other uses with respect to probable quick availability for fire work.

FIRE-FIGHTING EQUIPMENT: The requirement is an adequate supply of tools and equipment, owned by the protective organizations, maintained in serviceable condition, and so located as to be of maximum utility and mobility. Tools and equipment should be of types adaptable to conditions in the district and in such quantity as will fully equip crews locally available.

MANPOWER: The standard of manpower is based on the extraordinary, not the average, condition encountered. In grading manpower for strength (permanent forces and emergency help) the inspector should keep in mind the question whether there seems to be strength and organization for peak loads, i. e., a string of simultaneous lightning or incendiary fires and/or to cope with weather conditions favoring rapid development of fires.

[7] Authorized by the Clarke-McNary Act of June 4, 1924. Under sec. 2 of this act authorization is granted for use of Federal funds in forest fire control work on privately owned lands within the States, subject to compliance with prescribed regulations.

PERFORMANCE: This factor is indicated by the fire records of past years. A fast start implies actually getting a suppression crew under way within 10 minutes of receipt of report of fire. A strong start implies a proper ratio between the number of men and amount of equipment first sent and the condition of advancement of the fire when reported. Standard suppression implies absolute control of not less than 95 percent of all fires by 10 a. m. the following day. Standard mopping up implies staying with fires after control is established and making strong effort at complete extinction. Complete records of all fires are required.

LAW ENFORCEMENT: A successful effort at obtaining satisfactory compliance with the forest fire code of the State in all portions of the district is expected.

Grading

Grade according to standards, giving full credit only where requirements are fully complied with.

_____	District, State of_____
Area protected_____	Area merchantable timber _____
Area cut over_____	Area in association _____
Area on tax roll_____	Delinquent _____

	Percent
1. GENERAL STRENGTH OF ASSOCIATION, FINANCIAL AND ADMINISTRATIVE_____	10
Percent of area on tax roll_____ / Percent of area delinquent _____ _____	5
Probable support from parent organization_____	2½
Independent financial resources_____	2½
2. PLANT_____	25
(*a*) DETECTION _____	5
Percent of area less than 6 miles from lookout _____.	
6 to 10 miles _____. Seen by daily patrols _____.	
Within 1 mile of occupied dwelling with phone _____.	
(*b*) COMMUNICATION_____	5
Use thoroughly adequate and reliable telephone system as standard.	
(*c*) TRANSPORTATION_____	5
-- percent of area within 1 mile of road.	
-- percent of area within 1 mile of trail.	
Cars or trucks owned by association and centrally located. Number _____.	
Pack animals. Number _____.	
NOTE.—It should be possible to reach one-half of fires within 1 hour; next one-fourth of fires within 2 hours.	
(*d*) FIRE-FIGHTING EQUIPMENT_____	10
Suitable hand tools in good condition for each member of force_____	1
Caches promptly available for any ordinary emergency_____	6
Made up in units to facilitate packing_____	1
Camp outfits promptly available_____	1
Pumps, etc., promptly available_____	1
Fully equipped with 1,500 feet of standard grade hose. One pump per 250,000 acres is standard.	
NOTE.—Pump credit not given if in inspector's judgment the district is insufficiently watered.	
3. MANPOWER—PERMANENT FORCE_____	30
Number of acres per man_____	3
One man per 15,000 acres is standard.	
Organized sawmill, woods, trail crews available_____	4
Good local help available_____	3
Members of force graded individually_____	20
Physical fitness, one-half.	
General fitness, one-half.	
Intelligence.	
Experience.	
Warden graded according to general fitness for job. Warden's grading is weighted to equal one-third of total.	

	Percent
4. PERFORMANCE	30
Fast, strong start	10
Prosecution	15
Mopping up	4
Records satisfactory	1
5. LAW ENFORCEMENT	5

Classification:

Districts grading from 85 to 100 percent shall be designated as class 1.

Districts grading from 70 to 84 percent shall be designated as class 2.

Districts grading from 55 to 69 percent shall be designated as class 3.

Districts grading less than 55 percent shall be designated as class 4.

IN THE PONDEROSA PINE REGION

The grading schedule proposed for the ponderosa pine region is not intended for use in the California portion of the region, since another schedule has been developed better adapted to special State-wide conditions existing there. There seems to be no reason why the ponderosa pine region schedule should not be used in Idaho, but until close observation of actual protection methods and administration in that State becomes possible through the actual writing of insurance it will be advisable to make use of a protection warranty calling for the maintenance of administration by a public authority, either the State forester or the Forest Service, or, in lieu of this, a warranty in which a detailed description is given of the protective organization that will be maintained. Policies containing the second warranty would, of course, be sold only to owners well qualified as to personal and business reputations, apparent moral and financial responsibility, and general integrity. (See the warranty suggested for private protection on p. 105.)

Different physical and climatic conditions also account for some differences in the schedule for grading protection in the ponderosa pine region as compared with the Douglas fir region. Greater general ease in traveling through the forest where no roads or trails exist makes possible a lowering of the standard of accessibility by travel routes. Better general atmospheric conditions throughout the fire season tend to give better visibility and permit a wider spacing of lookouts. Provision is therefore made for an allowance of a 12-mile detection distance under standard conditions. Early detection is, however, more important in the pine region because of the climatic and physical conditions, which favor the rapid development of fire in the very early stages. More point accumulation is, therefore, provided for under detection by raising its total from 5 to 15 percent, the difference being taken away from manpower and general performance, five points from each.

As has been said, the details of these suggested protection grading schedules are provisional only. Changes will undoubtedly be made as the result of actual experience. The form of grading schedule proposed for use in the ponderosa pine region follows. It is believed that the modifications are self-explanatory.

Schedule for Grading Forest Fire Protection in the Ponderosa Pine Region

This schedule is to be applied to protective units under the jurisdiction of the State forester, either directly or indirectly, and also to those administered by the United States Forest Service through cooperative agreement. Rating is by districts—as established by general agreement, where protection is administered directly by the State forester or indirectly by him through association activity; or, in the case of Forest Service protection, by ranger districts. A State or association district is ordinarily a county (roughly) and is in direct charge of a district warden.

This schedule should not be used for grading protection supplied by private owners or associations independent of immediate supervision and inspection by the State forester. All properties within any one district, as established, grade equally. No protection warranty is required in Oregon or Washington but must cover for all policies insuring forest property in Idaho.

This schedule is not applicable to the portion of the ponderosa pine region lying in California. All California protection is to be graded by the schedule developed for use in that State alone.

Standards

GENERAL STRENGTH: For full credit a district should be under the immediate direction of the State forester; or, if administered by an association, not less than 50 percent of the forest property in the district should be voluntarily protected through association membership. Not over 10 percent of the forest property in the district should be delinquent in the payment of property taxes. The independent financial resources of the association members and other forest owners in the district should be given consideration.

Full credit can also be given for protection furnished directly by the Forest Service through cooperative agreement, provided, in the inspector's judgment, the standard maintained so warrants. This involves a favorable location of the forest headquarters with respect to transportation, communication, and the procuring of emergency help. (See schedule for grading forest protection in California.) There must be an adequate fire plan applying to private lands as well as national-forest lands, together with means of carrying out the provision of the plan effectively.

DETECTION: For full credit for detection all points in the district should be within 12 miles of an official lookout station reporting all fires to district headquarters. Partial credit may be given for daily patrols and/or proximity to occupied dwellings with telephones.

COMMUNICATION: Dependable telephone service is required from district headquarters to all members of the force and lookout stations, to all parts of the district, and to the nearest national-forest headquarters. Condition, as well as completeness, to be considered.

TRANSPORTATION: Not less than 50 percent of the area of the district should be within 1 mile of a road or trail. Each member of the force should be equipped with means of transportation suitable to his unit and duties. There should be, at district headquarters, cars or trucks, or both, with an aggregate capacity of not less than 15 men, with the customary equipment and tools. Consideration should be given, where of importance, to the availability of pack animals and equipment, including number and amount, condition, and other uses with respect to probable quick availability for fire work.

FIRE-FIGHTING EQUIPMENT: The requirement is an adequate supply of hand tools and equipment, maintained in serviceable condition, and so located as to be of maximum utility and mobility. Tools and equipment should be of types adaptable to conditions in the district and in such quantity as will fully equip crews locally available.

MANPOWER: The standard of manpower is based on the extraordinary, not the average, condition encountered. In grading manpower for strength (permanent force and emergency help) the inspector should keep in mind the question whether there seems to be strength and organization for peak loads (i. e., a string of simultaneous lightning or incendiary fires) and/or to cope with weather conditions favoring rapid development of fires.

PERFORMANCE: This factor is indicated by the fire records of past years. A fast start implies actually getting a suppression crew under way within 10 minutes of receipt of report of fire. A strong start implies a proper ratio between the number of men and amount of equipment sent and the condition of advancement of the fire when reported. Standard suppression implies

absolute control of not less than 95 percent of all fires by 10 a. m. the following day. Standard mopping up implies staying with fires after control is established and making strong effort at complete extinction. Complete records of all fires are required.

LAW ENFORCEMENT: A successful effort at obtaining satisfactory compliance with existing forest fire codes in all portions of the district is expected.

Grading

Grade according to standards, giving full credit only where requirements are fully complied with.

_____ district, State of _____

Area protected _____ Area merchantable timber _____
Area cut over _____ Area in association _____
Area on tax roll _____ Delinquent _____
Area administered directly by State forester _____
Area administered by United States Forest Service _____

	Percent
1. GENERAL FINANCIAL AND ADMINISTRATIVE STRENGTH	10
Of association districts:	
Percent of area on tax roll ____ }	
Percent of area delinquent ____ }	5
Probable support from parent organization	2½
Independent financial resources	2½
Of State forester districts (and districts protected by the United States Forest Service):	
Equipment	5
Personnel (second line of defense)[a]	2½
Performance	2½

NOTE.—Performance under this head, in the case of Forest Service protection, relates to the fire history of the national forest as a whole. In State forester districts it relates to the district.

2. PLANT	35
(*a*) DETECTION	15
Percent of area less than 12 miles from lookout ____.	
12 to 20 miles ____. Seen by daily patrols ____.	
Within 1 mile of occupied dwelling with phone ____.	
NOTE.—Give only one-fifth credit to 12- to 20-mile distances from lookouts, for daily patrol and/or dwelling.	
(*b*) COMMUNICATION	5
Use thoroughly adequate and reliable telephone system as standard.	
(*c*) TRANSPORTATION	5
____ percent of area within 1 mile of road.	
____ percent of area within 1 mile of trail.	
Cars available to individual guards. Number ____.	
Cars or trucks at headquarters. Number ____.	
Pack animals. Number ____.	
NOTE.—It should be possible to reach one-half of fires within 1 hour, next one-fourth of fires within 2 hours, but, in general, credit for trails should not exceed one-fifth of that given roads passable by autos.	
(*d*) FIRE-FIGHTING EQUIPMENT	10
Suitable hand tools in good condition for each member of force	1
Caches promptly available for any ordinary emergency	6
Made up in units to facilitate packing	1
Camp outfits promptly available	1
Pumps, etc., promptly available	1
Fully equipped with 1,500 feet of standard-grade hose. One pump per 250,000 acres is standard.	
NOTE.—Pump credit not given if, in inspector's judgment, the district is insufficiently watered.	

[a] The personnel backing up the local force on large fires, i. e., representatives of the State forester or the national-forest supervisor.

	Percent
3. MANPOWER—PERMANENT FORCE	25
Number of acres per man	3
One man per 15,000 acres is standard.	
Organized sawmill, woods, trail crews available	4
Good local help available	3
Members of force graded individually	15
Physical fitness, one-half.	
General fitness, one-half.	
Intelligence.	
Experience.	
Warden (or district ranger) graded according to general fitness as fire fighter. Warden's grading is weighted to equal one-third of total.	
4. PERFORMANCE	25
Fast, strong start	10
Prosecution	10
Mopping up	4
Records satisfactory	1
5. LAW ENFORCEMENT	5

Classification:

Districts grading from 85 to 100 percent shall be designated as class 1.

Districts grading from 70 to 84 percent shall be designated as class 2.

Districts grading from 55 to 69 percent shall be designated as class 3.

Districts grading less than 55 percent shall be designated as class 4.

IN THE CALIFORNIA SUGAR PINE–PONDEROSA PINE AND REDWOOD REGIONS

There is in California a considerable aggregate of land the protection of which is administered by the State under the jurisdiction of the State forester. Only a very small portion of this, however, is commercial forest land to which fire insurance is likely to be applied. The State forest fire protective agency is consequently not so well organized in California as are the corresponding organizations in Oregon and Washington. Furthermore, the State law is less vigorous in its application to commercial forest areas.

More or less fortuitously, because of the existing ownership distribution, the practice has become established of turning the protection of private lands over to the Forest Service for administration. The consequence of this is that in California standard protection is inevitably Forest Service protection. Nevertheless, variations exist in the absolute values of the protection afforded different areas, and a system of grading is needed.

Following is a proposed schedule for grading protection in the sugar pine region, devised in collaboration with J. H. Price:

Schedule for Grading Forest Fire Protection in California

This schedule is to be applied in or near the national forests and/or to properties the actual protection of which is administered by the United States Forest Service. Grading is by ranger districts, maps of which must be provided showing exact boundaries, township, range, and section lines. All properties within a ranger district grade equally provided policies include warranties that protection will be administered by the Forest Service. All policies not carrying such warranties will take the class 4 protection deficiency charge.

Standards

FOREST HEADQUARTERS: For full credit forest headquarters must be so located that second line of defense[9] action can be readily thrown into the district. There must be an adequate fire plan for the whole forest and sufficient personnel of the proper type, together with transportation equipment, and tools and other equipment, for the effective execution of the plan.

The inspector should bear in mind that on some forests second-line-of-defense equipment may be more advantageously kept at ranger stations than at forest headquarters but that the total amount available affects all districts. Local emergency help must be available at or near forest headquarters. The chief consideration is the intelligence with which the general fire plan for the forest is conceived, the ability of the force to put it into action, and the adequacy and arrangement of the equipment. The fire records of the past 10 years must disclose no indication of deficient conception or application of the general fire plan.

DETECTION: For full credit for detection all points in the district should be within 12 miles of an official lookout station. Partial credit may be given for daily patrols and/or proximity to occupied dwellings with telephones.

COMMUNICATION: Dependable telephone service is required from the district ranger to all members of the force and lookout stations, to all parts of the district, and to forest headquarters. Conditions as well as completeness are to be considered.

TRANSPORTATION: Not less than 50 percent of the area of the district should be within 1 mile of a road or trail. Each member of the force should be equipped with means of transportation suitable to his unit and duties. There should be, at the ranger station, cars or trucks, or both, with an aggregate capacity of not less than 15 men with the customary equipment and tools. Consideration should be given to the availability of pack animals and equipment, including number and amount, condition, and other uses with respect to probable quick availability for fire work.

FIRE-FIGHTING EQUIPMENT: The requirement is an adequate supply of hand tools and equipment, maintained in serviceable condition, and so located as to be of maximum utility and mobility. Tools and equipment should be of types adaptable to conditions in the district and in such quantity as will fully equip crews locally available.

MANPOWER: The standard of manpower is based on the extraordinary, not the average, condition encountered. In grading manpower for strength (permanent force and emergency help), the inspector should keep in mind the question whether there seem to be strength and organization for peak loads, i. e., a string of simultaneous lightning or incendiary fires, and/or to cope with weather conditions favoring rapid development of fires.

PERFORMANCE: This factor is indicated by the fire records of past years. A fast start implies actually getting a suppression crew under way within 10 minutes of receipt of report of fire. A strong start implies a proper ratio between the number of men and amount of equipment sent and the condition of advancement of the fire when reported. Standard suppression implies absolute control of not less than 95 percent of all fires by 10 a. m. the following day. Standard mopping up implies staying with fires after control is established and making strong effort at complete extinction. Complete records of all fires are required.

LAW ENFORCEMENT: A successful effort at obtaining satisfactory compliance with existing forest fire codes in all portions of the district is expected.

Grading

Grade according to standards, giving full credit only where requirements are fully complied with.

_____ district, area protected (public and private lands) _____
Area merchantable timber_____. Area cut over _____
Area under Forest Service protection (public and private) _____

[9] Support on large fires from the forest headquarters.

Percent

1. GENERAL ADMINISTRATIVE STRENGTH OF NATIONAL FOREST 10
   - (*a*) Equipment 5
   - (*b*) Personnel 2½
   - (*c*) Performance 2½

NOTE.—Performance under this head relates to the fire history of the forest as a whole.

2. PLANT 35
   - (*a*) DETECTION 15
     - Percent of area less than 12 miles from lookout ____
     - 12 to 20 miles ____. Seen by daily patrols ____
     - Within 1 miles of occupied dwelling with phone ____

NOTE.—Give only one-fifth credit to 12- to 20-mile distance from lookouts, for daily patrol and/or dwelling.

   - (*b*) COMMUNICATION 5
     - Use thoroughly adequate and reliable telephone system as standard.
   - (*c*) TRANSPORTATION 5
     - ____ percent of area within 1 mile of road.
     - ____ percent of area within 1 mile of trail.
     - Cars available to individual guards. Number, ____.
     - Cars or trucks at ranger station. Number, ____.
     - Pack animals. Number, ____.

NOTE.—It should be possible to reach one-half of fires within 1 hour, next one-fourth of fires within 2 hours; but, in general, credit for trails should not exceed one-fifth of that given roads passable by autos.

   - (*d*) FIRE-FIGHTING EQUIPMENT 10
     - Suitable hand tools in good condition for each member of force 1
     - Caches promptly available for any ordinary emergency 6
     - Made up in units to facilitate packing 1
     - Camp outfits promptly available 1
     - Pumps, etc., promptly available 1
     - Fully equipped with 1,500 feet of standard grade hose.
     - One pump per 250,000 acres is standard.

NOTE.—Pump credit not given if, in inspector's judgment, the district is insufficiently watered.

3. MANPOWER—PERMANENT FORCES 25
   - Number of acres per man 3
     - One man per 15,000 acres is standard.
   - Organized sawmill, woods, trail crews available 4
   - Good local help available 3
   - Members of force graded individually 15
     - Physical fitness, one-half.
     - General fitness, one-half.
       - Intelligence.
       - Experience.
     - Ranger graded according to general fitness for job as fire fighter.
     - Ranger's grading is weighted to equal one-third of total.

4. PERFORMANCE 25
   - Fast, strong start 10
   - Prosecution 10
   - Mopping up 4
   - Records satisfactory 1

5. LAW ENFORCEMENT 5

Classification:

- Districts grading from 85 to 100 percent shall be designated as class 1.
- Districts grading from 70 to 84 percent shall be designated as class 2.
- Districts grading from 55 to 69 percent shall be designated as class 3.
- Districts grading less than 55 percent shall be designated as class 4.

This schedule, as indicated, is based on the assumption of protection administration by the Forest Service, and properties on which this protection is not given are automatically classified in the lowest grade. If property is protected privately, the measure of the value must be arrived at separately and other factors must be taken into consideration.

The underwriter, once a district is graded and provision for a public protection warranty made, can more or less forget it. The protection will be supplied automatically or the policy will be voided. Where underwriting is to be done on the strength of private protection alone, however, a less dependable condition prevails, the measurement of value is less susceptible to standardization, and more safeguards in the form of warranties and inspections are required. Because, also, of the possible influence of moral hazard, the acceptance of liability might in some cases be refused where no protection of other than this sort was furnished.

Changes in the proposed California schedule from the schedule for the Douglas fir region mainly concern differences in physical conditions. Visibilities through the fire season are believed, for example, to be better, on the average, in California than in most of the Douglas fir region. Detection is also given a higher rating in the total point accumulation in California than it is given in the Douglas fir region. All these provisions are, of course, merely suggestive for the present and are subject to change on the basis of actual experience.

There will be no occasion for the application of this schedule to the redwood region, since no national forests are sufficiently close to encourage the practice of Forest Service protection. By the method proposed above, all forest property in the redwood region takes the charge for class 4 protection. This is believed to be entirely equitable. On an absolute basis, protection in the redwood region is graded as generally deficient, though on a relative basis it may perhaps compare not unfavorably with the protection afforded the other forested portions of the State. It is recognized that the climatic hazard is less severe in the coastal belt occupied by the redwood region, so that approximately equal final results are possible with less aggressive protective effort. This is not meant to imply, however, that protection is as good in the redwood region as it should be (*3*).

Underwriting and rating in the redwood region will have to be done, for the present, at least, on the basis of special warranties and a system of closer inspection and supervision of protection similar to the method used in the insuring of improved risks in manufacture where credits are given in the rates for private protection features.

PRIVATE PROTECTION

It has been suggested that in certain cases all protection, other than that supplied by the Forest Service be automatically graded as class 4. Recognition is, however, made of the desirability of providing for credit for other forms of protection where, possibly, the net result is better than that contemplated under the best of class 4 protection.

To provide for this a warranty somewhat along the following lines might be used, which, if incorporated in the policy, would carry with it a proper rate reduction:

Protection Warranty

This policy being written at a reduced rate based on the protection of the premises by an organization with supervisory service, personnel, equipment, and transportation system under the jurisdiction of (name of association or company) according to the following description: (Description of lookout system, telephone system, roads, patrols, wardens, and permanent force, tools, pumps, trucks, autos, and pack animals, and other pertinent features), it is a condition of this policy that due diligence shall be used by the insured to maintain this organization in complete working order at all times within April 1 and November 1 and that no change shall be made in said organization, equipment, or system without the consent in writing of this company.

Obviously, if underwriting and rating are to be based on the use of such warranties, greater general care must be exercised than where protection of a more public nature is afforded. In the first place, more careful attention must be given to the standing of the assured with respect to his reputation for integrity and moral responsibility, his business ability, and his financial standing. Where undue moral hazard might exist it would not, of course, be possible to supply insurance on the strength of this kind of protection; the principle that no one is insurable who prefers to have a fire is of prime importance.

It is also possible that in some cases where public protection is supplied it may be supplemented by protection administered privately, with the net effect of raising the protection value. Where this is the case the owner is equitably entitled to a reduction in his rate. The above warranty, or a similar one especially designed to fit the case, could be used as a basis for such a reduction. In this case also it would be necessary to exercise somewhat greater care than where no such concession was given, but the supervision by the insurer could be less strict than where the protection is wholly private.

The written permission to make a change, for which provision is made in the warranty, is, in this case, concerned mainly with the definition of the actual fire season of any specific year. The warranty must, of course, call for the maintenance of the full strength of the protective organization throughout the nominal fire season. If the real fire season begins later or ends earlier, active protection might conform to the shorter season, but the underwriter must know what is being done and must have authority to enforce the maintenance of conditions which carry out the spirit of the contract. In the spring, permission to go without protection can be granted for successive 10-day periods, say, until in the underwriter's judgment the fire season has started or is about to start. Usually, in the fall, one permit would suffice for the closing of the season.

THE CAUSATIVE FOREST FIRE HAZARDS

As has been stated, the influence of a causative agent is finished the moment that fire has been transmitted to the forest fuels. An agency assumes importance as a hazard according to the number of fires it starts. The technique of practice in the rating of causative

hazards is the same as for all other hazards; that is, it consists essentially of the establishment of a standard condition for which no specific charge is made, with provision for charges expressing the increase in hazard introduced by the action of specified hazard factors. The standard is the condition under which causative activity is at the minimum.

The inquiry into causative hazards was made through study of the original individual fire reports furnished by the wardens and rangers who fought the fires. While these may not always be accurate with respect to any given fire, nevertheless a large volume of data so produced is actuarially acceptable in such a study as this. Because of the work involved in analyzing all the fires in a region, data from selected counties only were used. The following discussion of causative hazard in the fir region illustrates the general principles involved and the technique of approach and study.

IN THE DOUGLAS FIR REGION

Detailed study in selected counties in the Douglas fir region for the 10-year period 1921–30 involved data on 4,268 fires, undoubtedly a sufficiently wide statistical base.

The individual fire reports assign as causes a wide variety of specific agents. This range was narrowed by grouping the causes having similar characteristics into classes of major importance. The following classes of causes were adopted for the purpose of forest fire hazard rating in the Douglas fir region: Railroads, lightning, recreation, ranchers, lumbering (logging), incendiary, and miscellaneous and unknown.

Railroad fires are those caused by common-carrier lines. Logging-railroad fires are charged to lumbering.

Recreation includes all forms of recreational entry and use of forest areas such as camping, smoking not otherwise classified, picnicking, hunting, fishing, and berry picking.

Rancher fires are those that result from the adjacency of agricultural development to forest land. Most rancher fires result from the escape of brush- and debris-burning fires but may be caused by the burning of buildings or other accidental fire occurrence.

Lumbering fires include those emanating from logging or lumbering operations, however they originate. The fires may start from intentional slash burning, from woods sawmills, or from a wide variety of intermediate causes.

Incendiary fires are, as the word implies, deliberately set with the hope that they will burn over more or less forest land. A variety of incentives accounts for this, among which may be a grudge against the owner, hope of improving grazing or berry production, hope of employment in the fire-fighting crew, or merely a belief that the forest itself is improved by being burned over. This last incentive approaches very closely the controversial question of light burning, so-called. Light burning is not approved for Pacific coast forests by the Forest Service.

Of all of the incentives to incendiarism, that of providing work for fire fighters is the most important to forest insurance because of the greater number of fires resulting from it and the fact that areas that combine timber value with difficult fire-suppression conditions

are most likely to be selected. This problem is one with which the protection organizations are contending vigorously, and reduction in the seriousness of its consequences can reasonably be hoped for.

Distinction between individual properties in relation to any one causative hazard can only be made when the causative agent can be allocated geographically with regard to the hazard. This study of causative hazard is accordingly essentially a map study.

The technique of this phase therefore involved first the indicating on suitable maps of the selected counties the locations of the forest areas being studied. The next step was to plot all of the fires by exact location, extent, and cause as indicated by the individual fire reports for the 10-year period studied. Causes were all grouped so as to come into one of the seven classes indicated.

No correlation can be established between location and the occurrence of fires from incendiarism and miscellaneous and unknown causes, and these causes have accordingly been taken as basic. Areas subject to fires from other causes must pay additional premium charges in proportion to the apparent increase in hazard.

Railroad, ranchers', and lumbering fires can only occur in forests adjacent to land occupied by railroads, ranches, or lumbering operations. It is accordingly a simple matter to segregate fires from these causes geographically. The only question relates to the distance from the agency within which practical considerations demand allowance for the increase in hazard. This distance varies between agencies. Correlations were statistically established for one-half mile, supplemented by rationalized differentiation for distances from one-quarter mile to, in the case of lumbering, a full mile.

Lightning and recreation cannot be so easily allocated. The method adopted with respect to these hazards was, therefore, an attempt to determine whether their occurrence was sufficiently localized that separate hazard zones could be delineated for them. If such zones could not be determined, these two causes would have to be thrown in with incendiarism and miscellaneous as basic causes applying equally to all properties. By making separate maps showing the locations of fires from these causes, however, it was found that it was perfectly feasible, in every county studied, to designate recreation zones and, in the counties where lightning had been a cause of any importance, to designate zones of its occurrence.

The mapping of the fires brought out, however, one additional correlation very strongly and indicated plainly that it could not be ignored in practical hazard rating. This was the heavy preponderance of fires near roads on which travel is reasonably easy and which indicated clearly that there is a material increase in the causative hazard in forests so located. Here again it appeared advisable to designate one-half mile as the distance to which practical recognition of this hazard increase should be carried. This imposed the necessity of making maps on which were shown the zones of forest land lying within one-half mile of all roads on which automobile travel is at all practicable and plotting on them all the man-caused fires.

Since causative hazard is a function of the number of fires in relation to area, it was necessary to determine, in the case of each specific causative hazard, the area within and the area outside of its zone of operation. This is easy in the cases of the recreation, light-

ning, railroad, and automobile-road zones. All that was necessary was to planimeter them and the whole privately owned forest area. The rancher zone had to be indicated by drawing a line on the map one-half mile outside of all agricultural and forest margins. This was an involved process, but when it was done it was a simple matter to planimeter the area indicated. The maps made in connection with the work of the forest survey were of great help in all of this causative-hazard analysis work.

Lumbering operations are not so easily located, since they are continually shifting, and nobody can say with accuracy how large a zone they expose at any one time or in the average. An approximate estimate, arrived at by a deductive process, is the best that can be obtained. Statistics available from the forest survey and other sources indicated the average area logged annually in the counties selected for intensive study in this phase of the inquiry. This information provided a starting point for the deductive process.

First, the half-mile strip of forest land immediately adjacent to the logging operation was adopted as the area subject to direct charge for exposure to the logging hazard. This complied with the practice already established for the other causative agencies. A little study, however, clearly brought out the observation that differences in logging lay-outs make a great deal of difference in the area directly exposed. Simultaneous operations on 16 separate forties, for example, give direct exposure to a much larger area of surrounding land than one single operation removing the timber from an individual section. Similarly, an operation which runs in long, narrow strips exposes a greater area than one which covers an equal but more compact area. Depending on whether an operation on a single section exposes damageable growth on one, two, or three sides, it can expose from 0.9 square miles to 2.3 square miles within the surrounding half-mile strip. It is improbable that very many operations expose growth on all four sides. At least one side has usually been cut previously.

Making allowance for the irregular shape of most operations and the fact that some are conducted at least part of the time in disconnected and smaller units, a 3-to-1 ratio straight through would appear to be entirely reasonable although utterly impossible to check. That is, for every unit of area cut over, three units would be assumed to be exposed directly to logging hazard. Averaging usable records of the areas cut each year in the region during the period being studied and multiplying by three gives in this way an approximate figure for exposure to lumbering hazard.

When the number of fires caused by a specific agency is known, as well as the area of the zone in which it operates, the increase in the hazard resulting from it can be computed through use of a specially developed formula. The figure desired is the percentage by which the specific agency increases the hazard over and above the hazard from the basic causes. Weight must be given not only to the number of fires but also to the area affected.

Let—

r=the area of the whole region under consideration,
z=the area of the zone of influence of the specific cause,
N_r=the number of basic fires in the region,
N_z=the number of fires resulting from the specific cause,

then—

$100\frac{rN_z}{zN_r}$ =the additional hazard in percent. (The percent by which the hazard is increased within the zone through the influence of the specific cause.)

To take a hypothetical case for illustration, assume that a total forested area is 2,765 square miles. The reports attribute 21 fires per year to basic causes (incendiary and miscellaneous and unknown) for the whole region. The reports also charge recreation (all forms) with an average of 36 fires per year. Study of the occurrence map, however, discloses that a zone can be described that contains practically all of these recreation fires (90 percent or more). This area is delineated as the recreation zone and is planimetered. It is found to contain 1,196 square miles.

The formula values then are:

r=2,765
z=1,196
N_r=21
N_z=36

The additional hazard within the recreation zone then is:

$$100\times\frac{2{,}765\times36}{1{,}196\times21}$$

Solving gives 396.3 percent as the increase in the inception hazard within the recreation zone arising from recreational entry and use. In this particular case fire would be very nearly five times as likely to occur in the recreation zone as in the portion of the region subject only to fires from basic causes.

It has been stated that the number of fires caused by a specific agency is a true measure of hazard. There is one major exception to this rule that must be made in rating forest-fire hazard.. Damage is the ultimate measure of hazard, and any accessory factor must be allowed for. Salvage is an extremely important accessory factor in lumbering or logging fires. If a logging operation can start fires, it can usually be counted on to effect salvage to a very considerable extent. This implies that the causative influence of logging fires should be discounted, and the suggested charge in the proposed schedule has been so computed. This applies, of course, only to classes A and B (timber of merchantable size). Where second growth and reproduction are exposed to the inception hazard of logging, they take the full charge indicated by the formula.

The presence of railroads, ranches, and/or automobile roads can also always be taken as evidence of an increased likelihood that salvage will be effected. The charges for these hazards to timber of merchantable size are accordingly properly discounted below those for unmerchantable timber and/or for merchantable timber possessing no known differential advantage in this respect.

IN THE PONDEROSA PINE REGION

The causative-hazard phase in the ponderosa pine region did not differ at all in principle from that in the Douglas fir region. The only differences in detail that were introduced were: (1) The addition of another general cause, stockmen, and (2) the designation of two classes of automobile roads, primary and secondary. This latter break-down was indicated in the pine region because of the greater mileage there of entirely unimproved road on which auto travel during the fire season is very easy and comfortable. Since travel on these unimproved roads undoubtedly differs widely in volume and kind from that on the primary routes, it was believed desirable to determine whether or not distinct correlations exist which would indicate the need of differences in the schedule charges for exposure, as between the two classes of road.

Figure 15 shows the counties that were selected for use in the causative-hazard study of the region. The county, in its entirety, was made the unit for study, and all fires, whether on national-forest or private land, were included. This was made possible by the fact that the Forest Service fire reports always show the county in which the fire occurred. In this phase, as in the whole of this regional study, no attention was paid to the Indian reservations.

Confining the detailed study entirely to Oregon, which might at first thought appear to be inequitable, was justified by some general analyses of cause percentages in other portions of the region. These indicated clearly that such differences as may exist are so slight and so well within the limits of inevitable error that any further extension of this phase would go beyond the point of diminishing returns.

This phase in the pine region embraced the classification of the causes of 3,245 separate fires, covering a 10-year period in the four counties studied. There is little question but that a statistical base sufficiently wide for the purposes of the study is thus furnished.

Lightning causes approximately half the total number of fires in the pine region, and its influence from an insurance point of view is uniform. That is, no zones are discernible on the occurrence maps in which lightning is a more important cause than it is elsewhere. A study of the occurrence map with respect to stockmen's fires also reveals that there are no special zones of activity of this cause. In the pine region, therefore, these two causes must be combined with incendiarism and miscellaneous and unknown as basic causes for which allowance is made only in the basis rate.

IN THE SUGAR PINE–PONDEROSA PINE REGION

As has been said, the ponderosa pine and sugar pine regions are definitely similar. All evidence points away from the likelihood that the necessity for any modifications would be indicated by a study of causative hazards in the sugar pine region as contrasted to the findings of the same study in the ponderosa pine region. This assumption was supported by men in California who were interviewed on this subject.

It seemed apparent, therefore, that any detailed study of human causative hazards in the sugar pine region alone was unwarranted by the existing conditions. Accordingly, no work has been done there

and causative hazard charges worked out for the schedule of rates for the ponderosa pine region will be applied without change in the sugar pine region.

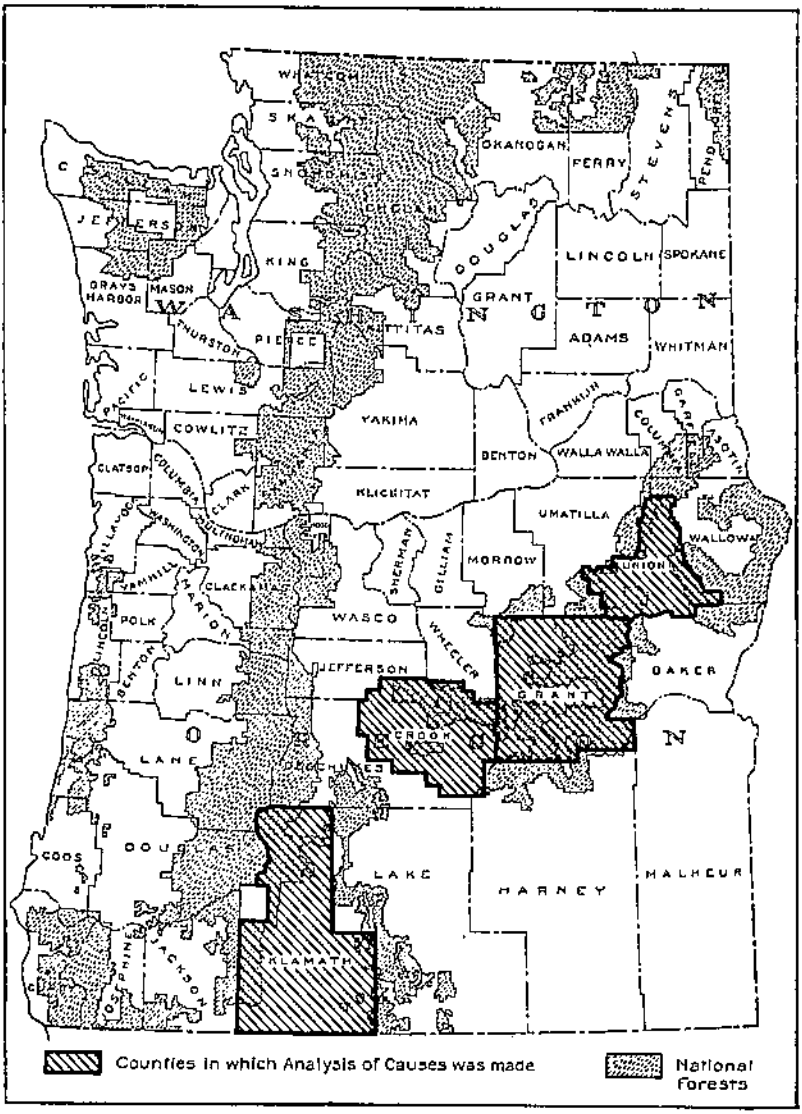


FIGURE 15.—Counties in the ponderosa pine region in which analysis of fire causes was made.

Study of the excellent fire record maps kept by the office of region 5 (the California region) of the Forest Service indicated plainly that differentiation is required in the sugar pine region with respect to lightning hazard.

Figure 16 shows the areas in which lightning fires occurred during the decade beginning with 1921 as a basis for designating the portion of the region to which a charge for lightning hazard will be applied. The exact manner of application is described in the discussion of construction of the rating schedule.

As in the other two regions, incendiarism will be taken as a basic cause for rate-schedule purposes and the underwriter will have to know specifically the localities in which incendiarism may make the writing of forest fire insurance prohibitive. For this purpose very good information will be obtained from the fire-record maps at the Forest Service region 5 office. The occurence of incendiary fires is shown by zones in the same manner as the occurrence of lightning fires is shown in figure 16.

There is some possibility that differentiation should be made in the charges for the causative hazard introduced by logging to allow for different methods and different types of equipment. In this connection a very good statistical record has been obtained from S. Rexford Black, secretary of the California Forest Protective Association. This is the composite logging-fire experience of the member companies of this association for the period 1926 to 1932, inclusive, giving in detail the exact number of fires caused by individual activities and items of logging equipment. These data have been used in the rating schedules for all three regions as a basis for credit allowances where logging hazard is reduced through the use of less hazardous machinery and equipment.

THE CONFLAGRATION HAZARD

In forest fire insurance, as in fire insurance for other forms of property, there will be difficulty in expressing a precise definition of a conflagration. In cities and towns it might be said that any fire that involves two or more separate buildings is a conflagration, but little practical use could be made of such a distinction. The wiping out of a whole country town could result in a loss that would be insignificant compared to the destruction of even two large buildings and their contents in the high-value district of a city. Similarly a 100,000-acre fire in some forest areas might cause less monetary loss than a 5,000-acre fire in others. The only criterion that is of any practical use for insurance purposes is the financial loss of sound insurable value.

Generally speaking, fires can be satisfactorily classified under three designations: Ordinary fires, minor conflagrations, and major conflagrations. Specific distinctions are, however, difficult to make where forest fires or fires in improved property are being considered. Major conflagrations certainly, and minor conflagrations possibly, convey the implications of public calamities. Ordinary fires are often serious from the public's point of view, but are not usually considered calamitous. Neither are ordinary fires calamities for the insurance carriers, whereas great conflagrations have, in times past, subjected them to very serious strains.

There have been, in the course of the history of this country, a number of great city fires the insurance losses from which have run to enormous figures. It is obvious that these losses have not been met out of the premiums collected in the cities in which the conflagrations occurred or even in the States in which the cities were

located. The payment of losses from these conflagrations has affected premium collections over the whole country, as it very properly should, since no city or State is free from the danger of suffering such a loss itself. Asking California, for example, to carry the

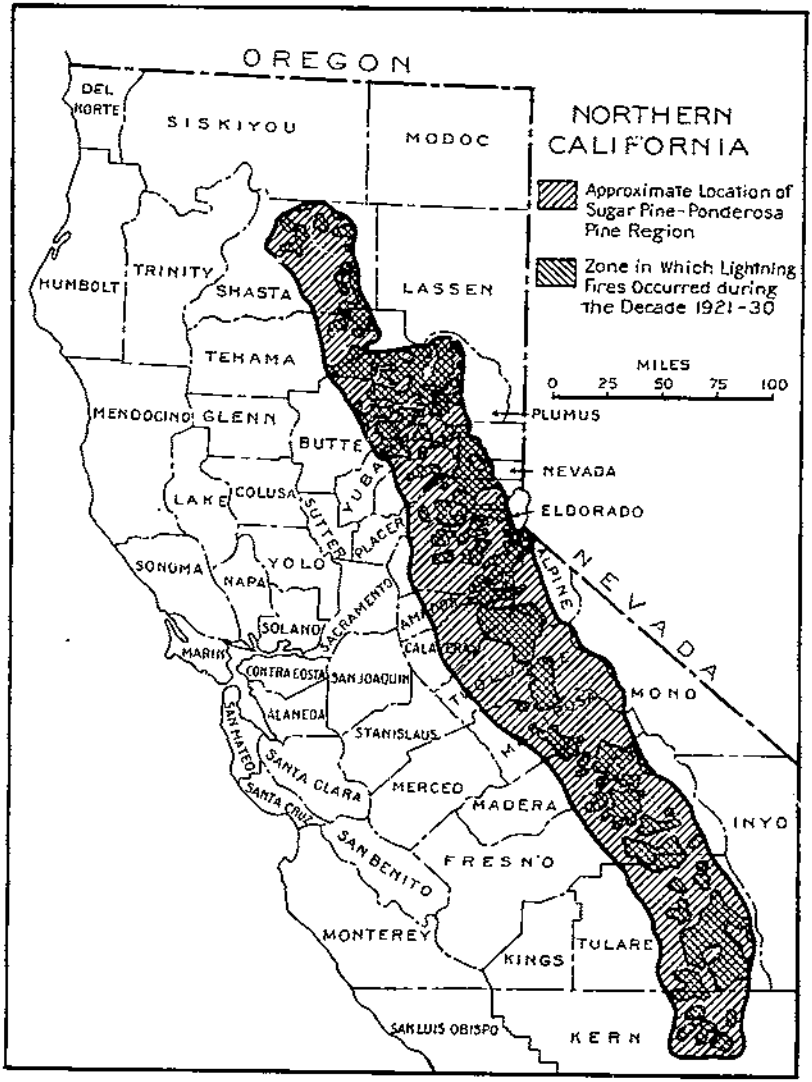


FIGURE 16.—Lightning fire occurrence in the sugar pine-ponderosa pine region of northern California, 1921–30.

whole burden of the San Francisco fire would create a rate level there for a long period of years that would constitute an inequitable burden.

The continuance of conditions favorable to the development of a conflagration justifies higher rates. The condition should be cor-

rected. Conflagrations may suddenly develop, however, in communities with good previous fire records and with no worse than average conflagration hazards. Since nobody can tell where this may occur, it is logical to extend the insurance principle of widespread contribution to include this possibility also. Richards (*12*) made the suggestion that if any single loss in any given State exceeds 10 percent of its annual premiums, such sum should be distributed between all the States in proportion to their premium income.

On general principles it is reasonable to suppose that some provision for country-wide distribution of conflagration cost will be desirable in forest fire insurance. Equitable allocation will depend on relative amounts of premium produced and actual conflagration hazards incurred.

IN THE DOUGLAS FIR REGION

The statistical data on which the study of losses in the Douglas fir region is based include all types of fires occurring during the period studied. Some of the larger fires could very properly be termed minor conflagrations, having covered areas of 25,000 to 30,000 acres. The estimated loss cost of 0.047 percent (p. 166) includes the net losses from all of these larger fires. No attempt has accordingly been made in this study to distinguish between ordinary fires and minor conflagrations. It appears that in the long run fires that could more properly be termed "minor conflagrations" will make up the bulk of the ordinary loss ratio, which will, consequently, show more annual variation than fire underwriters have become accustomed to in other forms of cover.

The summer of 1933 furnished conclusive proof that there is in the region a definite hazard from what can be called major conflagrations in every sense of the word. The Tillamook fire is estimated to have covered a total area of 244,706 acres of forest land and to have killed 10,257,500,000 feet b. m. of merchantable timber. Such a fire in the forests of the country is comparable to a Baltimore or Chelsea fire in the cities. Were it not for salvage probabilities it would be nearly comparable to the San Francisco fire. Even after all probable salvage, this one fire will have caused a loss in excess of twice the aggregate from all of the fires in the region for the previous 20 years.

The fact that such a conflagration can occur, particularly under present-day conditions, is of great significance to forest fire insurance. It raises acutely the questions whether this is a fair sample of the worst, and how often such catastrophes are likely to occur, questions on which only the past history of major conflagrations in the region can throw light. Unfortunately such records are fragmentary. The last previous conflagration year was 1902 and prior to that, apparently, about 1868. Recently, therefore, the major-conflagration interval has been approximately 30 years.

Following the Tillamook conflagration, William G. Morris, junior forester, Pacific Northwest Forest Experiment Station, conducted a comprehensive study of major conflagrations in the Douglas fir region, exhausting all obtainable sources of information. His conclusions, informally stated, are somewhat as given in table 10.

TABLE 10.—*Estimated major conflagrations in the Douglas fir region, 1840–1933*

Year	Name of fire	Estimated area burned	Year	Name of fire	Estimated area burned
		Acres			*Acres*
1840 [1]	Nestucca	380, 000	1902	Yacolt	430, 000
1849 [1]	Yaquina	800, 000		Columbia	170, 000
1868 [1]	Coos	300, 000	1933	Tillamook	240, 000
	Silverton	225, 000			

[1] Approximate.

Morris (*8*) speaks emphatically of the difficulty of ascertaining the truth about the great fires of the early days. The obscure records do not indicate accurately the times, locations, or extents of damage of early great fires. It is clear that many of them were the direct result of public indifference and lack of organized protection. Morris believes that several of the fires listed above as individual fires were, in fact, groups of smaller fires sometimes not even joining.

The Tillamook fire was, however, a major conflagration, in every sense, that occurred in spite of organized protection and developed from a single small fire. It proves incontrovertibly that forest fire insurance in the Douglas fir region must take major conflagration hazard into account.

At least three of these conflagrations were confined mainly to what is now national-forest land, and the national forests of the region must inevitably be considered as absorbing some of the major conflagration hazard in the region today. This inquiry is only interested in the conflagration hazard in the privately owned portion. The list actually narrows down to the Nestucca, Yaquina, Silverton, and Tillamook fires, which have together accounted for the burning of approximately 1,650,000 acres.

This means that unless another conflagration occurs meanwhile, the 100-year period 1840 to 1940 has produced at least four of these major conflagrations damaging mainly privately owned forest.

It could be argued that the development of modern forest fire protection decreases the probability of these major conflagrations and that some allowance should be made for this. Unfortunately the Tillamook fire undermines this theory for practical insurance purposes. No forest fire insurance project which did not make provision for meeting a major conflagration hazard would be likely to succeed in the long run.

The author's suggestion, incorporated in the rating schedule, is that the premium payment for major conflagration reserve should be predicated on an annual accumulation of $500,000 for the region as a whole during, at least, the first 10 years. What would be done thereafter would depend on the amount of business that had been done, the value of the reserve in proportion to the total liability at the time (a function of the rate of growth of the business), a survey of the existing conflagration hazard, and other factors.

This conclusion is drawn from an interpretation of the region's conflagration history as it has been portrayed above. The expectation is something like a $10,000,000 gross-loss fire every 20 to 25 years. No premium loading less than that suggested for this factor

could be justified as sound, particularly since the next great fire might come in less than 20 years.

The suggestion made by this study departs entirely, however, from the conception of conflagration reserve accumulation indicated in the general discussion of conflagration hazard. It does not spread it over other forest regions but puts the whole loading into the Douglas fir region. This suggestion is prompted by two considerations. The two pine regions also covered by this progress report have been practically free from destructive major conflagrations throughout their histories and ought not, therefore, to be penalized for this contingency as a contribution to the fir region. The Douglas fir region itself is, moreover, able to assume the required loading without incurring a prohibitive rate level, because of a relatively lower drain from ordinary fires and minor conflagrations, supplemented by a better salvage probability.

The suggested rate level for the Douglas fir region is accordingly arrived at as follows:

	Cents
Allowance for payment of ordinary losses	4.7
Allowance for business expenses and profits	4.7
Allowance for conflagration reserve	13.8
115-percent safety factor	26.8
Total average rate	50.0

When sufficient experience has been gained through actual practice to show clearly the true influences of some of the factors now unknown, it will be possible to make proper adjustment in the rate structure. An ample reserve for major conflagrations should be maintained, though, for a long period of years to come.

IN THE PONDEROSA PINE REGION

In the northern ponderosa pine region there are no historic records of such conflagrations as in the Douglas fir region, nor is conclusive evidence present on the ground.

It is possible that some of the more extensive stands of practically pure lodgepole pine may, at least in part, be accounted for as a consequence of old fires in the ponderosa pine type, but this is not a definitely established fact.

Consideration of the lightning-fire-occurrence maps makes inevitable the conclusion that burning of the forests in the pine region prior to the advent of organized protection must have been very common. The causative-hazard study indicates an average annual frequency of lightning fires of one per 52.5 square miles. To burn over the country each 10 years, in the average, these fires would have to average 3,360 acres in size. Probably they did not do this. On the other hand, it is known that the Indians caused forest fires both purposely and accidentally, though to what extent in this region there is no way of knowing definitely. On the whole, though, it seems reasonable to suppose that burning may have covered the equivalent of the whole area in 20 to 30 years. This could have been accomplished if the Indians started approximately one-quarter as many fires as did lightning, and the average size of each fire was 1,100 acres, not at all an unlikely contingency, since it is known that the Indians never made any attempts to extinguish forest fires.

In any event, two conclusions are inescapable: Some condition must have prevailed that prevented many fires from being heavily destructive to timber of merchantable size, and traces of past fires observable on the ground today may be the result of repeated burning and not of any single fire.

The observed destructiveness of the average forest fire in the pine region during the period covered by this study is not in harmony with the above considerations; that is, it is arguable that unless fires were, in the main, less destructive to merchantable timber than they have been during the past 10 years there could not possibly be as much or as continuous a stand of merchantable timber as does exist. It is empirically possible to produce a speculative accounting for this apparent contradiction, at least in part. For one thing, the pre-white-man forest contained no logging slash. For another, it is known that the decade immediately past has seen the culmination of the effects of a prolonged dry cycle. Finally, organized protection has produced a condition under which given areas not being burned as frequently as formerly accumulate more inflammable debris, undergrowth, and reproduction, with the result that fires, when they do burn, cause greater destruction to the merchantable trees.

From the above discussion it would seem that the lack of accurate knowledge of past conflagration history in the region is not serious because of the change that has come about in conditions in recent years, a change which is in many respects more fundamental in character in the pine than in the fir region. It was necessary, however, to resort to deductive reasoning and rational speculation in dealing with the conflagration hazard in the pine region to a greater extent, even, than in the fir region.

Such reasoning may go somewhat as follows: With due allowance for unknown variables which make the experience of any decade vary from that of another (which is more properly a function of general contingency), it can be concluded that any difference in the loss is accounted for either by a change in the number of fires or in their average destructiveness. With respect to the number of fires, always bearing in mind that the chief interest here is in the possibility of increases, it appears that since approximately half the fires are from the natural cause of lightning and since no material increase in the population is likely during the next decade, an assumption that the number of fires will not increase greatly is safe enough. The development of major conflagrations because of the influence of an increased number of fires is probably, then, not a serious likelihood.

The average destructiveness of fires is entirely a function of the contributive-hazard factors and is the component of the average sizes of fires and average destruction per unit of area. The final effect is the result of physical conditions, weather, and the protective effort. Any change must, therefore, be the result of changes in one or more of these general factors. In the pine region there can be little doubt but that physical conditions will tend to become worse, mainly because of the timber industry, which continually decreases the proportion of mature forest and replaces it with more hazardous types of cut-over lands and second-growth stands. If any influences are at work which tend to offset this trend they are not at present known. Such trends as appear to be in effect work with rather than against the tendency

for the physical hazard to increase. Among these are the greater amount of advance-growth reproduction that has come in under the mature timber since the acreage burned by lightning fires has been decreased by organized protection.

What the changes may be with respect to the weather influence nobody can tell, and no definite element of practical policy should be based on the possibilities. It may be that the end of a dry cycle has been passed. If this is true some benefits will accrue in the ensuing years, but changes in premium rates on this score must be made after and not before these advantages are realized. While, therefore, the climate does have a definite influence on the conflagration hazard, consideration of it in the present study would be highly inadvisable.

It is without great doubt safe to assume that any change in the status of protection that may take place during the next 10 years will be mainly on the side of improvement. Such influence, therefore, as protection will have on changes in the conflagration hazard can reasonably be expected to be toward diminution. There are, at present at least, no indications that any serious decrease in the effectiveness of protection needs to be feared, in spite of the depression. At the worst, protection may be expected to hold its own.

The evidence, then, tends to support a belief that the physical-hazard condition, as it affects the conflagration hazard, will be somewhat worse in the coming decade than it was in the one just past. The only other known condition on which legitimate speculation might be based is protection, which, as just stated, can probably be relied on to maintain its present degree of efficiency. The best possible rational speculation, then, is that some additional allowance should be made for major conflagration hazard.

In the fir region a $500,000-per-year loading was included in the premium collection to build up a major conflagration reserve. It appears that in the pine region a somewhat different approach is required. The evidence is more obscure. Tentatively, therefore, it is suggested that the average gross rate include a 25-percent allowance for major conflagration reserve.

In addition to this allowance, there must be also an allowance for general contingencies (the factor of safety). The recommendation is that this be set at 50 percent. There is, therefore, in the rate schedule suggested for the ponderosa pine region, a total loading of 75 percent over and above the rate indicated as necessary by the losses actually incurred in toto during the 10-year period studied.

As in the fir region, of course, adjustments would properly be made on the basis of 10 years of actual insurance experience. It is even possible that reserve allowances would be modified after 5 years. Should they prove to be insufficient during a 5-year period, upward revision could be made.

IN THE SUGAR PINE-PONDEROSA PINE REGION

It is apparent that the fire history of the sugar pine region bears a close similarity to that of the ponderosa pine region (*14*) and that few fires were heavily destructive of standing timber. Contemporary fires often kill only small percentages of the stands affected. Even the brush fields, which give clear evidence that fires sometimes effected complete destruction of the forest cover, fail to indicate

that there have ever been, in the sugar pine region, conflagrations comparable to those which are known to have occurred in the Douglas fir region. Evidence all points away from the likelihood of fires running up into the hundreds of thousands of acres.

During the decade 1911 to 1920 single fires burned areas of approximately 20,000 acres, and even with improved protection during the next decade there is every reason to expect that an occasional fire will reach this or larger proportions, but such fires cannot properly be termed major conflagrations.

It is not believed that the hazard from abnormalities outside the statistical base is as great in the sugar pine region as it is in the ponderosa pine region, but some allowance should be made for indefinite contingencies, one of which is the possibility that this analysis of the conflagration hazard is incorrect. The recommendation is, therefore, that a loading of 50 percent be put into the schedule of rates for this purpose. This will give the region a somewhat lower average rate on merchantable timber than that obtained in the ponderosa pine region and a slightly higher rate on second growth. Rate revision will be effected here, as elsewhere, on the basis of actual forest fire insurance experience.

FOREST FIRE INSURANCE FORMS RECOMMENDED FOR REGIONAL USE

The introduction of forest insurance, like that of any other new type of insurance, will necessitate the development of a considerable number of new forms. It is not desirable here to attempt to enumerate or describe all of the forms that general practice would eventually bring into use, since it would be impossible to foresee these in toto. Nevertheless it is advisable to devote some space to the subject of forms and to make tentative suggestions for a few of those the use of which will be more or less imperative.

To provide special forms for writing forest fire insurance suggestions are made for riders on the standard policy forms. Doubtless in their present wording these suggestions admit of improvement, and some modification may be expected even before they can be put to actual use. It may possibly prove desirable not to attempt to make one form serve all three purposes of covering timber of merchantable size, timber of unmerchantable size, and plantation trees, but to use three separate forms. Such a modification would be simple to effect.

Following are the suggested policy-rider forms for the Douglas fir and ponderosa pine regions. The form for the sugar pine-ponderosa pine region would be identical with that for the ponderosa pine region, with the single exception that November should be included in the dry season.

FOREST PROPERTY INSURANCE—DOUGLAS FIR AND REDWOOD REGIONS

[Front of form]

$_____ On standing timber of merchantable size and of the following species (and no others) _____

_____

$_____ On standing timber of unmerchantable size and of the following species (and no others) _____

_____

$_____ On plantation of living trees of the following species (and no others) _____

_____

situated on (his) (her) (their) property of _____ acres, located as follows:

_____

in the county of _____, State of _____

The term "timber of merchantable size" shall be construed to mean such portions of living trees of 16-inch or greater diameter at 4½ feet above the ground as are sufficiently free from all decay and other seen or unseen defects as to possess market value, unless otherwise noted hereon.

The term "timber of unmerchantable size" shall be construed to mean living trees of 3 feet or greater height, but not exceeding 16 inches in diameter at 4½ feet above the ground and sufficiently free from decay and other seen and unseen defects as to possess a potential market value, unless otherwise noted hereon.

The term "plantation" shall be construed to mean living trees planted by hand, as distinguished from reproduction or second growth which has come in from seeding without personal supervision and planting.

This policy does not cover any species or varieties of timber or growth on property other than that above described.

It is understood and agreed that this company shall not be liable for loss caused directly or indirectly by volcanic eruption, earthquake, or other natural convulsion.

It is further understood and agreed that this company shall be liable in case of loss, only for the difference between the value of the standing timber and/or plantation trees before the fire and the salvage value of the said timber and/or trees immediately after the fire.

It is understood and agreed that the premium rate named in this policy includes a charge equal to eighty percent (80%) of the annual premium for the additional hazard incurred during the dry season, and it is a part of the consideration of this policy, and the basis upon which the rate is fixed, that in case of cancellation by the assured the return premium shall be calculated at the customary short rates of the difference between the dry season charge and the full premium charged.

It is understood and agreed that the dry season hereinabove referred to shall be any part of the months of April, May, June, July, August, September, and October.

It is understood and agreed and made a condition of this policy that if cutting be commenced or continued on or within one-half mile of any of these lands, or any portable or permanent mill be or become erected on the premises, or within one-half mile of any part thereof, or, if the hazard be increased in any other manner, without consent of this company, endorsed hereon, this policy shall cease to cover and shall be null and void.

Attached to and forming part of policy no. _____ of the _____ Company.

Agency at _____ Dated _____, 19____.

The provisions printed on the back of this form are hereby referred to and made a part hereof.

_____,
Agent.

[Reverse of form]

It is further understood and agreed that the written application for the within insurance signed by the insured and dated _____ is hereby referred to and made a part of this policy, and said insured warrants that each and all of the answers made in said application are true to his best knowledge and belief and agrees that if any of said answers be known by him to be untrue this insurance shall be null and void.

It is understood and agreed that, in event of loss, this insurance shall attach to each and every acre of the property described herein, in the exact proportion that the value of each acre shall bear to the value of the whole property at the time of the fire, quality and density of stand, and logging facility considered.

In no event shall this policy be liable for more than $_____ per acre, nor more than $_____ per M bd. ft.

It is understood and agreed that, in event of loss, this company shall not be required to accept proof of loss nor to make payment of indemnity, unless it so

elects, prior to December 1 of the year next following the year of the date of said loss nor shall this company, in any event, be liable under this policy for payment of losses less than $_____ in the aggregate of actual value of property insured hereunder.

The time during which suit or action on this policy, for the recovery of any claim, may be commenced is hereby extended to the end of the thirtieth month next after the date of the fire.

Loss, if any, under this policy, shall be payable to _____ mortgagee, as interest may appear.

REDUCED RATE AVERAGE CLAUSE: In consideration of the reduced rate at which, and the form under which this policy is written, it is expressly stipulated and made a condition of the contract that, in the event of loss, this company shall be liable for no greater proportion thereof than the amount hereby insured bears to one hundred percent (100%) of the actual value of the property described herein at the time when such loss shall happen, nor for more than the proportion which this policy bears to the total insurance hereon.

THREE-QUARTER VALUE CLAUSE: It is understood and agreed to be a condition of this insurance that, in the event of loss or damage by fire to the property insured under this policy, this company shall not be liable for an amount greater than three-quarters (¾) of the actual cash value of each item of property covered by this policy at the location and as of the time immediately preceding such loss or damage; and in the event of additional insurance, then this company shall be liable for its proportion only of three-quarters (¾) of such cash value of each item insured not exceeding the amount insured on such item. Total insurance is hereby permitted for and limited to three-quarters (¾) of the cash value of the property herein described and to be concurrent herewith.

_____,
Agent.

FOREST PROPERTY INSURANCE—NORTHERN PONDEROSA PINE REGION

[Front of form]

$_____On standing timber of merchantable size and of the following species (and no others)_____

_____

$_____On standing timber of unmerchantable size and of the following species while on the same land with, and growing under the merchantable-size timber insured under item no. 1 (no other species insured)_____

_____

$_____On standing timber of unmerchantable size and of the following species while on land on which there is no timber of merchantable size (no other species insured)_____

_____

$_____On plantation of living trees of the following species (and no others)

_____

Situated on (his) (her) (their) property of _____ acres, located as follows: _____

_____

in the county of _____ State of _____

The term "timber of merchantable size" shall be construed to mean such portions of living trees of 12-inch or greater diameter at 4½ feet above the ground as are sufficiently free from all decay and other seen or unseen defects as to possess market value, unless otherwise noted hereon.

The term "timber of unmerchantable size" shall be construed to mean living trees of 1 foot or greater height, but not exceeding 12 inches in diameter at 4½ feet above the ground and sufficiently free from decay and other seen and unseen defects as to possess a potential market value, unless otherwise noted hereon.

The term "plantation" shall be construed to mean living trees planted by hand, as distinguished from reproduction or second growth which has come in from seeding without personal supervision and planting.

This policy does not cover any species or varieties of timber or growth on property other than that described above.

It is understood and agreed that this company shall not be liable for loss caused directly or indirectly by volcanic eruption, earthquake, or other natural convulsion.

It is further understood and agreed that this company shall be liable in case of loss only for the difference between the value of the standing timber and/or plantation trees before the fire and the salvage value of the said timber and/or trees immediately after the fire.

It is understood and agreed that the premium rate named in this policy includes a charge equal to eighty percent (80%) of the annual premium for the additional hazard incurred during the dry season, and it is a part of the consideration of this policy, and the basis upon which the rate is fixed, that in case of cancellation by the assured the return premium shall be calculated at the customary short rates of the difference between the dry season charge and the full premium charged.

It is understood and agreed that the dry season hereinabove referred to shall be any part of the months of April, May, June, July, August, September, and October.

Attached to and forming part of policy no. _____ of the _____ Company. Agency at _____. Dated _____, 19____.

The provisions printed on the back of this form are hereby referred to and made a part hereof.

_____,
Agent.

[Reverse of form]

It is understood and agreed and made a condition of this policy that if cutting be commenced or continued on or within one-half mile of any of these lands, or any portable or permanent mill be or become erected on the premises, or within one-half mile of any part thereof, or, if the hazard be increased in any other manner, without consent of this company, endorsed hereon, this policy shall cease to cover and shall be null and void.

It is further understood and agreed that the written application for the within insurance signed by the insured and dated _____ is hereby referred to and made a part of this policy, and said insured warrants that each and all of the answers made in said application are true to his best knowledge and belief, and agrees that if any of said answers be known by him to be untrue this insurance shall be null and void.

It is understood and agreed that in event of loss this insurance shall attach to each and every acre of the property described herein in the exact proportion that the value of each acre shall bear to the value of the whole property at the time of the fire, quality and density of stand and logging facility considered.

In no event shall this policy be liable for more than $_____ per acre nor more than $_____ per M bd. ft.

It is understood and agreed that in event of loss this company shall not be required to accept proof of loss nor to make payment of indemnity, unless it so elects, prior to December 1 of the year next following the year of the date of said loss, nor shall this company, in any event, be liable under this policy for payment of losses less than $_____ in the aggregate of actual value of property insured hereunder.

The time during which suit or action on this policy for the recovery of any claim may be commenced is hereby extended to the end of the thirtieth month next after the date of the fire.

Loss, if any, under this policy shall be payable to _____, mortgagee, as interest may appear.

REDUCED RATE AVERAGE CLAUSE: In consideration of the reduced rate at which and the form under which this policy is written, it is expressly stipulated and made a condition of the contract that in the event of loss this company shall be liable for no greater proportion thereof than the amount hereby insured bears to one hundred percent (100%) of the actual value of the property described herein at the time when such loss shall happen, nor for more than the proportion which this policy bears to the total insurance thereon.

THREE-QUARTER VALUE CLAUSE: It is understood and agreed to be a condition of this insurance that in the event of loss or damage by fire to the property insured under this policy this company shall not be liable for an amount greater than three-quarters (¾) of the actual cash value of each item of property covered by this policy at the location and as of the time immediately preceding such loss or damage; and in the event of additional insurance, then this company shall be liable for its proportion only of three-quarters (¾) of such cash value of each item insured, not exceeding the amount insured on such item. Total insur-

ance is hereby permitted for and limited to three-quarters (¾) of the cash value of the property herein described and to be concurrent herewith.

_____,
Agent.

APPLICATION FOR INSURANCE ON FOREST PROPERTY

(This application must be complete, and signed by the insured, and attached to the company's daily report, and copy thereof attached to policy. Unless specifically permitted in writing and endorsed on the policy, application must be made on or before April 1 of the year or season for which insurance is desired.)

For use only in Oregon and Washington west of Cascades (except Josephine and Jackson Counties, Oreg.) and the portion of California in which redwood is the principal commercial species

Application of _____ P. O. address _____
for insurance in the _____ Company.

Against Loss or Damage by Fire

To the amount of $_____ for the term of one year, from the ____ day of _____ 19____. On property particularly specified and described below, all only while situated as follows:

_____

_____

Item no.	Applicant's valuation	Amount to insure	Description of property to be insured
1	$_____	$_____	On approximately _____ acres of standing timber of merchantable size (16 inches and larger d. b. h.) of the following species (and no other) _____
2	$_____	$_____	On approximately _____ acres of standing timber of unmerchantable size (not less than 3 feet in height nor more than 16 inches (d. b. h.) of the following species (and no others) _____
3	$_____	$_____	On approximately _____ acres of living plantation trees of the following species (and no others) _____

All questions on both sides of this application must be fully answered by applicant

1. How long has applicant owned this property? _____. Is this property mortgaged or encumbered? _____. If mortgaged, give amount of mortgage. _____. Name and address of mortgagee _____

   If otherwise encumbered or title not clear, describe circumstances _____

   Is property in litigation or dispute? _____. Describe _____
2. Other insurance: Amount of other insurance (if any) on this property or applied for: $_____ as follows _____

   (Names of companies)
3. Have you ever had a loss by fire (any type of property)? _____. If yes, when and by what company insured? _____

4. Have you any fear of incendiarism? _____ If yes, describe _____

5. Has any other company ever cancelled insurance on property owned by you? _____ If yes, name of company _____

6. What is the average size of trees to be insured? Of timber of merchantable size _____ in. d. b. h.: Of timber of unmerchantable size _____ in. d. b. h. _____ ft. high: Of plantation trees _____ ft. high.

7. In insured timber of merchantable size, what is the average stand per acre by species?

   Of saw timber _____ (Species) M bd. ft., _____ (Species) M bd. ft., _____ (Species) M bd. ft., _____ (Species) M bd. ft.

   Of cord timber _____ (Species) cords, _____ (Species) cords, _____ (Species) cords, _____ (Species) cords.

8. What is the value by species:

   Of this saw timber _____ (Species) per M bd. ft., _____ (Species) per M bd. ft., _____ (Species) per M bd. ft., _____ (Species) per M bd. ft.

   Of this cord timber per cord? _____ (Species) per cord, _____ (Species) per cord, _____ (Species) per cord, _____ (Species) per cord.

[Page 2 of form]

9. Is any of this timber now being operated? _____ If yes, describe number of camps and sides and locations _____

10. Are any operations planned during the term of insurance applied for? _____

11. When was any of this timber last operated? (Give full particulars and dates) _____

12. Of timber of merchantable size approximately how many acres are in what you would describe as stands of heavy density? _____ Of moderate density? _____ Of light density? _____

13. Of timber of unmerchantable size approximately how many acres are in what you would describe as stands of heavy density? _____ Of moderate density? _____ Of light density? _____

14. In timber of merchantable size what is the approximate proportion by species (whether insured or not)? _____ (Species) percent, _____ (Species) percent, _____ (Species) percent, _____ (Species) percent.

15. In timber of unmerchantable size what is the approximate proportion by species (whether insured or not)? _____ (Species) percent, _____ (Species) percent, _____ (Species) percent, _____ (Species) percent.

16. With respect to plantation trees furnish the following information: Year planted: _____ By whom: _____
Spacing: _____ Cost per acre: _____ Species planted—how many of each: _____
Present percent of survival: _____ Present average height: _____ feet.

17. Are there any areas of logging slash on the property for which official slash disposal clearances have not been received? _____ If yes, state age and describe fully: _____

18. Are there any areas directly adjacent to this property on which there is logging slash for which official slash disposal clearances have not been granted? _____ If yes, state age and describe fully: _____

19. Are there any logging operations within 2 miles of any part of this property? _____. If yes, describe and give locations _____
20. Are there any areas of burned lands (new or old), grass lands, fern lands, brush lands, or cut-over lands on this property or within 1 mile of any part of it? _____. If yes, describe fully and give locations _____

_____

21. Are there any ranches or farms on this property or within one-half mile of any part of it? _____. If yes, describe fully, giving number and locations

_____

22. Does any railroad or logging railroad run through this property? _____ Within one-half mile? _____. If yes, is the line regularly fire-patrolled during the dry season? _____. If yes, describe the patrol _____
23. Are there any areas of dead or dying trees more than 100 acres in extent on or within one-half mile of this property (where more than one-half of the trees of any one species are affected)? _____. If yes, describe fully

_____

24. Is insurance desired on these dead or dying trees? _____.
25. Approximately what percent of the acreage of this property is on steep ground (over 40-percent slope)? _____. On moderately sloping ground (10- to 40-percent slope)? _____. On approximately level ground (less than 10-percent slope)? _____.

"APPLICANT'S WARRANTY": The undersigned applicant hereby warrants that each and all of the foregoing answers are true and correct to his best knowledge and belief, and agrees that said application shall constitute a part of the policy of insurance hereinabove applied for.

Date _____ _____, applicant.

I have known this applicant _____ years. I have (have not) inspected this property within _____ months. The property is approximately _____ miles from my agency. I approve this line and recommend that the insurance applied for be placed.

_____,
Agent.

[Page 3 of form]

[Space for diagram of property]

Show in the space above a diagram of the property indicating the locations and widths of any rivers, lakes, automobile roads, trails, cultivated fields, and fire lines; also locations of railroads, logging railroads, mills, logging operations, and ranches or farms within the immediate vicinity. Indicate also the locations of all types of growth and areas of brush, fern, grass, snags, and burned or cut-over lands; and locations of areas of dead and/or dying timber. Character and condition of fire lines and cultivated fields should be clearly indicated.

(NOTE.—In lieu of the above diagram, maps, plans, or plats may be furnished, if desired, showing the information requested.)

Before submitting this application please be sure that all questions are answered and all information requested is supplied.

It may be necessary to reject the application if all of the necessary information is not had prior to April 1.

Additional information may, if desired, be furnished on the back of this sheet.

[Page 4 of form to be blank]

APPLICATION FOR INSURANCE ON FOREST PROPERTY

(This application must be complete, and signed by the insured, and attached to the company's daily report, and copy thereof attached to policy. Unless specifically permitted in writing and endorsed on the policy, application must be made on or before April 1 of the year or season for which insurance is desired.)

For use only in Oregon and Washington east of Cascades, Josephine and Jackson Counties, Oreg., and those portions of Idaho, California, and Montana in which ponderosa pine is the principal commercial species

Application of _____ P. O. address _____
for insurance in the _____ Company.

Against Loss or Damage by Fire

To the amount of $_____ for the term of 1 year, from the _____ day of _____, 19____. On property particularly specified and described below, all only while situated as follows:

Item no.	Applicant's valuation	Amount to insure	Description of property to be insured
1	$_____	$_____	On approximately _____ acres of standing timber of merchantable size (12 inches and larger d. b. h.) of the following species (and no others) _____
2	$_____	$_____	On standing timber of unmerchantable size (not less than 1 foot in height nor more than 12 inches d. b. h.) growing under and on the same ground with the timber of merchantable size described in item no. 1, of the following species (and no others) _____
3	$_____	$_____	On approximately _____ acres of standing timber of unmerchantable size (as described in item no. 2) growing on ground other than that specified in item no. 2, and on which there is no timber of merchantable size, of the following species (and no others) _____
4	$_____	$_____	On approximately _____ acres of living plantation trees of the following species (and no other) _____

All questions on both sides of this application must be fully answered by applicant

1. How long has applicant owned this property? _____. Is this property mortgaged or encumbered? _____. If mortgaged, give amount of mortgage _____. Name and address of mortgagee _____.
   If otherwise encumbered or title not clear, describe circumstances _____
   Is property in litigation or dispute? _____. Describe _____
2. Other insurance: Amount of other insurance (if any) on this property or applied for: $_____ as follows: _____
   (Names of companies)
3. Have you ever had a loss by fire (any type of property)? _____. If yes, when and by what company insured? _____
4. Have you any fear of incendiarism? _____. If yes, describe _____
5. Has any other company ever cancelled insurance on property owned by you? _____. If yes, name of company _____
6. What is the average size of trees to be insured? Of timber of merchantable size _____ inches d. b. h. Of timber of unmerchantable size _____ inches d. b. h. _____ feet high. Of plantation trees _____ feet high.
7. In insured timber of merchantable size, what is the average stand per acre by species?
   Of saw timber _____ (Species) M board feet, _____ (Species) M board feet, _____ (Species) M board feet, _____ (Species) M board feet, _____ (Species) M board feet.
   Of cord timber _____ (Species) cords, _____ (Species) cords, _____ (Species) cords, _____ (Species) cords, _____ (Species) cords.

[Page 2 of form]

8. What is the value by species:
Of this saw timber per M board feet? _____ (Species) per M board feet, _____ (Species) per M board feet, _____ (Species) per M board feet, _____ (Species) per M board feet.
Of this cord timber per cord? _____ (Species) per cord, _____ (Species) per cord, _____ (Species) per cord, _____ (Species) per cord, _____ (Species) per cord.

9. Is any of this timber now being operated? _____. If yes, describe number of camps and sides and locations _____

10. Are any operations planned during the term of insurance applied for? _____

11. When was any of this timber last operated? (Give full particulars and dates) _____

12. Of timber of merchantable size, approximately how many acres are in what you would describe as stands of heavy density? _____. Of moderate density? _____. Of light density? _____.

13. In timber of merchantable size, what is the approximate proportion by species (whether insured or not)? _____ (Species) percent, _____ (Species) percent, _____ (Species) percent, _____ (Species) percent, _____ (Species) percent.

14. In timber of unmerchantable size, what is the approximate proportion by species (whether insured or not)? _____ (Species) percent, _____ (Species) percent, _____ (Species) percent, _____ (Species) percent, _____ (Species) percent.

15. With respect to plantation trees furnish the following information: Year planted? _____. By whom? _____. Spacing? _____ Cost per acre? _____. Species planted—how many of each? _____ Present percent of survival? _____. Present average height? _____ feet.

16. Are there any areas of logging slash on or directly adjacent to this property? _____. If yes, when was it made? _____. What method of slash disposal, if any, was applied? _____. Was slash disposal successful? ____

17. Are there any logging operations within 2 miles of any part of this property? _____. If yes, describe and give locations _____

18. Are there any areas of burned lands (new or old), grasslands, sage or other brushlands, or cut-over lands on this property or within 1 mile of any part of it? _____. If yes, describe and give locations _____

If cut-over lands, was cutting by clear-cutting or selection system? ____

19. Are there any ranches or farms on this property or within one-half mile of any part of it? _____. If yes, describe fully, giving number and locations _____

20. Does any railroad or logging railroad run through this property? _____. Within one-half mile? _____. If yes, is the line regularly fire patrolled during the dry season? _____. If yes, describe the patrol _____

21. What percent of the merchantable ponderosa pine trees (by number) do you estimate are at present affected by the western pine beetle? _____. What percent has been killed within the past year? _____.

22. Are there any areas of dead or dying trees more than 100 acres in extent on or within one-half mile of this property (where more than one-half of the trees of any one species are affected)? _____. If yes, describe fully _____

23. Is insurance desired on these dead or dying trees? _____

"APPLICANT'S WARRANTY": The undersigned applicant hereby warrants that each and all of the foregoing answers are true and correct to his best knowledge and belief, and agrees that said application shall constitute a part of the policy of insurance hereinabove applied for.

Date _____, 19__. _____ applicant.

I have known this applicant _____ years. I have (have not) inspected this property within _____ months. The property is approximately _____ miles from my agency. I approve this line and recommend that the insurance applied for be placed.

_____

Agent.

[Page 3 of form]

[Space for dingram of property]

Show in the space above a diagram of the property, indicating the locations and widths of any rivers, lakes, automobile roads, trails, cultivated fields, and fire lines, also locations of railroads, logging railroads, mills, logging operations, and ranches or farms within the immediate vicinity. Indicate also the locations of all types of forest growth and areas of brush, sage, grass, and burned or cut-over lands; and locations of areas of dead and/or dying timber. Character and condition of fire lines and cultivated fields should be clearly indicated.

(NOTE.—In lieu of the above diagram, maps, plans, or plats may be furnished, if desired, showing the information requested.)

Before submitting this application, please be sure that all questions are answered and all information requested is supplied.

It may be necessary to reject the application if all of the necessary information is not had prior to April 1.

Additional information may, if desired, be furnished on the back of this sheet.

[Page 4 of form to be blank]

APPLICATION FOR INSURANCE ON FOREST PROPERTY

(This application must be complete, and signed by the insured, and attached to the company's daily report, and copy thereof attached to policy. Unless specifically permitted in writing and endorsed on the policy, application must be made on or before April 1 of the year or season for which insurance is desired.)

For use only in California west of the main divide of the Sierra Nevada and a continuation of this line through Mount Shasta to the Oregon line (the portion of California where sugar pine is an important commercial species, but not including any portion of the coast range and redwood region)

Application of _____ P. O. address _____
for insurance in the _____ Company.

Against Loss or Damage by Fire

To the amount of $_____ for the term of 1 year, from the _____ day of _____, 19_____. On property particularly specified and described below, all only while situated as follows: _____
_____

Item no.	Applicant's valuation	Amount to insure	Description of property to be insured
1	$_____	$_____	On approximately _____ acres of standing timber of merchantable size (12 inches and larger d. b. h.) of the following species (and no others) _____
2	$_____	$_____	On standing timber of unmerchantable size (not less than 1 foot in height nor more than 12 inches d. b. h.) growing under and on the same ground with the timber of merchantable size described in item no. 1, of the following species (and no others) _____
3	$_____	$_____	On approximately _____ acres of standing timber of unmerchantable size (as described in item no. 2) growing on ground other than that specified in item no. 2, and on which there is no timber of merchantable size, of the following species (and no others) _____
4	$_____	$_____	On approximately _____ acres of living plantation trees of the following species (and no others) _____

All questions on both sides of this application must be fully answered by applicant

1. How long has applicant owned this property? _____. Is this property mortgaged or encumbered? _____. If mortgaged, give amount of mortgage _____. Name and address of mortgagee _____ _____. If otherwise encumbered or title not clear, describe circumstances_____ _____. Is property in litigation or dispute? _____. Describe_____
2. Other insurance: Amount of other insurance (if any) on this property or applied for: $_____, as follows _____ (Names of companies)
3. Have you ever had a loss by fire (any type of property)? _____. If yes, when and by what company insured? _____ _____
4. Have you any fear of incendiarism? _____. If yes, describe _____ _____
5. Has any other company ever cancelled insurance on property owned by you? _____. If yes, name of company _____
6. What is the average size of trees to be insured? Of timber of merchantable size _____ inches d. b. h. Of timber of unmerchantable size _____ inches d. b. h. _____ feet high. Of plantation trees _____ feet high
7. In insured timber of merchantable size what is the average stand per acre by species?

   Of saw timber _____ (Species) M bd. ft., _____ (Species) M bd. ft., _____ (Species) M bd. ft., _____ (Species) M bd. ft., _____ (Species) M bd. ft., _____ (Species) M bd. ft.

   Of cord timber _____ (Species) cords, _____ (Species) cords, _____ (Species) cords, _____ (Species) cords, _____ (Species) cords.

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[Page 2 of form]

8. What is the value by species:
Of this saw timber per M bd. ft.? _____ (Species) per M bd. ft., _____ (Species) per M bd. ft., _____ (Species) per M bd. ft., _____ (Species) per M bd. ft., _____ (Species) per M bd. ft.
Of this cord timber per cord? _____ (Species) per cord, _____ (Species) per cord, _____ (Species) per cord, _____ (Species) per cord, _____ (Species) per cord.

9. Is any of this timber now being operated? _____. If yes, describe number of camps and sides, and locations _____

10. Are any operations planned during the term of insurance applied for?_____

11. When was any of this timber last operated? (Give full particulars and dates) _____

12. Of timber of merchantable size approximately how many acres are in what you would describe as stands of heavy density? _____. Of moderate density? _____. Of light density? _____.

13. In timber of merchantable size what is the approximate proportion by species (whether insured or not)? _____ (Species) percent, _____ (Species) percent, _____ (Species) percent, _____ (Species) percent.

14. In timber of unmerchantable size what is the approximate proportion by species (whether insured or not)? _____ (Species) percent, _____ (Species) percent, _____ (Species) percent, _____ (Species) percent.

15. With respect to plantation trees furnish the following information: Year planted? _____. By whom? _____. Spacing? _____ Cost per acre? _____. Species planted—how many of each, _____ Present percent of survival? _____. Present average height? _____ feet.

16. Are there any areas of logging slash on or directly adjacent to this property? _____. If yes, when was it made? _____. What method of slash disposal, if any, was applied? _____. Was slash disposal successful? _____.

17. Are there any logging operations within 2 miles of any part of this property? _____. If yes, describe and give locations_____

18. Are there any areas of burned lands (new or old), grasslands, chaparral or other brushlands, California woodland, or cut-over lands on this property or within 2 miles of any part of it? _____. If yes, describe and give locations _____. If cut-over lands, was cutting by clear-cutting or selection system? _____

19. Are there any ranches or farms on this property or within one-half mile of any part of it? _____. If yes, describe fully giving number and locations _____

20. Does any railroad or logging railroad run through this property? _____ Within one-half mile? _____. If yes, is the line regularly fire-patrolled during the dry season? _____. If yes, describe the patrol _____

21. What percent of the merchantable ponderosa pine trees (by number) do you estimate are at present affected by the western pine beetle? _____ What percent has been killed within the last year? _____.

22. What other evidence is there of insect activity on this property? Describe _____

23. Are there any areas of dead or dying trees more than 100 acres in extent on or within one-half mile of this property (where more than one-half of the trees of any one species are affected? _____. If yes, describe fully _____

24. Is insurance desired on these dead or dying trees? _____.

"APPLICANT'S WARRANTY": The undersigned applicant hereby warrants that each and all of the foregoing answers are true and correct to his best knowledge and belief, and agrees that said application shall constitute a part of the policy of insurance hereinabove applied for.

Date _____, 19____. _____, applicant.

I have known this applicant _____ years. I have (have not) inspected this property within _____ months. The property is approximately _____ miles from my agency. I approve this line and recommend that the insurance applied for be placed.

_____,
Agent.

[Page 3 of form]

[Space for diagram of property]

Show in the space above a diagram of the property indicating the locations and widths of any rivers, lakes, automobile roads, trails, cultivated fields, and fire lines, also locations of railroads, logging railroads, mills, logging operations, and ranches or farms within the immediate vicinity. Indicate also the locations of all types of forest growth and areas of brush, chaparral, grass, California woodland, and burned or cut-over lands; and locations of areas of dead and/or dying timber. Character and condition of fire lines should be clearly indicated.

(NOTE.—In lieu of the above diagram, maps, plans, or plats may be furnished, if desired, showing the information requested.)

Before submitting this application please be sure that all questions are answered and all information requested is supplied.

It may be necessary to reject the application if all necessary information is not had prior to April 1.

Additional information may, if desired, be furnished on the back of this sheet.

[Page 4 of form to be blank]

Ordinarily such forms as are designed to cover special cases or conditions are included in the contract as warranties, since the insurer would otherwise be left without protection in case the condition provided for should cease to exist.

Following is a sample of a form that might be used to cover such a special condition:

RAILROAD AND/OR LOGGING RAILROAD PATROLMAN WARRANTY
(For use on standing timber and forest risks)

Commencement of policy	Expiration of policy	Amount insured	Old rate	New rate	Return premium

Warranted by the insured that due diligence will at all times be used by the insured to maintain one or more patrolmen on the rights-of-way of any and all railroads and/or logging railroads crossing or passing within one-half mile of the within described premises, said patrolmen to be continuously on duty between the hours of 8 a. m. and 8 p. m. on all days between June 15 and September 15 on which any trains are run on any of said railroads and/or logging railroads and on which there is an officially recorded precipitation at the nearest regular or cooperative Weather Bureau station of less than one-tenth (1/10) of an inch, unless otherwise specifically noted hereon; said patrolmen to follow all trains within one-half hour of the time of their passage and, in any event, to travel over the full length of the line between points 1 mile outside of the points of intersection of the railroad rights-of-way and the property lines of these premises, or the points of nearest approach, at least

twice daily. A breach of this warranty suspends this insurance during such breach.

Attached to policy no. _____ of the _____
(Name of company)

Issued to _____

Agency at _____ Dated _____ 19____

_____
Agent.

If a railroad line is effectively patrolled the hazard is decreased as compared to the average of railroad hazard unless all lines are similarly patrolled. Since the railroad-exposure charge in the rating schedule does not presuppose any patrol, it is equitable that an assured who maintains a patrol or who derives the benefit of a patrol maintained by another should be given some credit in his premium charge. Note, however, that the provision for his obtaining this credit carries with it the assumption of responsibility by him for the proper maintenance of the patrol. The assured must interest himself in this maintenance, for, if he should happen to suffer a loss during a time when the patrol was not being maintained in accordance with the agreement, his policy would not cover.

A humidity warranty has been developed by the insurance-rating organizations of Oregon and Washington in cooperation with the so-called "logging pool" for use in connection with fire insurance on logging camps, equipment, and felled timber. As given here, it includes a few slight modifications designed to make it fit the timber owner as the assured rather than the logger. Where the timber owner does not do the logging, he will have to exercise some jurisdiction in this respect in order to preserve the validity of his insurance if he has elected to have it written on this basis. This form is given here only to illustrate one of the requirements that will undoubtedly have to be recognized.

HUMIDITY WARRANTY

[For use on standing timber and forest risks]

Warranted by the insured that all logging operations on the within described premises will be completely suspended for any period in the months of April to October, inclusive, during which the relative humidity is below thirty (30) percent, and it is also understood and agreed that during the months of April to October, inclusive, the insured will have kept on the premises humidity measuring instruments consisting of approved hygrograph and hygrometer, and that due diligence will be used in maintaining such instruments in proper working order; that daily humidity records will be kept on file, together with the record of daily checking of the hygrographic instrument.

A breach of the above warranty renders this policy null and void during such breach. However, if all logging operations on the premises are suspended for a continuous period of 1 week or longer, daily humidity records need not be kept during such period.

Attached to, etc.

These allowances for extraordinary conditions are usually not mandatory but are optional with the assured, the alternative being the payment of premium at a higher rate. In certain cases the intention is to neutralize an extraordinary increase in hazard as, for example, when a manufacturing plant is shut down or vacant. This is usually taken as increasing the hazard by weakening detection and increasing the likelihood of trespass. An increase in the rate would thus be in order. If, however, the watchman service is increased or

strengthened the increase in hazard may be offset. One of these special warranty forms would cover the condition of strengthened watchman service and, if attached to the policy, would relieve the assured of the payment of additional premium.

If electric donkey engines only are used, the logging hazard is reduced below the average. An electric donkey warranty form could therefore be expected to be useful in some special cases, together with provision in the schedule for a rate credit if the warranty were attached to the policy.

Some assureds may be willing to maintain private protection of one kind or another over and above that required by law. This might be in the form of increased manpower or additional equipment. If a real reduction in hazard were effected it would be proper to recognize the fact in the same manner. Plowed strips between the insured property and recognized hazards could be made the subject of rate reductions and warranty forms. Maintenance of the strips according to specified standards would have to be made mandatory.

Experience based on actual practice could be expected to bring to light other needs for special warranties with accompanying modifications of the premium.

The suggested specific policy, application, and warranty forms have been devised in connection with this inquiry for use in the various forest regions. Variations in the forms between regions are designed to allow for recognized differences in hazard and other conditions.

CONSTRUCTION OF THE RATING SCHEDULES

The rating schedules here suggested for experimental use in writing forest fire insurance in the four forest regions of the Pacific coast territory are built on the general form of the so-called universal mercantile schedule. This form was adopted after considerable study as apparently very well adapted to the peculiar requirements of forest rating.

The function of any schedule of specific rating is, of course, to express in practical manner the variations of relative hazard due to the influences of specific factors that affect some properties (risks) without affecting others at the same time. The total degree of hazard varies according to the number and intensity of hazard factors taking effect.

The inquiries and analyses made in connection with the study are believed to have produced determinations of the grand aggregate of hazard, region by region, that are accurate within entirely allowable practical limits. When it is said, for example, that the average annual loss of merchantable timber in the Douglas fir region is 0.041 percent from ordinary fires and 0.075 percent from major conflagrations, very little speculation is involved. Defensible statistics show that this is very close to the actual losses.

The problem arises, however, of breaking the grand average down to express internal variations of relative hazard, and here a degree of speculation and rationalization becomes unavoidable. Fully adequate data are not available, at least without prohibitive expense. It can even be questioned whether they are available at all without the actual

practice of insurance itself. It is plainly understood that these variations exist. Obviously an area exposed to unburned logging slash incurs a greater hazard than one which is free from such exposure. Causative agencies increase the hazard of surrounding risks over and above that of risks further removed. Some hazard correlations were suspected and data were taken in an attempt to determine whether or not they were facts. In some cases no evidence of variation was produced. In others the data gave indication that the suspicion was well founded and provision was made in the schedule for allowance for the variation.

In this part of the study an attempt was made to determine separate burning ratios for each hazard factor known or suspected as imparting variation. This involved, of course, a knowledge of the amount at risk affected by the hazard factor in question. To the extent that this determination was possible, it was made. The data of the forest survey were extremely helpful in this connection.

Through the use of burning ratios for each factor, the theoretical hazard of the ultimate standard (best possible) risk was computed. Factor-burning ratios, as finally adopted, were sometimes the result of interpretation and rationalization of the figure developed purely from the data. There was no way to avoid this as the best data obtainable are sometimes not fully indicative. Nevertheless it is confidently believed that an entirely practical result has been achieved, subject certainly to improvement, but adequate to the needs of introductory practice.

The ultimate standard risk in the Douglas fir region, by the method adopted, is a property consisting of a pure stand of Douglas fir, class 1;[10] in climatic zone 1; under class 1 protection; of light density; entirely on level ground; incurring no hazard from unburned slash, lands recently cut-over, fern-, brush-, or grasslands, dead or dying timber, or snags; and not exposed to the causative hazards of railroads, lightning, ranches, lumbering, recreation, or roads. Such a risk does not exist, but the logical construction of the schedule necessitates the assumption of such a theoretical ideal in order that all ordinary allowances may go in as charges, thus cutting the requirement for credits to a minimum with consequent simplification. The hazard of such a theoretically ideal risk would be very low, about 0.00003 percent, according to the computation.

The opposite theoretical extreme, which also cannot exist in nature, is a risk which is practically certain to become a loss in any given year. The theory of the schedule is to start with the standard risk and make allowance for all of the collateral-hazard factors found to affect the particular risk being rated.

Three schedules proposed for introductory insurance writing in the four regions are presented in this bulletin, the Douglas fir and redwood regions being rated by the same schedule. A considerable quantity of summarized data is also presented, together with some

[10] Classes adopted for rate schedule use are: (1) Stands of trees mostly 20 to 40 inches d. b. h.; (2) stands of trees mostly over 40 inches d. b. h.; (3) stands of trees mostly 25 feet high to 6 inches d. b. h.; (4) stands of trees mostly 6 to 20 inches d. b. h.; (5) stands of trees mostly less than 25 feet high. These classes are listed on p. —, where they are designated as classes A, B, C, D, and E. Class 1 is the same as class B, class 2 as class A, class 3 as class D, class 4 as class C, and class 5 as class E. As given here the classes are arranged in the order of relative hazard, class 1 being the least hazardous.

of the process material. The purpose is to illustrate the sort of data obtainable and the use to which they were put.

The construction of the rating schedules involves the use of all these data as well as those for climatic and protective variations presented elsewhere in the bulletin. The extremes of variation are so great that no rate schedule coinciding with them could serve in a practical way. The actual schedules proposed compress the range very considerably. A strict adherence to the hazard scale shows a theoretical basis rate, for example, in the Douglas fir region, of 0.01 cent per $100 of value per year and a charge for exposure to unburned slash, in class 1, of 6,500 percent. The suggested schedule starts at 2½ cents and charges for exposure to slash, in class 1, 1,000 percent.

The test is, of course, whether each class will contribute its apportioned share of premium. Careful checks, giving weight to the distributions of hazard factors, indicate that the schedules do provide for this, and that, if all of the privately owned property in the territory could actually be insured, the grand average rate would be very close to the 45 cents planned for (on a 100-percent coinsurance basis). There is no way of knowing what the achieved average rate of the actually insured properties will be, but it will be higher or lower, in a practical degree, as the aggregate hazard incurred is higher or lower than the average. That is, it will provide for the collection of premium in practical relation to the hazard actually incurred.

The fixing of credit allowances in the rating schedules is mainly a matter of judgment, there being very little to go on statistically. Judgment is influenced partly by the probable reduction in the aggregate hazard and partly by the inducement value of the allowance. There is little use in granting a credit for a hazard reduction the cost of achieving which is greater than the amount of the credit. The question whether the allowances suggested are equitable can only be answered through actual practice and experience. Practice and experience may also indicate that it is not practicable to allow credits for all of the conditions suggested or, possibly, that credit allowance will be required for factors not mentioned here.

It will be noted that most of the charges in the schedules are in the form of percentages, while a few are flat charges in cents. The chief purpose of using flat charges is to keep the ultimate range of possible rates reasonably narrow. The deliberate narrowing of the range mentioned above does not, in itself, do this sufficiently. Even with the flat charges, as they are introduced, the theoretically possible range of the gross rate in the Douglas fir region runs between 2½ cents and $62.82. In practice, of course, neither of these rates would ever be achieved. Nevertheless, in order that the cost of the service rendered may be equitably shared by policyholders, it is essential that the rate range be not too great. The minimum rate and premium specifications at the ends of the schedules are necessary provisions to this same end. Whatever may be an owner's hazard his premium must at least defray the expense of underwriting and issuing the policy together with covering the value of the collateral services that fire insurance inevitably renders to property owners. There is a general factor of service rendered, the value of which is more a function of the value of the property than of the hazard incurred.

Proper rating must attempt to distribute this cost equitably. A strict adherence to the scale of relative hazard would not do this.

The rates proposed in the schedules presuppose the inclusion in the policy of the 100-percent coinsurance clause. That is, they are based on the measurement of losses exactly as they have occurred. Elsewhere in this report it is suggested that the first trials make use of the 100-percent clause. If a lower coinsurance requirement is used the rate scale will have to be raised somewhat. Standard formulas for this have already been long in use in the fire insurance business.

The schedules, as suggested, are intended for use in ordinary commercial fire insurance. This study has not attempted to suggest possible rates and forms for insurance covering only mortgagee interests or excess cover lines.

The schedules here suggested may be considered by some readers as too complicated. The purpose has been to swing such error as may be unavoidable toward this condition rather than toward too great simplicity. It will be easier to simplify later than it would be to introduce additional necessary allowances.

The actual use of the schedules will require some preliminary work, such as the construction of maps indicating the exact locations of climatic, recreation, and lightning zones throughout the territory, of which only the principle has been established in this bulletin. Some of these maps can be readily made from data already collected by the study and on file at the Pacific Northwest Forest Experiment Station, Portland, Oreg. There is also on file there a map book showing the climatic zones of the Douglas fir region, in final form, as a sample of a practical underwriting map.

On the following pages are presented, region by region, such summarized data and process material as can be shown with reasonable clarity. The files of the Pacific Northwest Forest Experiment Station contain the detailed statistics and computations on which these summaries are based. They are, of course, available for any purpose they can be made to serve. The proposed schedules themselves are presented at the end of this bulletin.

THE DOUGLAS FIR REGION

During the decade 1921 to 1930, inclusive, according to the summaries compiled by the State foresters of Oregon and Washington, the losses resulting from forest fires in the Douglas fir region [11] were as follows:

Merchantable timber killed (and destroyed)	M ft. b. m.	1,813,460
Second growth and reproduction burned	acres	193,620

The figures for the decade 1911 to 1920 were not actually used in the computations, but they show that the losses during that time were not badly out of line:

Merchantable timber killed (and destroyed)	M ft. b. m.	2,684,323
Second growth and reproduction burned	acres	122,585

To all practical purposes, the conclusions of the study are based on a 20-year experience. Although more timber was reported as

[11] These are losses on lands protected under the jurisdictions of the State foresters and reported upon by them. Privately owned lands and some publicly owned lands are included. Losses on the national forests or on other lands within the national forests which are protected by the Forest Service are not included.

damaged between 1911 and 1920, the rate of loss was not materially different, since there was more timber in the region at the time.

For this study the annual rate of reported loss was taken as:

Merchantable timber killed or destroyed	M ft. b. m.	181,346
Second growth and reproduction burned	acres	19,362

These figures were adjusted, on the basis of the original field analyses, as follows:

Merchantable timber killed or destroyed (27.5 percent increase)	M ft. b. m.	231,216
Second growth and reproduction burned (28 percent increase)	acres	24,783

The determination of the field analysis was, however, that the salvage probability of merchantable timber is 44.2 percent. From the evidence produced by the field analysis and the supplementary reports a partial loss probability of 60 percent in second growth and reproduction stands was arrived at.

The annual rate of net loss is accordingly taken as—

Merchantable timber	M ft. b. m.	129,019
Second growth and reproduction	acres	14,870

Careful analysis and interpretation of Forest Service figures compiled in 1931 indicates that this loss took place while the region contained approximately 311,600,000 M ft. b. m. of merchantable timber and 5,650,000 acres of second growth and reproduction, protected and reported on.[12]

Following is a preliminary integration of these figures:

Merchantable timber:		
Volume at risk	M ft. b. m.	311,600,000
Net annual loss	do	129,019
Rate of loss	percent	0.041
Second growth and reproduction:		
Area at risk	acres	5,650,000
Net annual loss	do	14,870
Rate of loss	percent	0.263

Forest fire insurance rating and underwriting require a more detailed break-down by classes than the simple separation of the merchantable from the unmerchantable timber. Five classes were established. (See footnote 10, p. 134.)

Figures for a determination of the volumes and areas at risk were taken from a 14-county sample from the forest survey, as summarized below and in table 11.

	Acres
Merchantable timber area	2,136,588
Total area of forest land	4,934,755
Area of fern, brush, grasslands (with or without snags)	1,147,782
Area cut over 1928 to 1930, inclusive	126,340
Area of snag lands	170,100
Area with more than 40-percent slope	982,054
Area with 10- to 40-percent slope	3,327,620
Area with less than 10-percent slope	625,072

[12] Later forest-survey summaries for the region indicate, for all ownerships other than national forests, a merchantable timber volume of 338,920 million board feet and 5,141,044 acres of second growth and reproduction. Allowing for private (and other) ownerships within the national forests, fire losses on which are not included in the reports used by this study, this indicates that the estimate of 311,600 million feet of merchantable timber at risk is approximately correct. There is, however, actually less second growth and reproduction in the region than is indicated by the earlier Forest Service figures. Integrating an annual net loss of 14,870 acres of young growth into 5,141,044 acres at risk gives an annual rate of loss of 0.289 percent instead of 0.263 percent as used.

TABLE 11.—*Recapitulation of stand data from 14 counties in the Douglas fir region, national-forest lands excepted, by classes*

Type	By volume		By area		
	Class 1, 20 to 40 inches d. b. h.	Class 2, more than 40 inches d. b. h.	Class 3, 25 feet high to 6 inches d. b. h.	Class 4, 6 to 20 inches d. b. h.	Class 5, 3 to 25 feet high
	M ft. b. m.	*M ft. b. m.*	*Acres*	*Acres*	*Acres*
Stands of pure Douglas fir [1]	25,385,423	35,875,811	170,400	824,290	245,820
21 to 50 percent hemlock	5,583,500	2,108,000	10,555	28,010	33,815
51 to 80 percent hemlock	3,043,000	600,000	6,035	46,630	21,405
Pure hemlock	4,071,810	700,000	5,700	34,350	11,825
21 to 50 percent cedar	1,203,000	964,500	4,100	6,950	14,500
51 to 80 percent cedar	501,500	311,300	1,200	2,950	4,700
Pure cedar	335,000	407,300	300	325	3,100
21 to 50 percent other	1,103,000	1,788,700	8,470	8,105	17,325
51 to 80 percent other	1,129,100	815,000	3,000	3,400	2,510
Pure other	1,201,000	860,000	3,510	920	1,755
Total	43,617,323	44,410,611	211,270	955,000	356,785
Heavy density	10,639,909	17,169,359	65,230	387,741	90,901
Moderate density	17,939,280	20,085,830	117,803	472,560	166,975
Light density	6,039,083	7,155,431	28,172	95,683	98,909

[1] Containing more than 80 percent of the predominating species.

The above figures recapitulate data for a 14-county sample. On this basis computation of values for the whole region results in a break-down as shown in the following summary and in table 12. It will be noted that the figure quoted for "area cut over 1928 to 1930" is not the result of proportional raising. This is because a better estimate of this area could be made by use of lumber-cut figures, which were known. While the 14 counties are, in most respects, representative of the region as a whole, cutting in them had not been as heavy during this period as it had in the rest of the region.

	Acres
Merchantable timber area	7,600,000
Total area of forest land	17,862,000
Area of fern, brush, or grasslands (with or without snags)	3,921,500
Area cut over 1928 to 1930, inclusive	690,500
Area of snag lands	615,600
Area with more than 40-percent slope	3,558,000
Area with 10- to 40-percent slope	12,040,000
Area with less than 10-percent slope	2,264,000

TABLE 12.—*Computed values for Douglas fir region (outside national forests) based on table 11*

Type	By volume		By area		
	Class 1, 20 to 40 inches d. b. h.	Class 2, more than 40 inches d. b. h.	Class 3, 25 feet high to 6 inches d. b. h.	Class 4, 6 to 20 inches d. b. h.	Class 5, 3 to 25 feet high
	M. ft. b. m.	*M. ft. b. m.*	*Acres*	*Acres*	*Acres*
Stands of pure Douglas fir [1]	89,868,000	126,970,000	602,300	3,054,000	(2)
21 to 50 percent hemlock	19,760,000	7,475,000	39,200	103,800	
51 to 80 percent hemlock	10,770,000	2,123,000	22,400	172,900	
Pure hemlock	14,410,000	2,478,000	21,150	127,200	
21 to 50 percent cedar	4,260,000	3,411,000	15,200	25,700	
51 to 80 percent cedar	1,986,000	1,101,000	4,500	10,900	
Pure cedar	1,186,000	1,441,000	1,100	1,200	
21 to 50 percent other	3,909,000	6,272,000	24,000	30,300	
51 to 80 percent other	3,998,000	2,885,000	11,150	12,600	
Pure other	4,253,000	3,044,000	13,000	3,400	
Total	154,400,000	157,200,000	784,000	3,542,000	1,324,000
Heavy density	69,530,000	60,810,000	241,900	1,437,000	337,400
Moderate density	63,500,000	71,080,000	437,700	1,751,000	619,600
Light density	21,370,000	25,310,000	104,400	354,000	367,000

[1] Containing more than 80 percent of the predominating species.
[2] Composition is not a factor in this class.

The class totals (exposed) in the region are:

Class 1	M ft. b. m.	154,400,000	
Class 2	do	157,200,000	
Class 3	acres	784,000	
Class 4	acres	3,542,000	
Class 5	do	1,324,000	

Amounts killed and areas burned, by classes, were determined from the detailed analyses and the supplementary reports and are shown in table 13.

TABLE 13.—*Gross and net losses by classes*

	Killed or burned over annually, gross	Actually lost annually, net		Killed or burned over annually, gross	Actually lost annually, net
Class:	*M. ft. b. m.*	*M. ft. b. m.*	Class—Continued.	*Acres*	*Acres*
1	69,776	51,608	3	743	446
2	161,440	77,411	4	3,717	2,230
			5	20,323	12,194

Integration by classes, on a volume and area basis, can then be shown as in table 14.

TABLE 14.—*Quantities at risk, gross and net losses*[1]

	Volume or area at risk	Gross loss		Net loss	
Class:	*M ft. b. m.*	*M ft. b. m.*	*Pct.*	*M ft. b. m.*	*Pct.*
1	154,400,000	69,776	0.045	51,608	0.033
2	157,200,000	161,440	.103	77,411	.049
	Acres	*Acres*		*Acres*	
3	784,000	743	.095	446	.057
4	3,542,000	3,717	.105	2,230	.063
5	1,324,000	20,323	1.535	12,194	.921

[1] Figures given here should not be confused with figures given in tables 4 and 5, which are only process figures, shown for purposes of illustration. The figures in tables 4 and 5 are derived from the field-analysis phase of the study. The supplementary individual fire reports indicated a break-down between classes different from that obtained from the field analyses. The figures given in tables 13 and 14 are the result of rational reconciliation of the two sources of material. The conclusion was that the closest approximation to the facts is expressed when 30.2 percent (roughly) of the gross loss and 40 percent of the net loss of merchantable timber is allocated to class 1, and when a straight 60-percent partial-loss factor is applied to all three unmerchantable classes.

Tables 15, 16, 17, 18, and 19 show the break-downs within the classes, by the adopted contributive hazards. With respect to these figures it can only be said that they are, in general, indicative. The narrowing of the statistical base and the uncertainty of the figures themselves make their use mainly interpretative. They are nevertheless of great value and definitely make possible a rating method involving differentiations that are authoritative and actual, although obviously the burning ratios as shown in the tables themselves cannot be used directly.

TABLE 15.—*Class break-down; class 1, thrifty merchantable, 20 to 40 inches diameter*[1]

Hazard	Exposed	Lost	Burning ratio	Hazard	Exposed	Lost	Burning ratio
	M ft. b. m.	*M ft. b. m.*	*Pct.*		*M ft. b. m.*	*M ft. b. m.*	*Pct.*
Heavy density	69, 530, 000	10, 760	0. 015	21 to 50 percent other	3, 999, 000	211	0. 005
Moderate density	63, 500, 000	39, 000	. 062	51 to 80 percent other	3, 998, 000	[2]	-------
Light density	21, 370, 000	1, 758	. 008	Pure other	4, 253, 000	[2]	-------
Pure Douglas fir	89, 868, 000	44, 041	. 050	Unburned slash [3]	4, 008, 160	17, 980	. 449
21 to 50 percent hemlock	19, 700, 000	4, 705	. 024	No special hazard	74, 003, 520	15, 595	. 021
51 to 80 percent hemlock	10, 770, 000	467	. 004	Fern, brush, grass	68, 372, 000	11, 120	. 016
Pure hemlock	14, 410, 000	179	. 001	Recent cut-overs	8, 016, 320	6, 013	. 086
21 to 50 percent cedar	4, 260, 000	1, 405	. 033	Snags	10, 739, 160	43, 100	. 401
51 to 80 percent cedar	1, 986, 000	[2]	-------	Steep slope	30, 700, 000	35, 017	. 114
Pure cedar	1, 186, 000	[2]	-------	Moderate slopes	104, 100, 000	16, 087	. 015
				Level	19, 600, 000	504	. 003

[1] Volume basis: Total exposure, 154,400,000 M ft. b. m.; total annual loss, 51,608 M ft. b. m. (0.033 percent).
[2] None.
[3] Slash exposure obtained by taking one-third of area cut over (1928–30, inclusive). Balance into recent cut-over (weed) areas.

TABLE 16.—*Class break-down; class 2, overmature merchantable over 40 inches diameter*[1]

Hazard	Exposed	Lost	Burning ratio	Hazard	Exposed	Lost	Burning ratio
	M ft. b. m.	*M ft. b. m.*	*Pct.*		*M ft. b. m.*	*M ft. b. m.*	*Pct.*
Heavy density	60, 810, 000	46, 244	0. 076	21 to 50 percent other	4, 272, 000	70	-------
Moderate density	71, 080, 000	29, 012	. 041	51 to 80 percent other	2, 886, 000	-------	-------
Light density	25, 310, 000	2, 155	. 009	Pure other	3, 044, 000	0	-------
Pure Douglas fir	126, 070, 000	50, 553	. 040	Unburned slash	4, 088, 110	63, 626	1. 556
21 to 50 percent hemlock	7, 475, 000	8, 085	. 110	Fern, brush, grass	70, 755, 770	9, 595	. 014
51 to 80 percent hemlock	2, 123, 000	469	. 022	Recent cut-overs	8, 206, 200	1, 938	. 023
Pure hemlock	2, 478, 000	-------	-------	No special hazard	74, 089, 920	2, 252	. 003
21 to 50 percent cedar	3, 411, 000	17, 490	. 513	Snags	11, 097, 368	73, 350	. 661
51 to 80 percent cedar	1, 101, 000	18	-------	Steep slope	31, 280, 000	57, 640	. 184
Pure cedar	1, 441, 000	117	. 008	Moderate slope	105, 960, 000	18, 510	. 017
				Level	19, 960, 000	1, 261	. 006

[1] Volume basis: Total exposure, 157,200,000 M. ft. b. m.; total annual loss, 77,411 M. ft. b. m. (0.049 percent).

TABLE 17.—*Class break-down; class 3, small poles 25 feet high to 6 inches diameter*[1]

Hazard	Exposed	Lost	Burning ratio	Hazard	Exposed	Lost	Burning ratio
	Acres	*Acres*	*Percent*		*Acres*	*Acres*	*Percent*
Heavy density	241, 900	107	0. 044	No special hazard	370, 138	152	0. 041
Moderate density	437, 700	290	. 066	Snags	55, 322	394	. 712
Light density	104, 400	49	. 047	Steep slope	156, 000	227	. 146
Unburned slash	20, 384	88	. 432	Moderate slope	529, 000	144	. 027
Fern, brush, grass	352, 800	132	. 037	Level	99, 000	75	. 076
Recent cut-overs	40, 678	74	. 182				

[1] Area basis: Total exposure, 784,000 acres; total annual loss, 446 acres (0.057 percent).

TABLE 18.—*Class break-down; class 4, large poles 6 to 19 inches diameter*[1]

Hazard	Exposed	Lost	Burning ratio	Hazard	Exposed	Lost	Burning ratio
	Acres	*Acres*	*Percent*		*Acres*	*Acres*	*Percent*
Heavy density	1,437,000	764	0.052	51 to 80 percent other	12,600	1	0.008
Moderate density	1,751,000	1,169	.066	Pure other	3,400		
Light density	354,000	316	.089	Unburned slash	92,092	1,035	1.124
Pure Douglas fir	3,054,000	1,829	.060	Fern, brush, grass	1,593,900	493	.031
21 to 50 percent hemlock	103,800	232	.224	Recent cut-overs	184,184	344	.187
51 to 80 percent hemlock	172,900	102	.059	No special hazard	1,671,824	358	.021
Pure hemlock	127,200			Snags	249,711	1,756	.703
21 to 50 percent cedar	25,700	29	.113	Steep slope	704,500	1,146	.163
51 to 80 percent cedar	10,900	10	.092	Moderate slope	2,387,900	824	.035
Pure cedar	1,200	2	.167	Level	449,600	260	.058
21 to 50 percent other	30,300	25	.083				

[1] Area basis: Total exposure, 3,542,000 acres; total annual loss, 2,230 acres (0.063 percent).

TABLE 19.—*Class break-down; class 5, reproduction less than 25 feet high*[1]

Hazard	Exposed	Lost	Burning ratio	Hazard	Exposed	Lost	Burning ratio
	Acres	*Acres*	*Percent*		*Acres*	*Acres*	*Percent*
Heavy density	337,400	1,082	0.321	No special hazard	624,928	4,136	0.662
Moderate density	619,600	9,602	1.550	Snags	93,342	11,733	12.570
Light density	367,000	1,510	.411	Steep slope	263,600	4,434	1.683
Unburned slash	34,424	3,990	11.591	Moderate slope	892,300	6,877	.771
Fern, brush, grass	595,800	3,380	.567	Level	168,200	883	.525
Recent cut-overs	68,848	688	.999				

[1] Area basis: Total exposure, 1,324,600 acres; total annual loss, 12,194 acres (0.921 percent).

Following is the summarization of the causative hazard study in the Douglas fir region, from which it is possible to compute weighted average increases in hazard in properties exposed.

RECAPITULATION—SUMMARY OF CAUSES

(From study of 10 counties in the Douglas fir region)

Protected area	square miles	9,043
Total fires	number	4,182
Man-caused	do	3,912
Lightning	do	270
Basic fires (incendiary, miscellaneous, and unknown)	number	1,086
Railroad fires	do	146
Area of zone within ½ mile of railroad	square miles	412
Lightning fires	number	270
Area of lightning zone	square miles	6,360
Recreation fires	number	1,393
Area of recreation zone	square miles	5,201
Man-caused fires within ½ mile of auto roads	number	2,361
Area of zone within ½ mile of auto roads	square miles	3,257
Rancher fires	number	525
Area of zone within ½ mile of ranches	square miles	2,417
Lumbering fires	number	762
Area of zone within ½ mile of lumbering	square miles	357
Class C fires	number	1,401
Total area	acres	676,332
Within ½ mile of auto road:		
Fires	number	750
Area	acres	312,683
More than ½ mile from auto road:		
Fires	number	651
Area	acres	363,649

It will be noted that a record was made both of the number of man-caused fires within one-half mile of an auto road and the area of this road zone. This is because it was observed that some man-

caused fires tend to concentrate near roads passable by automobiles. As is indicated by the figures at the bottom of the tabulation, evidence is negative that fires near roads are kept to smaller sizes. While the average size of class C fires (10 acres or more) is somewhat less near the roads, the number, per unit of area, attaining this classification is materially larger.

Before proper allowance can be made for differentiation for this concentration, a modification of the above figures is required. Roads do not start fires but the effect of their presence is such that they must be treated like genuine causes. They influence, however, only two classes of actual causes, basic and recreation. All the other causes correlate with factors independent of road location. (Lightning is a zonal cause but is obviously independent of auto roads. Railroads, ranches, and lumbering expose areas surrounding their exact locations. Once fires are correlated with them no further correlation is possible.)

For true differentiation, only the incendiary, miscellaneous, and unknown fires that occur at greater distances than one-half mile from auto roads, plus a proportional allowance, by area, for fires in this category within one-half mile, are truly basic. This is 435 plus 245=680. Recreation, by itself, causes, outside the ½-mile zone, 437 fires. It also causes, within the zone, independently of the roads, 246 fires, giving a total of 683 fires chargeable solely to recreation. There is, accordingly, a total of 1,116 fires chargeable solely to the roads (406 incendiary and miscellaneous and unknown, plus 710 recreation fires).

Adjusting the above recapitulation in the light of these considerations produces figures as follows:

REVISED SUMMARY OF CAUSES

(From study of 10 counties in the Douglas fir region)

Protected area	square miles	9,043
Total fires	number	4,182
Man-caused	do	3,912
Lightning	do	270
Basic fires (incendiary, miscellaneous, and unknown, not chargeable to auto roads)	number	680
Railroad fires	do	146
Area of zone within ½ mile of railroad	square miles	412
Lightning fires	number	270
Area of lightning zone	square miles	6,360
Recreation fires (not chargeable to auto roads)	number	683
Area of recreation zone	square miles	5,201
Fires chargeable to auto roads	number	1,116
Area of zone within ½ mile of auto roads	square miles	3,257
Rancher fires	number	525
Area of zone within ½ mile of ranches	square miles	2,417
Lumbering fires	number	762
Area of zone within ½ mile of lumbering	square miles	357

The resultant computation is as follows:

Cause	*Hazard increase (percent)*
Railroads	471
Lightning	56
Recreation	175
Roads	456
Ranches	289
Lumbering	2,839

These are the average increases in hazard over the basic or standard condition arising from the causes named, on a number of fires per unit of area basis. In almost all cases the unit of area is that lying within one-half mile of the causative agency. Lightning and recreation are, of course, zonal causes, as explained in the detailed discussion of causative hazards.

The construction of the schedule involves the use of all these data but with still further refinement, interpretation, and rationalized additions. The process is too involved for detailed textual description. Examination of the schedule itself will indicate what is meant here and the uses to which the material was put.

Before the schedule itself could be constructed, money values had to be introduced. Table 20 shows how this was done, how the allowances for major conflagrations, expense ratios, and factor of safety were introduced, and how premium collection between classes was provided for in proper ratio.

TABLE 20.—*Build-up of rate and premium collection between classes, Douglas fir region*

PURE LOSS COST—10-YEAR EXPERIENCE—NO CONFLAGRATIONS

Class	Value	Premium contribution	Rate (cents)
1 (20 to 40 inches)	[1] $154,400,000	$51,608	3.3
2 (larger than 40 inches)	[1] 157,200,000	77,411	4.9
3 (25 feet to 6 inches)	[2] 5,880,000	3,345	5.7
4 (6 to 10 inches)	[3] 44,275,000	27,875	6.3
5 (less than 25 feet)	[4] 1,324,000	12,194	92.1
Total	363,079,000	172,433	4.7

WITH 50-PERCENT EXPENSE RATIO PRORATED BETWEEN THE FIRST 4 CLASSES

1	$154,400,000	$107,143	6.9
2	157,200,000	160,713	10.2
3	5,880,000	6,945	11.8
4	44,275,000	57,871	13.1
5	1,324,000	12,194	92.1
Total	363,079,000	344,866	9.5

WITH CONFLAGRATION RESERVE ($500,000 PER YEAR) PRORATED BETWEEN FIRST 4 CLASSES

1	$154,400,000	$268,177	17.4
2	157,200,000	402,202	25.6
3	5,880,000	17,383	29.6
4	44,275,000	144,850	32.7
5	1,324,000	12,194	92.1
Total	363,079,000	844,866	23.3

RAISING TO BASIS OF 50-CENT AVERAGE RATE PRORATING BETWEEN FIRST 4 CLASSES

1	$154,400,000	$580,753	38
2	157,200,000	871,123	55
3	5,880,000	37,044	64
4	44,275,000	313,681	71
5	1,324,000	12,194	92
Total	363,079,000	1,815,305	50

[1] $1 per M ft. b.m. [2] $7.50 per acre. [3] $12.50 per acre. [4] $1 per acre.

Class charges (to be used in final rating schedule)—basis of class rates as above:

Class 1, standard, no charge.
Class 2, 44.7-percent charge.
Class 3, 68.4-percent charge.
Class 4, 86.8-percent charge.
Class 5, 142.1-percent charge.

Break-downs within the classes depend, as has been said, on the weights indicated by the amounts at risk affected by the individual hazard factors. As an example, the break-down of class 2 in the Douglas fir region is given as it was adopted on the basis of the obtainable statistics:

Hazard factor and exposure	
Deficient protection	Average is class 2 protection.
Adverse climatic condition	Average is zone 3.
Susceptibility	30 percent of volume takes susceptibility charge.
Moderate density	45 percent of volume takes moderate-density charge.
Heavy density	39 percent of volume takes heavy-density charge.
Moderate slopes	66.6 percent takes moderate-slope charge.
Steep slopes	20 percent takes steep-slope charge.
Unburned slash	2.6 percent takes unburned-slash charge.
Recent cut-overs	5.2 percent takes recent cut-over charge.
Fern, brush, grass	45 percent takes fern, brush, and grass charge.
Snags	7.5 percent takes snag charge.
Lightning zone	70 percent takes lightning charge.
Railroads	4.5 percent takes railroad-exposure charge.
Ranches	27 percent takes ranch-exposure charge.
Lumbering	3.9 percent takes lumbering-exposure charge.
Recreation zone	58 percent takes recreation charge.
Roads	36 percent takes passable road charge.

Combining these exposures with the charges prescribed in the rating schedule gives evidence that the average risk in class 2 will rate as follows:

Test of average rate, class 2, Douglas fir region:	*Cents*
Basis rate	2.5
Charge for class 2 protection	1.0
Charge for climatic zone 3	2.5
Key rate	6.0
Class charge	5.0
Class rate	11.0
Contributive hazards:	
Susceptibility (30 percent of 17 percent[1]=5 percent)	.5
Moderate density (45 percent of 50 percent=22.5 percent)	2.5
Heavy density (39 percent of 110 percent=43 percent)	4.7
Moderate slopes (66.6 percent of 60 percent=40 percent)	4.4
Steep slopes (20 percent of 500 percent=100 percent)	11.0
Unburned slash (2.6 percent of 1,000 percent=26 percent)	2.9
Recent cut-overs (5.2 percent of 50 percent=2.6 percent)	.3
Fern, brush, grass (45 percent of 35 percent=16 percent)	1.8
Snags (7.5 percent of 35 percent=2.6 percent)	.3
Total	28.4
Unexposed property rate	39.4

Causative hazards:	Cents
Lightning (70 percent of 6 percent=4.2 percent)	1.6
Railroads (4.5 percent of 56 percent=2.5 percent)	1.0
Ranches (27 percent of 28 percent=7.5 percent)	3.0
Lumbering (3.9 percent of 266 percent=10.4 percent)	4.1
Recreation (58 percent of 33.3 percent=19.3 percent)	7.6
Roads (36 percent of 27 percent=9.7 percent)	3.8
Total	21.1
Gross rate	60.5

[1] Taken as the average susceptibility charge for all species.

This sort of computation is never more than approximate, but it is the only process open to the inquiry. The average rate shown by the test is 60.5 cents, 5.5 cents higher than the average planned for by the schedule. Any attempt to improve the computations further would, however, exceed the possibility of practical significance, and the logical recourse is to accept the specifications of the schedule as they are given. This test was applied in all the other classes with similar results.

It will be noted that the rate schedule for the Douglas fir region contains provision for a differentiation that has so far not been mentioned. This is whether the hazard factor, not occurring on the insured property itself, is located to the north or east or the south or west. Because of a peculiar condition existing in this region, such a differentiation must be made, although no statistical material is available as a guide. As proposed here, the provision for this differentiation is purely rationalized.

In this region, practically without exception, forest fires are dangerous only when the wind comes from a point between due north and due southeast. Southerly and westerly winds bear humidities that seldom favor active burning. The spread of fire toward the north or east is accordingly a very rare exception to the general rule.

THE PONDEROSA PINE REGION

In the method of integration applied in the ponderosa pine region, two main considerations stand out. The first is that principles and values established in any one region bear some significance in all other regions. The second is that Forest Service estimates give at least a general indication of the characters and amounts of the private-forest holdings in any region. Lacking better data, these figures can always be relied upon to keep the findings of the insurance study within reasonable bounds.

The actual practice was a combination of two methods, one based on the findings in the Douglas fir region and the other on the Forest Service data. Two processes substantially paralleling each other were run, and the final pronouncement is the result of a rational reconciliation of the two separate results.

This process is based on the following consideration: Variations between component effects, region to region, are caused either by differences in the influences of the same hazard factors, by the influences of different factors, or by combination of the two. If all the differences are due to different values of the same factors, and all are properly measured and allowed for in both regions, then the

same basis rate will serve equally well in either region. If new factors come in, it is necessary to introduce them, and, if the data are properly collected, no difficulty is encountered in expressing their values in terms of the common basis rate (since they can always be related to one of the factors that is common). These new factors can either be introduced by themselves or buried in the basis rate, whichever best serves the purposes of simplicity and logical order.

The most desirable, and in fact the most likely, application is one which carries forward the same basis rate. The effect of this is a general conformity which minimizes the chance of confusion and error. The rate schedule proposed for the ponderosa pine region is built up from the same basis rate used in the Douglas fir region schedule—2½ cents.

This recommendation is made in spite of the fact that no climatic-hazard differentiation is made within the pine region, implying that the basis rate might be raised so as to include the climatic charge and eliminate the necessity of introducing it separately. But if this had been done there would have been insufficient spread between the basis rate and the final rates for proper differentiation between the other hazard factors particularly with respect to protection.

During the decade 1921 to 1930, inclusive, according to summaries compiled by the State foresters, the Forest Service, and the local protective associations, the losses resulting from forest fires in the ponderosa pine region were as follows:[13]

Merchantable timber killed	M feet b.m.	824,152
Second growth and reproduction burned	acres	172,124

Because of incomplete reporting, adequate figures for the preceding decade cannot be made available. According to the only obtainable record, losses in the ponderosa pine portion of Oregon and Washington during the decade 1911 to 1920, inclusive, were only about one-fifth of those reported for the succeeding decade. It is obvious, though, that the record is fragmentary. Some counties are entirely omitted. The only possible sound statistical base for the region is accordingly the reported experience of the 1921–30 decade.

The annual rate of reported loss is therefore taken as:

Merchantable timber killed or destroyed	M feet b. m.	82,415
Second growth and reproduction burned	acres	17,212

These figures were adjusted, on the basis of the original field analysis, as follows:[14]

Merchantable timber killed or destroyed (65.0 percent increase)	M feet b. m.	135,982
Second growth and reproduction burned (23.3 percent increase)	acres	22,087

In the ponderosa pine region, land bearing merchantable timber also bears advance-growth reproduction or second growth with potential insurable value which must also be considered. After applying the correction that was developed by the field-analysis work there

[13] These are losses on other than national-forest and Indian lands regardless of how or by whom they were protected and reported upon.

[14] The percent increases do not correspond to the increases quoted on p. 137, which applied to the Oregon and Washington portions only. No adjustments were applied to figures from California because of more intensive methods of data collection there.

was found to be an annual average of 21,804 acres of merchantable timber burned over. This constitutes, also, 21,804 acres of reproduction and/or second growth.

Actually, therefore, annual gross losses in the ponderosa pine region can be taken as:

Merchantable timber killed or destroyed	M feet b. m.	135,982
Second growth and reproduction	acres	43,891

The salvage probability of merchantable timber was determined by the field analysis to be 25 percent. Loss of reproduction and second growth on burned areas was almost invariably complete so no allowance has been introduced for partial loss. The net-area-lost figure is accordingly the same as the gross area burned.

Annual net losses in the region are accordingly taken as:

Merchantable timber	M feet b. m.	101,986
Second growth and reproduction	acres	43,891

According to carefully adjusted figures this loss took place on forest areas containing approximately 89,472,000 M feet b. m. of merchantable timber and 7,873,000 acres of reproduction and second growth.[16]

A preliminary integration of these figures is as follows:

Merchantable timber:		
Volume at risk	M feet b. m.	89,472,000
Net annual loss	do	101,986
Rate of loss	percent	0.114
Second growth and reproduction:		
Area at risk	acres	7,873,000
Net annual loss	do	43,891
Rate of loss	percent	0.557

This is the only classification required for practical forest fire insurance rating and underwriting in the region. Two classes only are used, (1) merchantable timber and (2) unmerchantable timber. The class charges are developed from the differential indicated above.

Tables 21 and 22 show a proportional break-down of a large sample of both private and national-forest property by forest types and hazard factors. Since detailed survey figures are not available for this region, there was no possibility of computing direct burning ratios as was done in the Douglas fir region. The development of the rating schedule from the statistics is consequently much more dependent upon speculation and rationalization than it was in the fir region. The work done in the fir region was of very great assistance and was drawn upon extensively, although, of course, not all of the factors could be measured in this manner but required additional data from the pine region itself.

The determination of the hazard value of the desert edge, for example, was made by ascertaining as closely as possible how much of the forest is within 1 mile of the desert edge and how damage in that portion compares with damage in the remaining portion. The indication was that about 10 percent of the forested area of the Oregon portion of the region is within 1 mile of the desert. Assuming this same distribution for timber of merchantable size and pro-

[16] These figures are estimates for the portions of the region from which the reported fire losses actually came. They are not estimates of any one class of ownership and are not comparable with any figures quoted elsewhere in this report.

portioning the loss as indicated near the bottoms of the two preceding forms indicate relative hazards as follows:

Within 1 mile of desert: 8,947,200 M feet board measure at risk; 74,930 M feet board measure lost; burning ratio, 0.837 percent.

More than 1 mile from desert: 80,524,800 M feet board measure at risk; 61,052 M feet board measure lost; burning ratio, 0.076 percent.

TABLE 21.—*Average annual loss in ponderosa pine type by hazard factors, Oregon and Washington only*[1]

Hazard factor	Net loss		Hazard factor	Net loss	
	Merchantable timber	Reproduction		Merchantable timber	Reproduction
	Mft. b. m.	*Acres*		*Mft. b. m.*	*Acres*
Total damage	133, 184	15, 261	Steep slopes	52, 385	5, 333
Age:			Moderate slopes	44, 505	5, 097
350 years plus	132, 726	14, 400	Level land	36, 294	4, 831
150 to 349 years	74	87	Within 1 mile of desert	85, 739	8, 856
Less than 150 years	384	774	More than 1 mile from desert	47, 465	6, 405
Heavy density	108, 174		Under merchantable timber		11, 704
Moderate density	15, 335		Not under merchantable timber		3, 557
Light density	9, 675			*Acres*	
Heavy brush	3, 240	470	Crown burned	10, 070	
Grass	121	487	Surface burned	10, 324	
Unburned slash	71, 213	9, 079			
No special hazard	58, 610	5, 225			

[1] Combining loss estimates from annual summaries (corrected) and contributive hazard study from field analyses, eastern Oregon and Washington, national-forest and private lands.

TABLE 22.—*Average annual loss in fir type*[1] *by hazard factors, Oregon and Washington only*[2]

Hazard factor	Net loss		Hazard factor	Net loss	
	Merchantable timber	Reproduction		Merchantable timber	Reproduction
	Mft. b. m.	*Acres*		*Mft. b. m.*	*Acres*
Total damage	22, 690	2, 357	Steep slopes	189	82
Age:			Moderate slopes	9, 767	965
350 years plus	22, 575	2, 298	Level land	12, 734	1, 310
150 to 349 years			Within 1 mile of desert	189	159
Less than 150 years	115	59	More than 1 mile from desert	22, 501	2, 198
Heavy density	17, 292		Under merchantable timber		2, 172
Moderate density	4, 925		Not under merchantable timber		185
Light density	473			*Acres*	
Heavy brush	350	48	Crown burned	1, 940	
Grass			Surface burned	1, 123	
Unburned slash	19, 964	1, 702			
No special hazard	2, 376	607			

[1] Including Douglas fir, fir-larch, and mixed conifers.
[2] Combining loss estimates and annual summaries (corrected) and contributive hazard study from field analyses, eastern Oregon and Washington, national-forest and private lands.

In other words, according to the data produced by this study, the fire hazard is 10 times greater within 1 mile of the desert edge than it is, other things being equal, in all the rest of the forest, an increase of 1,000 percent. A similar computation for unmerchantable timber showed an increase of 842 percent. These seem like large figures, but an examination of any fire-occurrence map will show the tendency for the larger fires to group in this zone. This hazard

increase can be accounted for by worse wind conditions, greater dryness, and the increased prevalence of whirlwinds near the desert edge. A whirlwind in a going fire can produce an appalling havoc in a surprisingly short time.

The charge introduced into the compressed rating schedule for proximity to the desert edge has been set at 775 percent for both classes. This charge should be closely watched as actual experience is gained, when modification may be required.

The range of hazard being narrower, the compression of the schedule in the ponderosa pine region from the actual hazard range is relatively not as great as in the Douglas fir region.

The final adaptation of the evidence produced by the data shown in tables 21 and 22 was based on long and complicated computations, involving such approximate weightings as could be determined, and upon necessarily liberal interpretations involving both rationalizing with respect to the pine region itself and the admission of evidence produced by the more intensive study of the Douglas fir region. For the present purpose a somewhat free discussion will serve better, it is believed, than an attempt to present a digest of the process itself.

No correlation could be developed, with respect to age classes, and this factor was accordingly omitted.

Although more merchantable timber is evidently lost in stands of moderate density than in stands of light density, a weighting of volumes at risk indicates that the fire hazard is actually greater in the latter. This is very likely due mainly to the development of heavier brush in the lighter stands which, when it burns, develops sufficient heat to kill most or all of the trees. The charges for unburned slash and heavy brush are drawn directly from the Douglas fir region schedule. No correlation could be developed for grass, and there is no fern in the region. The recently cut-over areas where the slash has been satisfactorily disposed of do not appear to cause a measurable increase in the hazard.

In the ponderosa pine region the sweep of the winds caused by insolational convection creates a tendency for fires to crown in stands on level ground. Where the terrain is broken, the wind is also broken, and a condition is apparently developed under which the effects of wind and terrain virtually neutralize each other. Accordingly no distinction is made in this region between degrees of slope.

It will be noted that in the pine region exposure charges are made equal in all directions rather than differentiated in favor of south and west, as is the case in the fir region. This is because, while most of the fires run toward the southeast on the convection winds, some of the worst ones have occurred on dry south and east winds. No justification could be developed for making any distinction with respect to probable direction of spread in terms of likelihood of loss.

The summary of the causative hazard study in the ponderosa pine region follows:

RECAPITULATION—SUMMARY OF CAUSES

(From study of 4 Oregon counties in the ponderosa pine region—10 years)

Protected area	square miles	8,547
Total fires	number	3,245
Man-caused	do	1,615
Lightning	do	1,630
Basic fires (incendiary, miscellaneous, and unknown)	number	250
Railroad fires	do	36
Area of zone within ½ mile of railroad	square miles	223
Lightning fires	number	1,630
Area of lightning zone		(1)
Recreation fires	number	897
Area of recreation zone	square miles	6,098
Man-caused fires within ½ mile of first-class auto road	number	687
Area of first-class auto road zone (½ mile)	square miles	1,719
Man-caused fires within ½ mile of second-class auto road	number	142
Area of second-class auto road zone	square miles	739
Man-caused fires more than ½ mile from any auto road	number	786
Area more than ½ mile from any auto road	square miles	6,089
Rancher (brush burning) fires	number	47
Lumbering (all causes) fires	do	112
Stockmen's fires	do	273
Class C fires	do	345
Total area	acres	125,673
Within ½ mile of auto road:		
Fires	number	159
Area	acres	92,246
More than ½ mile from auto road:		
Fires	number	186
Area	acres	33,427

[1] Entire region.

NOTE.—In the ponderosa pine region, there are five classes of causes which do not correlate geographically, namely: Incendiary, miscellaneous and unknown, lightning, and stockmen. The fires from these causes should all be combined into the basic group, making the number of basic fires 2,153. Correcting for roads, the correction not applying to lightning or stockmen's fires, leaves the number of truly basic fires 2,007.

Revising, to allow properly for the influence of auto roads, produces the following figures:

REVISED SUMMARY OF CAUSES

(From study of 4 Oregon counties in the ponderosa pine region)

Protected area	square miles	8,547
Total fires	number	3,245
Man-caused	do	1,615
Lightning	do	1,630
Basic fires (incendiary, miscellaneous and unknown, lightning, and stockmen not chargeable to auto roads)	number	2,007
Railroad fires	do	36
Area of zone within one-half mile of railroads	square miles	223
Recreation fires (not chargeable to auto roads)	number	404
Area of recreation zone	square miles	6,098
Fires chargeable to first-class auto roads	number	540
Area of first-class auto road zone	square miles	1,719
Fires chargeable to second-class auto roads	number	99
Area of second-class auto road zone	square miles	739
Rancher fires	number	47
Lumbering fires	do	112

Applying such weights as could be obtained in the region itself gave indication of increases in hazard with exposure to causes as follows:

Cause	*Hazard increase (percent)*
Lightning	[1]
Railroads	60
Recreation	28
Roads:	
First-class	134
Second-class	57
Roads combined	111

[1] No zone discernible.

The schedule as made up does not provide for a distinction between first- and second-class roads even though the process clearly indicates a hazard variable. Whether or not this differentiation ought to be made in actual practice is difficult to say definitely. On the one hand is greater simplicity and the elimination of the need to define a second-class road; on the other is an established variation in hazard

TABLE 23.—*Build-up of rate and premium collection, ponderosa pine region*

LOSS COST ONLY

Class	Insurable value	Premium contribution	Rate (cents)
Merchantable ponderosa pine	[1] $150,575,000	$178,475	11.4
Merchantable other species	[2] 13,421,000	15,208	11.4
Unmerchantable young growth	[3] 1,968,000	10,973	55.8
Total	171,964,000	204,746	11.9

50-PERCENT EXPENSE RATIO ALLOCATED TO MERCHANTABLE VALUE ONLY

Merchantable ponderosa pine	$150,575,000	$367,057	23.4
Merchantable other species	13,421,000	31,402	23.4
Unmerchantable young growth	1,968,000	10,973	55.8
Total	171,964,000	409,492	23.8

RAISING TO 40-CENT AVERAGE RATE,[4] PRORATING BETWEEN 3 CLASSES

Merchantable ponderosa pine	$150,575,000	$610,575	39.4
Merchantable other species	13,421,000	52,849	39.4
Unmerchantable young growth	1,968,000	18,432	93.7
Total	171,964,000	687,856	40.0

[1] $2.50 per M ft. b. m.
[2] $0.50 per M ft. b. m.
[3] $0.25 per acre.
[4] Strict application of the principle of the addition of a 75-percent conflagration and contingent allowance would produce an average rate of 41.6 cents. Rounding off to 40 cents makes the allowance actually used 68 percent.

of apparent importance. The author's inclination is toward not making the distinction, feeling that the increase in fairness would not justify the effort of distinguishing accurately between the classes of roads. If it is later decided that the differentiation is desirable, it can easily be introduced.

The actual charges for causative hazards in the schedule are the result of a process of harmonizing the statistical evidence from the region itself with the causative hazard measurements of the Douglas

fir region and the need for compression of the range of rating relative to that of hazard itself. It will be noted that some of the charges are very similar to corresponding charges in the fir region, while others are quite different. Differences are due to conclusions drawn from statistically establishable variations, from variations not statistically establishable but rationally obvious, and, to some extent, from the sheer need of introducing where possible such charges as will contribute to the production of a proper average rate. This latter requirement is a function of the checking method illustrated in the discussion of schedule construction for the fir region.

Since some of the figures that have been used are undoubtedly susceptible of betterment, practice must be applied in such a way that this betterment will be possible. No better source of statistical data could be devised than that which would result from the introduction of actual forest fire insurance practice on a broad scale.

The method of computing the distribution of premium collection between classes and building up the average rate for the region is illustrated in table 23.

THE SUGAR PINE–PONDEROSA PINE REGION

During the decade 1921 to 1930, inclusive, according to summaries embracing the whole fire experience, compiled by the Forest Service, the losses from forest fires in the sugar pine-ponderosa pine region of California (exclusive of those on national-forest land) were as follows:

Merchantable timber killed or destroyed	M feet b. m.	829,704
Second growth and reproduction burned	acres	105,160

An extensive examination of the record for the preceding decade indicated that the loss experience during that period did not differ greatly from that indicated for this decade. The annual rate of loss for the region is accordingly taken as:

Merchantable timber killed or destroyed	M feet b. m.	82,970
Second growth and reproduction burned	acres	10,516

No field analysis was run in the sugar pine region from which a basis of adjustment or correction of the reported figures could be deduced. Such correction is, moreover, not believed to be required in this region. Records have been, on the whole, very carefully kept and have been based on field data having a high degree of accuracy. The loss data from all fires of any material importance are obtained from damage surveys run by the administrative branch of the Forest Service with the same intensity and degree of accuracy as the field analyses conducted in the other regions by the insurance study itself. In this region, therefore, the losses are taken as reported, without adjustment.

As in the ponderosa pine region, land bearing merchantable timber also ordinarily bears advance-growth reproduction or second growth with a potential insurable value. The reported area of merchantable timber burned annually was 14,374 acres. Adding this to the 10,516 acres brings the total of reproduction and second growth annually burned to 24,890 acres.

Salvage probability of merchantable timber was taken to be the same as in the ponderosa pine region, or 25 percent. As in that region, also, complete destruction of reproduction and second growth on all areas affected by fire seems to be the general rule and no provision is made for partial loss in these stands.

Annual net losses in the region are accordingly taken as:

Merchantable timber	M feet b. m.	62,227
Second growth and reproduction	acres	24,890

According to 1931 Forest Service figures, this loss took place while the region contained approximately 54,032,000 M feet board measure of merchantable timber and 2,691,000 acres of reproduction and second growth. A preliminary integration of these figures is as follows:

Merchantable timber:		
Volume at risk	M feet b. m.	54,032,000
Net annual loss	do	62,227
Rate of loss	percent	0.115
Second growth and reproduction:		
Area at risk	acres	2,691,000
Net annual loss	do	24,890
Rate of loss	percent	0.925

As in the ponderosa pine region, this is the only classification required for practical rating purposes.

From these basic data, combined with the knowledge that the region differs only slightly from the ponderosa pine region in respect to fire, the construction of the rating schedule is a relatively simple process. As designed it is identical with the following exceptions:

1. There is no desert fringe in this region, but an equal charge is allocated to the strip lying within 2 miles of the edge of the California woodland type.
2. Allowance is made for climatic-zone variation within the region.
3. No charge is made for exposure to brush areas, since there is not believed to be sufficient variation in this respect.
4. The class charge for unmerchantable growth is greater.
5. A variation in lightning hazard is allowed for in the form of a credit applying in a part of the region (fig. 17).

Brush areas are so widely distributed throughout the region that equitable differentiation with respect to them would be practically impossible for insurance purposes. The introduction of the allowance for lightning hazard as a credit for the free area rather than as a charge for the exposed area is a departure from ordinary practice, but is, all factors considered, a simpler method of handling the matter in this particular case. Putting it in as a charge would have necessitated modifying all the other contributive hazard charges as they came from the ponderosa pine region although if most of the region had been lightning-free it would have been advisable to do this.

Table 24 shows the method of computing premium distribution between the classes and building up the average rate.

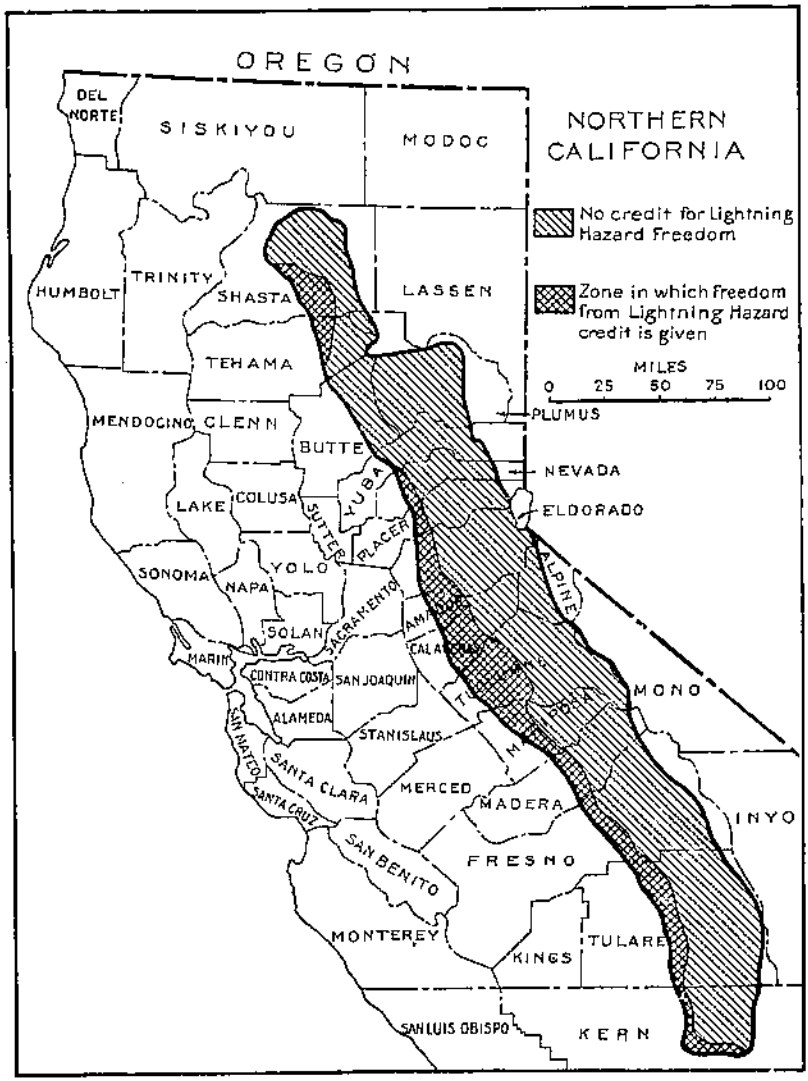

FIGURE 17.—Zone in the sugar pine-ponderosa pine region in which credit is given for freedom from lightning hazard.

TABLE 24.—*Build-up of rate and premium collection, sugar pine-ponderosa pine region*

LOSS COST ONLY

Class	Insurable value	Premium contribution	Rate (cents)
Merchantable pine	[1] $89,000,000	$102,350	11.5
Merchantable, other species	[2] 27,000,000	31,050	11.5
Unmerchantable young growth	[3] 2,691,000	24,892	92.5
Total	118,691,000	158,292	13.3
RAISING TO BASIS OF 35-CENT AVERAGE—INCREASE TO MERCHANTABLE ONLY			
Merchantable pine	$89,000,000	$260,628	33.7
Merchantable, other species	27,000,000	90,898	33.7
Unmerchantable young growth	2,691,000	24,892	92.5
Total	118,691,000	415,418	35.0

[1] $2.75 per M ft. b. m. [2] $1.25 per M ft. b. m. [3] $1 per acre.

PROPOSED SCHEDULES OF RATES

FOR FOREST PROPERTIES IN THE DOUGLAS FIR REGION OF OREGON AND WASHINGTON AND THE REDWOOD REGION OF CALIFORNIA

Regional basis rate: 2.5 cents.

CHARGES

Protection deficiency charge.—Four classes of protection deficiency; class 1, none; class 2, 40 percent; class 3, 80 percent; class 4, 120 percent.[10]

Protection deficiency by counties, and county basis rates

County	Class	Deficiency charge	County basis rate	County	Class	Deficiency charge	County basis rate
Washington:		*Percent*	*Cents*	Oregon:		*Percent*	*Cents*
Chehalis	2	40	3.5	Benton	2	40	3.5
Clark	3	80	4.5	Clackamas	1	None	2.5
Cowlitz	3	80	4.5	Clatsop	1	None	2.5
Grays Harbor	2	40	3.5	Columbia	1	None	2.5
Jefferson	3	80	4.5	Coos	1	None	2.5
Island	3	80	4.5	Curry	4	120	5.5
King	1	None	2.5	Douglas	1	None	2.5
Kitsap	2	40	3.5	Hood River	1	None	2.5
Lewis	2	40	3.5	Lincoln	2	40	3.5
Mason	2	40	3.5	Linn	1	None	2.5
Pacific	3	80	4.5	Lane	3	80	4.5
Pierce	1	None	2.5	Marion	1	None	2.5
San Juan	3	80	4.5	Multnomah	3	80	4.5
Skagit	2	40	3.5	Polk	2	40	3.5
Skamania	3	80	4.5	Tillamook	2	40	3.5
Snohomish	2	40	3.5	Washington	1	None	2.5
Thurston	2	40	3.5	Yamhill	1	None	2.5
Wahkiakum	4	120	5.5				
Whatcom	2	40	3.5				

Climatic zone charge.—Flat charges to be added to county basis rates: Zone 1, no charge; zone 2, 1.25 cents; zone 3, 2.5 cents; zone 4, 3.75 cents; zone 5, 5 cents.

Key rate: —— cents.

Class charge.—Flat charges to be added to key rate: Class 1 (20–40 inches),

[10] All properties in the redwood region of California take the class 4 deficiency charge. If better protection is provided, allowance is made for grading and rating under the private-protection warranty.

no charge; class 2 (more than 40 inches), 5 cents; class 3 (25 feet to 6 inches), 18 cents; class 4 (6–20 inches), 21 cents; class 5 (less than 25 feet), 30 cents.

Class rate: —— cents.

Contributive hazards

Charges for contributive hazards are percentages of class rates.

Susceptibility.—Hemlock, spruce, true firs, or other species except live cedar in the insured stand. Susceptibility charge applies to the portion of the insured value that rests in these species.

	Class 1	Class 2	Class 3	Class 4	Class 5
	Percent	*Percent*		*Percent*	
Hemlock	20	20	(1)	20	(1)
True firs	10	10	(1)	10	(1)
Spruces	20	20	(1)	20	(1)
Others	12½	12½	(1)	12½	(1)
Cedar:					
Live	None	None	(1)	None	(1)
Dead	20	20	(1)	None	(1)

[1] No susceptibility charge. Susceptibility variation not measurable in small trees.

Density.—Three grades: In classes 1 and 2 less than 30 M feet b. m. per acre (gross) is light density; 30 M feet b. m. to 60 M feet b. m. is moderate density; over 60 M feet b. m. is heavy density. In classes 3, 4, and 5 less than 40 percent stocking is light density; 40 percent to 70 percent is moderate density; over 70 percent is heavy density.

	Class 1	Class 2	Class 3	Class 4	Class 5
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Light density	None	None	16⅔	10	8
Moderate density	110	50	10	5	2
Heavy density	16⅔	110	None	None	None

Topography.—No charge in any class for level ground (less than 10-percent slope). Moderate slopes are 10 to 40 percent. Steep slopes are over 40 percent. Topography deficiency charge applies to portions of ground under the insured stand reported as being over the specified degrees of steepness.

	Class 1	Class 2	Class 3	Class 4	Class 5
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Moderate slopes	60	60	None	None	None
Steep slopes	500	500	35	35	35

SPECIAL HAZARDS

(*a*) *Logging slash.*—Unburned slash from logging or other wood-cutting operation whether or not cleared by State forester. Standard is 40 acres or more on the property or directly adjacent to the north or east. Standard is based on what will be on the ground at the end of the fire season, not what is there at the beginning. These charges are for slash only, whether or not logging is going on.

Slash exposure charges (same in all classes)—percents of class rate[1]

Area occupied by slash (acres)	On property	Directly adjacent		¼ to 1 mile		1 to 2 miles	
		North and east	South and west	North and east	South and west	North and east	South and west
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
40 or more	1,000	1,000	250	800	200	200	None
30 to 40	800	800	200	640	160	160	None
20 to 30	400	400	100	320	80	80	None
10 to 20	200	200	50	160	40	40	None
Less than 10	100	100	25	80	20	20	None

[1] No charge in any event for slash more than 2 miles away.

(*b*) *Recent cut-overs.*—Areas recently logged but on which the slash has been burned. Reproduction, fern, brush, or grass not yet established. Ground cover is mainly of species of weeds which will occupy the soil for a limited period. The same condition can result from accidental burning. Where it is known to exist it should be charged for in the rate.

Recent cut-over charges—percents of class rate[1]

Area of cut-overs—sum of all exposing areas (acres)	On property	Directly adjacent		¼ to 1 mile		1 to 2 miles	
		North and east	South and west	North and east	South and west	North and east	South and west
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
100 or more	50	50	12½	40	10	10	None
60 to 100	40	40	10	32	8	8	None
20 to 60	20	20	5	16	4	4	None
10 to 20	10	10	2½	8	2	2	None
Less than 10	None	None	None	None	None	None	None

[1] No charge in any event for exposure more than 2 miles away.

(*c*) *Fern, brush, and/or grasslands.*—Areas previously deforested by cutting or burning and mainly occupied by these types of growth either singly or in combination. May be with or without snags. There may be some regeneration of tree species but unless these actually occupy at least 60 percent of the ground (crown surface area) this classification must apply for rating and underwriting purposes even though the tree growth may be insured.

NOTE.—This charge also applies to all rates on properties in climatic zones 1 and 2 (full 35 percent).

Fern, brush, and/or grass charges—percents of class rate[1]

Area of fern, brush, grass—sum of all exposing areas (acres)	On property	Directly adjacent		¼ to 1 mile		1 to 2 miles	
		North and east	South and west	North and east	South and west	North and east	South and west
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
100 to more	35	35	9	28	7	7	None
60 to 100	28	28	7	22½	6	6	None
20 to 60	14	14	3½	11	3	3	None
10 to 20	7	7	2	5½	1½	1½	None
Less than 10	None	None	None	None	None	None	None

[1] No charge in any event for exposure more than 2 miles away (except where the charge is general).

Dead or dying timber.—Timber dead or dying from any cause. Applies only to classes 1, 2, and 4. Classes 3 and 5 are not insurable if dead or dying nor are they considered as measurably increasing the hazard to exposed insurable growth.

Susceptibility factor, if insured.—Class 1, 10 percent; class 2, 15 percent; class 4, 5 percent.

If not insured apply susceptibility factor to the exposed insured stand as follows: Full-susceptibility factor if dead or dying timber is on the property or directly adjacent north or east. Reduce one-half if over one-fourth mile away north or east. No charge if over 1 mile away. No charge for exposure at any distance south or west (including directly adjacent).

NOTE.—This charge is made only when more than one-half of the trees on an area of 250 acres or more are dead or dying.

Snag areas.—Distinct from dead or dying timber. A snag area as defined for rating and underwriting purposes, is any area of 50 acres or more on which there is an average of 10 or more snags per acre averaging 25 feet or over in height.

Deficiency charge, all classes, 35 percent. Apply pure deficiency charge for all exposing areas between 50 and 500 acres (of snags). Double for areas between 500 and 1,500 acres. Treble for areas over 1,500 acres. These charges are for direct exposure, north or east. (If more than one-half mile away, reduce charge one-half.) If more than 1 mile away, reduce three-quarters. No charge for exposure more than 2 miles away. If south or west, reduce charges three-quarters up to 1 mile. No charge over 1 mile.

Unexposed property rate: —— cents.

(Sum of all charges to this point.)

CAUSATIVE HAZARDS

Charges for causative hazards are percentages of unexposed property rates.

Property in lightning-hazard zone.—6 percent charge, all classes.

Railroad (common carrier).—Through property or directly alongside north or east. If to south or west, reduce charge three-quarters. If more than one-fourth mile away, reduce one-half. No charge for exposure more than one-half mile away.

NOTE.—This does not include logging railroads which take the lumbering exposure charge.

Exposure charge.—Class 1, 56 percent;[17] class 2, 56 percent;[17] class 3, 72 percent; class 4, 72 percent; class 5, 72 percent.

Ranches and farms.—On property or directly adjacent north or east. If south or west, reduce charge three-quarters. If more than one-fourth mile away, reduce charge one-half. No charge for exposure more than one-half mile away.

Exposure charges.—Class 1, 28 percent; class 2, 28 percent; class 3, 48 percent; class 4, 48 percent; class 5, 48 percent.

Lumbering.—Logging operation, sawmill, pulp- or fuel-wood cutting, or other forest exploitation activity on or directly adjacent north or east, or logging railroad through property or directly alongside north or east. If south or west, reduce charge three-quarters. If more than one-half mile away, reduce charge one-half. No charge if more than 1 mile away.

Exposure charges.—Class 1, 266 percent; class 2, 266 percent; class 3, 480 percent; class 4, 480 percent; class 5, 480 percent.

Property in recreation zone.—Thirty-three and one-third percent charge, all classes.

Automobile road.—Any road which can be traveled upon by automobile during the fire season and which is open to the public. No distinction for class of road or difficulty of travel if any car can be driven upon it. No charge if a locked gate is maintained by a public authority between the insured property and the point at which the road connects with a public road, provided the gate is more than one-fourth mile from the nearest property boundary. Auto road through property or directly alongside north or east takes full charge. If south or west reduce charge three-quarters. If more than one-fourth mile away reduce one-half. No charge if more than one-half mile away.

Exposure charges.—Class 1, 27 percent; class 2, 27 percent; class 3, 40 percent; class 4, 40 percent; class 5, 40 percent.

Gross rate: —— cents.

(Sum of all charges to this point.)

[17] Possibility of salvage in these classes.

CREDITS

Natural firebreaks.—Rivers, lakes, or cultivated fields (not grass or grain). Credit applies to portion of property lying within 1 mile if the edge of the break runs in approximately due north-south or east-west direction. If the break runs diagonally the credited portion is indicated by drawing due east-west and north-south lines from its ends (or intersections with the boundaries of the property). If break is one-half mile wide or wider give full credit; one-quarter mile to one-half mile, cut credit one-fourth. Natural breaks less than one-quarter wide credited same as artificial breaks.

Credits for a break lying to north, east, or northeast, 20 percent of gross rate; south, west, or southwest, 5 percent; all around, 25 percent. If the break runs through the insured property credits apply on both sides as indicated. Break lying to northwest or southeast (a break running northeast-southwest) produces a credit of 10 percent on both sides.

Artificial firebreaks.—Fire lines, maintained as such and approved by the underwriter. They may be specially constructed or they may be roads, highways, or old road or railroad grades maintained specifically as fire lines. In order that credit may be given, the breaks must qualify as lines at which going fires would ordinarily be stopped with a minimum of backfiring. They must be so maintained that backfiring could be safely undertaken at any time without preparatory work.

Credits for break lying to north, east, or northeast, 10 percent of gross rate; south, west, or southwest, 2½ percent; all around, 12½ percent. Credit given on both sides of interior breaks as indicated.

NOTE.—Credit for firebreaks is not given unless they (1) extend at least two-thirds of the distance across the property, or (2) are at least 1 mile in length. Internal breaks cannot give credit in more than two directions.

Warranty protection.—Properties on which protection has been graded as class 4 may be given a credit for the maintenance of special protection under warranty, supplied privately or by a local association. This credit is to be computed from the description of the protection given in the warranty and shall be such as to restore the gross rate to the level it would have attained if equivalent protection had been supplied in the regular manner.

Railroad patrol.—When the railroad or logging railroad patrol warranty is attached to the policy.

Credits for common carrier railroads, three-quarters of railroad exposure charge; for logging railroads, one-sixth of the logging exposure charge.

Shut-down of logging during periods of low relative humidity.—When the humidity warranty is attached to the policy.

Credit of one-fifth of the logging charge.

NOTE.—The humidity warranty can only be attached when the assured exercises full control over all logging operations exposing the property.

Seasonal shut-down of logging.—Credit can be given for the shutting down of logging operations exposing the property for the whole or a part of the fire season provided a bona fide experienced fire warden is kept on the property in addition to the protection otherwise allowed for in the rate. The end of the fire season is to be judged by the underwriter, and the resumption of logging must be with written consent only. No credit given unless the shut-down continues through to the end of the season, and shut-down must be warranted in the policy.

Credits for shutting down prior to May 1, full logging charge; shutting down prior to June 1, three-fourths of logging charge; shutting down prior to July 1, one-half of logging charge; shutting down prior to August 1, one-fourth of logging charge; full logging charge to apply if any logging is done during any part of August.

During specially wet springs and/or summers the underwriter can modify this rule so that credits may be given, under written consent attached to the policy, for delayed shut-downs, but in no event shall the credits be advanced more than 1 month; that is, logging in August must always take at least three-fourths of the full logging charge. Logging in June must always take at least one-fourth of the logging charge.

Less hazardous logging equipment.—Where logging equipment less hazardous than the usual types is used prescribed credits can be given under warranty.

Credits: Electric donkeys and loaders only, reduce logging charge one-fifth; tractors only, yarding to railroad, reduce logging charge three-tenths; no rail-

road, donkeys yarding to trucks, reduce logging charge one-fifth; tractors only yarding to trucks only, reduce logging charge two-fifths; gasoline donkeys and loaders only, reduce logging charge one-tenth.

Other improved equipment demonstrably less hazardous may be allowed for by such credit, under warranty, as the underwriter may judge to be in line with the credits prescribed above.

Mature redwood.—For the portion of the insured value represented by mature redwood a credit of 50 percent of the gross rate can be given, provided a form is attached to the policy specifically insuring redwood as distinct from the total value insured.

Net rate, gross rate less credits; minimum rate, 10 cents; minimum premium, $5.

FOR FOREST PROPERTIES IN THE PONDEROSA PINE REGION OF OREGON, WASHINGTON, CALIFORNIA, AND CENTRAL IDAHO [15]

Regional basis rate: 2.5 cents.

CHARGES

Protection deficiency charge.—Counties to be graded by applying forest protection district grading schedule. Four grades: Grade 1, no deficiency charge; grade 2, 40-percent deficiency charge; grade 3, 80-percent deficiency charge; grade 4, 120-percent deficiency charge.

County basis rate: —— cents.

Climatic zone charge.—To be added to county basis rates. Flat charge, zone 7, 7.5 cents (whole region is in zone 7).

Key rate: —— cents.

Class charge.—To be added to key rate. Flat charge, merchantable class (12 inches and more d. b. h.), no charge; unmerchantable class (less than 12 inches d. b. h.), 12 cents.

Class rate: —— cents.

CONTRIBUTIVE HAZARDS

Charges for contributive hazards are percentages of class rates.

Density.—Three grades in the merchantable class. Under 10,000 feet board measure per acre is light; 10,000 to 20,000 is moderate; over 20,000 is heavy density. No hazard variation with density recognized in unmerchantable class.

Merchantable class—Charges.—Moderate density, no charge; light density, 11-percent charge; heavy density, 65-percent charge.

SPECIAL HAZARDS

(*a*) Logging slash: Unburned slash from logging or other wood-cutting operation whether or not cleared by State forester. Standard is 40 acres or more on the property directly adjacent. Standard is based on what will be on the ground at the end of the fire season, not what is there at the beginning. These charges are for slash only, whether or not logging is going on.

Slash exposure charges [1]*—percents of class rate*

Area occupied by slash (acres)	On property or directly adjacent	¼ to 1 mile	1 to 2 miles
	Percent	*Percent*	*Percent*
40 or more	1,000	500	200
30 to 40	800	640	160
20 to 30	400	320	80
10 to 20	200	160	40
Less than 10	100	80	20

[1] Same in both classes. The underwriter is to decide whether or not the slash charge shall apply. Where partial slash disposal is judged to be sufficiently effective, the slash charge may be omitted. It must always either be charged in full or wholly omitted. No charge in any event for slash more than 2 miles away.

[15] Includes Jackson and Josephine Counties, Oreg., and Siskiyou County, Calif.

(*b*) *Heavy brush.*—Oak, willow, madrona, and/or other continuous brush occupying at least 60 percent of the surface area and averaging at least 6 feet high. No charge is made for the ordinary low manzanita, bitterbrush, and other commonly occurring brush species as they are found throughout the region. This charge relates to a definitely increased hazard arising from exposure to areas occupied by what could not properly be designated otherwise than as heavy brush.

NOTE.—This charge also applies to all rates on properties in Jackson, Josephine, and Siskiyou Counties, and in the portion of Klamath County lying west of Klamath Lakes and south of the south line of townships 35 WM.

Heavy brush charges[1]*—percents of class rate*

Area of heavy brush—sum of all exposing areas (acres)	On property or directly adjacent	¼ to 1 mile	1 to 2 miles
	Percent	*Percent*	*Percent*
100 or more	35	28	7
60 to 100	28	22½	6
20 to 60	14	11	3
10 to 20	7	5½	1½
Less than 10	None	None	None

[1] Same in both classes. No charge in any event for exposure more than 2 miles away (except where the charge is general).

(*c*) *Within 1 mile of desert fringe (any direction).*—This charge applies to fringes of all desert or other open land areas 2,500 acres or more in continuous extent. It does not apply to the fringes of small natural openings in the forest nor to artificially cleared areas unless there has been reversion to actual desert conditions.

Desert fringe charge (both classes), 775 percent.

Dead or dying timber.—Timber dead or dying from any cause. Applies only to merchantable class. Unmerchantable class is not insurable if dead or dying nor is it considered as measurably increasing the hazard to exposed insurable growth.

Susceptibility factor.—If insured, 10 percent. If not insured, apply susceptibility factor to the exposed insured stand as follows: Full susceptibility factor if dead or dying timber is on property or directly adjacent. Reduce one-half if over one-fourth mile away. No charge if over 1 mile away.

NOTE.—This charge is made only when more than one-half of the trees on an area of 250 acres or more are dead or dying.

Unexposed property rate, —— cents.

(Sum of all charges to this point.)

CAUSATIVE HAZARDS

Charges for causative hazards are percentages of unexposed property rate.

Railroad (common carrier).—Through property or directly alongside. If more than one-fourth mile away, reduce charge one-half. No charge for exposure more than one-half mile away.

NOTE.—This does not include logging railroads which take the lumbering exposure charge.

Exposure charges.—Merchantable class, 54 percent;[10] unmerchantable, 72 percent.

Ranches and farms.—On property or directly adjacent. If more than one-fourth mile away, reduce charge one-half. No charge for exposure more than one-half mile away.

Exposure charges.—Merchantable class, 35 percent; unmerchantable, 40 percent.

Lumbering.—Logging operation, sawmill, pulp- or fuel-wood cutting, or other forest exploitation activity on or directly adjacent, or logging railroad through

[10] Possibility of salvage.

property or directly alongside. If more than one-half mile away, reduce charge one-half. No charge if more than 1 mile away.

Exposure charges.—Merchantable class, 320 percent; unmerchantable class, 430 percent.

Property in recreation zone.—18 percent charge, both classes.

Automobile road.—Any road which can be traveled upon by automobile during the fire season and which is open to the public. No distinction for class of road or difficulty of travel if any car can be driven upon it. No charge if a locked gate is maintained by a public authority between the insured property and the point at which the road connects with a public road provided the gate is more than one-fourth mile from the nearest property boundary.

Auto road through property or directly alongside takes full charge. If more than one-fourth mile away, reduce one-half. No charge if more than one-half mile away.

Exposure charges.—Merchantable class, 30 percent; unmerchantable class, 35 percent.

Gross rate: —— cents.

(Sum of all charges to this point.)

CREDITS

Natural firebreaks.—Rivers, lakes, or cultivated fields (not grass or grain). Credit applies to portion of property lying within 1 mile of the edge of the break regardless of direction. If break is one-half mile wide or wider, give full credit. One-quarter mile to one-half mile, cut credit one-fourth. Natural breaks less than one-quarter mile wide credited same as artificial breaks.

Credits: For natural firebreak coinciding with the boundary of the property, the protected mile strip takes a credit of 10 percent of gross rate. If the break extends all around property, the whole is credited 20 percent. Internal breaks give 10 percent credit on both sides.

Artificial firebreaks.—Fire lines, maintained as such and approved by the underwriter. They may be specially constructed or they may be roads, highways, or old road or railroad grades maintained specifically as fire lines. In order that credit may be given, the breaks must qualify as lines at which going fires would ordinarily be stopped with a minimum of back-firing. They must be so maintained that back-firing could be safely undertaken at any time without preparatory work.

Credits for break coinciding with boundary of property, 5 percent. Internal breaks give 5 percent credit on both sides.

NOTE.—Credit for firebreaks is not given unless they (1) extend at least two-thirds of the distance across the property, or (2) are at least 1 mile in length. Internal breaks cannot give credit in more than two directions.

Warranty protection.—Properties on which protection has been graded as class 4 may be given a credit for the maintenance of special protection under warranty, supplied privately or by local association. This credit is to be computed from the description of the protection given in the warranty and shall be such as to restore the gross rate to the level it would have attained if equivalent protection had been supplied in the regular manner.

Railroad patrol.—When the railroad or logging railroad patrol warranty is attached to the policy.

Credits for common-carrier railroads, three-quarters of railroad exposure charge. For logging railroads, one-sixth of the logging exposure charge.

Seasonal shut-down of logging.—Credit can be given for the shutting down of logging operations exposing the property for the whole or a part of the fire season provided a bona fide experienced fire warden is kept on the property in addition to the protection otherwise allowed for in the rate. The end of the fire season is to be judged by the underwriter and the resumption of logging must be with written consent only. No credit given unless the shut-down continues through to the end of the season and shut-down must be warranted in the policy.

Credits for shutting down prior to May 1, full logging charge; shutting down prior to June 1, three-fourths of logging charge; shutting down prior to July 1, one-half of logging charge; shutting down prior to August 1, one-fourth of logging charge.

Full logging charge to apply if any logging is done during any part of August.

During specially wet springs and/or summers the underwriter can modify this rule so that credits may be given, under written consent attached to the policy, for delayed shut-downs, but in no event shall the credits be advanced

more than 1 month. That is, logging in August must always take at least three-quarters of the full logging charge. Logging in June must always take at least one-quarter of the logging charge.

Less hazardous logging equipment.—Where logging equipment less hazardous than the usual type is used, prescribed credits can be given under warranty.

Credits for electric donkeys and loaders only, reduce logging charge one-fifth; tractors only yarding to railroad, reduce logging charge three-tenths; no railroad, donkeys yarding to trucks, reduce logging charge one-fifth; tractors only yarding to trucks only, reduce logging charge two-fifths; gasoline donkeys and loaders only, reduce logging charge one-tenth.

Other improved equipment demonstrably less hazardous may be allowed for by such credit, under warranty, as the underwriter may judge to be in line with the credits prescribed above.

Net rate, gross rate less credits; minimum rate, 10 cents; minimum premium, $5.

FOR FOREST PROPERTIES IN THE SUGAR PINE–PONDEROSA PINE REGION OF CALIFORNIA

Regional basis rate: 2.5 cents.

CHARGES

Protection deficiency charge.—Ranger districts to be graded by applying schedule for grading forest fire protection in California. Four grades: Grade 1, no deficiency charge; grade 2, 40-percent deficiency charge; grade 3, 80-percent deficiency charge; grade 4, 120-percent deficiency charge.[20]

Ranger district basis rate: —— cents.

Climatic zone charge.—To be added to ranger district basis rate. Flat charges: Zone 4, 3.75 cents; zone 5, 5 cents; zone 6, 6.25 cents; zone 7, 7.5 cents.

Key rate: —— cents.

Class charge to be added to key rate. Flat charge, merchantable class (12 inches and more d. b. h.), no charge; unmerchantable class (less than 12 inches d. b. h.), 17.5 cents.

Class rate: —— cents.

CONTRIBUTIVE HAZARDS

Charges for contributive hazards are percentages of class rates.

Density.—Three grades in the merchantable class. Under 10 M feet board measure per acre is light; 10 to 20 M feet board measure is moderate; over 20 M feet board measure is heavy density. No hazard variation with density recognized in unmerchantable class.

Merchantable class.—Charges: Moderate density, no charge; light density, 11-percent charge; heavy density, 65-percent charge.

SPECIAL HAZARDS

(*a*) *Logging slash.*—Unburned (or partly burned) slash from logging or other wood-cutting operation. Standard is 40 acres or more on the property or directly adjacent. Standard is based on what will be on the ground at the end of the fire season, not what is there at the beginning. These charges are for slash only, whether or not logging is going on.

Slash exposure charges[1]*—percents of class rate*

Area occupied by slash (acres)	On property	Directly adjacent	¼ to 1 mile	1 to 2 miles
	Percent	*Percent*	*Percent*	*Percent*
40 or more	1,000	1,000	800	200
30 to 40	800	800	640	160
20 to 30	400	400	320	80
10 to 20	200	200	160	40
Less than 10	100	100	80	20

[1] Same in both classes. The underwriter is to decide whether or not the slash charge shall apply. Where partial slash disposal is judged to be sufficiently effective, the slash charge may be omitted. It must always either be charged in full or wholly omitted. No charge in any event for slash more than 2 miles away.

[20] All protection except that administered by the U. S. Forest Service takes grade 4 deficiency charge.

(b) Within 2 miles of California woodland belt.—To be indicated by map location. Broadly speaking, it is the lower edge of the ponderosa pine type which borders on the woodland type of the Sacramento and San Joaquin Valleys.

Charge for exposure to woodland belt (both classes), 775 percent.

Dead or dying timber.—Timber dead or dying from any cause. Applies only to merchantable class. Unmerchantable class is not insurable if dead or dying nor is it considered as measurably increasing the hazard to exposed insurable growth.

Susceptibility factor.—If insured, 10 percent. If not insured, apply susceptibility factor to the exposed insured stand as follows: Full susceptibility factor if dead or dying timber is on property or directly adjacent. Reduce one-half if over one-fourth mile away. No charge if over 1 mile away.

NOTE.—This charge is made only when more than one-half of the trees on an area of 250 acres or more are dead or dying.

Unexposed property rate: —— cents.

(Sum of all charges to this point.)

CAUSATIVE HAZARDS

Charges for causative hazards are percentages of unexposed property rate.

Railroad (common carrier).—Through property or directly alongside. If more than one-half mile away, reduce one-half. No charge for exposure more than 1 mile away.

NOTE.—This does not include logging railroads which take the lumbering exposure charge.

Exposure charges.—Merchantable class, 54 percent;[21] unmerchantable class, 72 percent.

Ranches and farms.—On property or directly adjacent. If more than one-quarter mile away, reduce charge one-half. No charge for exposure more than one-half mile away.

Exposure charges.—Merchantable class, 35 percent; unmerchantable, 40 percent.

Lumbering.—Logging operation sawmill, pulp- or fuel-wood cutting, or other forest exploitation activity on or directly adjacent, or logging railroad through property or directly alongside. If more than one-half mile away, reduce charge one-half. No charge if more than 1 mile away.

Exposure charges.—Merchantable class, 320 percent; unmerchantable class, 430 percent.

Property in recreation zone.—18 percent charge, both classes.

Automobile road.—Any road which can be traveled upon by automobile during the fire season which is open to the public. No distinction for class of road or difficulty of travel if any car can be driven upon it. No charge if a locked gate is maintained by a public authority between the insured property and the point at which the road connects with a public road provided the gate is more than one-fourth mile from the nearest property boundary. Auto road through property or directly alongside takes full charge. If more than one-fourth mile away, reduce one-half. No charge if more than one-half mile away.

Exposure charges.—Merchantable class, 30 percent; unmerchantable class, 35 percent.

Gross rate: —— cents.

(Sum of all charges to this point.)

CREDITS

Property in lightning-free zone.—See map. Properties or portions thereof lying within the zone which is free from lightning hazard, as indicated, to be given credit as follows: Credit for freedom from lightning hazard, both classes, 15 percent of gross rate.

Natural firebreaks.—Rivers, lakes, or cultivated fields (not grass or grain). Credit applies to portion of property lying within 1 mile of the edge of the break regardless of direction. If break is one-half mile wide or wider give full credit. One-quarter mile to one-half mile, cut credit one-fourth. Natural breaks less than one-quarter mile wide credited same as artificial breaks.

[21] Possibility of salvage.

Credits: If the natural firebreak coincides with the boundary of the property the protected mile strip takes a credit of 10 percent of gross rate. If the break extends all around property the whole is credited 20 percent. Internal breaks give 10 percent credit on both sides.

Artificial firebreaks.—Fire lines, maintained as such and approved by the underwriter. They may be specially constructed or they may be roads, highways, or old road or railroad grades maintained specifically as fire lines. In order that credit may be given, the breaks must qualify as lines at which going fires would ordinarily be stopped with a minimum of back-firing. They must be so maintained that back-firing could be safely undertaken at any time without preparatory work.

Credits: Breaks coinciding with boundary of property, credit 5 percent. Internal breaks give 5-percent credit on both sides.

NOTE.—Credit for firebreaks is not given unless they (1) extend at least two-thirds of the distance across the property, or (2) are at least 1 mile in length. Internal breaks cannot give credit in more than two directions.

Warranty protection.—Properties on which protection has been graded as class 4 may be given a credit for the maintenance of special protection under warranty, supplied privately or by a local association. This credit is to be computed from the description of the protection given in the warranty and shall be such as to restore the gross rate to the level it would have attained if equivalent protection had been supplied in the regular manner.

Railroad patrol.—When the railroad or logging railroad patrol warranty is attached to the policy: Credits for common-carrier railroads, three-quarters of railroad exposure charge. For logging railroads, one-sixth of the logging exposure charge.

Seasonal shut-down of logging.—Credit can be given for the shutting down of logging operations exposing the property for the whole or a part of the fire season provided a bona fide experienced fire warden is kept on the property in addition to the protection otherwise allowed for in the rate. The end of the fire season is to be judged by the underwriter and the resumption of logging must be with written consent only. No credit given unless the shut-down continues through the end of the season and shut-down must be warranted in the policy.

Credits for shutting down prior to May 1, full logging charge; shutting down prior to June 1, three-quarters of logging charge; shutting down prior to July 1, one-half of logging charge; shutting down prior to August 1, one-quarter of logging charge; full logging charge to apply if any logging is done during any part of August.

During specially wet springs and/or summers the underwriter can modify this rule so that credits may be given, under written consent attached to the policy, for delayed shut-downs but in no event shall the credits be advanced more than 1 month. That is, logging in August must always take at least three-quarters of the full logging charge. Logging in June must always take at least one-quarter of the logging charge.

Less hazardous logging equipment.—Where logging equipment less hazardous than the usual type is used prescribed credits can be given under warranty.

Credits for electric donkeys and loaders only, reduce logging charge one-fifth; tractors only yarding to railroad, reduce logging charge three-tenths; no railroad, donkeys yarding to trucks, reduce logging charge one-fifth; tractors only yarding to trucks only, reduce logging charge two-fifths; gasoline donkeys and loaders only, reduce logging charge one-tenth.

Other improved equipment demonstrably less hazardous may be allowed for by such credit, under warranty, as the underwriter may judge to be in line with the credits prescribed above.

Net rate, gross rate less credits; minimum rate, 10 cents; minimum premium, $5.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

The schedules of premium rates proposed in this bulletin are intended primarily for use during the introductory and experimental stage of practical insurance application. Experience may very likely indicate the desirability of considerable modification, both in form and general rate level produced.

These schedules are based on a statistically ascertained normal loss expectation for the territory as a whole of 0.082 percent per year (8.2 cents per $100 of value), distributed between the forest regions of the Pacific Coast States as follows: For the Douglas fir region, 0.047 percent; for the northern ponderosa pine region, 0.119 percent; and for the sugar pine-ponderosa pine region, 0.133 percent.

In their present form, the rate schedules would produce, if all the privately owned forest property in the territory were insured, an aggregate average premium rate of 0.450 percent (45 cents per $100 of value), divided among the regions as follows: For the Douglas fir region, 0.500 percent; the northern ponderosa pine region, 0.400 percent; and the sugar pine-ponderosa pine region, 0.350 percent. These are 100-percent coinsurance rates. (See p. 8 for a comprehensive discussion of the coinsurance principle.) The explanation of the spread between a loss expectation of 0.082 percent and a premium rate level of 0.450 percent is given in detail in the discussion dealing with rate-schedule construction. Briefly, it is accounted for by a number of factors not expressed by the normal burning ratio. An established insurance business, sure of volume and relative stability, would have no sound justification for so high a rate level. If premium income can be built up to and maintained at $300,000 or more per year, a material horizontal rate reduction will be indicated, provided, of course, reasonably good underwriting conditions prevail. With less than $150,000 of premium income the business would have insufficient stability to justify rates as low as are here suggested. The range of premium income between these figures is accordingly that for which the suggested rate levels are proposed.

Other factors, more permanent in character, enter into the unavoidable spread. One of these is conflagration hazard, which is not included in the figures quoted above. This factor badly upsets the 0.047-percent figure for the fir region by accounting for losses, over a period of years, greatly in excess of the aggregate from ordinary fires. It also costs money to conduct an insurance organization, so provision must be made for the so-called expense ratio. Then there are a number of factors which remain somewhat uncertain no matter how much or how long business is done. Some margin of safety must always be maintained to cover uncertain contingencies, among which may be mentioned the moral hazard, adverse selection of liability (a disproportion of more hazardous risks), the deviations of parts as compared to the whole, the influences of hitherto unknown trends, and the possibility of error in computations.

It is readily recognized that a low premium rate level with equitable differentiation allowing for variation in relative hazard is in itself an inducement to good volume and average spread of liability. The lower the rates can be made, the more satisfactory forest insurance will be for the insurers as well as those insured, and if it is to succeed in the long run, the property owners must be given the full benefit of such rate reductions as can be made with adherence to sound insurance principles.

Since the territory embraced in the regions studied (including the redwood region) contains approximately two-thirds of the privately owned timber of merchantable size in the whole country, and covers a wide geographical range and variety of conditions, it can in all

probability support a sound forest insurance project without regard to the rest of the country.

Such investigation as it has been possible to make indicates that the average rates here suggested would be within the economic reach of many forest owners. Even if an owner should not feel that he could afford to carry full insurance he could often materially improve his financial position by carrying partial insurance. The hazard of loss from fire is an ever-present liability against any forest property. Other things being equal, it is surely preferable to carry the liability as an annual premium payment rather than as an indefinite and troublesome discount on the capital value.

The loss figures quoted above are averages for large numbers of properties affected by several factors of variable hazard. On some properties the net hazard is much lower than the average, while on others it is unquestionably prohibitively high. Good underwriting judgment will undoubtedly sometimes dictate the rejection of proffered lines. Factors of variable hazard have been identified as demanding recognition in practical rating schedules, and their influences have been measured statistically. Among them are such contributive factors as composition (by tree species), topography, sizes of trees, snags, and logging slash; and such causative factors as railroads, recreationists, ranchers, and loggers. The forest fire climate and the grading of the protection in the locality where the risk is located are also allowed for. It was possible to obtain data in sufficient quantity and detail to develop expressions of burning ratios of the standard (minimum hazard) risk and of risks exposed to the influences of the various factors increasing the hazard. The difference is, of course, the amount by which the rate must be increased over that for the standard risk for proper adjustment to increased hazard. In actual practice, the range of rates is considerably narrower than that of hazard variation. This necessity is imposed partly by inescapable requirements in practical administration and partly by general principles of equity in the distribution of services.

To illustrate the wide range of hazard itself, as disclosed by the statistical studies, a property in the Douglas fir region fully exposed to unburned logging slash hazard is, other things being equal, 65 times more likely to suffer loss than a property not so exposed.

Schedules start with a basis rate of 2.5 cents per $100 of value per year, taken as representing the ultimate standard for the irreducible minimum of hazard. Charges for factors increasing the hazard could, if they were all present in maximum degree on any one risk, raise the rate to $62.82. Conditions in the field are such that it is utterly impossible for all adverse factors to operate together. They all do, however, operate somewhere and must accordingly be allowed for. Provision is also made for credits for somewhat extraordinary factors reducing the hazard such as artificially maintained fire lines, cultivated fields, patrols and watchmen, and less hazardous logging machinery.

The technical underwriting and administrative problems encountered in forest fire insurance do not need to be unduly feared. Their solutions will be no more difficult than some that have been accomplished by both the insurance and the timber businesses. The main essentials are a determination to succeed on the part of the insurance

business and a willingness on the part of the forest owners to give proper support in the form of a good volume of business, with the spirit of fair play on the part of both.

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