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Rural dieback

SUMMARY

Over the past two decades in Australia, there has been a dramatic increase in the rate of decline or death of native trees (especially eucalypts) in many rural areas. The problem occurs mainly among remnant trees on lands that have been selectively cleared for cultivation or grazing, rarely within undisturbed stands. It affects a wide range of tree species in many forest vegetation types. The causes of this 'rural dieback' are not completely known, but are thought to involve complex interactions of 'natural' and management-related factors that stress or injure trees. One of the principal factors seems to be the extensive tree clearing that has taken place since first settlement. Rural dieback is causing increasing community and government concern in most states, as the ecological and economic consequences of widespread tree loss are becoming apparent. Research programmes are underway around Australia to determine the extent and causes of tree decline and ways of combating the problem.

What is dieback?

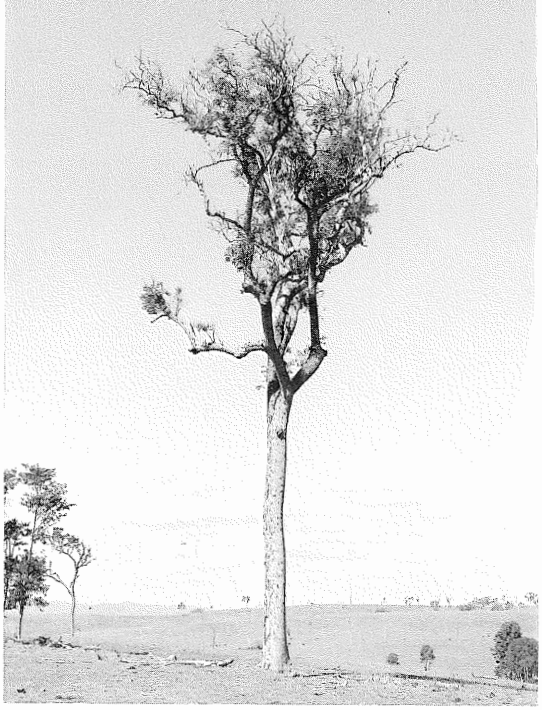
Dieback is a symptom of tree disorder. It is characterised by a progressive, usually protracted, dying-back of tips or branches in the crown of a tree. It can be caused by a variety of damaging agents acting singly or in combination to affect the tree's physiological processes, and it may lead to tree death if the cause of the disorder persists.

In a tree with severe dieback most minor and major branches are dead and leafless, and the remaining green crown is composed mainly of secondary epicormic regrowth on the larger branches or stem. Thus a tree with dieback often develops a characteristic stag-headed appearance. It may not die for many years and may make several temporary recoveries during this time. Occasionally, complete recovery occurs. An important concept is that dieback is not necessarily an infectious 'disease' as it is sometimes popularly portrayed, but can be caused by non-living as well as by living agencies.

Causes of dieback

As outlined in previous chapters, there are many factors (insects, pathogens, poisons etc.) known to produce disorder in trees. Many of these factors, acting singly or in combination, have been suggested as causes of rural dieback in Australia. However, our knowledge of the mechanisms involved in tree decline is far from complete, and the relative importance of these possible factors probably varies with place and time. While it has sometimes been possible to identify a single major causal factor of a particular decline (e.g. dieback of many eucalypts in parts of the Lockyer Valley in south-east Queensland is due to increased soil salinity), a single causal agent is the exception rather than the rule. Normally, complex interaction of factors are involved, often over a long time span. Such relationships are illustrated in Figure 17.1, and are discussed below.

Intensification of land management for pastoralism or for agriculture is almost always ac-



Typical 'stag-headed' appearance of a tree with severe dieback in its crown.

These trees are already showing symptoms of dieback and will be further stressed by the activities of cattle which regularly gather at the site.

companied by some clearing of native forest or woodland. Removal of selected trees and an increase in the production of pasture and crops drastically alters the environment of the remaining trees in ways that can sometimes lead to their dieback and death.

Salinity can be a result as well as a cause of tree decline. Removal of deep-rooted trees from the water-intake zones of a catchment may decrease water usage through reduced evapotranspiration and hence cause the water-table to rise. If the groundwater is saline, or the soil contains salt, the rising water-table brings salt to the surface lower down in the landscape where it may accumulate and also contaminate surface water. Salinisation due to such tree losses, or due to irrigation with saline water, may in turn cause trees to decline in the salinised zone of the landscape. Excess salt may be directly toxic to trees, or may affect their vigour and predispose them to attack by insects and disease, or worsen the effects of such agents. Salt tolerance of trees varies considerably within and between species, and may be affected by a variety of factors such as climate, site conditions and stage of growth. Waterlogging often occurs in conjunction with salting where rising water-tables approach the surface, and its effects are sometimes difficult to separate from those of salinity.

Tree clearing, planting of crops and pasture improvement may increase the populations of defoliating insects and also concentrate them on the smaller number of trees that remain. For example, some adult insects that feed on trees have larvae that feed on the roots of grasses and crops. Pasture and crop development may thus help the growth and survival of these larvae. Fertilising may also make the foliage of trees more attractive to insects. Trees may be injured directly by excessive concentrations of fertilisers or by herbicides used for the control of weeds. Trees may also be stressed through increased competition from grasses.

Many studies have indicated that the abundance and diversity of birds and animals decline when woodland is partially cleared and low shrubs are destroyed by grazing livestock. Some of these species are important predators of tree-feeding insects. Beneficial insects may be similarly reduced. For example, the clearing of trees and shrubs may reduce the availability of nectar for the adults of wasps the larvae of which parasitise insects feeding on trees. The resultant reduction in levels of predation and parasitism of tree pests may contribute to higher pest numbers, increased defoliation, dieback and tree death. Studies in the New England tablelands of New South Wales showed that bird numbers declined dramatically from over 20/ha in healthy eucalypt woodland to

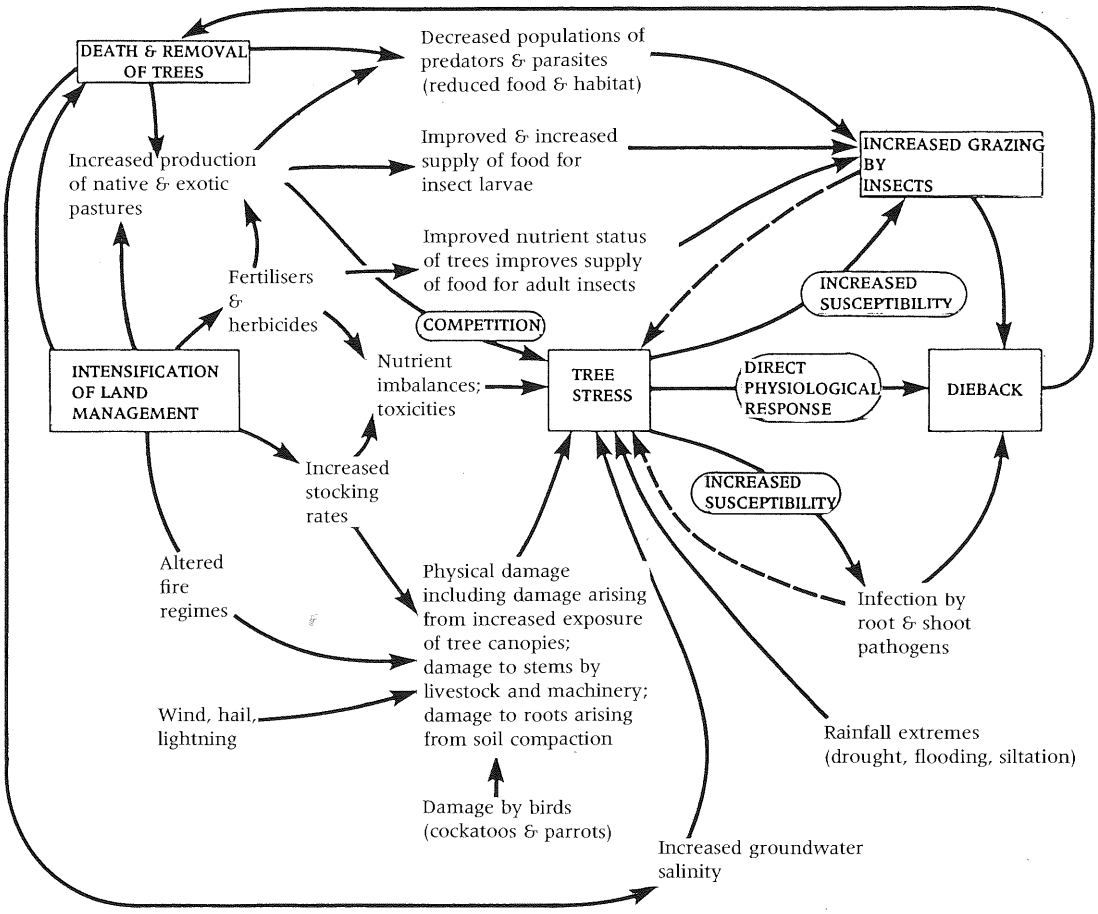


Figure 17.1 A model of initiation and development of dieback of rural trees

Overclearing in susceptible catchments may lead to saline water rising to the surface and in turn to further tree loss, as has occurred here in the Lockyer Valley of south-east Queensland.

2.4/ha in areas affected by severe dieback and to less than 1/ha in treeless grassland.

While some of the factors that stress trees are natural, their impact on trees may be exacerbated by management practices. For example, the canopies of the trees remaining after selective clearing are more exposed to damage by wind, and trees growing in compacted soils will be more severely affected by droughts and floods. An increase in the frequency or intensity of fires may lead to increased tree mortality and disorder, particularly among young trees (Chapter 16). Other damaging influences may be entirely due to management. For example, livestock may damage trees both directly (e.g. grazing or trampling of young trees, girdling of trees because of rubbing or stripping of the bark) and indirectly (e.g. soil compaction, accumulation of animal excreta). Wounds caused by farm machinery may allow the entry of pathogens and insects.

Stress, from whatever cause, may predispose trees to attack by insects and pathogens, and make them less able to cope with such attack. The mechanisms underlying this increased susceptibility are not completely known, but, in the case of predisposition to attack by leaf-feeding insects, they are believed to involve changes in certain chemical constituents of foliage. Such changes may weaken the natural chemical defensive systems of the tree against insects, and/or improve the quality of the insects' food. Decline in tree vigour following defoliation is probably largely due to the depletion of carbohydrate reserves during production of new leaves. Trees already weakened from other causes and low in such reserves at the time of serious insect outbreaks would succumb more quickly than healthy, vigorous trees. Cycles of defoliation and refoliation may continue over many years, with alternating periods of partial recovery and worsening dieback as environmental influences on trees and insects fluctuate. Ultimately, the trees may die if repeated defoliation leads to exhaustion of carbohydrate reserves. Tree mortalities due to dieback are additional to the losses due to clearing and old age, and so exacerbate the effects of reduced tree cover. This trend is accelerated where natural regeneration is prevented or limited by such factors as salting, grazing by livestock, and repeated fire.

The model in Figure 17.1 thus highlights the complexity of rural dieback and the extent of land managers' contribution to the problem. Factors such as drought, flood, fire, storm, insect damage and disease are natural hazards for trees in much of rural Australia. Native tree species in their undisturbed environment seem generally well adapted to cope with these hazards. Dieback and death of trees due to these agents, and to old age, does occur in undisturbed areas, but the incidence of tree disorder is usually low, tree losses are compensated by natural recruitment, and an ecosystem balance is maintained. However, as indicated in the model, in an environment that has been greatly modified for agriculture or grazing by livestock, this balance may be upset by any of a number of factors that create additional hazards or stress for trees, or that favour pests, or enhance the effects of damaging agents, or inhibit natural regeneration. When this occurs, the incidence of tree disorder and mortality may increase dramatically.

Significance and extent of dieback

While the full extent of rural tree decline in Australia has yet to be determined, dieback among native trees has been reported from all states, and extensive tree loss has occurred in some areas. The best known example is in the New England tablelands of northern New South Wales where millions of trees have died since the late 1960s. The reported causes of these diebacks have varied with geographic region and with time, and have included most of the elements discussed earlier in this section. A wide range of eucalypt and other tree species is affected (e.g. in Queensland, dieback of varying severity has been recorded in 67 tree species, including some commercially important timber species). Dieback has affected trees of all ages from seedlings to mature and over-mature trees. The problem has been most severe among the older-age classes.

Until recently, the main impact of dieback was regarded as one of aesthetics. However, studies in areas where considerable tree loss (from whatever cause) has occurred have revealed serious economic implications for both rural and urban communities. These include loss of productive farmland due to erosion or salting, loss of valuable timber resources, loss of shade, shelter and windbreaks, loss of habitat for insectivorous birds and animals that predate crop pests, loss of honey production, and costs of remedying damage to roads, property, waterways and reservoirs caused by landslip, erosion or siltation. Such additional costs to the rural producer flow on to the urban consumer.

In Australia, dieback is not a new phenomenon, and reports of widespread, and sometimes spectacular, tree disorder date back to the 1850s. While the increased frequency of reports of dieback over the past two decades may, in part, reflect an increasing public awareness of the prob-

lem, there is no doubt that the present decline is of unprecedented magnitude and appears to be worsening in all states.

What can be done about dieback?

As outlined in the discussion of the model, there are many factors ('natural' and management related) that have contributed, and continue to contribute, to rural tree dieback in this country. Not all these factors lend themselves to effective remedial action (e.g. climatic factors are beyond man's influence; direct control measures against pests and diseases are likely to be costly, difficult or undesirable; reduction in the intensity of land use may be socio-economically impractical). However, one factor appears to be a key element in the development of rural tree decline (and in other forms of environmental degradation), and seems capable of practical address. This is the extensive tree clearing that has taken place since first settlement. Links between over-clearing and the occurrence and severity of dieback have been well established. For example, in Queensland, severe dieback is occurring in areas where more than 50% of the original tree cover has been cleared, and serious erosion and salting problems are also developing in such areas, exacerbating disorder. Restoring the cover of trees and undergrowth on denuded or degraded lands and the maintenance or enhancement of existing vegetation cover in other areas, therefore, offer the best hope for remedying environmental degrade.

As a result of increasing community awareness of the importance of trees and the role of management in tree decline, some steps have recently been taken towards addressing the problem. For example, several Commonwealth and state organisations are engaged in identifying and mapping areas affected or at risk, and in setting priorities for tree establishment. Government and private funding for research and reclamation projects has increased, and there are numerous community groups and individuals involved in tree-planting programmes. A range of policy measures has been implemented by governments in Australia to maintain and promote tree cover on private property, including covenants in land titles, direct regulations, grants and loans to facilitate tree planting, and tax incentives or disincentives. Increasing emphasis is being placed on education programmes and extension literature to promote the benefits of trees and of rural nature conservation, and to encourage the better use and management of land. Many of these initiatives have involved co-operation between landholders, scientists and government, and an interdisciplinary approach to the problem. However, it is apparent that much more is needed just to contain environmental degradation in Australia. An actual reversal of the current trend will require substantial effort and resources over several decades.

Much information is now available to property-owners on practical measures that can be instituted to restore, maintain or enhance tree cover

Heavy infestation with mistletoe will weaken and may eventually kill a eucalypt. The above decline and death of trees was probably due to a combination of influences. One or two mistletoes on a vigorous tree have little effect, even if the affected branches are killed. Mistletoes make their own food but use the tree's water and nutrients. If it is accessible, the mistletoe can be cut off with the branch on which it grows, ensuring it will not re-sprout from its roots within the branch. Mistletoe can also be controlled by use of weedicides, such as 2,4-D, applied selectively to their foliage or injected into the tree's trunk in the correct manner, otherwise the tree can also be killed. (See Calder and Bernhardt (1983) *The Biology of Mistletoe*. Academic Press, Sydney; and other literature.) photo: Greening Australia

on their land. Many such measures are outlined in other chapters of this book. Important points to remember about dieback are that it is a condition not a disease, and that its causes are closely related to management of the land. It is not solely due to natural causes, contrary to the belief of many landowners. Therefore no tree species can be regarded as entirely immune to dieback, although some species may be more adversely affected than others. Any solutions to the problem must necessarily include radical changes in attitudes towards the role of trees on rural lands and in some land-management practices. If tree loss without adequate replacement is the key factor in tree decline and some other forms of environmental degradation, then efforts to retain or restore tree cover in critical areas offer hope of reversing present trends.

Further reading

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