"FIRE DAMAGE IN THE FOREST"

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by

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FIRE DAMAGE IN THE FOREST.

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There is a widely held belief among laymen that except in the case of catastrophic fires, where the whole forest is totally destroyed and human lives lost, fire does little, if any, damage to the forest.

Foresters the world over realise that this is very far from the truth but, in Australia, very little actual work has been done on the assessment of fire damage and although we might talk glibly of fire damage we cannot, in many cases, back our statements with figures.

The objective of this paper is to stimulate discussion on this very important subject with, it is hoped, resultant suggestions for lines of research or the publication of figures derived from observations or measurements in our own forests.

It would appear that the logical approach to the subject is to list all the known possible causes of damage; to discuss each one briefly and to mention the results of some of the work that has been done along those particular lines in forests overseas.

Fire causes damage to the forest by injuring:-

1. Merchantable trees: (a) kills some outright;
   (b) kills some by delayed action;
   (c) others injured causing retarded growth.
2. Established regrowth.

Further, it has very marked effects on:-

3. The regeneration of the forest.
4. The quality of forest products.
5. The protective influence of forest cover.
6. Forest composition and succession.
7. Recreational and scenic values.
8. Grazing values.
9. Human life, property and activities.
10. Wild life.
11. The physical and chemical properties of the soil.

and finally it creates conditions favourable to tree-destroying insects and diseases.

Taking each one in order, it is well known that certain Eucalypts and almost all exotic conifers are very fire-sensitive and are killed outright by fire. Mountain Ash and the Mallets of West Australia are typical examples, Mallet being particularly fire-tender; the radiant heat of a fierce fire will frequently kill quite large Mallet trees without their being touched by the flames.

The mature trees of other more resistant species are injured by fire scarring as the result of repeated fires and the burning of debris accumulated against the butt. The loss of the entire tree occurs by burning down or by destruction of the tissues all around the tree. One of the commonest and very serious types of damage in our Eucalypt forest is the severe malformation, including forking in young sapling stands.

Apart from the scorching of the leaves, there is frequently little obvious damage immediately following the fire, but work in America has shown that the visible effect is frequently delayed.

Stickel found that in certain hardwood sample plots fire damage was not readily apparent until the following growing season, by which time 47% of the trees were found to be dead.

Besides the obvious loss as evidenced by dead trees, increment is lost by the destruction of the leaves which are the food factories of the tree.

Growth must be arrested while the tree draws on its reserves to grow a new canopy of leaves.

In pole stands in the United States, one worker showed that in 13 years the recorded loss on burned areas amounted to 9% of the diameter growth, 19% of height and 22% of the volume growth shown by unburned areas.

This is a fertile field for experiments in Australia.

3. The Regeneration of the Forests.

The bearing of the seed crop is interfered with. It is not merely a destruction of the matured seed vessels, but if the tree is in bud these are destroyed and the next seed crop is prevented.

This destruction of the buds represents also a very considerable loss to the community in general by preventing the next flowering and thereby diminishing to a greater or less degree the honey crop that comes off the forest.

The normal process of restocking cutover areas is upset by fire.

Young seedlings, either just germinated or in their very young stages, are killed outright.

After reaching advanced sapling size many Eucalypts survive light fires with little mortality and frequently without obvious material damage, other than that caused to the crown, but a close examination almost invariably reveals patches on the trunk over which the cambium has been killed.

The growth of saplings is retarded, the degree of retardation depending on the degree of defoliation and injury to the growing tissues.

However, owing to the lesser height and thinner bark, the effect of fires is much greater on seedlings than on larger and more mature trees.

Work done in America showed that 190° F. applied to the outer bark of saplings for a few minutes killed the cambium, whereas older trees with thicker bark withstood 900° F. for up to 11 minutes before the cambium was killed. Regeneration is also impeded by the increased air and soil temperatures and the intensified effects of insolation frost, evaporation and soil desiccation caused by the removal of the protective blanket of litter.

All of these causes of damage are a source of direct loss of increment in the forest, but there are certain important factors that should be considered. Firstly, we have the loss of increment due to the killing of the growing stock and then there is the timber actually destroyed by fire and which is irrecoverable.

The immature growing stock killed is lost for all time, but a certain amount of salvage is possible from mature trees killed. However, this salvage is usually rather costly and generally uneconomical as compared with harvesting a mature living stand..

4. Reduces quality of Forest Products.

The quality of the resulting lumber is affected, in some

instances by scarring and in others by influencing normal building of the tissues resulting in the temporary prevention of the development of true wood leading to the formation of pockets of "included sap".

The traumatic stimulus of fire also frequently results in the formation of gum veins and pockets and deformation of grain due to proventitious shoots.

5. Protective influence of Forest Cover.

The blanket of forest litter shelters the soil from extremes of temperature, loss of soil moisture due to evaporation and from other unfavourable factors. Even a light fire can destroy this litter, although at certain seasons of the year and under certain favourable conditions it is possible to burn off the top layer of "flash" fuel without seriously interfering with the real protective layer on the surface of the mineral soil.

The natural processes occurring within the soil are all too frequently overlooked by foresters and interference with these by continual burning cannot altogether be disregarded. For instance, fire by upsetting the nutritional balance in the tree itself can militate against or even prevent the growth of mycorrhiza. We know that mycorrhiza plays a very important part in the healthy development of pine stands, but we do not know that it does not play any part in the healthy growth of the Eucalypts.

The soil fauna plays a paramount role in the breaking down of the forest litter for its absorption into the mineral soil; this fauna is completely destroyed by the fire that consumes the whole of the soil cover, and although no figures are available in Australia, as many as 120,000 insects per square yard have been counted in pine litter in America. Fierce fires destroy the Ao horizon and with it the micro and macro organisms that have built it up.

Workers in the United States claim that it takes at least 10 years for this soil population to return and again build up a fair Ao horizon. It is of interest, in passing, that in Western Australia in the course of work on composts, it was found that it was seven years before a soil fauna began to develop. Considering therefore the great importance of this soil population it is believed that much too little thought has been given to this aspect of the effect of fire in the forest. A further important effect of the forest litter is to protect the mineral soil from the other forces of nature. After a severe fire the mineral soil is exposed and tends to become desiccated and compacted, thus becoming impervious to water. This effect, together with the removal of the absorbing blanket of litter, increases the "flash" run-off following rains. The litter tends to hold up the precipitated moisture and the loose texture of the surface soil, brought about by the work of the soil fauna, ensures that this water is to a great extent absorbed into the soil. When these absorbing layers are removed and the surface compacted, a much greater proportion is shed as run-off.

In one instance results of experiments showed that the run-off from bush was 28% of the precipitation, while the run-off from the same area following a fire was 70%. Some American figures of run-off and loss of surface soil might be interesting. One worker found that on one experimental area, the unburned plot gave a run-off of 250 gallons and a loss of 0.01 tons of soil per acre, while the figures for the burned plot were 27,600 gallons and 0.15 ton per acre. The following table also from America is interesting:-

Type of Watershed	Rainfall	Watershed area	Peak run-off	Eroded material
	ins.	sq. miles	cu.ft./sec.	cu.yds/sq.mile
33% burnt 2 months before	12.5	19.30	320	30,700
Unburnt	10.8	16.85	53	56
100% burnt	12.5	0.48	1,000	50,000
Unburnt	12.4	0.30	25	52

No details of soil types for these areas are given, but the figures are rather remarkable. Without having any figures to quote, the Australian Forester can cite many examples where the streams from protected forest are crystal clear while the creeks from adjoining untimbered or badly burned timber lands are turgid and silt laden.

The effects of this removal of the protective blanket is cumulative, and soil loses its rich surface layer and is deprived of a large proportion of the available rainfall, this gradually impoverishes the soil, the stand deteriorates, the resultant insolation and lack of replenishment of the soil cover aggravates the position until finally, in extreme cases, the whole forest is destroyed, the whole of the fertile surface soil is eroded and the barren subsoil or native rock exposed. The resultant desolation must be left to centuries of Nature's ministrations to be rehabilitated.

6. Forest Composition Succession.

Vegetation develops naturally upwards to the climax type and continual burning retards this development. This fire effect can be used as a silvicultural tool and is so used in America in the perpetuation of some of their forests where a fire-hardy type is not the desired crop and it may be of greater importance in Australia than is realised at present.

For example, in Western Australia, it is easy to visualise the replacement of Jarrah by Marri in certain circumstances and the very fire-sensitive Brown Mallet has most certainly been replaced by the very resistant Wandoo on the frequently burned slopes and low flats.

Continual burning is definitely important in retarding the climax of high forest without dense understorey. Fires through the forest actually frequently increase the fire hazard by encouraging a dense crop of ephemeral scrubs.

The normal change from the temporary and the climax type takes place naturally unless some artificial agency intervenes. Frequent fires represent such an agency preventing this normal progression. Generally the vigour of temporary fire types reaches a maximum in a comparatively short time, probably in the order of 5 to 10 years so that a single severe fire will not halt the general scale of plant succession permanently, but will result in a fire type that with subsequent protection of the area from fire, should be eliminated in probably 20 to 25 years.

These figures are merely speculative, but hold very well for the Euc. astringens associations. However, they must vary for every plant community and therefore present a most interesting field for investigation in Australia with results that should be extremely valuable.

Our hopes, based on memories of virgin stands, are that the hazard of the fuel bed is not an increasing one, when the stand takes command of the site, the highly inflammable storey of ephemeral scrubs die out and the normal processes of nature eventually strike a balance so that the annual leaf fall is accommodated by the absorption into the soil of an equivalent quantity of older litter so that the fuel bed remains relatively constant.

There will be some to challenge this statement, but observation in certain areas of Western Australia support it unequivocally and it should not be an insuperable task for Foresters throughout Australia to record their observations on various forest types so that eventually we might get to know something about our forest floor conditions.

7. Recreational and Scenic Values.

The value of the tourist trade to the economy of a nation is only just being realised in Australia. At the moment tourist agencies report full bookings at resorts three months ahead.

Tours are overbooked and more and more tourist coaches are being brought into commission. This is only the local tourist traffic, more and more thought is being given to interesting overseas tourists to visit our resorts.

Generally speaking the forests are the playgrounds of the tourist and agencies invariably report a sharp falling off of trade when bush fires are raging. Travellers do not enjoy travelling through smoke haze and although the danger is frequently greatly exaggerated, they are frightened of possible accidents through falling trees. Furthermore, a blackened desolation can hold no attraction for the tourist; it may serve as an object lesson but that is cold comfort.

This matter of loss of tourist traffic is one of the intangibles, but is a subject that cannot be ignored and it is incumbent on Foresters to make a serious study of it with the dual object of protecting the forest from the tourist as well as for him.

8. Grazing Values.

A commonly held fallacy is that periodic burning improves grazing in the forest, but experience has shown that this is far from the whole truth. Temporarily perhaps the occasional fire may improve the grazing, but fire gradually kills out the more succulent plants, which are replaced by much hardier woody species and tough tussock grasses.

A good example of this was the Bogong high plains where the enquiry revealed that continual burning and overstocking have almost completely ruined the grazing on the area. Protection from fire slowly permitted the return of the better fodder grasses. Western Australia is fortunate in that our forests have little grazing value and, therefore, this problem does not assume such serious proportions here as it does in other States.

9. Human Life and Property.

This is one fire damage that is never controverted. The value of a human life is incalculable and yet every year witnesses the destruction of human beings by forest fires. Every fire is a potential killer and as this fact is brought home to the man in the street, we Foresters should get more and more co-operation in fire prevention.

Apart from actual loss of life, losses of property, fences, houses, stock and feed each year in Australia must run into hundreds of thousands of pounds. Detailed reports on all major fires should be obtained by local authorities to bring home to the people and governments the tremendous losses sustained through bush fires.

10. Wild Life.

Generally in Australia wild life is regarded as "vermin", but this, of course, is far from true. The forest fauna fills a definite place in the scheme of things and destruction of animal or bird life, either directly by killing or indirectly through destruction of shelter, sanctuary or nesting areas, must inevitably have a considerable effect on the whole adjoining area through the upsetting of the delicate balance of nature.

The whole subject is bound up, too, with the tourist traffic; wild duck sanctuaries are burnt out, and as is usually the case when dealing with fire damage, one finds oneself contemplating numerous subsidiary causes of loss to the nation generally which are far removed from the original damage under discussion.

Fire control, of course, plays a very important part in the science of game management which, however, is a subject outside the scope of this paper.

11. Physical and Chemical Properties of the Soil.

This is a very controversial subject and one about which we know comparatively little. There are certain well known effects of fire, such as destruction of humus and the protective layer of litter already dealt with, considerable loss of nitrogen and possibly, through displacement and leaching, certain other soil salts. However, published results to date are contradictory and the whole subject could well be one for specialised research.

12. Permits ingress of tree-destroying insects and diseases.

The destruction of timber by wood-destroying insects and fungi is one of the "box office" losses. One that everyone working in the forest knows about and everyone in the timber trade deplores, particularly because it represents actual loss of cash. It is not generally realised, however, that the biggest proportion of this loss is due indirectly to fire.

Practically all wood-destroying insects can only gain entry to the timber through a patch of bare wood, the bark of the tree almost invariably imposing an impenetrable barrier to their entrance. Fire kills patches of bark and growing tissue and the bark eventually falls away exposing an area of dead wood. It is through such patches that borers gain entrance and once established in the bole, continue therein throughout their life doing untold damage.

Fungi too require an area of dead wood to become established and it is almost invariably through fire scars that wood-destroying fungi gain entrance.

Storm damage to crowns or boles can also provide a place of entrance, but these instances are rare compared with the prevalence of fire scars.

Finally, burnt out butts are an open invitation to termite and in some Australian species the loss of timber through termite attack is more than considerable.

The foregoing is a brief outline of the ways in which our forests can be damaged by fire with consequent loss of wealth to the nations. Many of the statements made cannot be denied, others are controversial, and it is hoped will produce fruit in the way of discussion.

There may be much more information extant on fire damage in Australia than is published and this should be made available to Foresters so that we who are charged with the protection of our national heritage may be in the position to set to work to make a reliable statistical record of losses due to fire, to ascertain to what extent expenditure on fire control is justified and to satisfy critics that any form of fire control whatever is justified.