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By PAUL A. HERBERT

The United States is making rapid progress in the scientific management of its forests. The Federal Government and many of the States are practicing forestry on public lands and are attempting to give fire protection to private forest land. Private owners, however, have not as yet generally taken up the practice of forestry as is evidenced by the millions of acres of non-productive, privately owned forest land throughout the country. If private forestry could compete with other productive enterprises, thousands of acres of land capable of growing trees would not come into the possession of the State every year because of default in the payment of taxes.

The reluctance of landowners to go into forestry as a business undertaking is based mainly on general observations of the risks and the rate of tree growth, and rough and ready calculations as to future costs and prices. Most of them will admit they do not know just how much of a return the forest business will bring, but they generally believe the return will be less than they can obtain in other enterprises. In this, they are perhaps correct, at least, in so far as forests returning an intermittent income are concerned. Even under the best management such forests do not, as a rule, return over six per cent on the investment, which, considering the risk involved is not considered an adequate return to the entrepreneur. The ways usually suggested to make private forestry a paying business are more equitable taxation, governmental aid, and better protection. It is thought by those making the suggestions that the application of these remedies coupled with increasing stumpage prices, will make it feasible for private owners to grow timber. All these items tend either to decrease the cost of production or decrease the risk to which the capital invested is exposed.

It is not within the scope of this bulletin to treat of the subject of forest taxation or governmental aid. Suffice it to state that the main advantage to be gained from deferred forest taxation, the usual remedy suggested, is not reduced costs but reduced risks. With the increasing cost of political administration, it is very doubtful whether future timber growers can expect much relief in so far as costs go. A deferred tax system should, however, allow the timber grower to estimate his future tax bill. It will also mean that if the timber is destroyed, or for any reason depreciates in value before it is utilized, he will not lose the taxes as he does under the present taxing system. This reduction in the entrepreneur's risk far outweighs any possible reduction in cost. If the second suggested remedy, governmental aid, is confined to performing that which the individual cannot very well do for himself, such as long-time research, it will be moving in the right direction. This is both a method of reducing cost and risk. The third remedy, more efficient protection, is a further means of reducing the risk and will be discussed in some detail.

Forest protection is universally considered necessary to make private forestry pay. Forest protection includes not only fire protection but also protection from insects, diseases, and various climatic factors. For every dollar spent in protection, there is some reduction in risk. After a certain point, this reduction of risk becomes less and less for every additional dollar spent in protection for the reason that risk can never be reduced to zero no matter how great the expenditure (1). As a matter of fact, long before the chance of loss approaches a theoretical minimum, a point is reached beyond which any expenditure for protection is an economic waste. Protection increases the cost and reduces the risk but does not eliminate it.

Theory of Property Insurance

The basis of all insurance is the risk or uncertainty to which our present-day economic life is subject. Even though risk may lend spice to man's existence, he endeavors in most cases to remove it from his business undertakings.

There are three classes of risks; (a) those that can be designated by a definite mathematical expression, (b) those that can not be definitely foretold in advance but can be given an approximate value by the statistical study of past behavior, and (c) those risks which do not lend themselves to any orderly tabulation (2). We are concerned with property risks, especially fire, which fall in the second group. Fire risks can be averaged and an approximate value given to this uncertainty.

As an illustration, let us assume that there are ten thousand forest land owners, each with a thousand acres of timber valued at $100 per acre. Let us further assume that the lands are all subject to approximately the same degree of risk, and that, while it is not known just where the loss will fall, the fire statistics for a period of years show that the average annual loss for the entire group is $1,250,000, which is one-eighth of one per cent of the entire value of one billion. Thus, the individual uncertain losses, when grouped, result in a definite loss. The statistics would show, too, that, while this is the average loss, the actual loss for any one year may vary from one-sixteenth of one per cent to one-fourth of one per cent. The probability of loss, then, for the group is fairly accurately determinable, but the individual landowner does not know how much of a loss he will have in any year; if he be very unlucky he may lose everything. An investment of this character, fraught with such uncertainty, would require a very large return to be attractive to the investor unless some means of doing away with the fire risk could be found.

There are various ways of removing the risk from such a business venture, as (a) elimination (protection, research, and similar means), (b) assumption by manager, and (c) by transferring the risk to others. Past experience has shown that a combination of all three of these is usually essential to reduce the uncertainty in any business to a satisfactory level. The third of these methods of removing risk (by transferring it to others) is usually known as insurance. Insurance is a social device for accumulating funds with which to meet what from the individual's view, are wholly uncertain economic losses, by combining and transferring many individual risks to one person or group of persons (3). The empirical law of large numbers as illustrated by the example stated in the last paragraph, makes it possible to separate losses to many individuals into definite losses and variable losses

(4). The greater the number of risks combined, the smaller the percentage of variable loss, and hence, the greater the accuracy in determining the expected loss, and the cheaper the cost of the insurance. Thus, were it not for the managerial expenses included in the insurance premiums, property owners would never find it economical to carry self insurance, for the more risks in a group the better the average.

Each individual forest owner in the example given above would, because of the tremendous risk, demand a return above that earned by safer investments. Just how much each owner would demand is a matter of conjecture. He would certainly expect at least a two per cent additional income and even then he would be subject to the same risk. His chances of losing are as great as before, except that now if he does not lose, he has two per cent for his anxiety. The total additional income received by these 10,000 owners, if they all considered the risk worth only two per cent, would be $20,000,000. The consumer would have to pay for this excess earnings by a higher price for lumber. Of this $20,000,000, the owners as a group would only lose, on an average, $1,250,000 through fire loss. The other $18,750,000 would be their profit for assuming the risks. The gain to the individual landowner is, however, very uncertain. Many would receive their two per cent additional, but those who bore the brunt of the fire loss in any year would lose heavily. Insurance would remove the fire risk to the individual owners, so that they would be willing to forego the additional two per cent income. Combining of all these risks and transferring them to one person would make it possible for him to compensate those burned out at approximately a cost of one-fourth of one per cent, or $2,500,000 for the group which includes not only indemnity to policyholders but also the expense of conducting the business. The owner would be satisfied with his smaller income because he is sure of it, and the consumer would only have to pay the additional $2,500,000, instead of the $20,000,000 that he would have to pay when no insurance is carried.

Advantages of Forest Insurance

The preceding section has already indicated that insurance, by eliminating much of the risk, will place forestry on a business basis. The capitalist will find the profits obtainable are large enough to be attractive in view of the reduction of the uncertainties. The investor will consider the insured forest as sufficient security to warrant lending funds to the business at the usual rate of interest. Forest owners, in the past, have had to invest their personal funds in the unsecured forest property, or borrow money at excessive rates of interest. Forest property secured by an insurance policy will be considered sufficient collateral for loans at the same interest rate charged on other commercial paper. The forest owner today must carry the bulk of the property with his own capital before he can induce investors to lend him funds. Thus, an individual must have considerable means of his own before he can carry on an extensive forest business. Insurance will make it possible for those with comparatively little capital to enter into the forest business, because much of the fixed capital can be borrowed with the forest as collateral. Thus, insurance reduces the cost of production and the saving brought about will be passed on to the ultimate consumer in lower prices.

Though the benefits to the private citizen by a general adoption of adequate forest insurance are very important to him, society in the end will

be the principal beneficiary. Where timber is now being removed as quickly as possible to mitigate unsecured losses, a more conservative liquidation of capital will be followed when it is possible to secure indemnity for these losses. Thus, our rapidly waning supply of timber would secure more conservative utilization. Then, too, millions of acres of non-productive land will, with the advent of proper insurance facilities, become valuable timber producing units, as the risk to which such property is now exposed is one of the chief retardents of the business of tree producion. This will mean that these idle acres will be put to work and timber produced thereon. It will do much to lessen the stringencies and the high prices of the timber shortage to come. Many of the counties in which idle lands are located are in serious financial difficulties, because of the small taxable value of such non-productive land. This has resulted in heavy taxes on the other property in the county. Therefore the sooner such land is put to work creating goods, the sooner the tax burden will be lessened on other property. Insurance will, furthermore, tend to create a continuous forest business by the security guaranteed to the invested capital. Such a continuous business is necessary if fluctuations in taxable wealth and the resulting evils thereof within the timber producing counties are to be avoided. Continuous production will also do away with the nomadic woods-worker and the attendant social evils arising from such an existence. Forest insurance then, while an aid to private enterprise, will indirectly be of benefit to society as a whole.

The skeptic may ask, "What are the disadvantages of forest insurance?" Theoretically, there are no disadvantages to properly conducted insurance. If the forest business cannot afford to pay insurance premiums, it cannot afford to stand the fire loss, as the insurance premium is but an index of the fire loss. True, the fire loss is not evenly distributed as are the insurance premiums, and may miss some particular piece of property entirely. The other objection that has been raised to insurance is that it will create serious moral hazard tending to increase the economic loss from fire. This is not an objection to the theory or proper practice of insurance, but to mal-administration. The rapid growth of insurance, naturally, gave rise to certain practices which were neither to the best interests of society nor to the insurance business. Adjustments have been made and remedies are being applied; sometimes, by coercive action of the State but more often by the industry itself. Insurance practice is by no means ideal at the present time, but statistics show that insurance when properly applied has not increased the moral hazard. It has, on the other hand, in many cases brought about remarkable reductions of actual fire loss, and must on the face of the evidence be considered a method of conserving wealth.

Forest Fire Losses

Before attempting an analysis of forest fire hazard, a general exposition of forest fires and the losses sustained through them is pertinent. The forester recognizes three distinct types of forest fires; the surface fire, the ground fire, and the crown fire. Surface fires are those which run along the ground, burning the leaves, grass, and other litter. They flare up when conditions are favorable, burning in addition the underbrush and young trees. Surface fires are by far the commonest form of forest fire and, while they do least damage per acre burned, the aggregate loss from such fires is immense, forming the bulk of the damage to forests from fires.

Ground fires are so called because they literally burn the ground and expose the mineral subsoil. Such fires occur only where there is a considerable accumulation of duff or peat, and then only during periods of excessive drought when this organic matter is dry. When they do occur, however, the damage is very great, as they destroy all plant life and greatly reduce the fertility of the site.

The crown fire is one that runs in the tree tops and is very destructive. It is rare in Michigan. Surface fires occasionally flare up into the crowns and burn there for a short distance before again dropping to the ground. These are the common crown fires of Michigan.

These three types of fires, singly or in combination, may cause many or all of the damages discussed below:

1. Fire consumes the leaf litter and all or part of the humus. This is the commonest damage by forest fires. It decreases the fertility of the soil and lessens its water-holding capacity. Such losses, while in the aggregate enormous, are seldom recognized in this country although it is possible to insure against such loss in some of the countries of Europe. This damage is not included in our forest fire statistics.

2. Fires usually burn or, at least, kill the young trees (reproduction). The public generally includes such reproduction in the term undergrowth or brush, and hence, not of any value. When such brush is partly made up of young trees, its destruction is an important potential loss, as this reproduction furnishes the trees of the future, the trees that will take the place of the present crop when cut. This loss is seldom included in fire loss figures.

3. Fires injure or destroy timber that, while of considerable size and out of the reproduction class, is still not merchantable. Merchantibility is determined by economic conditions, and therefore varies considerably, depending on the species and the locality in which it is growing. In Michigan, six inch spruce and 12 inch hardwoods are generally considered merchantable limits. The public readily recognizes the potential value of unmerchantable timber, but the determination of present value is so difficult of accurate solution that the losses from this source, even when included in forest fire statistics, furnish a very inaccurate estimate as to the actual damage incurred. Injury to such timber is not always evident until years after the fire, and such losses are, of course, very seldom included in any damage estimate. Often, subsequent insect or fungus attack can be traced directly to fire scars. In such cases, it would seem that, as fire is the primary cause of the infection, such loss should be partly chargeable to the original fire.

4. Fires also injure, kill, or occasionally burn up merchantable timber. The loss here is small if the timber is about ready to cut. However, if the timber is not readily accessible or is not financially mature, the salvage value does not represent its true value. Loss to merchantable timber is generally recognized and is fairly accurately reported, depending mainly on the cruising ability of the estimator. The bulk of the forest fire losses as reported by the various protective organizations represents this damage.

5. Fires injure and destroy the root stock. This is especially true of ground fires. Such damage is particularly important in coppice forests where future stands are the sprouts from the old roots and stumps. In France, such coppice growth is very important because of the scarcity of fuel, but in this country, save where forests are grown for fuel, pulp, or

chemical wood, such loss is not important. It has never been included in fire loss data.

6. Fires increase the cost of forest administration by necessitating alterations in the plan under which the forest is being managed. Such alterations in working plans often require new surveys and extensive adjustments of cutting practice. This loss is recognized in Europe but will not be of importance in Michigan until our forest areas are brought under management.

7. Fires destroy cultural features necessary to the efficient practice of forestry, such as logging railroads, flumes, fences, lookouts, or administration buildings. Such tangible losses are recognized and tabulated. No differentiation is made, however, between the necessary cultural features listed above and dwellings, resorts, timber, and lumber located on the forest area but not an intregal part of the forest business.

8. Fire very often makes important changes in the composition of the forest, usually to its detriment. Aspen, pin cherry, and other inferior species take possession of the area and may lengthen the period necessary for the re-establishment of the more valuable species. Even though the forester recognizes the damage done, the measuring of it is impossible with our present limited knowledge of plant succession.

9. Fire usually creates more hazardous conditions. Humus, while dry enough during drought to burn, usually contains considerable moisture, thus acting as a fire retardent. When this is once removed, a rank growth of herbs and grasses often follows which is much more easily ignited and will burn under less favorable weather conditions than was necessary to burn off the original humus. A second fire destroys the young seedlings and sprouts which have grown up since the first fire, and, as there are then often no seed trees left on the area, the chances are that the area will be devoid of valuable tree growth for many years to come. Protection organizations recognize this, and also the increased danger of fires originating in old burns, but such dangers can not easily be measured in dollars and cents.

10. Fire decreases the supply of game and fish. It decreases the game by reducing the shelter and, at times, the food supply besides the actual destruction of the animals and birds trapped and bewildered by the flames. Fish are destroyed in large numbers by leaching of the lye and washing of charcoal and earth into the streams. The food supply is decreased and the spawning grounds are covered with silt. Furthermore, fires reduce the volume of water during the dry seasons, and this coupled with a reduction of shade along streams, results in warmer water. Less water means lower fish-holding capacity and high water temperature is detrimental to one of our finest game fish, the trout. These losses are now recognized by sportsmen, although the extent of the loss is usually not fully appreciated. Measuring such a loss is, of course, out of the question except in so far as the receipts from licenses and earnings of guides and others dependent on sportsmen for a livelihood furnishes an index.

11. Fire decreases the aesthetic value of the region by the destruction of the forest, birds, and many other factors which draw the vacationist by the thousands into the northern part of Michigan each summer. Reduced revenues secured from transients only reflect to a small degree the dissatisfaction and disappointment felt by them.

12. The damage by forest fires reaches far beyond the district where they occur. The destruction of the forest eliminates the natural reservoir

which feeds the streams at a fairly uniform rate. Fire reduces the water-holding capacity of the soil and causes floods, which assume very serious proportions along the lower reaches of many streams. These flood waters wash away the soil and often deposit it on some fertile field further down the stream. These damages caused by forest fires have already been recognized to be of national importance, and have led to many laws beneficial to conservation, not only in Michigan but throughout the nation.

This brief exposition of damage caused by forest fires is not complete. The serious loss of life that has been entailed in forest fires in the past need not be retold here. The diminution in contentment, happiness and satisfaction, the final measure of monetary loss, cannot be encompassed by the mind as many fire losses are insidious and not recognized as such.

Forest Fire Hazards

In this discussion, the term hazard will be used in its technical sense to denote any factor which might in any way increase or decrease the risk to the forest through the agency of fire. Thus, there are two kinds of hazard, positive hazard which increases the chance of fire, and negative hazard which decreases the risk (5). Under this definition a look-out tower is a negative hazard for it decreases the risk of fire loss; whereas a railroad right-of-way would constitute a positive hazard as it increases this risk. Hazards may also be grouped as to whether they are physical or moral. Physical hazards include all those factors of risk that are inherent in the forest itself or in its environment. Moral hazard is the additional uncertainties created by man above that generally attributed to the several physical hazards. The term conflagration hazard is simply a term used to designate a combination of positive hazards that may give rise to an extremely destructive fire. Physical and moral hazard can be further divided into a number of broad divisions as the following discussion will indicate.

Climatic or meteorological hazard includes all the climatic factors which might in any way affect the possibility of a forest being injured by fire. Constant climatic hazard makes certain forest regions greater risks than others, while within each forest region fluctuating weather conditions increase or decrease the risk to any particular forest area above or below that of the average for the region. The coast forests of the Pacific northwest are generally of low climatic hazard, although occasional fluctuations in weather conditions may increase the climatic hazard tremendously for a short time. Climatic hazards include rain, snow, lightning, humidity, evaporation, wind, fog, and temperature (6). Several of these climatic hazards usually act in combination with still other physical hazards and it is very difficult, if not impossible, to evaluate each factor separately.

The constant climatic hazards in Michigan determine the average length of the fire season and materially affect its intensity. Precipitation here is the principal factor of climatic hazard. The average annual precipitation over the northern half of the Lower Peninsula and the eastern part of the Upper Peninsula is approximately 25 to 30 inches. The rest of Michigan receives a little more rain, approximately 30 to 35 inches. Total rainfall in itself is no direct criterion of hazard; the time of the year that this precipitation occurs and the frequency of precipitation is much more important. Michigan, especially the southern part of the Lower Peninsula, has a remarkably even distribution of rainfall. The precipitation during the grow-

ing season, May to September inclusive, is approximately 15 to 18 inches for the northern part of the Lower Peninsula and eastern part of the Upper Peninsula. This is two per cent above the average monthly precipitation for the year. Unfortunately, during the months of March, April, and October, when an excess of rain would be especially desirable, the rainfall is normal or even slightly below normal, amounting to from one to two and one-half inches. August is the driest of the summer months and this doubtless, is one of the factors that causes an increase in the number of fires during this month. Michigan is covered with snow for a period of 120 days in the Upper Peninsula and for 90 days in the northern half of the Lower Peninsula (7). During this period, of course, the fire hazard is negligible.

The data in the last paragraph are based on averages, but it should be remembered that the departure from these averages is very important in predicting probable conflagration hazard. Michigan is rather favorably situated in this respect, weather reports showing that the frequency of precipitation, being less than one-half the average, is about 30 per cent. Approximately one-third of the days in the Upper Peninsula have .01 inch of rain. The northern part of the Lower Peninsula, however, has fewer rainy days. These days can, furthermore, be bunched and bring about excessive positive hazard during the rest of the month. As a matter of fact weather statistics show that an average of two 20-day droughts with less than .25 inch of rainfall in 24 hours occur during March to September inclusive (7). These figures all tend to show that the positive precipitation hazard in the Lake States is greater than all other forest regions except the Rocky Mountain region and the southwest.

Lightning, a climatic hazard of much importance in many parts of the United States, is of minor consideration in Michigan because electrical storms here are generally accompanied by rain which quenches any lightning fires that may start. Only one per cent of the fires in Michigan are attributable to lightning (8). The other climatic hazards such as humidity, evaporation, and temperature are either the resultant of several factors, or operate in conjunction with still other physical hazards, and will be considered in connection with edaphic hazard.

Edaphic or soil hazard refers to those physical hazards of site upon which the forest is growing. The composition and the physical condition of the soil and the underlying strata influence its water-holding capacity. The litter and humus which by its character and abundance influences the hazard, depends also partly for its inflammability on the moisture content of the mineral soil beneath. Temperature measurements do not show any relation to the moisture content of the litter and humus because various other climatic and edaphic factors influence relative humidity and its subsequent effect on evaporation (9). The relative humidity in Michigan is generally over 50 per cent and the evaporation lower than in other inland regions. These factors tend to reduce the fire hazard. It must be remembered, however, that the initial precipitation is rather low and that the character and physical condition of much of Michigan's forest soil is such as to minimize these seemingly favorable factors. The porous sandy nature of the soil on the jack pine plains tends to absorb and release moisture very readily. Thus, the actual inflammability may be very great despite a comparatively high humidity and low evaporation.

The moisture content of the litter and humus is dependent on so many

factors that the measurement of any one of these factors will not indicate the inflammability of the forest floor. Relative humidity, without doubt, is the best indirect indicator of the probable trend of the moisture content of the forest floor, although it would seem that a very careful study of the other factors of hazard must be made for each individual locality before much reliability can be placed on relative humidity readings. Direct measurement of the moisture content of the duff is, of course, the most accurate and simplest method of determining the present inflammability of the litter and humus but it does not give any indication of probable future trend.

Biotic or occupancy hazard refers to the plant life occupying the site. Coniferous stands are always considered a much greater hazard than broadleaf stands. Not only are the species of tree and the stocking important factors of biotic hazard, but the age of the trees must also be considered. Young stands, for example, incur larger losses per unit of value than do older stands. Thus, in young growth, a fire may often result in a total loss, whereas, in an older stand, the damage will usually be partial. This is due to two independent factors: First, the trees as they grow older become more fire resistant, and many may survive the fire. Second, those trees killed or damaged in older stands usually have a salvage value. The silvicultural system of management, too, influences the biotic hazard. Thus, forests with a dense understory, as compared to ones without such an understory, usually have a smaller risk of kindling because the moisture in the leaf litter is conserved (10). However, during a drought these same stands have a greater risk of burning because of the additional small combustible material present, and because it increases the task of suppression.

Pure coniferous stands, such as are found on the sandy plains and in many of the swamps of Michigan, are more hazardous than similarly located stands of hardwoods. Part of Michigan is covered by very open stands of scrub oak, popple, and occasional pines accompanied by a very inflammable ground cover consisting of sweet fern, grasses, and other small plants. Here the risk of fire is very great, but the damage per acre, due to understocking with inferior species of trees, is comparatively small. In Michigan's northern hardwood-hemlock type, the hazard is generally less than in coniferous stands of the same age and stocking.

Topographic hazards refer to topographic features such as streams, rock ledges, slope, and exposure, which often have a material effect on the hazard. Thus, it has been found that the moisture content on a north slope may be above the danger point, which is eight per cent of moisture, for three-fifths of the season as compared with one-third of the season on a southern slope (11). Railroads in a plains country need a more extensive system of fire prevention than in a mountainous region because the railroads follow the water courses in the latter (12). However, the forced draft necessary to get over mountain grades tends to create a very serious kindling hazard unless the right-of-way is clean. Rivers and barren mountain ridges are excellent fire lines, materially reducing the conflagration hazard. Topographic hazard in Michigan is not very important because the general level character of the country does not materially influence climatic, edaphic, and occupancy hazards. Poorly drained depressions increase or decrease the hazard. During the average season most swamps are a negative hazard, but during dry periods such swamps become menaces. Swamp fires usually are very destructive, and cost, per unit of value and area burned over, a great deal more for suppression than any other type of fire.

Exposure hazard refers to all cultural features constructed by man. An objection to this classification may be made in that the hazard of any man-made structure is dependent on his vigilance or lack of it, and hence, is really a moral hazard. Underwriters, however, are wont to consider that a railroad, for instance, definitely increases the hazard irrespective of the care taken in preventing fire (13). No matter how great the precaution taken, fires still seem to occur, and thus the justification of considering such cultural structures as constituting a distinct hazard. Railroads, farms, towns, roads, logging operations, mines, and other industrial establishments constitute some of the commoner exposure hazards. Towns are usually considered a positive hazard.

There is considerable difference of opinion, however, as to whether such cultural objects as roads, railroads, and camp sites, can be considered positive or negative hazards. Roads are said to increase the efficiency of the protective forces, and therefore, are considered a distinct negative hazard by some. Any operation employing labor such as a hotel or logging operation, if properly protected, is considered as an aid in suppression as it serves as a source of fire fighters. The countries of western Europe, where a permanent system of roads covers every managed forest are used as examples of how such cultural exposure hazards reduce the risk of fire losses.

It is true that roads and towns aid in forest protection in Michigan as they do in Europe, but it is also true that the people who use these roads here do not fully understand the economic and social significance of the forest as well as do the people of Europe. The ultimate cause of fire in Michigan is almost exclusively due to man's presence. As long as the fires due to the carelessness of man increase, improvements which aid him in gaining access to the forest and in remaining there, must be considered overwhelming positive hazards. When the people of Michigan and the residents of other states who enjoy our hospitality realize the value of forest growth and actively aid in forest protection by the example they set, then will motorized highways, hotels, and towns be a greater aid in protection than they are a danger. As forest fire conscientiousness is created, all such exposure hazards will tend to decrease the chance of fire loss, but, at the present time, the forest area that is not frequented by man has a very small kindling risk. This outweighs the difficulty of suppression which arises when men must travel long distances on foot to get to the fire because there are no roads.

Railroads, then, are a distinct positive hazard not only in their operation but, also, in that they offer access by man to the forest area. In those states (Michigan not included) in which railroads are held strictly accountable for fires caused in connection with the railroad's operation, the positive hazard will be somewhat reduced because damages can be collected (14). Of course, many fires start along a railroad right-of-way for which the railroad can not be held responsible. Railroads in Michigan are required to keep their right-of-way clean and have their locomotives properly equipped with spark arresters. The numerous suggestions made by Michigan fire wardens to reduce the railroad fire hazard include safety strips along right-of-ways, patrols, and more rigid inspection.

Logging operations in Michigan are not as important exposure hazards as they are generally credited with being, as only about two per cent of our fires originate in this way. Fire wardens in touch with the situation suggest that this hazard can be still further reduced by education, brush disposal,

cleaning up logging right-of-ways, and requiring companies to put their wood's crews on the fire line. The influx of pioneer farmers has materially increased the positive exposure hazard in many parts of Michigan. This hazard is steadily increasing despite the educational propaganda being used to combat it. State fire wardens believe that the new permit system of slash burning in land clearing will materially aid in reducing this type of hazard. Carelessness in road building has been responsible for many fires in the Upper Peninsula. A permit to burn refuse, and holding contractors liable for damages is considered the best means of meeting this hazard.

Protection hazard, a form of exposure hazard, constitutes all those forces brought to bear by man to mitigate the destructive positive hazards to which the forest is subject. Grazing is a protective hazard, then, when it is used to reduce the biotic hazard by over-grazing or when the runways serve as a fire line in fire protective work (15). Roads, trails, and telephone lines are distinctly classed as protective hazards when they are used in connection with fire protection. Roads, for instance, must be weighed both as to their protective hazard and the positive exposure hazard created by them. Thus some roads, essential to efficient protection, may on the whole be considered a distinct asset, whereas a road which tends to bring a large number of transients into the region and is of little value for protection may be a positive hazard. The protective hazard always receives considerable attention because it is usually possible to measure its component parts and determine an index figure to show its efficiency year by year and to compare one protective unit with another.

Forest protection in Michigan is being carried on almost exclusively by the State and Federal Governments. Very few private owners attempt systematic forest protection. As stated by Peterson (16) Michigan is in urgent need of additional appropriations to reduce the fire loss to a minimum. Still, Michigan protection, considering the severe positive hazards to which the forests are exposed, is much more efficient than might be expected. Statistical reports prepared by the Lake States Forest Experiment Station tend to show that Michigan compares favorably in many respects with the other Lake States in the handling of its fire problem. The total average fire damage reported in Michigan is only $58,500 and the average size of the fires over the last ten-year period was 339 acres. The last five years has seen a material reduction in the number of acres per fire; the average fire for 1919-23 burned over 100 acres less than the fires of the previous five years. Approximately 73 per cent of the fires in Michigan every year burn over more than 10 acres. The total area burned annually averages 256,680 acres or approximately one and one-half per cent of the forest area of Michigan estimated to require fire protection. These figures show that Michigan's forests are exposed to a very serious fire hazard and that much must still be done, both in the matter of expenditures and efficiency, to lower the hazard to a reasonable level.

At the present time, the fire rotation is shorter than the average tree rotation which is incompatible with the practice of forestry. If the timber land burns over faster than the timber grows, the forester's efforts are futile. Other states have successfully coped with excessive fire loss, and Michigan can do likewise.

Moral hazard is the most important fire hazard. It can be divided into incendiary hazard and negligence hazard. Of the two, the latter is generally the most important, and also, the most difficult to control. Forest protective

organizations find that their best weapon against negligence hazard is education. Constructing and maintaining such negative exposure hazards as prepared fire-places for tourists and supervised camp grounds also tends to reduce negligence hazard. They find too, that the measurement of this hazard is practically impossible. Efforts have been made to divide the negligence hazard into classes dependent on the source. Thus, hunters and fishermen may be considered lesser hazards than campers and tourists, because they realize more fully the effect of fire. On the other hand, the camper and tourist while admittedly more likely to set fires, are usually restricted to certain localities along the means of communication, where the protective organization can take special precautions; the sportsmen, on the other hand, penetrate the most inaccessible regions, making detection and subsequent suppression much more difficult. Incendiary hazard is also classified as to origin. Fires are often set by those who think they see an improvement wrought by the use of fire, as, for instance, fires used to improve pasturage or to decrease fire hazard (17). Other fires are set with malicious intent either toward a neighbor, a member of the protective organization, or society in general. This group includes fires set by imbeciles and pyromaniacs who cannot be held responsible for their actions. Fires are at times also set by those seeking the job of extinguishing them.

The negligent moral hazard is especially important in forest protection in Michigan because of the large influx of tourists, hunters, and fishermen with little knowledge of the inflammable character of forest growth. Prevention through education by means of posters, personal solicitation, and newspapers is the best means of reducing such hazard. Fire permits, designated fire-places and camp sites, ash receptacles on automobiles, prohibiting the use of factory made cigarettes, no smoking in the forest, the closing of the hunting season during drought, and active prosecution, are some of the suggestions offered by the State conservation officers to reduce moral hazard. Over 50 per cent of the fires in Michigan are directly chargeable to negligent hazard whereas only two per cent of them are incendiary.

Conflagration hazard is a real danger in Michigan although climatic, edaphic, and biotic hazards are not especially favorable to conflagration. The vast contiguous forest areas due to the absence of negative topographic and exposure hazards tend markedly to increase the conflagration hazard. The large size of the average fire and the big percentage of fires burning over more than ten acres are statistical proof of the importance of the conflagration hazard. Sufficient statistical data are not available to indicate how often a distinct conflagration year may be expected. Since 1914 there have been three years during which the fire hazard has been exceptional, namely, 1920, 1923, and 1925.

All causes of fire are thus included under one or more of the hazards discussed above. To decrease or eliminate any cause of fire, the hazards which are responsible must first be studied and plans outlined for their control (18). It will be found that the element of moral hazard which is operative in most causes of fire cannot be completely controlled. To eliminate it would mean the removal of the accompanying physical hazards which is usually impossible. Thus, most hazards, while to some degree controllable, can never be eliminated. Before attempting to rate the above hazards in Michigan for insurance purposes or to discuss possible means of organization, it is necessary to review briefly past insurance history so that we may profit by experience.

The History and Present Status of Forest Insurance

The first forest fire insurance of record was written by stock fire insurance companies in France and Germany about 1880 (44). These ventures were not very successful either from the underwriters's point of view or from that of the insured; the volume of business was too small and the premium rates too high. Stock companies are still writing forest insurance in these countries today (19 and 20).

In February, 1912, the Norwegian Mutual Forest Fire Insurance Company was organized. Reports show that in December, 1923, this company had insured 70 per cent of the insurable acreage in Norway (43). It is evident from this that in spite of the small fire loss in that country, $1.37 per acre, forest insurance is in great demand.

Finland's chief natural resource is its timber. The importance of the forest industries and the inability to eliminate the fire hazard by protection, early led to the discussion of the forest fire insurance problem. Today there are several mutual forest fire insurance companies operating in Finland (21). Saari (10), in his statistical study, found that the area of insured forest burned between 1914 and 1922 amounted to 0.32 per cent of the total area insured, whereas, the state forests burned over during the same period amounted to 1.03 per cent. This would seem to indicate that insurance did not increase the moral hazard but may even have decreased it.

The first successful attempt to insure forests in Sweden came in 1919. This was offered by the Swedish Veritas, a powerful stock company, with the aid of Professor T. W. Jonsson, of the Forest Academy, and a committee of the Swedish Tariff Society (44).

Other countries having more or less successful forest insurance are Belgium, whose forest insurance is written by general companies at high rates (22), and Holland which has the distinction of having the oldest operating mutual forest insurance organization. This company was founded at Zutphen in 1894 and has twelve classifications based chiefly on biotic hazards. In the little country of Denmark, the Danish Plantation Society has been insuring the property of its members since 1902. Only plantations are insured and its liability is limited to the cost of replanting the area. Limited insurance coverage has been obtainable in Switzerland since 1906 (23).

The London Lloyds, one of the world's largest underwriters, has at various times written isolated policies in different countries. In recent years, they have limited their activities to excess lines received from other reputable companies writing forest insurance.

North American Insurance

Forest insurance in America is a very recent development. Previous to 1916 policies were written only on the solicitation of the property holder for the protection of odd lots of valuable timber for a few years or to aid in the floating of a bond issue. The first organization to actively solicit forest insurance in the United States was the Phoenix Assurance Company of London, England. The Pacific Coast department of this company announced on April 8, 1916, that it would write timber insurance in Washington and Oregon west of the Cascade mountains. This venture did not prove remunerative and so was discontinued in 1918. The timber landowner

considered the insurance unsatisfactory because of the small line acceptible and because of the co-insurance clause attachment (24).

The first organization in the United States dealing exclusively in forest insurance was the Timberlands Mutual Fire Insurance Company incorporated in New Hampshire, February 21, 1917 (25). The company did a very conservative business, insuring all kinds of timber but selecting its risks very carefully; lands close to railroads, recent slash, portable mills, picnic grounds, large cities, and other unfavorable exposure hazards "were avoided." The company dissolved at the end of 1918, having "established the principle of timberland insurance and not being particularly interested in the commercial aspect of the matter." The organization refunded approximately 14 per cent of the premiums collected from the policyholders in 1918 and returned five per cent annually on the guaranty capital (26).

The operations of this company do not represent a fair example of what forest underwriters could expect in Michigan. First, the company was actively engaged in insurance underwriting for only seven months, which is too short an experience upon which to base future operations. Secondly, the climatic hazard was far below the average during this same period, and therefore any loss ratio would be very misleading. Thirdly, this company was organized by a group of public-spirited citizens who also held much of the insurance, and whose property was extremely well protected. Hence, the fire danger was below what it would be ordinarily. The Globe and Rutgers Fire Insurance Company took over the business of the Timberlands Mutual and still writes a small amount of forest insurance.

In 1923 the Home Insurance Company of New York and its allied companies, the Franklin Insurance Company of Philadelphia and the City of New York Insurance Company, offered to write forest insurance. Its coverage is restricted to forests in the northeast. In 1924, encouraged by its writings in merchantable timber, the company agreed to write plantation insurance. This was the first progressive plan for the insurance of non-merchantable timber offered in this country. In the insurance schedules, the value of plantations up to 15 years is considered 80 per cent of the cost of planting, with compound interest at five per cent from the date of planting, minus any decrease in normal stocking. Normal stocking is considered to be one per cent decrease in stocking per year (27).

The Home Insurance Company has offered the timberland owners of the Northeast excellent protection, not only to merchantable timber but also to plantations. At the present time, however, no coverage is available on non-merchantable naturally grown stands, although this will doubtlessly in time become one of the more important lines in the forest insurance business. To date, except for isolated policies, no insurance has been written in Michigan.

Forest Insurance Organization

Any organization to carry on successfully the extensive underwriting of forests must solve the following problems:

1. It must have sufficient spread, covering not one but preferably many forest regions in order to avoid bankruptcy. A bad fire season might embarrass even the strongest company if its policies were localized in one region.

2. It must be operated at minimum expense. The premium must be largely an index of fire loss as the low returns from forestry investments,

the long period of time involved, and the uncertainties other than fire are such that expenses must be kept as low as practicable.

3. The organization must be willing and able to write all the coverage demanded. The solution here is not only a strong and large organization willing to write large lines subject to one risk, but also facilities to reinsure excess lines.

4. Insurance companies must carry on forest insurance business with utmost efficiency to keep rates at such a figure that private forestry will be practical. This means a careful study of forest fire hazard, forest valuation, and forest fire damage. These problems are essential forestry problems and cannot be adequately handled by insurance men without forestry training.

It has already been pointed out that in the application of insurance, many individual risks are transferred to some manager to hold and administer. The form that the management takes characterizes the several types of insurance business. Those organizations that write insurance as a profit making enterprise for the manager are usually known as stock companies, but if carried on as individuals they are known as "Lloyds." If the manager is on a salary, the profits being returned to the policyholder, the business is on a co-operative basis. It is also possible for society through the state or national government to manage its own insurance. Finally, large corporations having extensive holdings not subject to the same conflagration hazard can afford to carry their own insurance. Such self-insurance is truly a form of insurance; instead of paying out premiums to another, the money is usually paid into a reserve fund to take care of any losses that might occur. If no special reserve fund is carried, the loss must be paid out of the general assets of the business.

Of these various types of organization, the stock company ranks first in the United States. In this corporate form, the stockholders, who have risked their capital in the venture, also receive any profits that may accrue. The officers of the company, who are also usually stockholders therein, determine the general policies of insurance conduct and premium investment. The large organization of the stock company with its many officials, adjusters, clerks, and agents results in a high expense ratio. A high expense ratio, of course, means high premium rates. This is to the disadvantage of the stock insurance companies in writing forest insurance as the return on forest property is low. Even under these conditions they will doubtless continue to write more and more forest insurance as the margin of profit becomes larger in timber production. For the time being, they must of necessity write all the insurance because no other type of organization is in the field.

Individual underwriters usually call themselves Lloyds after the world renowned London Lloyds. Each company of a Lloyd organization underwrites a small part of many risks, and therefore the destruction of any particular risk will only cause it a small loss. It would seem that the Lloyd principle of small individual lines written by adequately secured underwriters, at low operating costs, but at a small margin of profit, might furnish an excellent scheme of forest insurance underwriting. It might be possible in time to build up a strong organization of Lloyds in this country, embodying all these advantages. Most states now have rather stringent requirements for Lloyd associations. To do business in Michigan, such an organization must deposit $200,000 as security, and cannot expose itself to

a loss on any risk in excess of one-fifth of their assets and underwriting liability (28). Such an organization to write forest insurance successfully would not only have to be satisfied with a small margin of profit but would have to have sufficient members to enable large timberland owners to obtain complete coverage.

Co-operative property insurance is conducted by a salaried or commissioned manager, any profit or loss going directly to the policyholders. The mutual form of organization for forest insurance has several drawbacks. Perhaps the most important of these is that the forest risks are very generally subject to a conflagration hazard which the mutual organization cannot meet unless it has a very large reserve. A local mutual, then, covering a small portion of a state would be out of the question. The general mutual offers the only co-operative forest insurance enterprise that is immediately applicable. Such a mutual would generally lack the close and sympathetic supervision of the policy holders, but it would have sufficient other business to allow it to carry forest underwriting during the pioneer stage at approximately the loss ratio. The expenses could be spread over the general business of the mutual, and an extraordinary loss in any one year could be met from the reserve fund.

There still remains to be considered state insurance and self-insurance. Theoretically governmental enterprise, because it can be conducted at cost and on a large scale, should be the cheapest form of business organization. Voluntary governmental fire insurance has successfully competed with private insurance in many countries of Europe (29). It seems doubtful, however, whether a similar enterprise would succeed here. The only advantages that can be claimed for such voluntary government insurance over the mutual enterprise are greater security and freedom from taxation. Mutual insurance has, however, a greater degree of private initiative which would tend to outweigh these advantages.

Compulsory forest insurance, no matter by whom administered, has several very important advantages in that all risks are gathered together reducing the uncertain losses to a minimum. Compulsory governmental insurance would then, theoretically, furnish insurance at the lowest rate possible; the combination of all risks secures a more accurately determined loss ratio, the vast amount of business also decreases the expense per unit and, finally, no profits nor special reserve funds need be earned. Even with all these advantages, there are many who have no faith in governmental participation in business and feel that such insurance would be a failure.

The first concrete suggestion for compulsory governmental forest insurance in the United States was put forward by D. R. Brewster in 1920 (30). This plan combined fire protection and insurance. All forest lands save the farm woodlots were to be assessed at their true value with due regard for moral hazard. The miminum value was to be $1.00 per acre and the premium thereon two cents. In 1923, the writer prepared a plan of governmental compulsory forest insurance with some fundamental differences from the above plan (31). Under Brewster's plan, any additional valuation above the minimum of $1.00 per acre was dependent upon a field inspection by an appraiser. Even with a preliminary general survey and classification, it seems that it would be physically impossible to appraise all our cut-over land. The new plan called for the preparation of conservative tables of value for all species, mixtures and regions to be used by the owner as an aid in determining the true value of his land.

The new plan also embraced the entire country, the actual insurance administration, with federal supervision, being left to the several states, with the Federal Government reinsuring all risks at the burning rate. This reinsurance feature and participation of the Federal Government would tend to secure uniform insurance practice and would materially cheapen the cost of such insurance, as the Federal Government would carry most of the conflagration hazard. Michigan or any other state by itself is entirely too small an area as a basis for insurance with the conflagration hazard included. The expense to the Federal Government would be very small; an additional fiscal agent to receive the premiums from the states and to pay out indemnities, and a few forest actuaries to supervise the actual insurance administration would be ample.

Brewster fixes a flat rate on all property regardless of hazard. Of course, such a stand would give rise to unending criticism. It is obvious that there are some timberlands which are many times as hazardous as other tracts. The writer prepared examples of detailed schedules of rates for the Lake States and New England based upon the several hazards. The maximum annual premium per one hundred dollars worth of insurance in the Lake States from this schedule is 95 cents, the average premium would be approximately 55 cents, and the minimum seven cents. The Lake States schedule is included under the section on, "Insurance Rates." These rates are based on the full valuation of all the forest land in the region, including government and state. The author believes that the plan as outlined here has enough inherent advantages to be successfully carried on by the government.

We now come to the last possible method of handling forest insurance; namely, self-insurance. Self-insurance is practical only because of the expense ratio present in all other forms of insurance. Approximately 45 per cent of the insurance premium collected by stock companies goes to pay administration costs (32). A few large industrial concerns with risks scattered throughout the country carry no outside insurance. In view of the high costs of administration, the Federal Government, many of the states, and some of the larger private timber land holders can afford to write their own forest insurance. Any forest business before attempting to insure itself should determine approximately how great the average annual loss will be, the probable variation, and the frequency of conflagrations. A company will find self-insurance advantageous only when it has many pieces of forest property so separated as not to be subject to the same conflagration. Large lumber companies owning extended areas so blocked and connected that a fire starting on the tract is likely, under favorable conditions, to burn it all over, is not a safe forestry investment with only self-insurance, no matter how large the area. The best results with self-insurance will be obtained if the company owns property in several of the forest regions of the country. A bad season in one region will often be offset by a favorable season in another. Most businesses of tree production will, for administrative reasons, be limited to compact blocks of land centering around a single manufacturing unit or one or more shipping centers. This necessarily means considerable conflagration hazard which, unless the business is exceptionally large, can be adequately provided for only by some form of outside insurance.

Insurance Rates and Rating

All property insurance premiums are at the present time determined from rating schedules. These schedules are based upon one or more basic

charges to which additions and subtractions are made for differences in the hazard. They are drawn up by experienced underwriters who rely upon their judgment and experience as to what the charge for a particular hazard should be. The lack of proper statistical records makes it difficult to determine rates from past experience, and companies, for this reason, hesitate in adopting experience rating. But, if rates cannot be based upon experience in ordinary fire insurance, it is obvious that experience rating in forest insurance is at present also impossible. Forest fire statistics are at best unsatisfactory. No organization is today collecting the data that must be available if insurance rates are to be formulated from actual past experience. Reform in the collection of forest fire statistics has been urged by various writers (33). In the words of Sparhawk (34): "Our fire records are incomplete, inaccurate, and lacking in uniformity, and do not in most cases give the details necessary for proper classification while our knowledge of the values at stake is even more deficient." Sparhawk recommended a central acturial bureau, but, thus far, little headway has been made either in the method of collecting the data, its accuracy, or its compilation.

The present methods of collecting forest fire data are often fundamentally wrong. The appraisal of the value damage by local wardens is particularly objectionable. There are few men reporting fires in the State of Michigan who have a good conception of the principles underlying the determination of value in non-merchantable timber, and, as a result, such losses are seldom reported. A similar condition prevails to a more or less extent in every organization collecting fire data in this country. Furthermore, the man in the field should not be called upon to make estimates that require both considerable time and technical training. His efforts should be directed chiefly toward prevention and suppression.

It is impossible under present conditions to send a special appraiser to each fire, but, even now, it would seem that large fires could be handled in this way. For the average fire, the report must still be compiled by the local warden, but the data called for can be clarified. The area burned over should be tabulated by acres, or better yet, on larger irregular fires, by metes and bounds accompanied by a rough sketch map. The average diameter, the species and density of the trees, and the site should be enumerated, together with the approximate number of trees damaged or killed (18). The elapsed time and other data now customarily collected for each fire to determine the efficiency of the protective organization, and to determine various factors of hazard need little revision. A report covering points enumerated above can be filled out with greater accuracy by the average warden than the ones now in use.

The data collected should be transmitted to a forest actuary who is not only well acquainted with the localities from which the reports come but who is also thoroughly conversant with the subjects of forest valuation and statistical methods. The tabulations made by him should be by regions, types, age groups, and causes. While it would, doubtless, be best to collect and tabulate the data not only by these groups but also as Sparhawk (34) suggests, by degrees of occupancy and exposure hazard, it is questionable whether the field man should at this time be burdened with such additional work. Not only does it mean more time to fill out the report but it would tend to make the reporter careless and indifferent toward the entire report because the information desired is so indefinite. Nor could uniformity be secured because no rigid rules can be laid down with our present knowledge, and

each man would have to rely upon his own judgment as to the grades of hazard. It would seem that such detailed statistical methods will have to await the time when all major fires will be appraised by a trained forest actuary.

It has been argued, too, that the damages should be expressed in units of measure instead of monetary units or, if monetary units are used, they should be fixed for at least a decade and should not fluctuate according to changes in market prices (35). It is not within the scope of this paper to go into the merits of these and other suggestions for the reform of forest fire statistics. It must be remembered, however, that basic data should be collected and then tabulated in such form as to lend itself to various interpretations. Thus, primary tabulations of loss should be in units of measurement from which any monetary value desired can be calculated. Protective effort should be tabulated by man-hours. It cannot be urged too strongly that changes in statistical methods should only be made after thorough and painstaking consideration.

Few exhaustive statistical studies of forest fires have been undertaken in this country, save the admirable but restricted analytical study of Show and Kotok for California (1). This dearth of statistical studies is chiefly due to a lack of data or, if available, they have generally been very unreliable and not susceptible to statistical analysis. The Lake States Forest Experiment Station has been working upon a general study, some phases of which have already been completed. For insurance purposes, the period of time covered by the data at hand is too short to be of much value in determining rating schedules, but it is not necessary, as one writer states (14), that experience rating alone should be used to secure satisfactory rates for forest insurance. The Scandinavian countries, surely, have satisfactory forest insurance rating, but they have not been able to base their rates on experience rating schedules.

The first schedule of rates following is intended for the use of private companies now engaged in writing the usual fire insurance lines. The second schedule was prepared for the Senate Committee on Reforestation, 67th Congress (31) and is reproduced here to show the probable rates possible in the Lake States, if all forest property were insured by the Government. According to our meager statistical knowledge, approximately 12 cents per 100 dollars represents the actual annual burning rate. If this were a reliable figure the insurance premium would be 25 cents per 100 dollars worth of insurance on forest land of average hazard. Naturally, insurance will be taken out on the more hazardous forests first, and the damage incurred would be more accurately calculated than now. Both of these factors would tend to increase the burning rate and, hence, the average rate as calculated from the first schedule is considerably higher than this.

SCHEDULE I—FOREST INSURANCE SCHEDULE OF RATES FOR THE STATE OF MICHIGAN—COMMERCIAL COMPANIES

	Plus	Minus
Basic charge per $100 of insurance	$0.75	
Exposure hazard on property or on adjacent property:		
Railroad right-of-way	.20	
Coal burning	.10	
Spark arresters		0-.08
Patrol system		0-.10
Fire lines		0-.10
Railroad fire fighting force		0-.10
Right-of-way clean		0-.05
(Maximum deduction 14 cents. Coal burning 22 cents.)		
Motorized highway	.10-.30	
Right-of-way clean		0-.05
Fire line		0-.10
Patrol		0-.15
Wagon road or trail:		
Right-of-way clean		0-.05
Summer resort or camp ground	0-.25	
Fire protective system		0-.15
Logging	0-.15	
Coal burning machinery	.10	
Spark arresters		0-.07
Fire protective system		0-.15
Other industrial establishments	0-.40	
Fire protective system		0-.40
Farms	0-.20	
Land clearing going on	.10-.40	
Exposure hazard within two miles of property:		
Railroad right-of-way	.10	
Coal burning	.05	
Spark arresters		0-.04
Patrol system		0-.05
Fire lines		0-.05
Railroad fire fighting force		0-.05
Right-of-way clean		0-.03
Motorized highway	.05-.15	
Right-of-way clean		0-.03
Fire lines		0-.05
Patrol		0-.08
Wagon road or trail:		
Right-of-way clean		0-.03
Summer resort or camp ground	0-.15	
Fire protective system		0-.10
Logging	0-.10	
Coal burning machinery	.05	
Spark arresters		0-.04
Fire protective system		0-.10
Other industrial establishments	0-.20	
Fire protective systems		0-.20
Farms	0-.10	
Land clearing going on	.05-.20	
Towns of under 500 inhabitants within two miles of property	.10-.20	
Increase charge in direct proportion to population and decrease charge twice the base charge for each additional mile distant.		
No charge when over 50 miles away.		
Maximum charge $0.50.		
Slash:		
If property or property adjacent has been logged within 10 years without adequate brush disposal	.15-.30	
Protected by fire line		0-.15
If within two miles of such property	.07-.15	

SCHEDULE I (Continued)

	Plus	Minus
Sport:		
Fishable water on or within one-fourth mile of property	$0.10–.20	
Fishable water within 2 miles of property	0–.10	
Land posted with warnings		0–.05
Blueberry land:		
On property or adjacent	.10–.20	
Within 2 miles of property	.05–.10	
Nature of stand:		
Plantations and young growth under 25 years of age:		
Conifers	.40	
Mixed stands	.20	
Broadleaf	.10	
Pure (90%) conifers over 25 years	.15	
Swamp broadleaf type		.10
Protection:		
System of detection and suppression		0–1.00
System of fire lines		0–.50
Conflagration hazard	0–.50	

SCHEDULE II—GOVERNMENTAL FOREST INSURANCE SCHEDULE OF RATES FOR THE LAKE STATES

	Plus	Minus
Basic charge, $0.25 per $100.		
Cultural features on property or adjacent:		
Railroad right-of-way	$0.10	
Coal burning	.05	
Oil burning	.02	
Patrol system		.01
Fire lines		.02
Maintaining fire-fighting organization		.01–.02
Keeping right-of-way clear of inflammable material		.01
Motorized highway	.12	
Fire line alongside of road		.02
Fire line 50 feet back from road		.06
Keeping road clear of inflammable material		.01
Summer resort or camp ground	.06	
Industry:		
Logging	.02	
Coal-burning machinery	.02	
Properly protected by spark arresters		.01
Patrol		.01
Other industrial establishments	.04	
Unfavorable labor	.01–.02	
Fire-fighting organization		.01–.02
Earth roads (non-motorized)		.01
Posted		.01
Trails		.01
Cultural features within one mile of property:		
Railroad right-of-way	.04	
Oil burning	.01	
Coal burning	.02	
Patrol system		.01
Fire lines		.01
Maintaining fire-fighting organization		.01
Keeping right-of-way clear of inflammable material		.01
Cultural features within one mile of property and over one-fourth mile:		
Motorized highway	.06	
Fire line alongside of road		.01
Fire line 50 feet back from road		.03
Keeping road clear of inflammable material		.01
Summer resort or camp ground	.03	
Industry:		
Logging	.01	
Coal-burning machinery	.01	
Property protected by spark arresters, etc		.01
Patrol		.01
Other industrial establishments	.02	
Unfavorable labor	.02	
Fire-fighting organization		.01
Earth roads (non-motorized)		.01
Property within 5 miles of any incorporated town with population of 3,000 or under (Increase rate one-half in direct proportion with population and inversely in same proportion according to distance; i. e., town 15 miles away with population of 12,000 charges $0.45; maximum, $0.08; minimum, $0.00.)	.03	
Property or adjacent property logged within 10 years without adequate disposal	.05	
If adjacent logged property segregated by fire line natural or artificial		.02
Property within one mile of area logged without proper slash disposal	.02	
If adequate fire lines are present		.02
Fishable streams (on property or directly adjacent)	.04	
Fishable streams one mile away (no fire line)	.02	
Blueberry lands one mile away (no fire lines)	.01	
Blueberry lands (on property adjacent)	.02	
Nature of stand:		
Plantations and young growth under 25 years old:		
Coniferous	.08	
Broadleaf	.05	

SCHEDULE II (Continued)

		Plus	Minus
Pure coniferous stands over 25 years old		$0.02	
Swamp type			.01
Swamp type other than pure conifers			.02
Protective features:			
System of patrol and suppression			.01–.08
Property visible from lookout not over 10 miles away			.03
Property visible from lookout not over 20 miles away			.03
Fire line around property			.02
Maximum	$0.95		
Average	.55		
Minimum	.07		

The values assigned to the several hazards listed in the foregoing schedules are based mainly upon the opinion of the author, and are substantiated by statistical or other evidence only in general, as discussed in the previous section on hazard. It is considered that the commercial schedule is suitable for use during the pioneer stage of forest insurance when the volume of underwriting is very small and when most of the risks that are written tend to be exceptionally hazardous. If the schedule is in error, it is on the side of conservatism. As soon as the principle of forest underwriting has been established and the volume of business assumes substantial proportions, it is anticipated that a decided downward revision will be possible.

Evaluation of Michigan Forest Growth for Insurance Purposes

Insurance premiums are ordinarily based on the sales value of the property insured. This value would have to be determined by the owner as it would be too expensive for the insurance company to appraise the property before issuing a policy. If a loss occurs, inspection would usually be undertaken to determine the true value before and after the fire. In the case of most property, the owner is usually well aware of its approximate value; but few people have any idea of the value of a stand of timber that is not yet merchantable. This is one of the most difficult problems of the forest insurance business and is one of the reasons for its slow development.

The difficulty in valuing timber in Michigan is due chiefly to the fact that the true or expectation value usually differs so markedly from the sales or market value. In immature forests, future value discounted to the present time is commonly known as expectation value. It is well to point out here that the terms used above are not synonymous with merchantable value. Merchantable value refers to the value of the products that can be secured now from any particular stand of timber. In the past, the sales value has usually been measured entirely by merchantable value. Thus, a stand of pine 30 years old might produce only $45 worth of timber and this was therefore, all that the tract would usually bring if sold. Farsighted individuals are now beginning to realize that such a tract, if allowed to go on growing, would in time be worth more than $45 plus future expenses and compound interest at the usual rate. The sales value, then, would be more than the merchantable value. If there is sufficient competition in buying the timber, the sales value will rise to the true or expectation value which will, of course, be the future value discounted to the day of the sale at the going rate of interest.

The future value used would be the merchantable value at that age when the timber as a growing crop would cease to return the usual rate of interest on the investment. When this age is reached for any particular stand, the expectation, sales, and merchantable values are the same. If the timber is not then cut, the value, while increasing for a time, will not increase as fast as the costs. The age at which these values first meet can best be termed the age of economic maturity.

The subject of forest valuation has been treated by many authors (36, 37, 38) and will receive only incidental treatment here.

In Europe, the general public has already learned to appreciate the potential value of immature timber to such a degree that the difference between the true value of trees over one-third rotation age and their sales value has become small and progressive insurance companies have been able to determine the valuation for such stands (39). But Europe, even with its century-long experience, cannot use expectation value for stands younger than one-third the age of economic maturity. This is due to the long period that must be covered by the calculations. Who can foretell with any degree of certainty what the hazards, costs, and demand thirty to a hundred years in the future will be? European foresters and insurance companies have found it necessary in such cases to base their values not on the expectation value but on replacement value, which comprises the costs of planting and other expenses, with compound interest to date (40). To prevent frauds, such as padded expenditures, a maximum figure must be set which is not as high as the expectation value. Young, naturally seeded stands, when insured at replacement value, arbitrarily include the average cost of planting for the region.

Can insurance companies in America adopt the method of valuation used in Europe? Not without radical modification, because the valuation of our immature timber by expectation and replacement value might be much higher than the market value. This would encourage incendiarism. Insurance value, generally speaking, must correspond to market value. Under certain conditions, plantations might be insured at replacement value. As long as it remains in the hands of the original owner and no financial stringency exists, the criticism that the plantation cannot be sold at replacement value, and that, therefore, a distinct moral hazard exists is not correct. Where the plantation has changed hands, the purchase price should be used as the insurance value.

The Home Insurance Company has as yet found no increased moral hazard in insuring plantations at slightly under 80 per cent of the replacement costs. Since it is the hope of foresters that planting will in the future be reduced to a minimum by proper harvesting, it would seem that plantation insurance will not be a very important part of insurance underwriting. As long as there is no increase in moral hazard, plantation insurance can well be written on the basis of replacement value, with suitable deductions made for understocking and possible moral hazard. Such a high valuation would tend to encourage forestry by making the public realize that young forest growth has a definite monetary value. If such realization leads to widespread plantation insurance and an increased moral hazard, the valuation would have to be reduced to sales value.

It must be remembered that forest plantations are worth no more than naturally stocked stands of the same species, age, and condition. The true value is not based on past costs but on future value. In Europe where this

is clearly understood, very young natural stands are not insured on the cost of replacement but on the average cost of the planting stock and planting for that region in addition to any other expenses incurred, such as taxes and administration. This, naturally, puts the value of such stands on a par with plantations.

In Michigan any attempt to value second growth stands, which are under one-third rotation age, at their true value, would lead to a tremendous increase in the various phases of moral hazard, since such stands possess a sales value of only a fractional part of their replacement value as determined by European methods. The best that can be offered by insurance companies is to insure on the replacement value, covering only such items as taxes, interest on bare land value, and such costs as protection and administration, all carried at the going rate of interest to the present age of the stand. The number of years to be used in computing the age should not exceed the average age of the timber. For example, a piece of land logged over twenty years ago and heavily burned ten years later with consequent loss of most of the young growth, would only be considered 10 years old at this time. Deductions also would have to be made for density and condition of the stand. If the market value is greater than the replacement value, such value would be used; but, on the other hand, if market value is less than the replacement value, percentage deductions would have to be made wherever necessary to prevent moral hazard.

In either natural stands or plantations which are over one-third rotation age, expectation value as applied by some European companies cannot be used in this country because of the wide divergence between expectation value and sales value. For such stands, average sale values for the several regions must be determined, and these revised upward as the general public begins to realize the true value of immature timber. Such a tentative table has been prepared for the upper half of the Lower Peninsula of Michigan.

VALUE PER ACRE OF CORRECTLY STOCKED STANDS OF SECOND GROWTH—NORTHERN HALF OF LOWER MICHIGAN

Diameter, breast high, inches	Red and white pine	Jack pine	Northern hardwoods
1–2	$10.00	$2.00	$5.00
2–4	30.00	5.00	15.00
4–6	55.00	10.00	25.00
6–8	85.00	30.00	40.00

This table applies only to correctly stocked stands on average sites. Stands that are abnormal as to site or density will require a correction factor to these values.

CORRECT DENSITY TABLE—NUMBER OF TREES PER ACRE

Diameter, breast high, inches	Red and white pine	Jack pine	Northern hardwoods
1–2	700–2000	1000–2100	600–1500
2–4	650–1400	700–1400	500–1300
4–6	600– 900	500– 900	350– 700
6–8	500– 700	400– 700	300– 500

The value of the stands that vary from this correct stocking should be determined by the ratio between the actual stocking and correct stocking. Thus, an acre of 250 white pines from 6 to 8 inches in diameter would equal $\frac{250}{500}$ or one-half of $85.00. A stand of 1 to 2 inch white pine containing 500 trees would be valued at $\frac{500}{700}$ or five-sevenths of $10.00.

Stands over six to eight inches in diameter at breast height are usually sold at their merchantable value and must be insured at this value even though the expectation value of some stands might be considerably more. As this fact becomes better known and the hazards are decreased, the sales value of such stands will increase above the merchantable value. Forest insurance valuation, as long as insurance is a voluntary act, cannot usually rise above sales value. As such sales values fluctuate widely, the tables as here presented are merely crude guides to be prepared by the insurance companies for the use of applicants for forest insurance. The insurance company will usually find it necessary to issue the policy on the valuation as determined from such tables, but it should be clearly understood that the face value of the policy is simply the maximum loss for which the company can be held liable and that the actual value before and after the fire must be determined on the ground by the adjuster.

Adjustment of Losses

The troubles of the insurance adjuster are not over when he has made a determination of the value of the stand before the fire. As long as this is based more or less on current market prices within the region, the differences of opinion must necessarily be rather small. However, wide differences of opinion can prevail as to the percentage of loss and salvage value. In very young stands where a heavy fire kills all the trees outright, the problem is simple, but what is the damage to an immature stand when only a few of the trees are killed outright but many of them injured? Again, just what is the loss to merchantable timber either with or without salvage? The damage to forests from fire, save when the trees are killed outright, presents a problem such as no insurance adjuster has had to face.

Fire, in burning over a forested area, does considerable damage which is not apparent to any but the trained observer. Even then, in many cases, the best technically trained and experienced forester will find it nearly impossible to form a satisfactory estimate of the property damage immediately after a fire, because many of the injuries may not become noticeable until the next growing season. Most fires, in all except young stands, do not kill many of the trees outright but so injure them that they may die in the next year or two; other trees may be permanently retarded in growth and value, while still others will, in a year or two, show no ill-effects of the fire except a period of slow growth and possibly a fire scar.

It would seem that the company should be held liable only for the vegetation occupying the site when the insurance was written. Leaf litter, soil fertility, difficulty of management, and other factors, while sometimes insured in Europe, should not be included here until forest insurance is on a firmer foundation. The forest adjuster must first determine whether the value as stated in the insurance policy is equitable. If not, this must be arrived at by the methods discussed in the last section. Then a careful

cruise of the area should be made to determine by species the percentage of the trees which are killed and injured as compared to the total number present.

The greatest difficulty will be the appraisal of the loss to the injured trees. Insurance for fire can only cover the losses due directly to the fire or to fighting the fire. Thus, a tree with the cambuim partly destroyed by fire may offer in years to come excellent prey for insects and disease germs. The danger from such secondary losses depends partly upon the steps taken in forest sanitation before and after the fire, and, therefore, such losses are not entirely attributable to the fire which exposed the tree to their attacks. Trees, thus fire scarred, which years afterward show insect or disease attack can often be salvaged before appreciable damage is done. Different authors (1, 41) have pointed out the difficulty of determining fire injury to trees, citing studies upon which their conclusions are based. No one, however, has ever attempted to give detailed instructions for the measurement of fire injury because each fire varies from all others. The forest adjuster must base his decision upon past experience and through understanding of the culminant effect of fire. The mathematical determination of loss (42) is difficult because it is usually impossible to determine the per cent of damage with an accuracy commensurable with the accuracy of the formulae and, where these formulae are based on the expectation value, the future growth and stumpage values cannot be accurately determined.

When it is possible to salvage the fire-killed and injured timber, the forest adjuster must first determine the amount of timber damaged and then the salvage value of this timber. Whether it is possible to salvage the timber depends on such factors as accessibility, species, age, and whether all the timber is to be removed in the salvage operation or only that which is injured. The owner of a stand just approaching maturity might not care to cut all the timber on a tract after a light fire destroyed a third of it, because the expectation value of the uninjured timber is worth more to him than its present merchantable value. In such cases, the adjuster must determine whether the salvage of the killed and injured timber will pay for itself regardless of the other timber present.

More satisfactory adjustment of loss is possible if the appraisal is made sometime after the fire. Fires in the summer and fall should be appraised after growth has begun the following spring. Early spring fires can be appraised the following fall. Damage to broadleaf trees should always be determined when the trees are in leaf, as it is obviously impossible to make a satisfactory appraisal when the trees are dormant or when there is snow on the ground. Insurance policies should contain a clause stating that adjustments will be made within one year from the date of the fire at such time as the company deems most advisable. Naturally, the company should be held liable for the accrued interest on the damages as finally determined. By thus delaying the appraisal a more equitable adjustment can be made, usually to the benefit of the insured. The company would have to face the chance of a second fire causing additional loss before the adjustment is made and the possible depreciation in the salvage value.

Insurance Costs

Can timberland owners afford to carry insurance on forest properties? If they are really in the business of growing trees, it is not a question of affording insurance but a question of affording to conduct the business, as

insurance is a legitimate expenditure in tree production. Some may state that they have reduced fire hazard to a minimum and can afford to assume the risk from fire. That is self-insurance and can usually be carried only if the property is not in one block and not subject to conflagration hazard. Measurable risk must be eliminated if the operation is to be removed from the realm of speculation. The owner should know what the measurable risk is. He can then decide what course he intends to pursue in regard to insurance, whether it will be cheaper to self-insure or to carry commercial insurance.

Let us assume a rather extreme example. Suppose that a private citizen were to purchase land on the jack pine plains stocked with small jack pine at five dollars per acre. Could such land make an adequate return on the capital invested? Over one per cent of the jack pine plains are burned over annually. Assuming that he had to hold the land 40 years before harvesting the crop, approximately half of his timberland would have been burned over. Under these conditions there would be little possibility of making a profit. Suppose he inaugurated intensive protection to reduce his burned area to approximately one-tenth of one per cent at an annual cost of approximately two per cent of the initial investment. Under these conditions he would only stand to lose one-twenty-fifth of his area by fire in the forty years but his protection costs might make the venture unprofitable.

Now let us assume that commercial forest insurance is available as outlined in this bulletin. The hazards as they are generally found on the jack pine plains would call for a premium rate of two per cent for the first 30 years and thereafter only 1.75 per cent. He insures his timber and lists his land under the Pearson Commercial Forest Reserve Exemption Act entitling him to an annual tax of 10 cents per acre and a cutting tax of 25 per cent. He does not spend any money for protection or administration. He is entitled to six per cent on his investment and expenses. The following table shows the status of his investment at the end of different periods during the growth of the stand:

D. B. H. inches	Number of years	Taxes	Insurance value	Insurance cost	Interest on land	Total investment
1–2	10	$1.32	$2.00	$0.53	$3.95	$5.80
2–4	20	3.68	10.00	3.58	11.03	18.29
4–6	30	7.90	30.00	13.33	23.72	44.95
6–8	40	15.48	60.00	37.70	46.45	99.63

If the owner cuts the timber when it reaches its fortieth year, stacking 30 cords at a stumpage price of five dollars per cord, which is not improbable, and pays the 25 per cent yield tax, he would not only clear his investment at six per cent but about thirteen dollars additional. If the timber burned before maturity, he would receive indemnity from three dollars to thirty dollars below his investment cost. This is unavoidable at this time because the market value of young growth is so low. From the insurance company's point of view an indemnity below investment value is very desirable as it removes the moral hazard that might be present if the owner could get back his money, dollar for dollar, at anytime by burning his timber.

It must be remembered that the above example is taken for rather slow growing, low valued timber, and in the region of greatest hazard in Michigan.

If insurance makes such an investment practical there, it will easily do so where a more valuable, faster growing species can be used. Where planting costs add to the initial investment greater returns are, of course, necessary. Thus, a stand of white pine planted at a cost of ten dollars on land which costs five dollars per acre, with average fire hazard and insurance costs, producing 35,000 board feet at twenty dollars per thousand in 50 years, would return one hundred thirty-two dollars in profits above six per cent on the investment. It is, of course, a debatable question whether white pine stumpage 50 years hence will be worth twenty dollars per thousand.

It will be noted that the owner did not spend any money for protection in either of these instances. The State is now furnishing protection and the loss is about one per cent in area annually. Under usual conditions there would, however, probably be some annual or periodic expense for improvements, protection and administration. Money so expended might reduce the insurance costs by reducing the fire risk. Statements that fires must be confined to approximately one tenth of one per cent of the area in order to make a risk insurable seem to be incorrect. An attempt to formulate the degree of protection necessary before a piece of forest property can be profitably managed by a private individual depends upon so many independent, variable factors that any general statement like the above cannot be accurate. Nor can one determine what percentage of cost should be assigned to insurance premiums. In cases of extreme hazard it is conceivable that insurance premiums will be the biggest item of expense which the owner will have to meet, especially if taxes are low and initial costs negligible. In the examples just cited, the insurance costs amount to approximately 30 per cent of the total expense for the white pine plantation and 32 per cent for the jack pine stand.

Summary

Forest insurance is a necessary adjunct in the business of forestry, especially where an annual return cannot be obtained as would be the case in a forestry business operating in the cut-over and burned-over areas of Michigan. If the business of tree production is to be carried on by private capital, it must compete with other private business as to security. This it cannot do without insurance because the profits obtainable, even with a yield tax, are not large enough to counterbalance the risk that remains after protective efforts have been increased to an economic maximum.

Most timberland owners, because of the risk of conflagrations, cannot use the method of self-insurance. They must either co-operate with other forest owners and combine their losses or pay an outside party to assume them. According to the commercial schedule, the average hardwood stand could be insured for approximately 90 cents per 100 dollars of value. Pine stands would insure at $1.05 and young, mixed stands such as are common on the jack pine plains but not exposed to any major hazard could be insured at about $1.15 per 100 dollars.

Only the value of forest growth should be insurable for the time being. After forest insurance has been definitely established, litter, humus, and root stock might possibly be added as insurable items. The technical details of valuation and adjustments must be undertaken by properly trained adjusters. Values, generally, cannot be more than the current market value of the timber in question. European methods of evaluation cannot be adopted in this country at this time because expectation values of immature stands

are not well enough understood. Value and loss adjustments present the most difficult problems of the forest adjuster and can only be determined by a field examination preferably several months after the fire.

European experience is an indicator but not a guide. It suggests that insurance is necessary not only when the fire risk is large, but, also, when it is small. It furthermore indicates that fire hazard in this country can be reduced considerably before the point of maximum protective expenditure is reached and that fire hazard has been decreased by proper insurance.

Forest insurance experience in the United States is too meager to serve as a basis for future conduct. The earlier attempts were either too short-lived or too limited in scope; the present writings, while a distinct advance, are still limited in territory and age classes covered and in the size of the policies accepted. Then, too, rates are not only higher than necessary but, also, too high to be within the reach of most timberland owners. Lower insurance rates and a greater demand for insurance coverage will go hand in hand with better protection and higher stumpage prices.

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