Dieback describes a condition where trees die or decline in condition prematurely and often rapidly. Often large numbers of trees are affected at once. Dieback contributes to the loss of tree cover (tree decline) in many rural areas. Other factors that contribute to tree decline are lack of regeneration, natural deaths of aging trees, wind-throw and clearing.

Dieback-affected trees typically have poor crowns, with sparse foliage and a large proportion of dead twigs and branches. The affected trees may partially recover by growing new shoots from the trunk and major branches (epicormic shoots). In most cases these shoots die back as well, although recovery from dieback is possible. Root systems in dieback-affected trees are similarly reduced. The exact symptoms depend on what is causing the dieback. There are several causes of dieback; these vary from region to region.

Some forms of dieback have probably always occurred in Australia. Our environment is marked by extremes of drought, flood, pestilence and fire. All of these can cause trees to die or place unusual stress on trees. Consequently, when trees die, often many die at once.

Dieback has become more common in rural areas, and many causes (including chronic defoliation by insects) appear to be linked with landuse practices. Increased soil salinity and waterlogging are most apparent in deforested catchments. Both chronic lack of water and prolonged inundation due to river regulation appear to contribute to dieback of river red gums (Eucalyptus camaldulensis); and fungal diseases, such as Phytophthora root rot, can be spread by earth-moving equipment and vehicles.

Causes of dieback

**Insects**

Dieback in rural areas often involves repeated defoliation by a variety of native insects. Severely defoliated trees become susceptible to fungi, which cause lesions (cankers) in the branches, causing them to die back.

---

The insects involved include psyllids, scarab beetles, chrysomelids (leaf beetles), leaf hoppers, sawfly larvae, scale, gall-forming insects and skeletonizing caterpillars. In addition, outbreaks of phasmatids (stick insects) can occur in forests. The relative importance of a particular species of insect can vary over time, and since different insects prefer different species of eucalypts, the relative susceptibility of eucalypt species changes.

In recent years, psyllids have been the most prominent defoliating insect in Blakely’s red gum (E. blakelyi) woodlands on the Central and Southern Tablelands. Psyllid outbreaks have also been observed on yellow box (E. melliodora) in the Hunter Valley and river red gums on the Western Plains. Defoliation by scarab and chrysomelid beetles was a major contributor to dieback on the New England Tablelands in the late 1970s, but their populations collapsed during the 1980–83 drought, and since then infestations have not been as severe.

Several factors appear to contribute to the occurrence of insect outbreaks.

*Favourable weather conditions*
Insect outbreaks generally occur when the weather favours the insect’s breeding and survival. Many species of insects are susceptible to extremes of heat or cold or prolonged wet or dry spells.

*Effects of clearing and pasture improvement on scarab beetles*
Scarab beetles that feed on eucalypt foliage (e.g. Christmas beetles, Anoplognathus spp. or smaller Sericestis spp.) have larvae that feed on the roots of pasture plants and on soil organic matter. These beetles have become a greater problem on rural eucalypts, probably because the number of scarab beetles per tree increases as the ratio of trees to pasture declines. Populations of scarab larvae can build up to greater densities in improved pastures than in native pastures. However, soils beneath improved pastures usually dry out faster than those beneath native pastures so that populations of scarab larvae in improved pastures may collapse to a greater extent during dry spells. This means the relative abundance of scarabs in improved versus native pastures depends on weather patterns.

*Reduced effectiveness of control by natural enemies*
In healthy bushland, parasites and predators may kill a large proportion of insects and thereby reduce the rate at which their populations increase. For example, parasitic wasps locate hosts and at least some species breed more successfully if the density of their host is high. Birds tend to feed more intensely on localised concentrations of insects, which may reduce the likelihood that an insect outbreak will develop.

Many insect-feeding animals that may have once controlled insects have disappeared from or become rare in rural areas, chiefly as a result of the loss of farm bushland. Bandicoots, which eat scarab larvae, and gliders, which often eat insects on trees, have disappeared from much of the Tablelands. Densities of birds in areas affected by dieback are about 10% of those in healthy woodland. In addition, the number of bird species is dramatically reduced in small patches of bushland that have been taken over by aggressive birds such as Noisy Miners. The activities of some parasitic wasps and flies depend on nearby sources of food, such as nectar from tea trees (Leptospermum) or blackthorn (Bursaria spinosa). Some species of wasp and fly seldom fly more than 200 metres from such sources of food, so these parasites can not control insects in areas where nectar-bearing plants are absent.
More nutritious foliage
Foliage with enhanced nutritional value (particularly available nitrogen) can increase the number of young each female insect produces (fecundity) and may increase the growth rates and survival of the young insects. More nutritious foliage can result from:
(1) increased soil fertility beneath trees due to pasture improvement, together with the long-term effects of livestock camping and excreting beneath trees;
(2) trees being under stress; or
(3) trees having a greater proportion of younger, more nutritious leaves because most leaves are eaten by insects before they become old.

More work is required to quantify these effects. For example, eucalypts generally increase their rate of growth in response to fertiliser, unless insects defoliate them.

Drought
Severe droughts can cause trees and other woody plants on sites such as hilltops or sandy gullies to die off suddenly if the soil-profile dries out completely. The foliage wilts and browns-off, and usually the trunk splits. Often longicorn beetle larvae injure trees further by entering through splits and girdling the tree. At least some drought-affected trees regenerate from epicormic shoots when the drought is over.

Chronic water shortages can also injure trees, especially water-demanding species such as river red gums. The crowns thin out and the trees may be rendered more susceptible to secondary fungal infections. Along many inland streams, the frequency and duration of floods has been reduced by river regulation, and in some places large quantities of groundwater and river water have been used for irrigation, possibly contributing to water shortages experienced by trees during dry spells.

Salinity
Increased soil salinity affects large areas of Australia, including NSW. It usually results from rising water tables that are related to loss of tree cover or, in irrigated areas, from accumulation of salt in soils after irrigation water has evaporated. Eucalypt trees can withstand moderate levels of soil salinity. Tolerance varies both between and within species. Water logging and salinity often occur together, and trees suffering from waterlogging can become less tolerant of salinity.

Dieback caused by salinity can often be distinguished because trees in salt-prone areas (e.g. discharge zones) are most affected, with many trees becoming affected at the same time.

Salt-affected areas usually have:
• ground that is boggy, at least occasionally
• species of plants that tolerate high salt levels, such as couch and barley grass
• high soil conductivity
• a high water table (usually < 1 m below the surface).

Sometimes salt-affected trees are severely defoliated by insects. This can make it difficult to know whether insects or salt, or both together are causing the dieback.

Phytophthora root rot
Phytophthora cinnamomi (cinnamon fungus) is a major cause of dieback of eucalypts and many other native plants in Western Australia, Victoria and Tasmania. The fungus also causes root rot of avocados on the North Coast of New South Wales. It is a water-borne pathogen that principally attacks major roots of trees. It is uncertain how important the disease is in NSW. It has not been found in trees affected by dieback on the Northern Tablelands. However, dieback attributable to the fungus has been noted in the Southern Tablelands.

The disease can be distinguished from other forms of dieback since:
• Other native species (e.g. banksias, grass trees) are also affected.
• Among eucalypts, ashes and stringybarks (sub-genus Monocalyptus) are more susceptible than gums and boxes (sub-genus Symphyomyrtus).
• The disease spreads progressively as an identifiable front through vegetation and more quickly down-slope than up-slope.
• The disease often spreads from an area of soil disturbance such as a track or road works.

**Other diseases**

Several other fungal diseases affect leaves, stems or roots of eucalypts. The mushroom-forming fungus, *Armillaria luteobubalina*, causes a severe root rot. It can become established in old stumps and spread vegetatively from tree to tree via root contacts, resulting in roughly circular patches of dieback-affected trees.

A syndrome called ‘Mundalla Yellows’ appears to be killing eucalypts, banksias and tea trees, particularly in South Australia, and appears to be spreading. The foliage of affected plants turns yellow. The agent responsible for this disease is still uncertain.

**Natural deaths of aging trees**

The symptoms of natural aging can be difficult to separate from those of dieback. Aging trees (often called over-mature trees) usually have thinner, more irregular crowns, many dead branches and hollows. Larger, older trees are less vigorous; the ratio of leaves (which produce food) to supportive tissue (which needs food) is smaller; wood decay accumulates; and the risk of wind-throw increases.

Aging trees are very important for wildlife: many species of parrots and other birds, as well as possums, gliders and bats nest in their hollows.

Natural life spans of trees vary for different species and depend on environmental conditions. Most species of eucalypts can live at least 200–300 years under good conditions, although some species can be more short-lived, such as black sally (*E. stellulata*) on the Northern Tablelands, which probably lives less than 100 years. Many wattles only live for 10–20 years. At the other extreme there are individual river red gums and mountain ash trees over 1000 years old, and some rainforest trees live much longer. The life expectancy of trees is reduced by injuries, such as repeated scarring by fires.

**Self-thinning of dense regrowth stands**

Regrowth forests are often denser than the original forests. As a stand develops, competition for resources intensifies. Smaller trees tend to be crowded out, lose condition and eventually die. During episodes of dieback when all trees are under stress, trees within regrowth stands are often in especially poor condition, because they tend to be crowded by larger surrounding trees, and are less capable of competing for resources.

**Other factors contributing to dieback**

Factors that contribute to (or cause) dieback in particular localities include mistletoes, herbicide spray drift or spillage in waterways, girdling of trees by livestock, earthmoving—particularly the burial of tree roots, fire, frost, wind pruning, hail and localised pollution.

**Diagnosing the cause of dieback**

Dieback often occurs over a protracted period, and sometimes it is difficult to diagnose its cause. Several factors may contribute to dieback at the same time. In other cases it is difficult to ascertain the cause unless the case has been monitored from the outset. For example, a severe hailstorm will strip leaves off trees and bruise the surface of small branches. This can result in severe, but localised, dieback, possibly due to fungal pathogens entering the wounds. Several years after the event it is impossible to tell what caused the initial injury to the trees.

**Geographic distribution of dieback**

Large areas all over Australia have been affected by dieback. In NSW it is particularly common in remnants of woodlands and isolated trees on the Tablelands and in river red gum
and box communities further inland. For example, dieback of bimble box (*Eucalyptus populnea*) is evident in large areas on the Western Plains.

There are numerous reports of more localised occurrences of dieback. Dieback of forest red gums (*E. tereticornis*) occurs on the North Coast. Dieback of cabbage gum (*E. amplifolia*) occurs near Gloucester and on the Cumberland Plain near Sydney; dieback of stringybark (*E. caliginosa*) in parts of the Northern Tablelands and dieback particularly of yellow box (*E. melliodora*) in the Upper Hunter Valley. Dieback of rough-barked apple (*Angophora floribunda*) and kurrajong (*Brachychiton populneus*) has occurred recently on the northwestern Slopes, but most kurrajongs seem to have recovered in recent years.

Dieback also occurs in forests, for example, in cool temperate rainforests, particularly in areas affected by logging or road construction.

In most areas, isolated trees appear more affected, and rates of insect defoliation on them are greater.

**Recovery from dieback**

Dieback does not always kill trees. Dieback was widespread in the late 1970s on the Northern Tablelands, but insect populations collapsed in the early 1980s and trees that were still in a fair condition generally recovered. In general, only the most severely affected trees continued to die.

Juvenile eucalypts are a vital insurance against dieback. In a natural woodland, they remain suppressed beneath mature trees, sometimes for many decades, but they begin to grow when the trees above them die. They usually survive in natural pastures, which have not been ploughed or too heavily grazed over a protracted period.

**What can be done about dieback?**

We know much about dieback, but there is still much that we do not know. In many cases good land management will prevent dieback (e.g. by preventing salinity or, perhaps, by providing habitat for wildlife), but some risk of dieback will always remain. We need to maintain juvenile trees in the understorey to enable replacement of trees lost due to dieback.

Here are some recommendations:

**Don’t panic.** Retain dieback-affected trees, which may still recover. Even dead trees are valuable for wildlife, especially old ones with hollows.

There are labour-intensive ways of salvaging individual trees, such as pollarding (cutting off the major branches and allowing the tree to re-sprout) or injecting systemic insecticides. However, such treatments cannot be economically carried out over an entire property.

**Retain as many juvenile eucalypts as possible.** This will usually mean avoiding ploughing, applying herbicide or sowing exotic pastures around existing trees or in other areas where juvenile trees are common, and where you want regeneration to proceed. These areas can be maintained as native pasture.

**Control livestock** to prevent both injury to trees and accumulation of manure beneath them, and to allow seedling trees to become established. Fencing may be necessary to prevent livestock camping under trees, eating juvenile trees and other shrubs and sometimes girdling adult trees.

**Plan to retain large connected patches of bushland.** If possible, plan for patches of bushland of over 20 ha linked with corridors 80–100 m wide, or more. Smaller patches are liable to be taken over by Noisy Miners, which keep out smaller bush birds needed to control insects.

**Retain other habitat,** such as fallen logs and dense thickets of trees to provide habitat for birds and other animals that help to control insects.

**Retain a diversity of trees, shrubs, herbs and grasses** to encourage a diversity of wildlife species, including beneficial insects.
Regeneration following dieback near Hillgrove, east of Armidale. The two photos are of the same scene, note the black stump in the centre of each photo.
Acknowledgments
Thanks to Nick Reid, Jill Landsberg, Peter Smith and Bert Jenkins for commenting on the manuscript.

References and further reading

Christopher Nadolny
Department of Land and Water Conservation
PO Box U245 Armidale NSW 2351
Phone (02) 6773 5265
Email: cnadolny@dlwc.nsw.gov.au

(Original version 1996; this edition August 2002)

Published by:
Centre for Natural Resources
New South Wales Department of Land and Water Conservation
Parramatta

September 2002
© NSW Government
ISBN 0 7347 5289 X
CNR 2002.025