The Application of Forest Fire Insurance to the Douglas Fir Region
by
M. A. Palmer

A Thesis
Presented to the Faculty
of the
School of Forestry
Oregon State College

In Partial Fulfillment
of the Requirements for the Degree
Bachelor of Science
June, 1939

Approved:

Professor of Forestry

SCHOOL OF FORESTRY
OREGON STATE COLLEGE
CORVALLIS, OREGON
Application of Forest Fire Insurance to The Douglas Fir Region

We have made tremendous progress in the development of forestry in the United States even though it be of comparative recent growth, but the record of our achievements looks small in view of our goal, that of growing sufficient quantity and quality of timber to meet the domestic demand. Many things are in need of improvement. Closer utilization, more efficient manufacturing methods, sustained yield management and other better forestry practices, all would contribute toward the attainment of that goal. Those forests handled by the Forest Service and other public agencies are being managed with those considerations in view, but since only approximately one fifth of the total forest area is in the hands of such agencies, it can be readily seen that those areas in private ownership are the ones which are most in need of improvement. The Federal Government and many of the states are managing their forests with an eye to the needs of the future generation, but the bulk of the private owners are not. Millions of acres of land remain unproductive due to the reluctance of landowners to enter forestry as a business undertaking. This reluctance is based upon the length of time necessary to grow a timber crop and upon a casual inspection of the many risks involved. While little can be
done to eliminate the length of time required, much can be
done to control or remove the risk element. This can be
accomplished by either of several ways, a more equitable tax
system, governmental aid, or through more thorough protection.

It is not the purpose of this paper to discuss the prob-
lems of taxation, but with the uncertain yet undoubtedly in-
creasing cost of government, it will be necessary to instit-
ute a tax plan whereby the owner is given assurance that
future tax levies will not be so exorbitant as to cause him
to lose that which he has planned for. The remedy which is
generally acclaimed to be the most equitable is the deferred
yield tax. This method is advantageous in two ways. It
cannot be raised by county or state governments, and if fire
or insects should cause considerable damage the tax money
would not be paid, and thus could not be lost.

Governmental aid for private forestry is undesirable.
If it cannot succeed in competition on an equal basis with
other industries and if it cannot carry its full share in
governmental support, we are better off without it. However,
governmental aid in the form of research work, especially
that which must be established for indefinitely long periods
of time would be entirely acceptable, and would benefit not
only forestry but other industries as well. This would in no
way tend to eliminate the risk element, except that it would
aid the businessman to improve his arts and sciences and con-
sequently to increase his profits.

Improved protection would do the most toward the elimi-
ation of risks, but it alone is insufficient. Up to a certain
point for every dollar that is added to protection costs, an increasing amount of efficiency and decreasing losses result. Beyond this point every dollar added results in less efficiency than was obtained with the preceding dollar. Since fire is a natural agency, it will always be present to some degree, but the expenditures of great sums of money to reduce risks which can never be entirely eliminated is not justified beyond the point of diminishing returns. The residual risks, since it is incapable of being entirely eliminated must be assumed by the entrepreneur and added to his costs of production as a return for risk bearing, or it must be transferred to others. The latter is the basic principle of insurance, which may be defined as "a social device whereby one person is enabled to make a contract with another, the second party agreeing to assume certain definite risks of the first party upon payment by the latter of a compensation called the premium". (2:19)

ADVANTAGES OF INSURANCE

Insurance would perform many functions for forestry, many of which would be accepted without notice by the general public. Primarily it would substitute a small but certain loss which can be definitely planned upon for large, sporadic and uncertain losses which can not be foreseen. For instance an individual who is planning to enter forestry as a business knows that fires are constantly destroying forest properties, and he knows that fire will constitute one of his sources of
loss. If he could definitely foresee when and where that loss would occur, he could make the necessary provisions to control it beforehand, but since he cannot, he has no way of knowing when his efforts will be obliterated by some conflagration. While definite forecasting for the individual is practically impossible, calculation of risks for a large group can be more or less definitely approximated. A study of forest fire losses in the Douglas fir region would show a group yearly average of approximately a million dollars, and with individual fires doing damage varying from practically nothing to a hundred thousand dollars or more. A fire of the latter nature could easily and has easily wiped out the operator or several operators because no provisions had been made for such a heavy loss. On the other hand with a small yearly payment the operator could cancel his loss off as a yearly carrying charge, and yet obtain complete or nearly complete reimbursement in case of catastrophe.

Insurance would serve as a basis for credit extension. A bank or loan company in making or extending a loan to a business first investigates its assets, and then ascertains what protection it has in case of fire. It can be readily understood that with the assurance of complete protection it would be much easier to obtain loans and credit extensions. Furthermore, since the financing agent or agency would have definite protection for his investment, he would be inclined to lower his interest rates on money loaned to the forest entrepreneur.
While the benefits to the private landowner would be of great importance to him, those derived by the general public would be still greater. A system of forest insurance would stabilize the industry, and cure it of many undesirable features. Nomadic types of laboring classes would soon cease to exist, progress would be seen in the development of community life. The bugaboo of forced liquidation could be met on equal terms, and productive land would not revert to tax delinquent roles. A more intelligent and more economically planned liquidation of forest properties would ensue, and better utilization result. Business men would recognize the potential forest producing capacities of millions of acres of now unproductive land and would be more willing to invest because the principle retardent, total loss through forest fire, would be alleviated. With these now idle lands in production, tax pressures would be mitigated and the present burden on other forms of property would be relieved. All in all, forest insurance would prove to be a boon not only to private industry but to society as well.

Theoretically insurance has no disadvantages. Many people claim that it would tend to increase the moral hazard, and the possibilities of this must be admitted. However, this is not the fault of insurance, but is due to the practice of insuring unstable businessmen and due to poor administration. In regards to the former statement, H.B. Shepard states that: (5:19)

Moral hazards arise from a small but unscrupulous minor-
ity 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. --- That 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.

In regards to the latter consideration, that of poor administration, it is to be noted that during the boom days of general fire insurance, many degenerative practices were instigated. In the insuing years many adjustments have been made either by the insurers or by state legislation. Underwriters have accomplished much in determining the personal character, integrity, and solvency of the applicant. This information can be obtained in a number of various ways. Commercial ratings showing the assets, liabilities, stability, general credit records, etc., have been available for some time. (1:236) A study of these various ratings combined with an investigation of the financial temptation is highly desirable. Over insurance, that is insurance in excess of true value is one of the greatest causes of high moral hazard. This must be avoided, but it will take some time before sufficient knowledge is obtained to prevent this.

HISTORY OF FIRE INSURANCE

Several countries have made notable progress in the development of forest fire insurance. Norway was the pioneer, having instituted a compensation fund which was organized and accepted by a large number of owners in November, 1911. (7:288) Contracts provided for compensation for damage to
the forest floor and to immature stands of timber. Norwegian companies were the first to develop "Insurance for all eternity" which consists in paying one considerable premium only. This permanently guarantees the area concerned against loss up to a specified sum. If annual insurance is desired, the premiums are high for the first year or so. Thereafter they scale down rapidly and after twenty-five years they become paid-up permanent policies. The amount of insurance is dictated by the desires of the owner, and in case of loss the claim is agreed upon by the company. In case of disagreement the assured and the insurer each appoint one representative to settle the claim. If there is further disagreement an umpire is chosen by the representatives and he is the final judge of the validity of the claim. No appeal is legal, either by the assured or by the insurer. (8:246-248)

In 1914 the first company was organized in Finland. It was a mutual as was the second which was organized in 1916. These two companies at that time represented over 30,000 owners (15:135), and this number has been greatly increased by other organizations of similar nature, since developed. Of all the countries which now have forest insurance, Finland shows the most development and has the most careful and scientific studies.

Sweden now has four or five companies who will insure everything from young plantations to shipments of lumber to foreign lands (8:247).

Up to 1925 Denmark was the most backward, having but one
concern, the Heath Company (Hedesholm) which issued very limited and restricted coverage. Since that time rapid strides have been made, the Danish Plantation Insurance Company (Dansk Plantageforsikringsforening) being one of the most progressive.

On August 14, 1930 representatives from companies of the above mentioned Scandinavian concerns met in Oslo, Norway, and formed a "union". The purpose of this so-called union was "to collect and issue statistics and information on forest fire protection and insurance to member companies and the formation of uniform compensation rules". (15:134) The executive committee consisted of representatives from the Norwegian Mutual, Svenska Veritas (Sweden), and the Owner's Mutual of Finland.

There has been some insurance written for forests in France, but the reluctance of the concerns to issue coverage on those areas which are in most need of it has inhibited development. (6:239) French concerns also demand excessive rates, charging on the average seventy cents for every one hundred dollars of coverage, plus special charges for higher hazards. For example, a levy of ten cents per one hundred dollars is charged wherever there are possibilities of lightning, but no credit is given for the additional protective precautions taken for the additional hazard.

Agitation for insurance for forests began in Japan as far back as 1916, but it was not until 1920 that the Toho Fire Insurance Company of Tokyo offered to underwrite forest property. In 1931 there were four companies issuing
insurance, but to date little has been written. This is due to excessive caution in selection of risks, insurance being issued only on plantations older than 10 to 20 years; a need for big reserves; and incomplete fire statistics. (17:82)

INSURANCE FOR TIMBERLANDS IN THE UNITED STATES

The first attempt at a definite program of forest insurance was instituted by the Phoenix Assurance Company of London who solicited timber insurance in Oregon and Washington in 1914. The demand which had been anticipated was not forthcoming, and consequently the company discontinued its activities in this company in 1916. (9:514) In 1917 a group of nine companies and private individuals formed the Timberlands Mutual Fire Insurance Company of Portsmouth, New Hampshire. Previous to incorporation, the members of this company had decided from a review of the statistics then available that the fire loss was least in the New England states and that total loss from conflagration was remote. They believed that premiums could be set at 2%, basing this figure on an expectation loss of 0.5% plus a management charge of 0.5%, and the remaining 1% as safeguard against any unforeseen contingency that might arise. Business was carried on on this basis for one year, and the succeeding year the rate was reduced to $1\frac{1}{4}%. At the end of the second year the organization transferred its holdings to Globe Rutgers of New York. At the time of transference, the company was contemplating a further reduction in rates, namely to $1\frac{1}{2}%. The war more or less
interrupted the expansion of this company, but nevertheless the original members were not interested in the financial aspects of the matter but merely conducted it as a business experiment. Although risks were carefully selected the members of this company felt that with "3 or 4 million dollars worth of insurance the rate should not be over 1%." (18:296)

It is interesting to note that in spite of initial cost of founding such an organization, the lack of knowledge concerning such matters, and the small numbers concerned this company kept their disbursements to 72% of total income. The total of all policies issued was $327,192, 87.4% of this was in merchantable timber, and constituted but 67 policy holders.

Other companies now offer limited coverage for timber lands, but do not directly solicit such business. Their rates are rather high, and they are extremely careful in their selection of risks.

THE INSURANCE COMPANY — ESSENTIAL REQUIREMENTS

In order for insurance to produce the desired benefits and yet be practicable from a business point of view, certain essential conditions must be present. The assured must be subject to a risk which is important enough to warrant the existence of an insurance contract. It is quite obvious that forests are subject to a real risk and that that risk is of sufficient importance to justify insurance on them. The cost of insurance must not be prohibitive. Otherwise only a
small group of businessmen would find it acceptable, and the law of averages which can be applied most successfully only to large groups would not be applicable. Likewise it is a cost which must be kept in proper proportion to other business expenses. A high ratio in regards to other costs would defeat its purpose, that of averaging the losses of a large number of individuals in order to reduce them to the lowest total average loss. In order to operate on a safe basis, the company must accept a large number of risks. It is only through a combination of the risks of many owners that the law of average may be applied. If an insurance plan involved but two or three persons it would be but little better than if each person assumed his own. Last, the extent of the hazard must be capable of approximate mathematical calculation. This is absolutely essential in order to determine the premium rates and the reimbursements, and offers the greatest stumbling block to the organization of forest insurance companies. How it can best be successfully overcome will be discussed in subsequent pages.

TYPES OF INSURANCE COMPANIES

In general there are six different types of insurance agencies, (1) self insurance, (2) stock companies, (3) Mutual organizations, (4) reciprocal underwriters or inter-insurers, (5) Lloyds, and (6) governmental or state agencies. Each of these has definite characteristics and consequent advantages and disadvantages. (3:28-38)
Self insurance has been defined as the periodic laying aside of sums to provide a fund for reimbursements for any loss sustained. Its chief advantage lies in the fact that the assured operates the fund himself and any reductions in loss through efficient management or protective devices is a direct gain and a benefit to himself only. Its chief disadvantage lies in the length of time which it takes to build up a reserve capable of repaying the loss. Thus, during the initial years of establishment, a fire might wipe out the reserve fund and the operator too, while if the same loss occurred after it had reached its maximum size it could easily have sustained the loss. This form of insurance has some application for the larger timber companies, but it is not considered appropriate for the majority of forest land owners, who possess relatively small amounts of acreage.

Stock are organized for profits, those that own the stock being entitled to any profits and being liable for any losses incurred. The capital obtained through the sale of stock is used for the organization of the company, but the law requires that a certain portion must be maintained as capital. This is termed the surplus, and is used as an additional guarantee to the assured. The chief advantage of the stock company is that it offers a definite contract with a guarantee in the form of the capital and the surplus obtained by stock sales. Its disadvantages will result through a high expense rate because it is organized for profit, and because it is managed by stockholders and not by policy holders.
The next type of company to be considered is the mutual association, which is a plan whereby small owners insure themselves by combining their risks. It differs from the stock company in that the insurers are the insured, and consequently any amount remaining in excess of the losses are returned to the insured as a saving. Similarly any loss in excess of collections must be paid for by the insured. Thus, the policy holder is liable for any losses incurred while he is a member of a mutual organization. One of the advantages claimed for the mutual type of company is that it is able to do business at less cost than other organizations. Whether this is a constant advantage depends upon the relative efficiency of the management. If the association is composed of a small number of owners or of a small amount of acreage, it may be unable to pay losses in case of widespread disaster. Another disadvantage is claimed for the mutual company as a result of the fact that no second party intervenes between the policyholder and the losses. In other words, there is no one except the policy holders to guarantee the validity of the contract. In spite of the many disadvantages claimed for this type of organization it is perhaps the most logical of any, with the possible exception of the stock company. It is the type which is found operating so successfully in Norway, and is the type on which the initial forest fire insurance company in the United States was based.

The reciprocal type of company is really a development of the mutual idea. The policy holders are both insured and
insurers. However, the head of the organization is given the power of attorney-in-fact by the various members, and he has complete charge of the affairs of the organization. The advantages and disadvantages are similar to those claimed by the mutual company.

Lloyds are groups of men who individually guarantee the safety of that portion of the article to which he subscribes. Any one member cannot be held responsible for the obligations of the other underwriters. The name Lloyds is adapted from the name of a London coffee trader who organized the first group of underwriters for waterborne shipments. Since that time the original Lloyds have expanded until now they issue almost every conceivable type of insurance. This type of organization is not looked on with as much favor as other forms, but this is due, not to the inherent characteristics of the system, but to the lack of integrity of the underwriters.

"The London Lloyds should not be confused with their American imitators, as they are a trustworthy incorporated organization of individual underwriters so organized and banded that losses are practically always paid in full". (9: 515)

State or governmental insurance is an "enterprise operated by the state or nation, the government assuming liability for the payment of the losses". Theoretically this type would offer the lowest cost due to the widespread character of the risks, but it is doubtful if efficiency and morale necessary to this type of an enterprise could be developed and maintained by public agencies.

BASIS OF VALUATION FOR DAMAGE APPRAISAL

The valuation of timber presents one of the most difficult
problems that arises in a consideration of insurance for timber lands. Overpayment of loss must be avoided, but loss payments must be fair and equitable in order to fulfill the functions of insurance. These loss payments must be based upon the value of the property before and after damage, and not upon an assumed value per acre. Furthermore damages are payable in money and not direct restoration. Thus, in case of total loss of the timber by fire, the compensation must be just equal to that sum necessary, for the assured to purchase an acre similar to the destroyed. This takes into consideration only if full coverage is carried. If the area is only partially covered the loss payment will be in proportion to the amount of insurance carried. If losses are thus paid only on a basis of actual damage, over valuation will raise the premiums with no corresponding rise in repayment. This will be a factor which will tend to reduce the moral hazard.

In general the basis for damage appraisal is the difference between the value before the fire and the value after the fire. The value before the damage must be determined by a commercial rating rather than by a rating based on the personal judgement of the owner. In other words the compensation must be calculated by actual cost or sales data and not on a "sentimental value peculiar to the owner". (19:121) In determining the value of the stand before being damaged there are several fundamental concepts to be recognized. The expected income if it is not too far in the future and if it can be
ascertained with a fair degree of accuracy, is acceptable as a basis for compensation payments. However, the cost of restoration if it is less than the realization value is the acceptable basis. In using either method the cost or income data must be based not on exceptional figures of the individual but on average figures for the region.

There are three classes of forest property: merchantable timber, second growth immature timber, and artificial plantations. The latter is of but very minor importance in the Douglas fir region at the present time.

Obviously the methods of appraisal of damage to merchantable stands will not be applicable for immature stands of second growth. Fire damaged merchantable stands generally have some immediate salvage value while immature forests do not. Furthermore, the value of immature stands must be based, not on their derived value as truly merchantable stands of the future. This introduces a discounting factor. Naturally the question as to what constitutes merchantable timber arises. As a general rule, trees under 20 inches dbh, are not considered as being marketable, but this cannot be stated as the exact diameter limit of merchantability. In some cases an advantageous market might exist for the highest diameter classes below this 20 inch arbitrary class, but this is exceptional, and will be considered only in special cases. Furthermore, for stands to be marketed at some future time, the present value must be based on estimates as to when it will become merchantable. This time element will vary with the
desires and objects of the various owners of the immature stands.

APPRaisal OF DAmAGE TO MERChANTABLE STANDS

All burns in mature or merchantable timber will fall into one of three classifications; where the entire stand is destroyed or rendered unmerchantable; where the entire stand is killed or so damaged as to make death inevitable; or where but part of the stand is killed or damaged and the remainder is unharmed. (20)

In the case where the entire stand is destroyed the damage will be that of the full stumpage value before the fire, and this full stumpage value is that which the timber would bring on the open market.

Where the entire stand is killed or so damaged as to make death of the remaining living trees inevitable the damage will consist of the difference between the value before and after the burn. In this classification salvage operations will undoubtedly recover some, if not the majority of the loss, and in this case the appraised damage will consist of increased costs of logging, loss of value due to lowered quality, quantity, and grade, and loss through the deterioration of the timber because of insects, fungus, or reburns. These loss values may be estimated, or if it is possible to wait until after the salvage operation is over the yield data of the burned area can be taken directly from the cost and return records kept by the company. The
latter is the recommended procedure in the majority of cases. If the timber cannot be logged immediately this salvage value may partially or entirely disappear, and the merchantable condition at the time it can be logged is the basis for payment of losses to present stumpage value. The present value of the stumpage however is not the future value discounted, but rather is the future value discounted minus the future yearly expenses discounted. Thus, in formula form;

\[
V_0' = \frac{Y_n}{1.0p^{n-a}} - \frac{e(1.0p^{n-a}-1)}{(1.0p)(1.0p^{n-a})} \text{ or,}
\]

\[
V_0' = \frac{Y_n - 1.0p^{n-a}}{1.0p^{n-a}}
\]

where \( V_0' \) is the present value,

\( Y_n \) the net value at the time of the salvage cutting,

\( p \) the interest rate,

\( n \) the number of years in the rotation, and

\( a \) is the present age of the stand.

It is to be noted that this formula does not give us the damage to the stand, but rather the present worth if burned. If the stand would be logged at the same approximate time regardless of whether it were harmed or not, the damage formula becomes

\[
D = V_0 - V_0' = \frac{Y_n}{1.0p^{n-a}} - \frac{e(1.0p^{n-a}-1)}{(1.0p^{n-a})} - V_0' \text{ or,}
\]

\[
D = \frac{Y_n - Y_n'}{1.0p^{n-a}}
\]

where \( D \) is the present damage to the stand.
\[ V_0 \text{ the present derived value of the stand after burning,} \\
V_0^* \text{ the present derived value of the stand if unburned,} \\
Y_n \text{ the future yield if unburned, and} \\
Y_n^* \text{ the future yield if burned.} \\
\]

This is the so-called expectation value formula fitted to the case cited.

In a situation such that but a part of the stand is killed or damaged and the remainder unharmed, the calculation for compensation payments will be handled in a manner similar to that given above.

**DAMAGE TO IMMATURE STANDS OF SECOND GROWTH**

Natural reproduction plantations, and stands approaching merchantability are included in this classification. The first two will usually be handled by a cost or replacement calculation, and the latter by an estimation of the expectation value.

Natural reproduction and plantations include those stands whose average age is not greater than one-third to one-half of the rotation. The rotation in such cases being the length of time it takes the stand to attain at least minimum saw log size. The damage to such stands can most readily be determined on a cost per acre, or replacement basis from the formula

\[ D = C (1.0p^a) - \frac{e}{op} (1.0p^a-1) \tag{3} \]

where \( D \) is the damage, \( a \) the age of the stand when destroyed, \( C \) the cost of planting, and \( e \) the annual expenses.
In some cases it may be desirable to change the value of "a". When the average growth has been unusually slow due to excessive stocking or suppression the values should be discounted only for the period of years necessary to produce on the area trees of the same size as those destroyed. For example a 20 year old suppressed stand might be equal in size to a normal stand 10 years of age. In this case "a" in the formula would be 10 years instead of 20 because that is the time it normally takes to produce trees of this size. In some cases "c", the cost of planting, may be zero due to natural restocking by seed trees or by seeds from adjacent stands of cone bearing timber. In such a case the damage is equal to the value of the annual per acre charge capitalized for the period necessary to bring about a replacement of the damaged stand. In regard to this, H. B. Shepard, Senior Forest Economist for the United States Forest Service, states;

"Much of the second growth and reproduction privately owned today is the gratuitous results 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". (5:27)

In any case, however if it were impossible to obtain another property stocked in such a manner as to equal in value the one destroyed, and if it were impossible to rely on natural reproduction coming in the cost of planting the area should be included in obtaining the damages.

For stands approaching merchantability (age equal to more than a third of the rotation) the expectation value is computed as the basis for damage payments. This value is
merely the estimated value per acre at the end of the rotation minus the value of future annual costs, and the result discounted to obtain the present value. In formula form;

\[ D = \frac{Y - \frac{e}{op^n-a} (1 \cdot op^n-a - 1)}{1 \cdot op^n-a} \]  \hspace{1cm} (4)

where \( Y \) is the yield per acre determined from yield data, and estimated value per thousand feet, board measure, 
\( e \) the annual expense, 
\( n \) the years in the rotation, and 
\( a \) the age of the stand.

If the stand is only partially destroyed or damaged, the formula

\[ D = \frac{Y_n - Y'_n}{1 \cdot op^n-a} \]  \hspace{1cm} (1)

is used.

**COLLECTION OF STATISTICS FOR RATING SCHEDULES**

The only method of rating forest lands in the Douglas fir region for premium determination developed to date was devised by H. B. Shepard under the auspices of the United States Forest Service. This was done in 1930 to 1934 when he was assigned to the Pacific Northwest Forest Experiment Station at Portland, Oregon, and the results of his extensive study is published in a bulletin dealing with forest insurance. A brief review of the methods of rating as devised by him will be given.

A primary essential for any fire insurance organization
is a scientific and statistically correct arrangement of facts concerning past losses and their distribution over the territory to be insured. Most of the basic data for the study was secured from fire reports and questionnaires submitted by local wardens for the period 1921 to 1930, and from records of fires contained in the files of the Forest Service for the same period. Since this data was usually based upon estimated and not exact measurements, it was necessary to find some check whereby the accuracy of these estimates could be determined. This was done by selecting fourteen counties in Oregon and Washington and making detailed analyses of all areas, 200 acres or more in size, burned within the last three years and reported as doing damage to mature stands or to younger growth. This field data obtained from these check plots was 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 mostly over 25' high, up to 6" d.b.h.
Class E -- Stands mostly less than 25 feet high.

Allowance was made for partial damage, and the actual losses in each of the above classes were tabulated, a summary of which is given in table 1 in the appendix.

The deviation by which the wardens reports differed from these field results was determined in terms of percentage, and these percentages were applied as a correction factor to the wardens data. The resulting figures constituted the basic data for the study. The average yearly
damage and salvage of merchantable timber for the period 1921 to 1930 is given in table 2, and the net area of unmerchandable timber lost is given in table 3.

The total area in the region in each of the five classes which is subject to fire risk must next be determined. In 1931 the United States Forest Service compiled the following figures. (5:137)

<table>
<thead>
<tr>
<th>Class</th>
<th>Total Area</th>
<th>Net Annual Loss</th>
<th>Rate of Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merchantable timber</td>
<td>311,600,000 M b.f.</td>
<td>129,019 M b.f.</td>
<td>0.041 %</td>
</tr>
<tr>
<td>Second growth and reproduction</td>
<td>5,650,000 acres</td>
<td>14,870 acres</td>
<td>0.263 %</td>
</tr>
</tbody>
</table>

For the purposes of fire insurance a more detailed breakdown is desirable. This was done by sampling the same fourteen counties in which the field analyses were made. The percentages in each of the five classes was determined for these representative counties, and applied to the above mentioned data. The resultant figures are to be found in table 4, also in the appendix.

The net annual loss in each of these classes was then determined on a percentage basis using the data found in tables 2 and 3. The gross and net loss in relation to the quantities at risk (see table 4) as calculated, is to be found in table 5. The classes in this table are rearranged in accordance with the ascending order of the loss ratio, hereinafter termed the burning ratio, and are now spoken of
as risk class I, risk class II, risk class III, et cetera.

The data given in table 5 assumes that all areas classified in the same risk class are subject to the same degree of hazard. Unfortunately, such is distinctly not the case, and a more complete breakdown of each of the various risk classes must be made on the basis of the different hazards to which a forest may be subjected. Mr Shepard has divided these into two general groups, those which are causative, and those which are contributive. (5:52) Causative hazards are determined through the correlation of the occurrence of fires and the agency responsible for their incidence, while contributive hazards affect the extent and seriousness of the loss once the fire has started.

The importance of any causative agency varies with the number of fires for which it is responsible, and the standard by which the degree of hazard it exerts is measured is the condition under which the number of fires it starts are at a minimum. For this minimum standard no additional premium charge is to be made. For the purposes of his study, Mr Shepard made detailed analyses of some 4,638 fires, all of which were classified as being a result of one of the following groups of causative agencies; railroads, lightning, recreation, ranchers, lumbering, incendiary, and miscellaneous and unknown.

If the area of effective zone of any of these agencies and if the number of fires caused by this agency are known the increase in hazard over and above the hazard from the
basic fires (incendiary, miscellaneous and unknown) can be determined from the following formula, (5:109)

\[ \text{Percentage increase of hazard} = 100 \times \frac{r N_z}{z N_r} \]

where \( r \) equals 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, and
\( N_z \) the number of fires resulting from the specific cause.

An example might help to illustrate this point. Let us suppose that a forest property consists of 25,000 acres, 20,000 of which are subject to fires from stockmen and ranchers in the vicinity; that the basic number of fires is 8, and that the fires caused by these stockmen is 5. Fitting these figures into the formula,

\[ \text{Increase in hazard} = \frac{25000 \times 5}{20000 \times 8} = 7\% \]

The increase in hazard is thus 7\%, and the hazard to which the area is subject is roughly one and three-fourths times that which it would be if no fires were caused by stockmen or ranchers.

Since damage is the ultimate measure of hazard, any factor which tends to lower this must be accounted for. Thus, the presence of roads and trails, railroads, ranches and logging operations while increasing the percentage of hazard,
also increase the likelihood of salvage operations. Thus, the charges for this hazard must be discounted in order to take into consideration the above factor. This discounting process will apply only to merchantable timber since it is the only one possessing salvage value.

Immediately after a fire has started, the causative hazard no longer influences the action of the fire, but consequences depend upon the influence of the contributive hazards, the condition that surround the initial flame. These conditions can be divided into three groups; physical make-up of the forest; weather conditions, and the effectiveness of the protection agency.

There are many physical hazards which affect the seriousness of the burn, but these may briefly be listed as follows. (5:71)

1. Average size of the trees.
2. Density of the stand.
3. Composition of the stand.
4. Occurrence of unburned slash, ferns, brush, etc.
5. Occurrence of snags on or near the area.
6. Character of the topography.

Density and the composition of the stand can be said to be factors of susceptibility, and as such reflect the resistance of the species. These factors are dependent upon a large degree to such things as bark thickness, root habit, bark resin, branching habit, inflammability of foliage, and the amount of lichen growth. (21:463) The relations between
these factors and the extent of killing in actual burns was determined through evidence collected in the field, and the resultant figures provide a means of measuring these susceptibility factors. Another of these factors is the deterioration after death. Other things being equal, western red cedar would enjoy lower rates than other species such as hemlock due to less rapid deterioration and therefore better chance for more complete salvage.

The collected data also gave evidence by which a correlation of damage and the presence of slash, snags, or the character of the topography was made possible.

Many different degrees and combinations of the above may be cited, but the policy in rating confines itself to providing for every degree of hazard which is practical, and only actual experience in the writing of insurance will define the limits of these possibilities.

Climatic hazard

Since weather influences the rate of spread of a fire once it has started, zones of variation for this hazard must be determined. This was done by mapping with contour lines various numbers of days of average drought. Days of maximum drought, summer precipitation, low humidity and minimum humidities. These elements were combined to form the forest fire climatic chart shown in Plate I.

The percentage increases of each zone is based on the average of the five factors and this average was approximately
50% higher for each zone. These percentages are applied to the regional basic rate of 2½ cents in order to obtain the specified charge for climatic hazard.

Effectiveness of Protection

Other things being equal fire damage varies with effectiveness of the protective organization. Therefore some device must be set up whereby the general efficiency of the protective organization can be definitely measured. Required standards are set up, and the agency is graded on the basis of how completely it meets these requirements. A method of doing this was developed under the Clarke McNary administration for a study of forest fire control work in the various states. A form such as was developed is given in the appendix.

Conflagration hazard

While the statistics covered by the adjusted wardens data will cover all ordinary fires in the course of the average years time there still exists a certainty of major calamities which can only be termed conflagration. Such was the Tillamook fire of 1933 which covered 244,706 acres and which killed 10,257,500 M b f. Exact records of other great conflagrations in this region are rather fragmentary, but enough data can be pieced together to roughly indicate the yearly chances of a reoccurrence of such a fire. Wm. G. Morris in 1933 made a study of these past major fires and Table 6 in the appendix shows the results of his investigations.
In order to set up a reserve to cover this hazard Shepard suggests setting up a minimum of $500,000 a year for the first ten years and then changing this depending on the amount business, value of the reserve built up, and a survey of conflagration hazard at that time. He bases the $500,000 on an expectation loss of $10,000,000 every twenty to twenty five years.

CONSTRUCTION OF THE RATING SCALE

That risk which is to be the standard by which all forest properties are to be rated will consist of the lowest possible combination of hazards for the region. It will therefore consist of "a pure stand of Douglas fir, class 1 (20" to 40" dbh) in climatic zone 1, under class 1 protection, entirely on level ground, of light density, incurring no hazard from slash, lands recently cut over, fern, brush or grass lands, dead or dying timber or snags, and not exposed to the causative hazards of railroads, ranches, lumbering, recreation or roads". (5:134) Naturally a risk such as this does not exist, but the setting up of such a theoretical basis is necessary in order that all changes in the premium rates shall be as charges against the property rather than as credits to it. The rate level suggested by Mr. Shepard for the average forest property, based on a loss from ordinary fires of 0.041 percent and 0.075 percent from major conflagrations is as follows. (5:116)
Allowance for payments of ordinary losses --- 4.7 cents
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

These rates are then prorated among each of the risk classes in order to determine the premiums collected between classes. This data is summarized in table 7 in the appendix.

After all the factors of hazard and exposure are determined for a given forest property, it will be classified as one of five classes. Each of these five classes will have a set premium rate which is based upon a definite percentage above the standard risk rate discussed in a previous paragraph. These class charges to be used in the final rating schedule are as follows; (5:144)

Rate Class 1, standard, no charge
Rate Class 2, 44.7 percent charge
Rate Class 3, 68.4 percent charge
Rate Class 4, 86.8 percent charge
Rate Class 5, 142.1 percent charge.

Thus, to determine the premium rate for any area, it will be necessary to classify all the hazards and determine the extent of their influence in percentages. A recapitulation of these will then determine the rate class, and the application of these rate class percentages to the standard rate (see table 7) will give the annual premium charge for the area for every one hundred dollars of appraised value.
SUMMARY

Forest fire insurance, an indirect means of protection, would be of much aid in the establishment of a more general acceptance of sustained yield management. It would help the individual owners by assuming their residual risks and by lowering their rates of interest and extending their credit. It would help the general public by tending to improve and stabilize community life, tax rolls, and industrial programs. All in all forest insurance would be a boon to any region whose principle land use is the growing of timber and other forestry products.

All the essential requirements from a practical business standpoint can be readily met if a scientific approach to the problem is employed.

The methods of damage appraisal, hazard rating, and premium schedule determination given in this paper are merely cited as examples of the methods discussed. A more thorough and detailed analysis along the same general lines of investigation as developed by Mr. Shepard would be necessary before forest insurance could be written on a scientific basis.
Combination of Seasonal Precipitation, Mean Drought Period, Maximum Drought Period, Number of Days Below 35 Percent Relative Humidity, and Low Relative Humidity.
Plate I

FINAL FOREST FIRE CLIMATE CHART
**Table 1**

**FIELD ANALYSIS DATA**

Actual losses by classes with allowance for partial damage

<table>
<thead>
<tr>
<th>Class</th>
<th>Total acres burned</th>
<th>Killed or net area lost</th>
<th>M b f</th>
<th>Area</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merchantable timber before salvage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A (over 40&quot;)</td>
<td>11,453</td>
<td>437,366</td>
<td>88.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B (20&quot;-40&quot;)</td>
<td>5,587</td>
<td>56,451</td>
<td>11.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmerchantable timber</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C (6&quot;--20&quot;)</td>
<td>8,694</td>
<td>2,374</td>
<td>24.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D (25' to 6&quot;)</td>
<td>360</td>
<td>324</td>
<td>3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E (to 25' in height)</td>
<td>9,822</td>
<td>7,073</td>
<td>72.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>35,916</td>
<td>493,817</td>
<td>9,771</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Table 2

**ADJUSTED FIRE WARDENS FIGURES**

Annual damage and salvage of merchantable timber by classes

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>204,857</td>
<td>96,019</td>
<td>46.9</td>
<td>108,838</td>
<td>84.4</td>
</tr>
<tr>
<td>B</td>
<td>26,359</td>
<td>6,178</td>
<td>23.4</td>
<td>20,181</td>
<td>15.6</td>
</tr>
<tr>
<td>Total</td>
<td>231,216 M</td>
<td>102,197 M</td>
<td>44.2</td>
<td>129,019 M</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 3

**ADJUSTED FIRE WARDENS FIGURES**

Computation of net area of unmerchantable timber annually lost by classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Net area lost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Net area lost</td>
</tr>
<tr>
<td>C</td>
<td>3,119</td>
</tr>
<tr>
<td>D</td>
<td>424</td>
</tr>
<tr>
<td>E</td>
<td>9,279</td>
</tr>
<tr>
<td>Total</td>
<td>12,822</td>
</tr>
</tbody>
</table>
### Table 4

**ADJUSTED FOREST SERVICE SURVEY DATA**

<table>
<thead>
<tr>
<th>Class</th>
<th>Quantities at risk in the various classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>157,200,000 M</td>
</tr>
<tr>
<td>B</td>
<td>154,400,000 M</td>
</tr>
<tr>
<td>C</td>
<td>3,542,000 acres</td>
</tr>
<tr>
<td>D</td>
<td>784,000 acres</td>
</tr>
<tr>
<td>E</td>
<td>1,324,000 acres</td>
</tr>
</tbody>
</table>
Table 5
Quantities at risk, gross and net losses

<table>
<thead>
<tr>
<th>Class</th>
<th>Volume or area at risk</th>
<th>Gross loss</th>
<th>Net loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>acres or Mbf Percent</td>
<td>acres or Mbf Percent</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>154,400,000 M</td>
<td>69,776 M</td>
<td>0.045</td>
</tr>
<tr>
<td>II</td>
<td>157,200,000 M</td>
<td>161,440 M</td>
<td>0.103</td>
</tr>
<tr>
<td>III</td>
<td>784,000 ac</td>
<td>743 ac</td>
<td>0.095</td>
</tr>
<tr>
<td>IV</td>
<td>3,542,000 ac</td>
<td>3,717 ac</td>
<td>0.105</td>
</tr>
<tr>
<td>V</td>
<td>1,324,000 ac</td>
<td>20,323 ac</td>
<td>1.535</td>
</tr>
</tbody>
</table>
Table 6
Estimated major conflagrations in Douglas fir region

<table>
<thead>
<tr>
<th>Year</th>
<th>Name of fire</th>
<th>Estimated area burned</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840</td>
<td>Nestucca</td>
<td>350,000</td>
</tr>
<tr>
<td>1849</td>
<td>Yaguina</td>
<td>800,000</td>
</tr>
<tr>
<td>1868</td>
<td>Coos</td>
<td>300,000</td>
</tr>
<tr>
<td></td>
<td>Silverton</td>
<td>225,000</td>
</tr>
<tr>
<td>1902</td>
<td>Yacolt</td>
<td>430,000</td>
</tr>
<tr>
<td></td>
<td>Columbia</td>
<td>170,000</td>
</tr>
<tr>
<td>1933</td>
<td>Tillamock</td>
<td>240,000</td>
</tr>
<tr>
<td>Class</td>
<td>Value</td>
<td>Premium Contribution</td>
</tr>
<tr>
<td>-------</td>
<td>---------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>1. (20-40&quot; dbh)</td>
<td>$154,400,000</td>
<td>$51,608</td>
</tr>
<tr>
<td>2. (over 40&quot;)</td>
<td>157,200,000</td>
<td>77,411</td>
</tr>
<tr>
<td>3. (25' to 6&quot;)</td>
<td>5,880,000</td>
<td>3,345</td>
</tr>
<tr>
<td>4. (6&quot; to 19&quot;)</td>
<td>44,275,000</td>
<td>27,875</td>
</tr>
<tr>
<td>5. (below 25&quot;)</td>
<td>1,324,000</td>
<td>12,194</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>363,079,000</strong></td>
<td><strong>172,433</strong> ave. 4.7</td>
</tr>
</tbody>
</table>

With 50% Expense Ratio Prorated Between The First 4 Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Value</th>
<th>Premium Contribution</th>
<th>Rate (cents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>154,400,000</td>
<td>107,143</td>
<td>6.9</td>
</tr>
<tr>
<td>2.</td>
<td>157,200,000</td>
<td>160,713</td>
<td>10.2</td>
</tr>
<tr>
<td>3.</td>
<td>5,880,000</td>
<td>6,945</td>
<td>11.8</td>
</tr>
<tr>
<td>4.</td>
<td>44,275,000</td>
<td>57,871</td>
<td>13.1</td>
</tr>
<tr>
<td>5.</td>
<td>1,324,000</td>
<td>12,194</td>
<td>92.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>363,079,000</strong></td>
<td><strong>344,866</strong></td>
<td>9.5</td>
</tr>
</tbody>
</table>

With Conflagration Reserve ($500,000 per year) Prorated Between The First 4 Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Value</th>
<th>Premium Contribution</th>
<th>Rate (cents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>154,400,000</td>
<td>268,177</td>
<td>17.4</td>
</tr>
<tr>
<td>2.</td>
<td>157,200,000</td>
<td>402,262</td>
<td>25.6</td>
</tr>
<tr>
<td>3.</td>
<td>5,880,000</td>
<td>17,383</td>
<td>29.6</td>
</tr>
<tr>
<td>4.</td>
<td>44,275,000</td>
<td>144,850</td>
<td>32.7</td>
</tr>
<tr>
<td>5.</td>
<td>1,324,000</td>
<td>12,194</td>
<td>92.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>363,079,000</strong></td>
<td><strong>844,866</strong></td>
<td>23.3</td>
</tr>
</tbody>
</table>

Raising to Basis of 50-cent Average Rate Prorating between first 4 classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Value</th>
<th>Premium Contribution</th>
<th>Rate (cents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>154,400,000</td>
<td>589,753</td>
<td>38</td>
</tr>
<tr>
<td>2.</td>
<td>157,200,000</td>
<td>871,123</td>
<td>55</td>
</tr>
<tr>
<td>3.</td>
<td>5,880,000</td>
<td>37,644</td>
<td>64</td>
</tr>
<tr>
<td>4.</td>
<td>44,275,000</td>
<td>313,681</td>
<td>71</td>
</tr>
<tr>
<td>5.</td>
<td>1,324,000</td>
<td>12,194</td>
<td>92</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>363,079,000</strong></td>
<td><strong>1,815,395</strong></td>
<td>50</td>
</tr>
</tbody>
</table>
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 one 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 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.

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 PROTECTION AGENCIES

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

____________________ District, State of ________________

Area protected _______ Area merchantable timber _______
Area cutover _________ Area in association ____________
Area on tax roll _______ Area delinquent _______________

1. General strength of association, financial and administrative
   a. Percent of area on tax roll ____________ 5 %
   b. Percent of area delinquent
   c. Probable support from parent organization 2 1/2

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 an 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.
      pack animals
      Note: it should be possible to reach one-half of fires within 1 hour; next one-fourth within two hours.
   d. Fire-fighting equipment _____________ 10 %
      Suitable hand tools in good condition for each member of the 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. Credit not given if in the inspector's judgement the area 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
      the job. Warden's grading is weighted to equal one-
      third of total

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 de-
signated as class 4.
Literature Cited

1. Hardy, Charles O.  
   1924 Readings in Risk and Risk Bearing  
   University of Chicago Press

2. Riegel, Robert and Loman, H.J.  
   1922 Insurance Practices and Principles  
   Prentice-Hall, Inc., New York

3. Young, T.E.  
   1908 Insurance  
   Sir Isaac Pitman & Sons, Ltd., New York

4. Herbert, Paul A.  
   1928 Forest Insurance and Its Application in Michigan  
   Special Bulletin No. 179

5. Shepard, H.B.  
   1937 Forest Fire Insurance in the Pacific Coast States  
   U.S.D.A Technical Bulletin No. 551

   1928 Studies in French Forestry, 288-290, 534-536  
   John Wiley & Sons, New York

7. Nygaard, J.  
   1923 Skogbrandforsikringen i Norge 1912-1922. Det  
   Norske Gjensidige Skogsbrandforsikringselskap  
   (Forest Fire Insurance in Norway 1912-1922. The  
   Norwegian Mutual Forest Fire Insurance Company)  
   Translation by Hult, G.W.  
   Timberman, 25:8:52, 68, 70, 76, June 1924  
   Portland, Oregon

8. Perry, George Sargent  
   1929 Forestry in Sweden, 246-248

9. Herbert, P.A.  
   1924 Principles of Forest Insurance  
   Jour. of For. 22:5:513-517, May 1924

10. Herbert, P.A.  
    1924 A Plan of Combined and Federal Forest Protection  
    Jour. of For. 22:2:236, Feb. 1924
Literature Cited

11. Brown, W.R.
   1920 Standing Timber Insurance
   Jour. of For. 18:4:338-345, April 1920
   1926 Jour. of For. 24:243-249, March, 1926

12. Brewster, Donald C.
   1920 A Plan for Combined Insurance and Fire Protection
   Jour. of For. 18:8:803-805, December, 1920

13. Sparhawk, W.N.
   1920 Suggestions for Rating Risks in Forest Insurance
   Jour. of For. 18:7:701-709, November 1920

14. Baldwin, H.I.
   1936 Forest Fire Insurance in Sweden
   Jour. of For. 34:12:1068, December, 1936

15. Baldwin, H.I.
   1931 Scandinavian Forest Fire Insurance Companies
   Organize a Union
   Jour. of For. 29:1:134, January, 1931

16. 1925 Forest Fire Insurance in Norway
     Timberman June, 1925

17. Yatagai
   1933 History and Present Status of Forest Fire Insurance
     in Japan
     Jour. of For. 31:1:79, January, 1933

18. Chapman, Herman Haupt
    1926 Forest Finance
    Chapter 20. Pages 294-307
    Tuttle, Morehouse & Taylor
    New Haven, Conn.

19. Chapman, Herman Haupt
    1914 Forest Valuation, Chapter 14
    Tuttle, Morehouse & Taylor
    New Haven, Conn.

20 1914 "Standard Instructions for the Determination of
    Fire Damages"
    U.S. Forest Service Publication

21. Starker, T.J.
    1934 Fire Resistance in the Forest
    Jour. of For. 32:4:462-467, April 1934