Wandoo crown decline

linked to a changing environment?

Wandoo is an attractive white gum common in the medium and lower rainfall areas of the Wheatbelt and Great Southern regions. These striking trees, as well as the highly diverse associated flora and fauna in wandoo woodlands, are enormously valuable ecological assets. However, the health of wandoo has been declining.

By Erik Veneklaas and Liz Manning

Wandoo (*Eucalyptus wandoo*) is one of several prominent tree species under severe stress in south-western Australia. Others include tuart (*E. gomphocephala*), flooded gum (*E. rudis*) and marri (*Corymbia calophylla*). These cases of decline may have common causes. There have been several changes in the environment, varying from widespread clearing and related effects on local climate and hydrology, to impacts of fire management, commercial use of ecosystems, spread of introduced animals and the presence of pollutants and agrochemicals. Also, in the south-west, rainfall has been declining for two to three decades. Given the significance of water in this region, any reduction is likely to have a considerable impact on ecosystems. It may not be a coincidence that trees like wandoo, which dominate the ecosystems they occur in, are the first species that are affected.

Wandoo's ecological value

Wandoo is endemic to Western Australia and provides an important habitat for wildlife. It is regarded as a keystone species for an entire ecosystem type. A myriad of insects and other invertebrates inhabit the trees' bark and foliage, attracting insectivorous birds. Flowers produce abundant nectar, a source of food for birds and insects. Many animal species such as the red-tailed phascogale, brushtail possum, several bat species and a variety of birds including the rufous tree creeper, regent parrot, Carnaby's cockatoo and barn owl use hollows in the branches and the trunk of trees. Hollow logs on the ground provide homes for numbats, chuditch, echidnas, carpet pythons, Gould's monitors, western bearded dragons and other reptile species.

However, extensive clearing for agriculture has diminished and fragmented the distribution of wandoo, leading to a severe loss of habitat for wildlife. This is seen in the dramatic reduction in the number of available nesting and feeding trees for species such as Carnaby's cockatoo. Remaining nesting and feeding areas are threatened by salinity, waterlogging, grazing, firewood collection and changes in fire management. The long-term survival of species such as Carnaby's cockatoo is closely linked to the survival of its habitat and the retention of nesting and feeding trees such as wandoo.

What is wandoo crown decline?

Wandoo crown decline is characterised by browning and the death of portions of the upper and outer foliage of the tree, a symptom known as 'flagging'. Epicormic shoots (new foliage) sprout along the trunk and lower limbs to replace the dead twigs and foliage. But this growth may also die, resulting in progressive loss of the tree crown and sometimes the death of the tree. The decline process can eventually stabilise and the tree may recover as epicormic growth replaces the lost canopy. Wandoo crown decline has been observed in many areas across wandoo's natural range since the mid 1980s.

In contrast, healthy wandoo trees have well-developed crowns, abundant blossoms and clean trunks. Intact wandoo woodlands comprise large, old trees with scattered clumps of younger trees where regeneration has occurred on ashbeds from fires. The woodlands support a healthy and diverse associated flora and fauna community.

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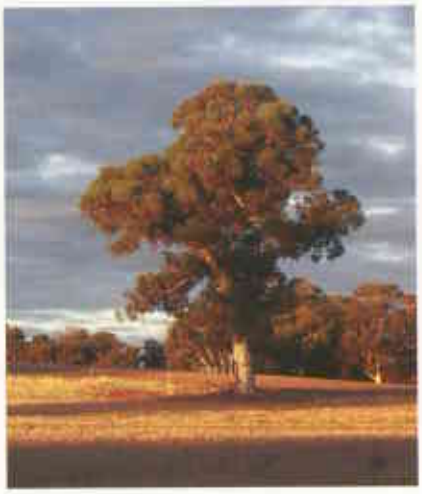
Main Wandoo woodland.
Photo – David Bettini

Above Wandoo flowers and buds.
Photo – Jiri Lochman

Left Carnaby's cockatoos use wandoo hollows to nest.
Photo – Birds Australia



Top left A Gould's monitor on a wandoo stump at York.

Above left Clearing for agriculture has diminished wandoo's distribution through the Wheatbelt.
Photos – Liz Manning

Above A declining stand of wandoo.
Photo – Allan Wills

Possible causes of decline

Drought stress and insect and fungal attack all appear plausible causes of wandoo crown decline, but it is probably the combination of these and other factors that explain the current decline. There is no conclusive evidence that trees are succumbing to drought stress directly and, while the evidence for the involvement of insect borers and fungi is strong, it is not clear why these organisms have rather suddenly become a problem.

Why is it so difficult to identify a cause? Health problems in trees can prove difficult to identify for a number of reasons. Firstly, changes in trees take a long time to manifest themselves—trees are big and able to resist some stresses for a long time. Moreover, patterns in tree health within a woodland or region can be confusing because some trees are more resistant than others, and growing conditions can be quite different even for neighbouring trees. Furthermore, interpreting tree health is complex because many ecological factors act upon trees. Even if only one factor is ultimately responsible for a tree health problem, many other factors interact and are involved in the stress and response of the tree. Unfortunately, the ecology of wandoo woodlands is poorly known and not always easy to investigate.

Wandoo woodlands have been subject to many changes over the past century including clearing, exploitation, altered fire regimes, invasive animals, plants and diseases. Wandoo crown decline, however, had not been noticed on a large scale until the mid 1980s. This coincided with the start of an extraordinary decrease in average annual rainfall.

Wandoo is declining in locations with widely different management and conservation status including sites with minimal intervention. This supports the idea that the cause must be sought in a regional change rather than a factor that acts locally.

Drought stress may be one of these regional factors. Unfortunately, it is not always easy to diagnose drought stress in trees in our region, because symptoms of drought are often not clearly visible. Moreover, many species have a high level of tolerance to seasonal drought. Nevertheless, trees do experience bad years and careful observation shows they grow less and are more susceptible to pests and diseases during long dry periods. This illustrates the complexity of tree responses—trees may suffer and even succumb to insect pests or root diseases, not necessarily because a

new pest arrives in the woodland, but because the resistance of the trees is weakened. Evidence is accumulating that pest and disease organisms have a key role in the damage observed in wandoo crowns. Accurate and comprehensive information is important in understanding decline syndromes, such as where and when crown decline is occurring.

Based on our current knowledge of declining rainfall and on the visible symptoms of crown decline (flagging), the research is now focusing on clarifying the interrelationships between changes in the environment, and the presence and impacts of insects and fungi.

Wandoo's water requirements

We know that trees need water and, therefore, where rain is the only source of water, a reduction in rainfall must have some consequences for tree vigour and health. But why would this have a greater impact on wandoo than on other species—wouldn't this apply to all trees? Could it be possible that wandoo suffers more than other trees that grow in the same region, or even in the same woodland? New studies carried out by The University of Western Australia's (UWA) School of Plant Biology provide insight into how trees experience drought in their environment and what the consequences of drought might be.

State-of-the-art equipment is used to measure the amount of water flowing through vessels in the sapwood, from the roots to the crowns. This flow is driven by suction, created by transpiring leaves. The more water a leaf loses and the less it is replenished by water from the roots, the stronger the suction becomes. The stronger the suction, the easier it is to access water from relatively

Above left Wandoo and powderbark (*E. accedens*) can occur together and have very similar appearance and ecology.
Photo – Liz Manning

Left Wandoo stands out with its mottled bark.
Photo – Hans Lambers

Above This giant wandoo has a girth measuring nearly 5.2 metres and could be more than 450 years old.
Photo – Liz Manning

Above right Intact wandoo woodlands support a diverse and healthy understorey.
Photo – Hans Lambers

How can you help?

The Wandoo Recovery Group (WRG) coordinates government and community-based actions to implement community awareness programs and help secure funds. It promotes, supports and coordinates research into wandoo decline and recovery.

The group organises wandoo crown assessment surveys with community groups to collect information and monitor changes in the health of wandoo. All interested groups are encouraged to get involved.

A historical review of wandoo health and the changes to woodlands is planned for the future. The research will provide vital information on whether the current decline is unique or periodic. Community members with knowledge about wandoo health, particularly before the 1970s, are invited to share this information with the WRG.

For more information on the activities of the group, and how you can help, contact the WRG Executive Officer Liz Manning. Contact details are on page 22.

dry soils. However, when the suction becomes too strong the water columns in vessels may break, rendering the transport system ineffective and whole twigs or branches may dry out.

Plants control the water status of their leaves by closing and opening pores in their leaves through which vapour diffuses to the air. Knowing the diversity of plant types and environments in nature, it is no surprise that different species use this control mechanism in different ways. For example, control is much tighter in species that are adapted to low and unpredictable rainfall, because if they left their leaf pores open for too long they would run out of water quite quickly.

The interesting results for a mixed eucalypt woodland show large differences in the water use patterns of wandoo and other eucalypts growing at the same location. As soils dry out over summer, jarrah and marri reduce their water use by closing the pores in their leaves, especially during the hot afternoons, but wandoo keeps them open and continues to use large amounts of water. While leaf dehydration in jarrah and marri is moderate, wandoo trees typically lose up to 35 per cent of the moisture held in their leaves on summer days. This dehydration leads to suction in wandoo vessels that are one-and-a-half to two times as strong as those in jarrah and marri. Perhaps one would not expect such a 'careless' water use behaviour in a species that often grows in lower-rainfall regions than jarrah and marri. But this may just be the right strategy for wandoo in its natural habitat. Wandoo usually grows in places where, in summer, most of the stored soil water is held tightly in clays. This water can only be obtained by species that develop and can withstand large 'suctions' such as wandoo. For these trees, this tightly-bound water represents a considerable volume of water that does not require a conservative use—except, perhaps, during long-term droughts when suctions needed to extract this water may become critically strong. Soils have indeed dried out considerably over the past decades, and groundwater level and stream flow have declined in all catchments. There could be a direct link between the low water level of the dams of the Darling Range and the condition of the woodlands in the catchments feeding them.

Above Ryan Hooper from UWA installs insect traps in the canopy of a wandoo tree.
Photo – Heather Monteiro

Top right Scientists use probes to measure the flow of sap in trees.
Photo – Pieter Poot

Right Type 1 borer (larvae) burrowing beneath the branch surface.
Photo – Ryan Hooper

Insects and fungi damage

A research project being conducted by UWA's School of Earth and Geographical Sciences addresses the hypothesis that insects and pathogens have become more prevalent and damaging in recent years, due to changes in climate and subsequent alterations to landscape and site factors. Trees examined by UWA researchers showed that dying branches are invariably associated with damage by wood-boring insects and decay-causing fungi. The borer burrows beneath the branch surface, forming galleries within the branch tissue. It appears that the borers do not themselves cause enough damage to explain branch death, but their tunnelling provides the fungi with access to the wood. The fungi cause decay (lesions) in the branch tissue surrounding the corridor. These lesions resemble a narrow scar meandering down the length of the branch that follows the borer corridors beneath the surface. The fungi decompose the wood to such an extent that it loses its capacity to supply the foliage with water, and leaves dry out and bleach, causing the typical flagging—isolated branches with dead foliage among seemingly healthy foliage. Most of the observed damage to date has been attributed to a specific insect known as 'Type 1 borer', which is thought to be a native jewel beetle.

Although the few years of research have produced some important clues about wandoo crown decline, considerably more work needs to be done before the causes and the solutions to the problem are identified and understood. Research at UWA will increasingly focus on the complex interactions between environmental change and the threats posed by insects and fungi.

Evidence of a changing environment

Understanding the decline of wandoo could be considered a test case of our ability to comprehend the complex impact of environmental changes, and in particular climate change. The south-west of Australia harbours a very important part of the world's species diversity, and climate models predict that this region will be subject to substantial change. This poses some big questions. Will plants and animals just tolerate these changes? Will their health suffer? Will their populations migrate to more favourable places, if there are any? What will happen to important ecological interactions, such as pollination, seed dispersal and pest control when plant and animal communities change? Shifts in species interactions may have consequences that we are not yet able to predict. Conservation biologists in the State are facing this challenge and increasing their research effort to safeguard WA's biodiversity.

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The authors would like to thank Pieter Poot and Peter White for their input into this article.

Volume 22 Number 4 WINTER 2007

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Regulars

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Phone (08) 9334 0481 or (08) 9334 0437.
Prepress and printing Lamb Print, Western Australia.

© ISSN 0815-4465

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Published by the Department of Environment and Conservation, 17 Dick Perry Avenue, Kensington, Western Australia.

Department of Environment and Conservation
Our environment, our future