FIRE AND THE FOREST

(California Pine Region)

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CUMULATIVE NATURE OF FIRE DAMAGE

The forests of the California pine region have been subjectec1 to recurring fires for centuries. The effect of these repeated fires is recorded in the forest itself – and the record is impartial and unchangeable. A fire in this region[1] must be considered not as an isolated event, but as one of a series. Its immediate effect on the forest is superimposed on the injury caused by previous fires. Its full effect can not be appreciated without investigation of the condition of the forest years afterwards. Fire injury is cumulative, and to understand the consequences of fire today it is necessary to know how often the forest has been subjected to fire injury in the past.

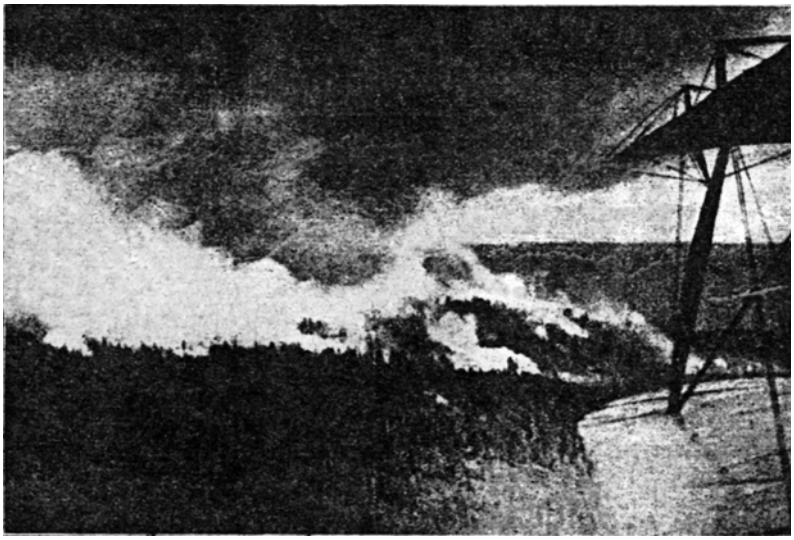

Fig. 1.– In California the known history of fires, as recorded in the trees themselves, dates back to 1685. Organized protection has developed in the last 20 years to the - point of stopping a considerable amount of wastage, but fire losses in the forests still much too high.

[1]For a more detailed study of the effects of fire, in the California pine region, see United States Department of Agriculture Bulletin 1294, "The Role of Fire in the California Pine Forests," by S. B. Show and E. I. Kotok. 1294. Copies of this bulletin may be obtained free upon request from the District Forester, San Francisco, Calif., or the United States Forest Service, Washington D. C.

Every forest visitor must have noticed the most obvious of the records left on the forest by the fires of the past – the prevalence of trees with fire scars or cat faces, mute evidence that fire is no new thing. This evidence can not be obliterated, and careful study of the scars on thousands of trees enable us to piece together the fire history of more than two centuries. The date of each injury can be set, because immediately a fire wound is made on a living tree, a new layer of woody growth starts to cover it over. Even after the lapse of centuries it is possible to count back the number of annual rings overlaying the scar and to determine the year of the injury.

So it is found that there have been bad fire years in which fires covered practically the entire area of the pine region. At an average interval of eight years and dating back at least to the end of the seventeenth century, fires ran-through the timber, leaving their mark, just as fires do today. The years 1685, 1690, 1699, 1702, 1708, 1719, 1726, 1735, 1743, 1747, 1750, 1757, 1766, 1786, 1796, 1804, 1809, 1815, 1822, 1829, 1837, 1843, 1851, 1856, 1865, 1870, 1879, and 1889 were bad fire years, as indicated by thousands of scarred trees throughout the mountains. These fires must have burned unchecked for months, but the fact that forests have persisted in spite of the recurrence would indicate that many were light surface fires.

What the causes of these fires were we can not tell in detail. It is certain, however, that lightning started numerous fires then as it does now, for many of the same trees which furnish the fire history show also scars caused by lightning. Tradition, too, credits the Indian with deliberate setting of fire in the forest, and at least it is certain that if he did not cause fires he had neither the means nor the desire to put out those that started. With the coming of the white man, and particularly after the discovery of gold, fires became more numerous. The pioneers, like the Indian, found the forest an obstacle, or at best a source of wood to be used without thought of replacement. To the prospector, the hunter, the stockman of the early days, the best forest was an open one, and fire was the easy means to make it open. So until the creation of the national forests, fires spread year after year largely unchecked. Indeed, the remarkable persistence of forests, in spite of repeated burning, led the early settlers to accept readily the belief that fire not only did not injure the forests, but was a positive benefit.

The mere existence of a timber stand today seems proof that fire is no serious enemy; but study of that very stand may show unmistakably the cumulative effect of repeated burns. The presence of fire-scarred trees, an understocked stand with less wood than younger but fully protected forests, a lack of seedlings under the mature forest, the encroachment of brush - these are all convincing evidence of the wearing down of the stand by fire. All these and other effects are to be found in abundance, and must be weighed before an adequate judgment of the real effects of fire is possible.

KINDS OF FIRE DAMAGE

In the California pine region[2] as in many other forest regions, only a small part of the damage done by fire is immediately evident. Fires run through these pine forests, but comparatively lightly. Only occasionally and in the younger stands do they flare up into the tops of the trees and become crown fires. For the most part the fires are confined to

the underbrush and forest litter, burning fallen dead trees, and killing by heat rather than by actual flame the crowns of live, full-grown trees.

FIRE SCARRING AND BURNING DOWN OF VETERANS

From a close study of the condition of the virgin forests today, the effects of fire can be determined in detail. As a result of former fires, many trees already bear scars, and these are a common point of attack for even the lightest surface fire. In some species of trees a coating of inflammable pitch covers the wounds, and the underlying wood is likewise impregnated. Once this catches fire it may burn for many hours; the wood is slowly eaten away, and finally the tree may fall. This form of loss – burning down of previously scarred trees – is found on all burns, no matter how light or how severe may have been the fire.

It is peculiarly unfortunate, for generally the oldest and hence largest and most valuable individual trees are the victims. Their great age has subjected them most to fires in the past, and consequently they are the most deeply scarred. Both in forests of pine alone, and in those with a large amount of fir, this kind of burning down is an inconspicuous but very real form of loss and amounts on the average to nearly 1,000 board feet of wood an acre for a single fire, or 5 percent of the average merchantable forest.

Not all fire-scarred trees burn down, but a reckoning of those that persist shows that about 14 per cent of the full volume of timber is lost. Even a single fire has been found to increase the area of old scars by 50 percent, eloquent proof of the rapidity with which this process of forest deterioration works.

Besides enlarging old scars and burning down occasional trees, each fire, even though light, creates new scars to serve as future focal points for destructive attack. New scars are most commonly formed where logs burn in contact with living trees; and it is not to be forgotten that the down logs are generally tokens of a previous fire.

Each fire thus slowly but inevitably paves the way for more extensive and serious subsequent losses; and burning down alone, given repeated fires, reduces persistently the density of even the best forest. Even where the tree successfully resists burning down, the fire scarred area represents wood loss in the most valuable part of the tree, often sufficient to render the entire tree worthless to the lumberman.

wipes out entire tracts of varying size, leaving the other portions on the burn uninjured in this respect.

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[2]The California pine region contains the forests of western yellow pine (*Pinus ponderosa*), sugar pine (*P. lambertiana*), douglas fir (*Pseudotsuga taxifolia*), white fire (*Abies concolor*), and incense cedar (*Libocedrus decurrens*) that grow on both the east and west slopes of Sierra Nevada and the Coast Ranges, on the cross ranges of northwestern California, and on the broad plateaus of the northeaster part of the State. Interspersed with nearly 2,000,000 acres of land denuded of timber and now bearing only worthless brush, flanked as low elevations by a broad belt of chaparral brush land on which little evidence of timber exists, the region still contains 12,000,000 acres of virgin forest, besides 1,000,000 acres of productive cutover land.

Fig. 2. – Most fires in the California pine region are light fires; but even so, and although they may burn against the wind and down hill, as in the instance shown, severe damage is done. Losses in valuable trees burned down, in decreased growth of remaining trees, and most of all in destruction of seedlings and saplings, are much heavier than the casual observer realizes.

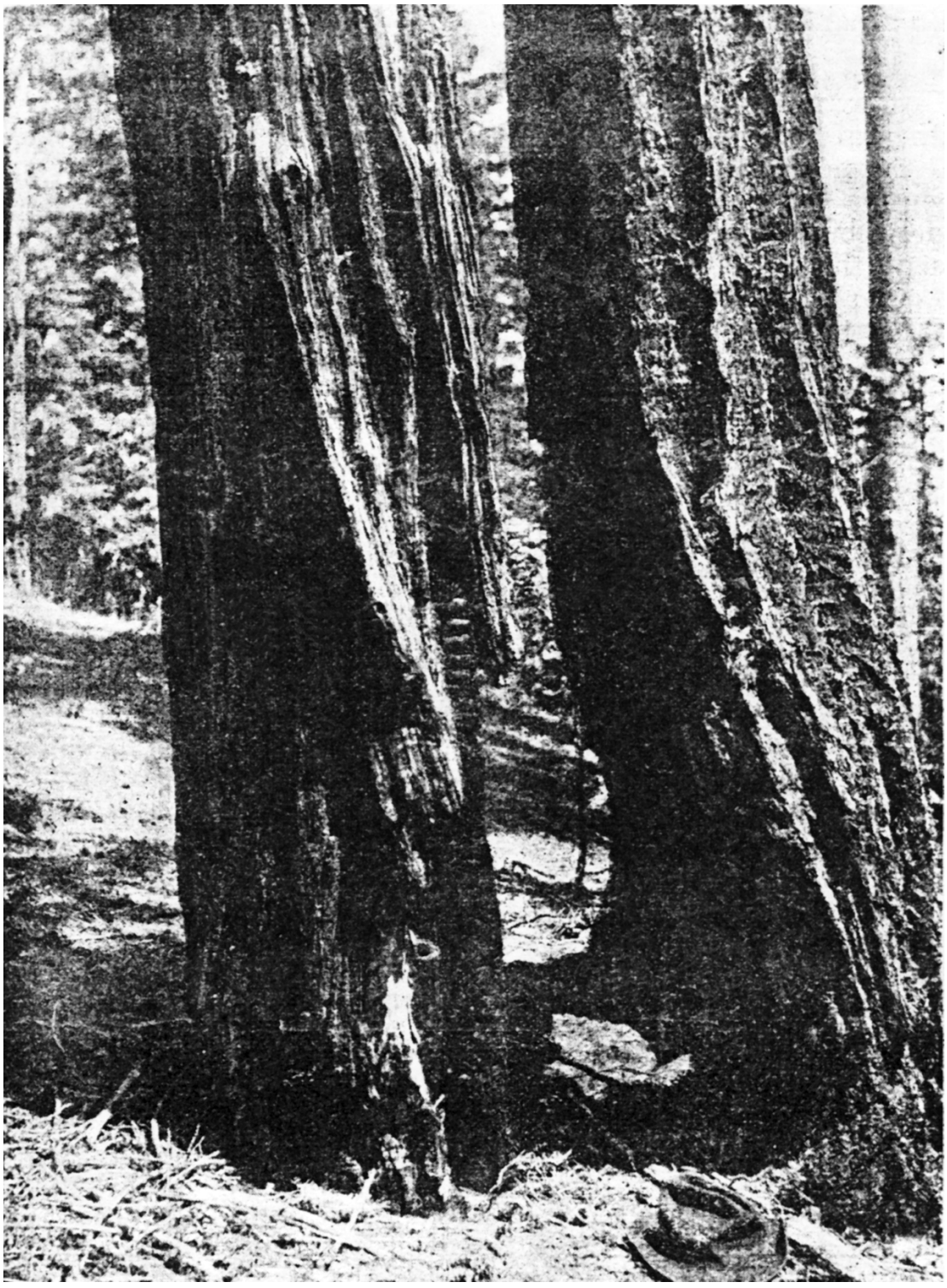

Fig. 3. – Open fire sears pave the way for a deeper burn next time and afford ideal places fungus and insect attack. With repeated assaults by fire, insects, and rot, the finally fall.

KILLING OF TREES BY HEAT

Unfortunately other forms of fire loss occur, chief of which is the killing of mature trees by direct heat. Ground fires shrivel and kill the needles of living trees or sweep into the crowns on every extensive burn. The amount of damage from this source varies widely, but averages nearly 1,600 board feet an acre for each fire. Usually heat killing

What happens on a particular area depends largely on the previous fire history. If the process of attrition has been slow and the virgin forest has remained dense, heat killing is generally unimportant. If, on the other hand, the forest has become open and invading brush has provided a great quantity of fuel fires become exceedingly hot, and heat killing is more prevalent. As the final stages of forest deterioration are approached, the remnant of the forest may be swept away at a single stroke, leaving useless brush in undisputed possession of what was once forest land. It becomes apparent that fire not only causes present damage in destroying merchantable trees, but paves the way for more serious future losses.

Like burning down, heat killing affects some species more than others. Yellow pine is the most resistant, fol1owed by sugar pin white fir, and. incense cedar, substantially in the same order as for burning down.

Heat killing is natura1ly most common and destructive in stands on the poorer quality of forest lands, for it is on such soils that that, timber is shortest and the crowns more exposed to the intense heat. Unfortunately it is on just such soils that the struggle of the forest to maintain itself is most severe.

INJURY TO CROWNS RESULTING IN REDUCED GROWTH RATE

Careful examination of a recently burned forest will disclose, besides burned - down veterans and patches of heat-killed timber, many trees with parts of their crowns dead. Although these trees may survive, their rate of wood production will be seriously reduced, some cases as much as 25 or 30 percent, as has been found by measuring the, width of the annual rings formed before and after injury. This sort of injury can never be detected without careful observation of the individual trees, but is none the less real. Here, too, different species react differently to a given degree of injury, the yellow pine showing the least and sugar pine the greatest reduction in growth rate.

FIRE AS AN AID TO INSECT DEPREDATIONS

The damage to virgin forests directly due to fire is serious enough; but it by no means represents all the damage caused by burning. Indirect injuries that follow in the wake of fire contribute also to the gradual wearing down of the forest. Of these one of the most disastrous is from insect attacks.

Small, insignificant appearing beetles, with the ability to kill the largest timber trees by mass action, find in fire an ally for their destructive activities. Attracted by the scorched needles or burned trunks, they congregate on the burned area and concentrate their first attack upon those trees which, weakened by the fire, wou1d otherwise probably have recovered, spreading to other and more vigorous trees later. Within the burn their numbers increase and an epidemic appears. On some burns the annual rate of loss on each acre has reached a figure of 500 to 800 board feet, compared with a loss of but 35 to

75 board feet on adjacent unburned areas. Generally such an epidemic appears the season after the fire, and is of short duration, subsiding to normal within three to five years. But during its course, much damage results, for insect killing tends to eliminate the largest and most valuable trees of the most valuable species.

FIRE AS AN AID TO FUNGOUS ATTACKS

Most prolonged, perhaps, of the steps in forest deterioration following fire is the cumulative loss due to fungus attacks upon the living tree, whereby the valuable heartwood is destroyed or rendered worthless. In a detai1ed, study of white fir, nearly half of all serious infections were traceable to fire scars, through which the spores of the fungus gained entrance to the heartwood. With incense cedar, two-thirds of all infections and 85 percent of the cases where serious cull resulted were due to fire. Both these species have come to be classed as inferior, not because of poor technical qualities of the wood, but rather because of the great frequency of decay, which is in large measure a 1egacy from fire.

An attempted determination of the complete loss of timber from a single fire undertaken immediately after the fire would show no trace of these 1ast three forms of injury. Years must elapse before the full extent of insect or fungous damage can be known, and reduction in growth due to crown injuries may continue for a decade or more.

FIRE AS A DESTROYER OF YOUNG GROWTH

Such in brief, are the ways in which fires, even light surface blazes, reduce or injure the merchantable portion of the virgin forest. But another and highly important part of the forest is made up of the young growth, the small, at present unmerehantab1e trees, which have sprung up in uncounted numbers since fire protection began. This young growth is proof in itself that the present virgin forest is understocked, for in a truly complete stand the available moisture is so fully utilized by the old trees that no young ones can gain a foothold. It is, however, the hope of the forest of the future; for it will fill in the openings and replace trees that are cut for lumber.

Young trees are particularly subject to destruction by fire, for the bark is thinner, the foliage closer to the ground, and the buds not so well protected from heat as those of the mature trees. Without young trees no forest can continue indefinitely. It is easy to visualize the outcome of these repeated fires, even if some small trees escape each time and only minimum damage results to the veterans. However slowly such a process may operate, gradually the forest will become more and more open. Fires will become more destructive, and finally even the finest and most persistent forest must succumb.

WHAT THE CALIFORNIA BRUSH FIELDS MEAN

One of the most striking facts about the pine region as a whole is the great area of potential timber and now occupied by worthless brush. Nearly 1 acre out of every 7 of timberland is taken over by brush, as one result of the recurring fires of the past; and the timber which this land could have produced would be enough to run the present lumber mills of the State for many years. Brush fields in the timber belt are not necessarily

Fig. 4. – Not in this generation will this woods road become again an avenue of green. A period of 15 years may intervene before seedlings again come in on the burned area, with another long period to follow before they reach the height these young trees had attained in 1924

permanent. They are evidence merely of the enormous power of repeated fires to reduce the forest to the vanishing point, and are but one step in the history of attrition.

If fire is excluded, the brush fields will in most cases revert to forest. Wherever seed trees have survived, and where brush fields and forest join, young growth soon begins the struggle to subjugate the brush and recapture the land. At best, reclamation of the brush fields is a slow process, for a quarter century is commonly required for the young trees to establish themselves and to thrust their crowns above the dense brush canopy. Fire in such restocking brush fields is therefore nothing less than a calamity, for complete destruction of the young trees usually results from the intense heat of flames. Fires in brush fields, as the ultimate step in attrition, may definitely wipe out the last remnant of the forest, leaving the ground to the undisputed possession of brush.

Each step in forest destruction makes fire protection more difficult, more costly, more uncertain. As the forest gradually gives way to brush, a more readily inflammable fuel awaits the flames, fires spread more rapidly, and control is harder. The brush fields represent in the highest degree the need for fire exclusion. Fires in brush fields may not only destroy the struggling advance guard of the new forest, but may attain such volume and energy as to sweep into adjacent forests with irresistible force, pushing back into the

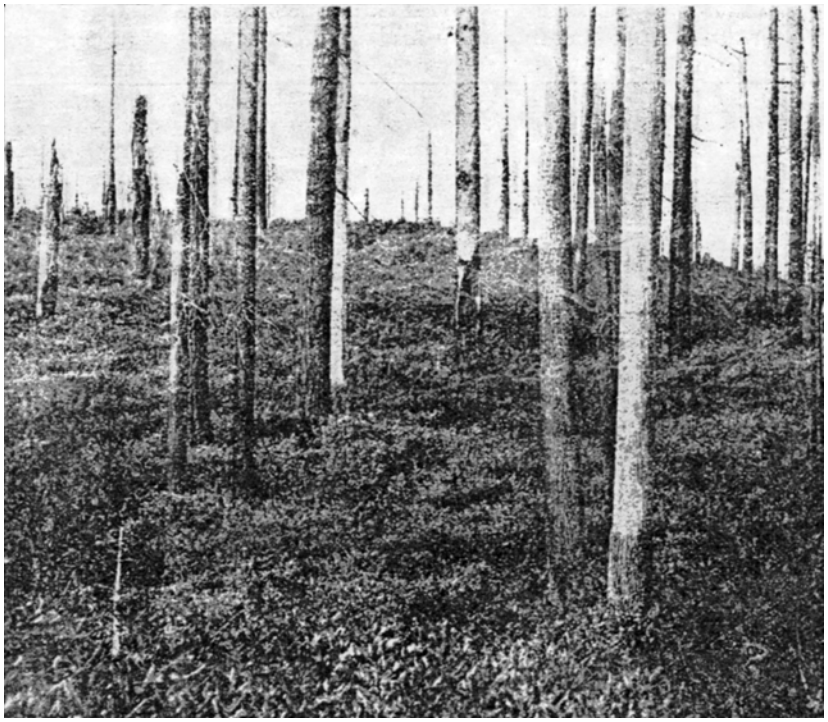

Fig. 5. – Repeated fires convert the forest into brush fields. Only through fire protection maintained for perhaps a century, or by expensive planting operations, may such an area be restocked. Could all California's brush fields be fully stocked with a mature forest, they would supply the timber needs of the whole country for a year and more.

forest and enlarging the brush fields. The point of contact between the two forms of cover is always a skirmish line. Given fire exclusion, the forest will: given fire, the brush.

THE FINAL STAGE OF FOREST DETERIORATION

Even the brush field does not always represent the final picture in the history of repeated fires. As the process of attrition can change the vegetative cover from forest to brush, so, if long enough continued, it will deprive the very soil of the ability to grow forests. This soi1 deterioration comes about through the gradual destruction of organic material, which on forest lands serves the purpose of a fertilizer. As fires become more and more intense and as the brush fields are burned to the ground, actual removal of the soil y erosion hastens the process of site deterioration. Finally even the brush species that go with the forest are unable to maintain themselves and a new group of brush plants, termed "chaparral," able to thrive on very poor and scanty soils, falls heir to the land. This, indeed, is the final stage in forest attrition, reached in most cases only after centuries of repeated fires. In the Mother Lode region of the west Sierra slope, thousands of acres of chaparral cover have replaced pine forests as the inevitable result of many fires.

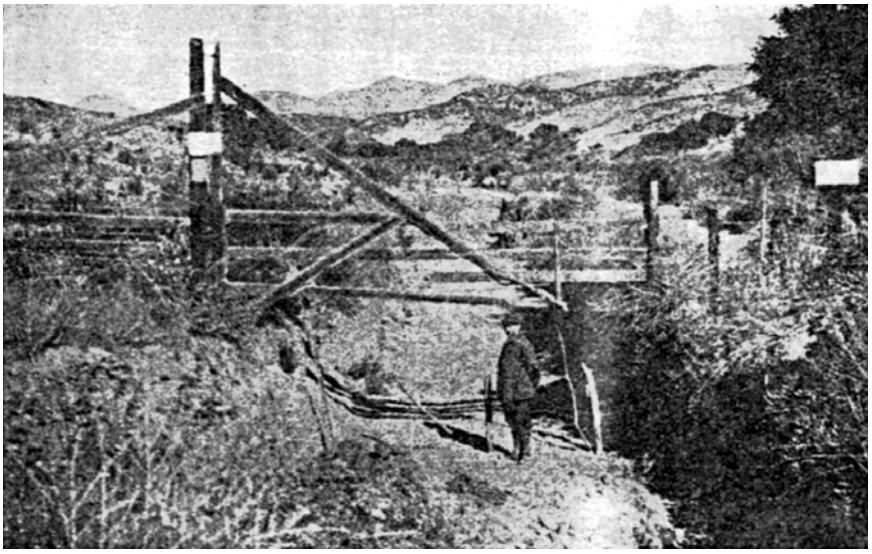

Fig. 6. – A typical by-product of forest destruction is erosion. Until the destroyed cover in this drainage area, this country road and the rustic gate operated harmoniously in conjunction. Since the fire, however, the road has been flooded each year by the runoff from the fireswept slopes. The gate and road now serve to measure the strength of one argument for fire exclusion.

FIRE ON CUT-OVER LANDS

Fire on cut-over lands, as in restocking brush fields, frequently annihilates the remaining portion of the forest – the young growth and unmerchantable trees – at a single stroke. As in the brush field, an enormous mass of fuel in the form of logging slash is ready for the flames and most or all of the trees of seeding age have been removed in logging. Consequently 6res are intense and destructive, wiping out the reproduction and leaving only scattered and inadequate seed trees to bear the burden of reseeding the land. Even if seed trees survive a slash fire, the loss is serious. Advance growth, 15 to 20 years old has been lost, and on most forest areas an equal period will be required to bring seedlings back on the land. Loss of, 30 to 40 years in growth, when timber can be grown in 75 years, is the equivalent of retarding by 50 per cent the growth of the new timber crop.

But in the possible destruction of seed trees fires cause a far more serious and consequential loss on cut-over land than in the reduction of the density of the young growing forest, important though that elimination of seed trees frequently resu1ts in the elimination of all timber growth, or any possibility of it, for a long time. Even few scattered seed trees in a brush field or on logged-off and promise an eventual return of the forest; but when they, too, are destroyed, the land can no longer be classed as forest land – it is waste, not only of no value in itself but a menace to surrounding 1ands of which forest values remain.

PROGRESSIVE FOREST DETERIORATION CAUSED BY REPEATED FIRES

The role of fire in the pine forests is thus a long and, complicated process, which has operated on an enormous scale for centuries, as the evidence in the remaining understocked forests and brush fields shows. Forest deterioration starts with the fire scar, of no great consequence in itself, leads through the understocked but still merchantable virgin forest, the open forest with brush understory, the restocking brush field with scattered forest trees, the complete occupation of the soil by brush, finally with the aid of soil deterioration and soil removal to the chaparral type no longer capable of supporting forest trees.

How seriously the fires of past centuries have reduced the density of our forests is well shown by the fact that in one national forest, on good soils second-growth stands have in the last 50 years attained a yield of 74,000 board feet an acre, whereas the virgin forest, from 200 to 300 years old, yields but 84,000 feet, or 46 per cent as much. In another forest in the rare patches of fully stocked virgin timber the yield, is 110,000 board feet, compared with 49,000 board feet to the acre for the average best. The virgin forest is certainly less than half stocked, chiefly as one result of centuries of repeated fires. When man becomes accomplice, as a cause of more frequent fires, he does not alter the process at all, but simply accelerates its action and increases the odds against the forest.

DAMAGE TO WATERSHEDS

Thee havoc of fire is not limited to its effect upon the production of timber; it also seriously disturbs the functions of forest and brush field as regulators of runoff and preventers of erosion.

In the citrus belt of southern California the intimate dependence of valley agriculture on mountain forests is thoroughly appreciated, as it is in older countries. Elsewhere in the State there is little recognition of the fact that fire damage to forest or brush cover will sooner or later affect the productivity of valley lands. However, as the change from extensive grain growing to intensive agriculture develops further in the great California Valley, the maintenance of an adequate and sustained supply of water for irrigation will become imperative.

The ways in which destruction of the mountain cover damages agriculture are the same in California as in other parts of the world, principally through the reduction of 1ow-water stages of streams, 1owering of the water table and erosion resulting in silting up of valley lands, reservoirs, irrigation ditches, and canals.

It can not be doubted that this secondary function of the forest is of considerable importance, even when the point at which the water is used is far removed from the fire-damaged area, and although no immediate effect of the forest destruction is evident in the condition of the water supply.

THE THEORY OF LIGHT BURNING[3]

The very persistence of forests and the fact that a single fire does not ordinarily wipe out the forest, except in the final stages of attrition, has 1ed some-people to believe that light fires were beneficial rather than injurious, because they apparently reduced the inflammable iatrical and thereby lessened the danger from summer fires. “Light burning,” as this practice is called, is the deliberate burning of the forest at intervals in spring or in fall in an attempt to insure, the safety of the merchantable timber. It is not to be confused with promiscuous forest burning, which disregards forest values and aims only to improve grazing, facilitate prospecting, or render the forest more open.

EXPERIMENTS IN LIGHT BURNING THE VIRGIN FOREST

The technique of light burning has varied both in the method used in controlling the fires and in protecting merchantable trees. One plan employed in the yellow pine and white fir forests recognized clear1y that even light surface fires were a source of danger to fire-scarred merchantable trees. Hence scars on all such trees were filled with earth and rock, and pine needles and other litter were raked from around the base of the tree so that fire could not reach the scar. Brush and advance growth which stood close to merchantable pines were cut, and logs lodged against standing trees were removed in advance of burning, which was done in late fall. As s result of these precautions, which cost about 50 cents an acre in 1910, damage to merchantable trees by the light fires was prevented.

The burning, however failed to accomplish a material reduction of hazard, which actually was greater five years after the fire than on unburned forest areas. This unsatisfactory condition resulted from the quantity of brush and many small trees killed but not consumed by the fires. As these gradually fell to the ground, and as the normal fall of needles and twigs continued, the inflammable material on the burn was rapidly replaced. Light surface fires thus create new supplies of fuel, often greater than those destroyed.

Another plan assumed that the main problem in carrying out burning operations was to control the spread of the light fires and that no special measures were required to protect the merchantable trees. Blocks of 160 and 640 acres were surrounded by fire line and each block was burned at night in summer by igniting the 1itter along the fire lines, allowing fires to spread toward the center of the block. The money cost was from 37 1/2 cents to $l per acre.

On this yellow-pine area, as a result of failure to protect the merchantable individual trees, the fires caused serious damage to the merchantable timber. The average direct loss was 425 board feet an acre burned down and 220 board feet an acre heat killed. The principal purpose of the work was to control forest insects, and at that, time it, was believed light burning would accomplish this besides reducing hazard. On the contrary, insect losses following the fire were 440 board feet an acre, about ten times as great as in

[3]Observations on light burning operations are given in greater detail in Department of Agriculture Bulletin No. 1294, already cited.

adjacent unburned forests. A. further effect of the fire was to destroy two-thirds of the advance growth on which the future forest so largely depends.

These light fires caused the very destruction that they were designed to prevent. Merchantable timber was killed by the fire and insect depredations were multiplied. Even reduction of the fuel failed of accomplishment, for within a single year after the burn a new layer of needles and twigs had been formed from the small and large trees killed by the fire.

Both these areas were on level or gently sloping ground and fires, once started, spread rapidly. A different situation was encountered in yet another instance, where part of the forest was in open yellow-pine forest on a flat and the rest was in mixed forest on diversified slopes. The owner made no attempt either to protect individual trees or to control the fires. Fires spread rapidly in the yellow-pine flat, where hazard was already low, but the results were similar to those on the other area, for patches of merchantable timber were heat killed, and some trees were burned down. Thus, though the direct money cost of the operation was low, the indirect cost or damage was high.

At the same time, burning was attempted on the slopes, where really serious hazards existed in the shape of brush. Although many fires were set, the ground cover would not carry the fire, and no reduction of hazard could be accomplished. The results prove that the practice of light burning is not the simple easy process it is sometimes assumed to be. With broken topography, the drier south slopes will burn when the moist north slopes will not. If burning is postponed till the latter will carry fire, the south slopes will suffer what amounts to a severe summer fire. This burning, like others, reduced the hazard temporarily where it was already low but created new sources of fuel which increased the original hazard within five years

On none of these areas was the burning repeated. In order to study the effect of several light fires, an experimental area representing a wide range of timber types and of degree and direction of slope, was twice burned, in the spring of successive years, the time of burning depending on the earliest date at which fire would run in the yellow-pine forests on south and west slopes. Here, too, it was impossible to burn the moister slopes, though fire spread rapidly in the yellow-pine stands. Only 60 per cent of the total area was burned over. Hazard was already low on the south slopes and the fires reduced it temporarily, but the more serious hazards elsewhere were practically untouched. In reducing hazard, even two fires had no pronounced effect, though the cost was 28 cents an acre for each burning.

One object of the burning was to destroy standing dead trees, or “snags,” and down logs which had accumulated in the forest. Although some were consumed, the total number on the area was greater than before burning began, for the trees destroyed by beetles and the green trees burned down were more numerous after the fire than the snags destroyed.

Damage to merchantable timber resulted from both fires. Burning down amounted to about 400 board feet an acre the first time and 500 the second, illustrating the acceleration due to repeated fires. Heat killing was absent in the first burn, but appeared in the second, where the first fire had burned down trees, which lodged against standing merchantable trees. The second fire consumed these down trees and destroyed living

trees with which they were in contact. A serious insect epidemic resulted from the fires with, a loss of 900 board feet an acre.

LIGHT BURNING IN SECOND-GROWTH FORESTS

The best examples of the effect of repeated light burns are to found in the second-growth forests of the Mother Lode region the Sierras, where on private lands light burning has been carried out frequently over a period of 20 or more years. These young forests are particularly subject to destruction by crown fires, and it was to minimize this danger that the light burning was done.

That the most insistent light burning does not prevent summer, crown fires is proved by such examples as the Rock Creek fire in 1910 in this region. This covered 2,160 acres of second growth, which had been light burned frequently and of which 75 percent was wiped out completely, the land reverting to a brush field. Another very instructive instance is that of the 1920 Cement Hill fire in the same locality, where the stand had regularly been light burned. In late November, long after the close of the fire season, while light burning was being carried on in these second-growth stands, high winds suddenly whipped up the flames, which leaped into the crown and destroyed all trees on tracts of 2 to 4 acres.

LIGHT BURNING A FAILURE

Other areas might be cited, but they would merely confirm the conclusions regarding light burning that have already been reached. Let us then sum up the case for light burning, remembering that to accomplish its purpose the amount of inflammable material must be considerably reduced; the direct money cost of burning must be kept within reasonable limits; and the indirect costs or damages both to merchantable and small trees must be held to a low percentage of the values at stake.

As a result of the careful experiments cited, it can only be concluded that the difficulties of actual1y carrying out burning with any form of control are very great. Variable topographic and sudden changes in the weather make burning at most times either impossible or destructive. Simultaneous treatment of large areas, except flats or broad slopes, is impossible.

A single surface fire reduces hazard only temporarily, and at the same time creates new sources of fuel, which in a few years make for a greater hazard than if burning had not been done. What is unavailing in virgin forests is still less advantageous in second-growth stands, where even repeated surface fires at frequent intervals do not immunize the stand from devastating crown fires. Light burning as actually carried out has only reduced the hazard where it was already moderate or low, and has shown no success in reducing high hazards.

In indirect costs or damages, light burning wherever practiced has exhibited the same forms of damage to merchantable timber and reproduction that it is designed to prevent. These include the enlargement of fire scars, burning down of previously scarred trees, heat killing, and induction of insect epidemics.

Fig. 7– The practice of light burning is more apt than not to result in the perpetuation and intensification of the very ills it endeavors to remove. Snags and down logs, left here by a typical light-burning fire, provides fuel for the next fire. In this they will be aided by a new litter of dead limbs and needles that have already begun to fall as a result of heat killing.

With any form of real control in burning, direct cost, though still probably much less than the indirect cost, is nevertheless a material item, ranging from 28 cents to $1 an acre. Since this must be repeated indefinitely to secure a permanent reduction of hazard, the cost to the owner of a large acreage would soon become impossibly high.

Even to those whose interest lies solely in the merchantable trees, light burning is a costly and dangerous practice, involving the sacrifice of part of the values which it attempts to preserve and with at best temporary reduction of fire danger.

On forest lands to be managed for new timber after the virgin forest is logged, light burning is impossible, since it is particularly destructive to advance growth. “Light burning” fires act on the forest in the same destructive ways as summer fires, differing only in degree.

LEGITIMATE USE OF FIRE IN THE PRACTICE OF FORESTRY

SLASH DISPOSAL IN CUTTING AREAS

Although general forest burning is obviously not a legitimate use of fire, there are several ways in which fire can be employed in the practice of forestry. The most important of these is in disposing of logging slash, which renders protection of cut-over lands such a difficult task. When so used the object is, of course, to dispose of the slash as completely as possible, with as little damage to young growth and seed trees as may be. Low cost is at the same time imperative.

Three principal methods of slash disposal are employed. The simplest is broadcast burning, whereby slash is touched off, usually in spring or fall, and the resulting fire stopped when virgin timber is threatened. The usual result of such burns is that fire not only removes the slash but destroys most or all of the remaining timber values, both in

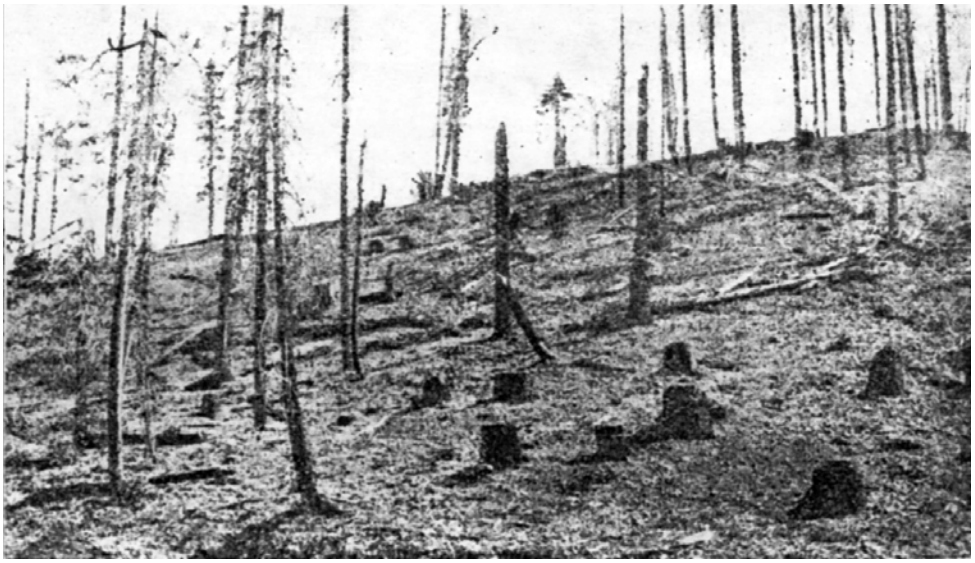

Fig. 8. – As a forest exterminator, broadcast burning of the slash left after logging is a most effective measure.

seed trees and in advance growth. The practice can not be tolerated, because the indirect costs or damages are excessively high, though the money cost is low. Broadcast burning has serious disadvantage that, by inducing the rapid spread of brush, hazard soon becomes as great or greater than is the slash were left untouched. At best only a temporary reduction of inflammable material is obtained.

A second method, burning in place, involves setting fire to individual piles or windrows of slash as they lie after logging. If moisture conditions are just right, the method is less destructive than broadcast burning; but if fires spread, a broadcast burn results. A serious disadvantage is that after logging the remaining young growth is mixed in with the slash, and burning in place usually destroys the stand.

The third method, piling and burning, accomplishes a 75 to 90 percent reduction without material sacrifice of young growth and seed frees. This is done by piling the slash in open spots as logging progresses and burning the piles individually at a season of the year - late fall or early spring - when the fires will not spread. The direct money cost of 35 to 50 cents for each thousand feet board measure cut is greater than in either of the other methods, but is simply justified by the practical elimination of indirect costs in the form of damages.

Piling and burning carefully done represents the maximum that can be accomplished by slash disposal to safeguard young on cut-over lands. In spite of the dangers inherent in any of fire in the woods, skillful employment of this method of slash disposal has thoroughly proved its value on national forest cuttings. s is well shown by the fact that fires starting where slash was piled and burned are but 4.5 per cent as large as where slash is left, supposing that both classes of lands are given an equal degree of protection.

SNAG BURNING

One of the most serious difficulties in fire control in the California pine region results from the numerous standing dead trees or snags, which when afire, throw sparks long distances ahead of the main fire. Such snags are frequently a legacy of past fires. Experiment shown that by igniting dead trees in late fall or winter, when fire will not spread on the forest floor, this hazard can be eliminated at a much lower cost than if the ax and saw were used for falling. Snag burning, like piling and burning of slash, represents a legitimate use of re in timber growing.

PROMISCUOUS FOREST BURNING

Burning of the forests, and of brush fields resulting from fires, is still practiced to some degree by people who wish to improve grazing or to facilitate prospecting. Although this practice masquerades under the euphemism of light burning, it is fundamentally different. Light burning seeks, even if mistakenly, to preserve timber values. Wholesale forest burning on the contrary aims to destroy the forest and to replace it with other types of vegetation suitable for livestock.

In the pine region grazing and timber growing necessarily conflict; what is advantageous to one is usually detrimental to the other. The more fully stocked the forests become, the slighter will be the production of forage; and conversely the more open the forest, the greater will be the number of cattle and sheep supported. Indeed, it is only' the general openness of the pine forests, resulting from centuries of fire, which permits grazing to be a major use. At the very lowest reckoning the average annual forest growth on protected lands can not be set at less than 300 board feet worth 50 cents, while only on the better grazing lands does the yearly forage value reach 15 cents an acre. On the vast majority of forestlands, timber growing thus is a higher use than grazing. As this fact is recognized, and as the effectiveness of fire protection increases, grazing will inevitably be relegated to a minor position in the scheme of forest management.

FIRE EXCLUSION THE ESSENTIAL IN FOREST RESTORATIQN

An examination of the role of fire would be incomplete if it disregarded the controlling influence which fire may exert, or what can and can not be done in managing forest properties. Not only is the quantity of wood in the forest persistently reduced by fire, but the, quality of the forest suffers as well. In modern logging the fixed investment is heavy, particularly in such items as railroad construction, and must be charged against the product from a given area. Reducing the stand by even 10 per cent, where the forest has barely enough timber to justify logging, may make it impossible to do cutting and improving of the stand at all.

Already this long-continued burning of the forests has reduced the volume of many stands below the point where profitable lumbering is possible. On one national forest in the pine region we pay the penalty for past fires by possessing but 52,000 acres of immediately exploitable timber out of a total of 660,000 acres of timer land. Of this enormous area, 215,000 acres are classed as brush fields, due primarily to fire, while 393,000 acres, though still timbered, have been so ravaged as to be unmerchantable. Open and scanty forests, stands defective because of fungous attacks following fire, and

small areas of dense timber surrounded by brush fields from which the forest has been swept by fire, make up this total. The financial problem of furnishing the intensive protection necessary to build up a great forest area where depletion has left but a small income-producing property is one of the greatest difficulty.

Under such circumstances, nothing less than fire exclusion will promote real progress toward a fully productive forest property. Even fires in the brush fields affect not only the productivity of those lands, but by sweeping into adjacent forests tend to reduce still further the forest area and to pile higher the burden of protection. The present average rate of 2 to 3 per cent of the brush field area burned annually serves merely to maintain the balance in favor of destruction and loss. Not only will the brush fields themselves remain relative1y unproductive and extremely hazardous, but the very existence of adjacent timber stands will be constantly threatened.

An adequate scheme of forest management and protection must recognize that even more important than preservation of what forest values we now possess is the task of restoring a forest depleted by centuries of repeated fire. Much of the considerable expenditure for fire protection is consequently an investment in the land itself rather than a carrying charge needed merely to secure the maturity of the particular crop now growing. To the extent that present expenditures make it easier and more certain to establish future forest crops after the first is harvested, to the extent that systematic fire exclusion produces a type of cover which makes protection itself more easy, to the extent that the productivity of the soil improves as a result of fire protection, to this extent it is evident that a great part of the money that must be spent in growing the first timber crop in brush fields can not be properly charged against that crop.

The assumption that all fire protection expenses are current costs, instead of to a large extent investments in future productivity of the land, is fallacious and dangerous, for it lends a specious air of mathematical truth to assertions that the cost of fire exclusion is frequently prohibitive.

No such fiscal theory of protection can hope to be adequate in attaining forest

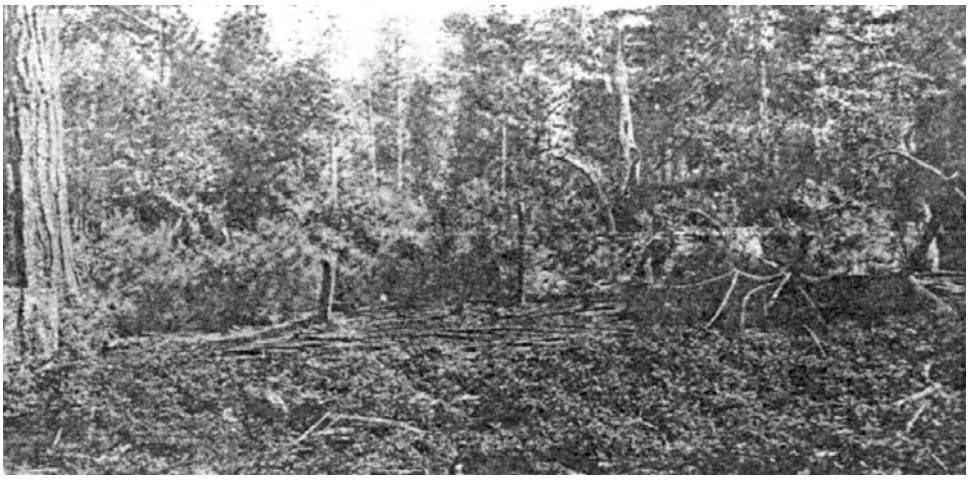

Fig. 9.-This view and the one following give indisputable evidence of growth possibilities for the new forest where fire is kept out. In this view the young stand back of the old fallen snag is just getting started.

restoration. It disregards the vital fact that the forest is one of the few fundamental physical bases of civilization, as a source of wood, as a regulator of the water on which va1ley agriculture and hydroelectric development depend, as a preventive of erosion, and as a powerful socia1 factor through the opportunities it offers for recreation.

THE ROLE OF FIRE AS A DESTROYER

This examination of fire and the forest leads to the outstanding conclusion that for centuries repeated fires in the California pine region have led to a steadily accelerating damage and forest deterioration. It explains the understocked but merchantable forest, the broken and patchy virgin stand of no present merchantability, the brush field with scattered groups or individual trees, the continuous brush field, restocking but slowly around the edges, and finally the chaparral area incapable of immediately supporting~ forest growth, all as progressive chapters in the story of attrition.

Existing difficulties in protecting and managing the forest area – difficulties due to past fires – will increase unless virtual fire exclusion can be put into effect. To build up these run-down properties to their tremendously high potential productivity is the real goal of forestry. On the success of this effort depends in large measure the permanent well-being not alone of those directly interested in the forest, such as the lumberman and timberland owner, but of the farmer and the manufacturer as well, who are affected indirectly.

The old misconceptions regarding fire in the California pine forests can profitably be cast out by all who have to do with these forest areas. It is to the interest of the entire

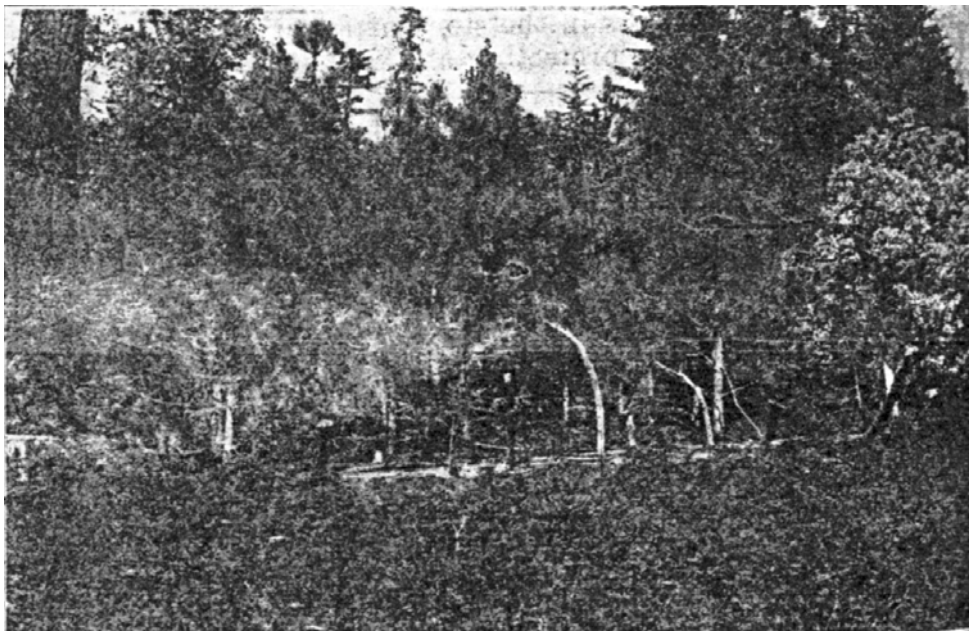

Fig. 10.-Ten years later brush still holds the foreground, but the new forest growth in the background has made wonderful progress. Such growth is not unusual with fire exclusion; but without it, or even with the most careful form of light burning, the seedlings and young trees are the first to suffer, halting the whole process of forest regeneration.

State to recognize that fire is a destroyer and that protection to attain success must amount to exclusion particularly in brush fields and on cut-over lands.

In such a program prevention of fire is an element of outstanding importance and in this every citizen can help.