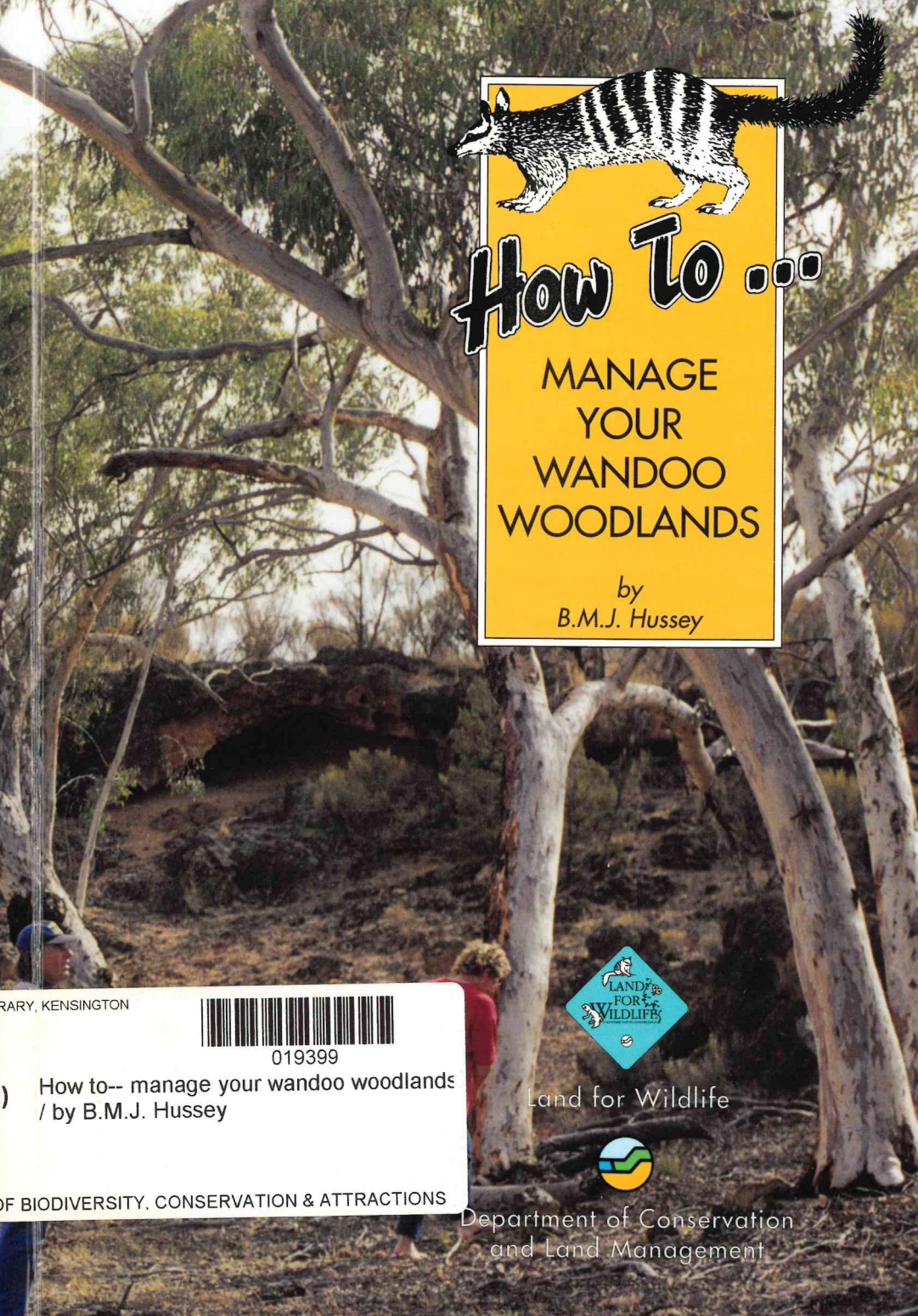

How To...

MANAGE YOUR WANDOO WOODLANDS

by
B.M.J. Hussey

ERRATUM

Page 9. Left axis of graph, diameter should be in mm.

Land for Wildlife

Department of Conservation and Land Management

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Cover pic: On its eastern margins, inland wandoo grows on the clay soil below breakaways. The sparse, mainly annual, understorey is typical of lower rainfall woodlands. "Weira-lea", Campion.

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Wandoo on the Darling Scarp, 2 years after fire, with Acacia pulchella. *Kalamunda.*

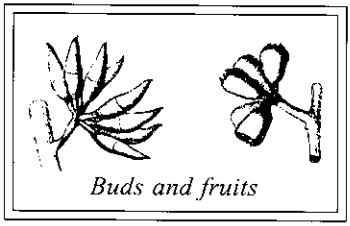
WANDOO WOODLANDS

'White gum' woodlands are a characteristic feature of much of Western Australia's agricultural area. The tall, stately trees whose white or speckled bark seems to change colour with the light, have a strong, individualistic feel about them. These woodlands are visually the essence of Australia.

These trees, which farmers call 'white gums', are actually three species, wandoo, inland wandoo and powderbark wandoo (usually simply called powderbark). 'Wandoo' is the aboriginal name for the tree. This booklet describes the trees and the vegetation communities where they occur, the wandoo woodlands, and suggests how they can be managed.

Wandoo woodland with Acacia urophylla. *Chittering.*

WANDOO, *EUCALYPTUS WANDOO*



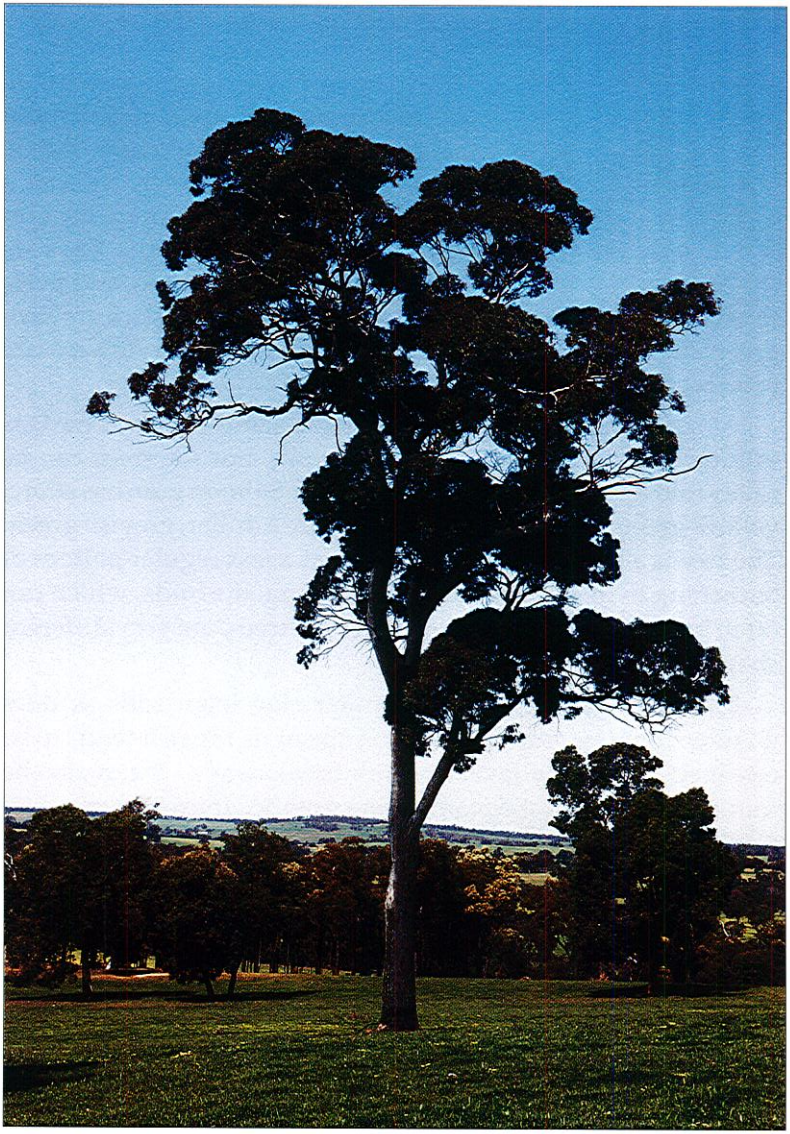
Buds and fruits

Wandoo is a medium to large tree which can grow to 25 m in height, with a trunk diameter of up to 1.4 m and a wide canopy. Young trees can have a rough, grey-brown bark, but as they mature the bark becomes a smooth cream or grey with flaky patches. The leaves are dull, greyish green, the buds horn-shaped and the flowers, which are produced in summer and autumn, are cream.

Wandoo typically grows on dark brown loamy sands or sandy loams. Usually clay occurs at shallow depth, and in valleys the soil may be a clay loam. Drainage may be poor. On the Darling Scarp, wandoo is often associated with dolerite dykes.

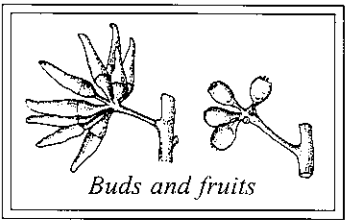
Wandoo grows from Mt Lesueur, near Jurien, southwards along the western margins of the Darling Range almost to Nannup. It reaches its most impressive growth, however, along the eastern side of the Darling Plateau, and extends eastwards to the Stirling Range. There is also an outlier population 50 km east of Narembeen. Along its eastern boundary wandoo is found with inland wandoo. Powderbark is found in the northern and western part of this range, on suitable soil types.

Wandoo may form a pure stand, but often it grows in a mixed woodland with other tree species, or in patches closely associated with the other trees. On the western side of its range it associates with marri (*E. calophylla*), jarrah (*E. marginata*) , Darling Range ghost gum (*E. laeliae*) and rock sheoak (*Allocasuarina huegeliana*), in the centre it associates with York gum (*E. loxophleba*), salmon gum (*E. salmonophloia*) and mallets (*E. astringens, E. gardnerii* and *E. argyphae*), while in the south, yate (*E. cornuta*) and flat-topped yate (*E. occidentalis*) occur with it. Flooded gum (*E. rudis*) is also found with wandoo along many creek systems.



Eucalyptus wandoo, *wandoo. "Glen Craig", Duranillin.*

INLAND WANDOO, *EUCALYPTUS CAPILLOSA*



Buds and fruits

Inland wandoo is a small to medium sized tree, usually not more than 20 m in height and 50 cm in trunk diameter, though a few larger trees (25 m to 1 m diameter) exist. Its bark is smoother than wandoo, and peels to reveal coppery patches. Like wandoo, the leaves are greyish-green, the buds are horn-shaped and the cream flowers are produced in summer and autumn.

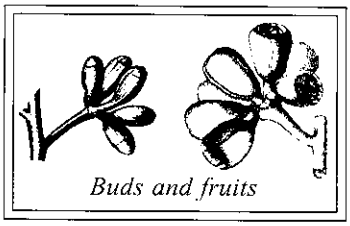
At some times of the year it has the same-coloured bark as salmon gum, with which it often grows, but the trees can be easily told apart by looking at the leaves. Salmon gum has shiny, yellow-green leaves, while wandoo's are a duller, greyish green. The tree is also usually shorter and has a less regular pattern of branching than salmon gum. In addition, the buds, which can often be found on the ground under the trees, are very different shapes.

Inland wandoo grows on similar clay loam soils as does wandoo, but towards the eastern edge of its range it tends to be confined to the clay layer beneath breakaways. It can also be found on low rises of decomposing granite. It usually grows in a mixed woodland with salmon gum, mallets and various mallees.

Inland wandoo grows with wandoo on its western boundary, and extends eastwards to Southern Cross. In the rest of this booklet, the two species will collectively be called 'wandoo'.

Eucalyptus capillosa, *inland wandoo. Quairading.*

POWDERBARK, *EUCALYPTUS ACCEDENS*



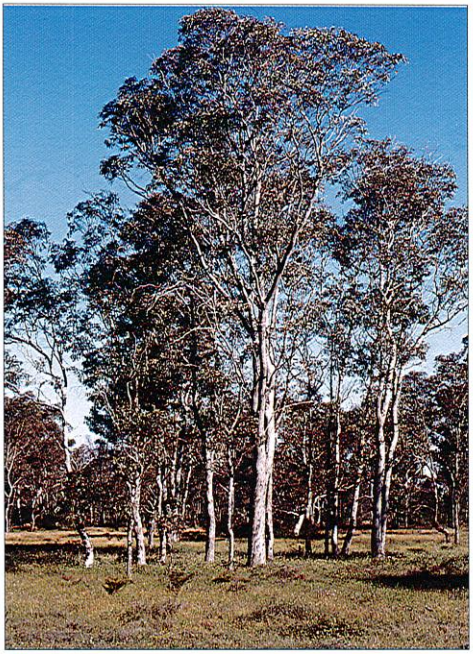
Buds and fruits

Powderbark is a medium to large tree which can reach 25 m in height and 1 m in trunk diameter. It has smooth white bark becoming pink or salmon-pink in summer. The bark has a powdery coating which rubs off like talcum powder on the fingers. The leaves are blue-grey and quite broad. The buds are bluntly rounded and the cream flowers are produced in summer.

Powderbark grows from just south of Geraldton, where it occurs in scattered clumps through the West Midlands heathlands, down the Darling Scarp to Serpentine, and along the eastern edge of the Darling Plateau to near Williams and Dryandra Forest. It grows on gravelly soil, specialising in breakaways and other hard lateritic sites. This is a very harsh environment, and the fact that Powderbark can grow to such a size in it, shows how efficient the tree is at extracting water and nutrients. On the Darling Plateau it often grows with jarrah, while below the breakaway it abuts mallets and wandoo.

Eucalyptus accedens, *powderbark. Chittering.*

HOW THE TREES GROW



A wandoo clump in open woodland over a ground layer of native grass, curly grass, everlastings and orchids. Broomehill.

Like most eucalypts, wandoo takes three years to produce a crop of seed. New leaf growth begins during January and February and new flower buds form in the axils of these leaves, taking a year to fully develop. The next February they will flower, and then take a year for the seed to ripen. The seed is generally shed while the fruit is held in the crown, and fruits of several ages may be held on the tree. After a ground fire (a mild fire that does not scorch the canopy), a heavy fall of seed will result. A crown fire, which burns the canopy, can kill the seed. Seeds can also be released from the capsules if the branch dries out - during severe drought, for example.

If there is an interruption anywhere in the cycle, caused by a drought, insect attack or some other feature, there will not be a good seed set. Generally good seed years occur about once every three years, but even then not all trees in the same woodland will be producing a good crop.

Under natural conditions, wandoo usually only germinates satisfactorily on an ashbed formed when a log or a pile of branches burns out. A whole cluster of seedlings come up and gradually self-thin over time. This is why wandoo woodlands have a 'clumped' appearance.

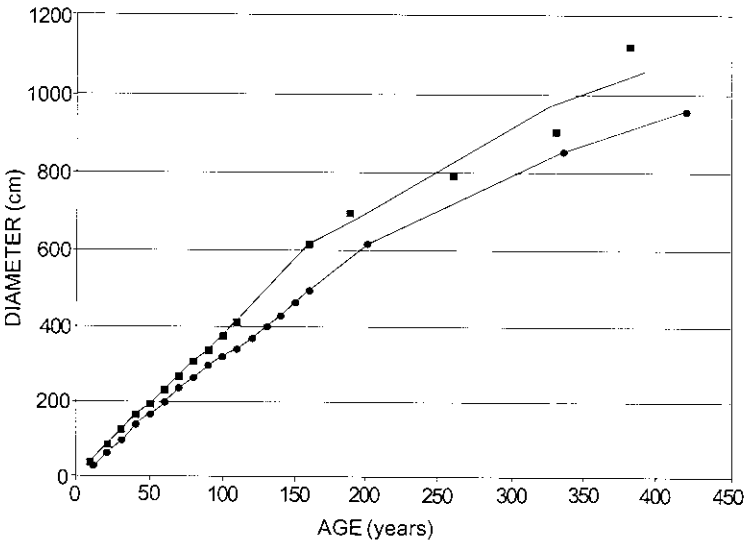
HOW OLD ARE YOUR WANDOOS?

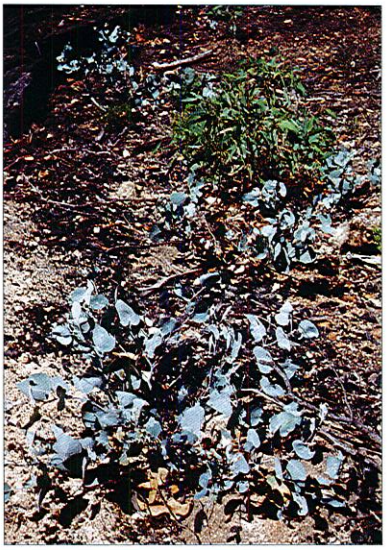
You can get an idea of the age of the trees in your remnant by measuring the diameter at breast height (dbh) of the dominant trees. These will be the mature veterans, or edge trees. (Other, subdominant, trees in the clump will probably be a similar age, but smaller.) Compare it to the graph below.

Note: ■ = trees from higher rainfall, edge of the Darling Plateau

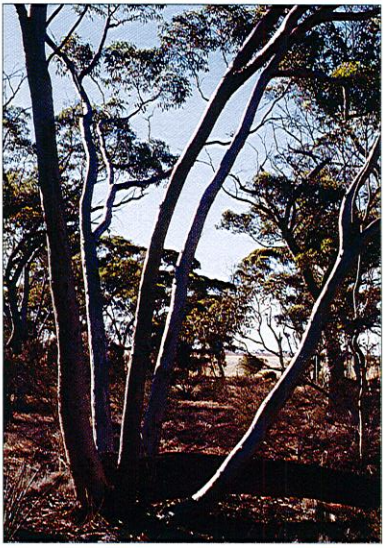
● = trees from the eastern part of the area, includes wandoo and inland wandoo.

Powderbarks are probably similar to ■





Three-year-old seedlings of powderbark (grey) and wandoo (green) growing on an ashbed created by a wildfire. Wooroloo.



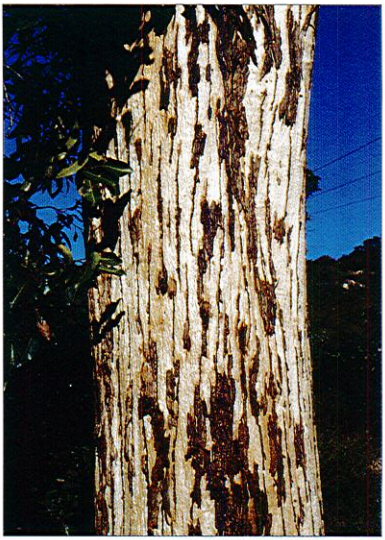
Inland wandoo coppice. Boolanelling.

In its first few years,wandoo does not immediately form one trunk. Instead, it forms a bush, puts down roots and grows a lignotuber. It may take up to ten years before one stem dominates, forming a sapling.

The lignotuber (a woody swelling at the base of the stem) contains reserves which enable the tree to survive stress from drought or wildfire. The main stem may be killed by such events (or removed during logging). Coppice shoots then grow from the lignotuber, eventually growing into big trees. However, these coppice trees are prone to being blown over in strong winds.

Severe drought causes great stress for trees. As water is lost, the bark shrinks more than the wood, opening up longitudinal cracks. The wood itself loses its resilience and whole limbs may fall, especially if there was an original point of weakness, at a fork, for example. Extreme heat and drought leads to the death of trees.

As trees age, a combination of termites, fungi and fire creates hollows, which are extremely important for fauna. It takes a long time for this process to occur. The youngest wandoo that has been noted with a hollow in it was 100 years old, but on average, hollows do not occur until the tree is 150 to 180 years old. Generally hollow size increases with increasing age of trees.



Longitudinal stress cracks in wandoo bark. Helena Valley.

Wandoo does not seem to be affected by the soil-borne fungus *Phytophthora cinnamomi*, whose symptoms are notorious as 'dieback disease' in south-west forests and heaths. However, it is particularly susceptible to the honey fungus, *Armillaria luteobubalina*, which is just as devastating a killer. Honey fungus is often noted in woodland on cut stumps but it soon spreads to living plants. Not much is known about how honey fungus spreads, but spores may be moved around by vehicles. There is no cure.

Wandoos may die back from the crown. This is caused by various aerial canker fungi, which usually enter the tree at the site of mechanical damage or insect attack. The canker kills the living tissue, spreading down the branch and eventually killing the tree. It can be controlled by lopping off infected branches.

THE WOODLAND MOSAIC - INTERACTIONS AND ECOLOGY

For greater detail about the following points, refer to 'Managing Your Bushland'.

THE STRUCTURE OF WOODLANDS - PLANT LAYERS - PATCHINESS

Woodland communities are dominated by trees, singly or in clumps, spread apart so that woodlands always have an open, sunlit appearance. Understorey grows below and between the trees, typically it consists of a shrub layer and a ground layer. The composition and density of the understorey varies, it is thicker and more abundant in higher-rainfall sites, becoming lower and sparser as the rainfall decreases. On the ground at all sites will be a litter of leaves and twigs, as well as larger logs, some hollow. Outcrops of rock may also occur.

Woodlands are not uniform, they contain patches of other vegetation - perhaps a thicket of shrubs on a gravelly ridge, a swamp, or a creekline. This patchiness increases the diversity of habitats within the woodland.

Woodlands in Western Australia seem to be adapted to grow in cycles. Some vegetation is long-lived, and is present during all stages of the cycle, and for several repetitions of it, for example some trees and shrubs with 'mallee roots'. Other vegetation componants are shorter-lived, and appear only during certain phases of the cycle, for example much of the shrub layer and some annuals. These elements remain on site as seeds, even if not visible as growing plants. The 'trigger' which initiates the re-starting of the cycle is usually fire, after which a mass germination often results. Gradually the shorter-lived plants die out and the woodland opens up, until the cycle starts again.

Powderbark woodland – note shrub and ground layer, plus trees of all age classes, from the bushy seedling in the foreground to veteran habitat trees. West Talbot.

Healthy woodland soil with leaf litter, animal faeces, lichens, moss and blue-green bacteria. Yoting.

Plant roots absorb water and mineral nutrients from the soil. In Western Australia the soils are generally low in nutrients, and most of what is available for plant growth comes from the recycling of leaf litter. This is usually done by litter invertebrates and fungi, but in the dryer regions the process is very slow, and termites are the most important agent in decomposition. Fires release mineral nutrients which have been locked up in woody material, and these nutrients in the ash fuel the rapid plant growth seen after a fire. Some nitrogen, however, is lost in the smoke. It is returned to the soil by the nitrogen-fixing wattles, peas and sheoaks which flourish afterwards.

Almost all Western Australian plants have special relationships with fungi; their roots and the fungal threads (called mycorrhizae) are intimately in contact, thus expanding the effective area of the root system. The fungi scavenge nutrients and pass them on to the plant, while the plant returns carbohydrate to the fungus. This mutual relationship is highly beneficial to both partners, and explains why superb woodlands grow here in such poor soil and low rainfall.

Undisturbed woodland soils often have surface crusts of lichens, moss and blue-green bacteria. These crusts are important in preventing soil erosion, and the blue-greens also fix atmospheric nitrogen. They may also be non-wetting, so that rain runs across them to enter the soil around the stem of a shrub or tree. In dryer regions, this water-shedding capacity may be important in providing sufficient water for established plants to survive.

PLANT COMPETITION

Because resources are in such short supply, plants compete strongly between themselves for what is available. In a healthy woodland, new plants will only be able to establish in a gap. Wandoos are especially efficient at 'defending' their space. Their roots have a greater ability to extract soil water than do most other eucalypts and, in addition, the chemicals which drip from their leaves actively discourage the growth of many seedlings.

FIRE

Fire, both naturally-caused and lit by Aboriginal people, has occurred in wandoo woodlands for millennia. It has both beneficial and harmful effects. On the one hand it releases nutrients into the soil, stimulates regeneration and creates hollows in dead wood, but on the other hand it can burn down mature trees and may even drive animals to local extinction.

Fire destroys habitat trees but, if all goes well, regeneration should occur on the ashbed. Inland wandoo, Wyalkatchem.

Now that most bushland remnants are relatively small and isolated, the effect of fires can be even more severe for the local fauna. Even if the animals survive the fire, they could starve to death afterwards. If the bush is isolated, new populations of animals will be unable to reach it to recolonise the regenerating habitat. However, some plants need fire as a trigger to stimulate regeneration - the challenge for a bushland manager is to balance these competing demands.

If the remnant is large enough, or if there are several remnants linked by bush corridors, it may be possible to burn small segments in sequence, to create a mosaic of vegetation at different stages of growth since the last fire. Provided that there is not a major weed seed bank on site to outcompete native seedlings, this should restart the vegetation cycle, and so provide a variety of resources for fauna. It needs to be done very carefully, however, to produce the regeneration effect required.

RESOURCES FOR FAUNA

Animals need food, space and shelter - also a mate - if they are to persist long-term. They compete with one another and are affected by predators and disease, as well as changes to their environment such as fire, drought or increasing salinity. From the land manager's point of view, it is important to provide food and shelter, and to control predators. Effectively, in woodlands, this means ensuring:

- a wide range of tree age classes, including some with hollows, and also dead trees or 'stags'
- a diverse understorey
- hollow logs and other plant debris on the ground
- a soil cover with some crusts and decomposing litter.

THE MISSING PIECES

However pristine a wandoo woodland may look, most have lost a component of their fauna, the medium-sized mammals and the larger, ground-nesting birds. Before foxes became

established, wallabies, bandicoots, potoroos and malleefowl lived throughout the region. They eat tubers, grasses, shrubs, insects and fungi, in the process turning over the soil. Native rodents and possums may also feed in this way.

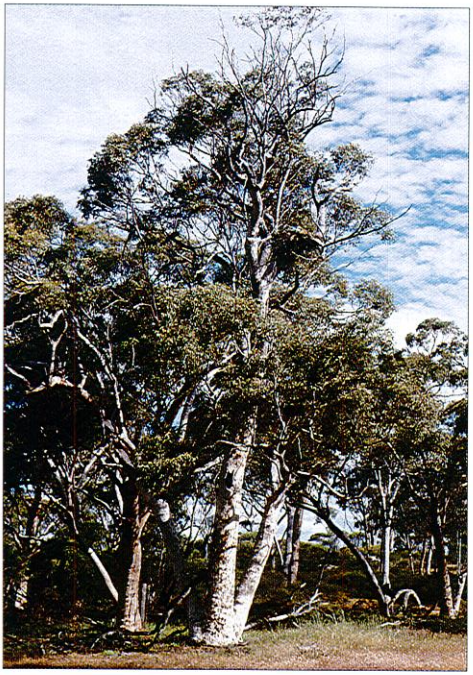
The diggings bury leaf litter, so speeding up decomposition and the return of useable nutrients. The disturbed soil permits much faster infiltration of water. It is also an ideal site for the germination of shrub seedlings, enabling consistent recruitment to the understorey, even in the absence of fire. But it is in the spreading of fungal spores that the animals have perhaps the greatest effect. Without their mycorrhizal partners, many native plants grow poorly or not at all. By eating the fungal fruiting bodies - both toadstools and underground truffles - the animals disperse spores by passing them in their droppings.

Many of the insects eaten by these mammals damage plant roots. Dalgytes (bilbies), for example, may dig quite a distance down to roots to eat the large wood-boring grubs of beetles and ghost moths. These grubs live for many years and may do a lot of damage, thus affecting the plant's viability. Without dalgytes, the grub stage has now lost a major predator - perhaps an increase in these grubs accounts for some of the 'stressed' appearance of some remnant trees?

These fungi have been dug up and partly eaten by a woylie. Dryandra.

THE HABITATS - PLANTS AND ANIMALS

Wandoo woodlands are not uniform, they are a mosaic of different habitats. The mosaics depend on climatic features, soil and position in the landscape as well as fire and disturbance history. The more varied the patch of remnant vegetation, the more diverse habitats it will have and the wider the range of wildlife - both plant and animal - it will be able to support.

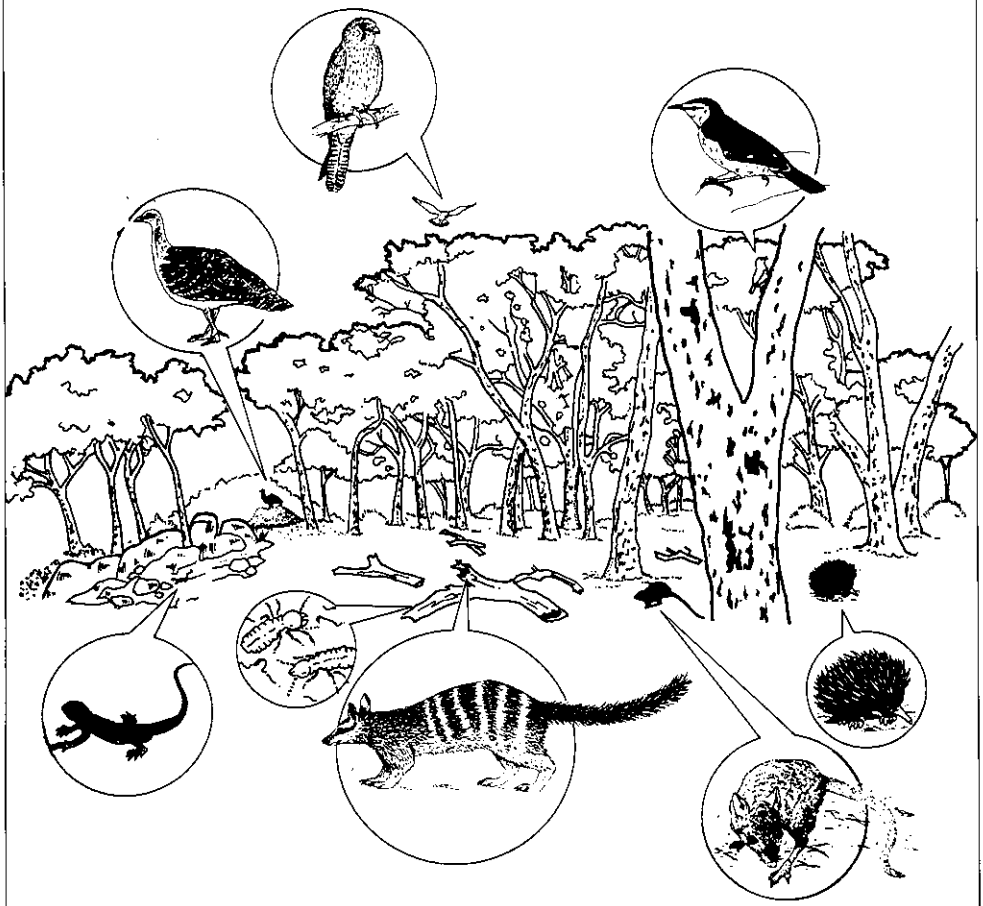


A habitat tree – note the eaglet. At least three of the hollows in this tree were being used for bird nesting. Konnongorring.

Wandoo grows mainly in an undulating landscape of wide valleys and gentle slopes. Where rocky ridges with gravelly soils and breakaways occur, they often support thickets of shrubs. Granite outcrops carry sheoaks. Where drainage is impeded, swamps and wet flats may be found. All these specialised communities form the woodland mosaic, but the following discussion will concentrate on habitat features within the woodland itself.

Note: habitat trees - large, mature (veteran) trees - are vitally important for fauna. They have been called 'nature's boarding house' because of the wide variety of food and shelter they provide to so many species.

THE HABITATS



HOLLOWS

A wide range of birds, reptiles and some mammals (especially bats) depend on tree hollows for nest sites and shelter.

Brushtail possum clawmarks on powderbark. West Dale.

- large hollows are suitable for cockatoos
- mastiff bats and black goannas may use the inside of a hollow trunk. Black goannas regulate their body temperature by moving up or down inside the hollow tree
- medium hollows are used by owls, parrots, mountain ducks and possums
- smaller hollows are used by lorikeets, tree martins and kingfishers as well as phascogales. Striated pardalotes use hollows with an opening no more than 3 cm wide!
- carpenter wasps may carry their paralysed prey to mud nests they construct in hollows
- numbats have been recorded climbing 4 m to a den site in the hollow of a dead tree
- carpet pythons use tree hollows to hibernate in over winter
- large caverns at the base of the tree may be used by echidnas or even kangaroos, while chuditch may use smaller ones.

BARK AND TREE TRUNKS

Wandoo bark cracks and peels away annually and the smooth trunk and flaking patches provide an important habitat for many animals.

- the flakes provide shelter for many invertebrates including spiders
- long-eared bats may shelter beneath large flakes of bark
- skinks and geckos both forage and shelter in these crevices
- black-capped sitellas, rufous treecreepers and yellow-plumed honeyeaters search the trunks for invetebrates to eat
- the borer larvae of insects such as longicorn beetles and ghost moths tunnel into the bark or wood
- Carnaby's cockatoos feed on the borer larvae.

TREE CANOPY

The wide, speading canopy of a tree provides a huge amount of leaves, flowers and fruits that can be utilised by fauna. Recent studies have shown that single trees can support thousands of insects from hundreds of different genera. As they consume the plant material or each other, their droppings fall to the ground where they become an easily-decomposed part of the soil nutrient cycle.

- a bewildering variety of insects feed on the foliage, including aphids, skeletonisers, lerps, leafhoppers, leaf beetles and various caterpillars
- predatory invertebrates like assassin bugs, ladybirds and spiders feed on other invertebrates
- insect-eating birds such weebills, striated pardalotes, western warblers, golden whistlers, brown-headed and black-naped honeyeaters feed in the canopy
- possums feed on foliage, and especially relish mistletoe
- when the trees are in flower, nectar eaters are attracted in large numbers. Wandoo is especially important in that it flowers in late summer, when little else is available. Native bees, hover flies, butterflies and moths use either the nectar or the pollen
- birds such as New Holland and brown honeyeaters consume the insects

- many birds build nests among the branches. They may be small and inconspicuous, like a thornbill's silken sock, or large, like the magpie's untidy construction
- the height, strength and isolation of a large tree is important for the nest of big birds such as the wedge-tailed eagle and other raptors
- many birds, such as swallows and swifts, catch midges and other insects flying just above the canopy
- night flying insects are taken by bats.

SHADE

Within the woodland, the tree canopies cast shade and ameliorate the local climate. Woodlands are never as hot, nor as cold, as adjacent open areas. Frost is far less severe. There is shelter from wind and the dehydrating effect of wind and direct sunlight. This all leads to a milder climate within the woodland, which has strong implications for the survival of woodland plants and animals, and also leads to difficulties when trying to re-establish a woodland ecosystem.

SHRUB LAYER

The shrub layer produces nectar and seeds, as well as foliage and other edible bits. Many animals move through the woodland to wherever the resources are available. The more varied the shrub layer, the more resources for fauna will be present at all times of the year. Shrubs may also provide nesting habitat.

- nectar brings in birds like the New Holland and white-cheeked honeyeater and the western spinebill, also honey possums and butterflies, native bees and other insects
- the many insects that live in and around the shrub layer attract birds such as willie wagtails, robins, thornbills, silvereyes and fairy-wrens, as well as skinks, geckos and frogs

Spring colour in the low understorey under wandoo, including dampiera, leschenaultia, white myrtle, flame pea, featherflowers and everlastings. Culbin.

- many ants specialise in collecting the seeds of shrubs such as woollybushes, hibbertias, wattles and peas, and carrying them off to their nests, where they either eat the seed or the fatty structures around it. Some seeds survive to form part of the soil seed bank
- seed of poison bushes is an important food of the common bronzewing
- dense shrubbery is the nesting site for birds such as wrens, honeyeaters and robins.

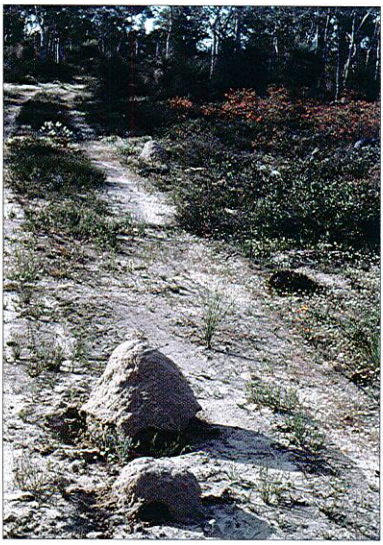
GROUND LAYER

The ground layer has many plants, both annual (such as everlastings) and perennial (such as orchids) which are characteristic of wandoo woodlands. There is also a litter of decomposing plant material and animal faeces, and areas where soil crusts develop.

- many ground-layer plants produce nectar or seeds eaten by fauna. For example, honeypot dryandras provide nectar for honey possums, while blue squill seeds are important for red-tailed black cockatoos
- fungi are an important source of food for mammals such as woylies and bandicoots
- litter and debris provides food for numerous animals such as ants, termites, cockroaches and millipedes, while carnivorous creatures such as wolf spiders, scorpions, centipedes, thorny devils and skinks eat them
- echidnas and numbats eat termites
- birds such as robins and fairy wrens forage for their insect prey on the ground or fallen logs, or in plants close to the ground
- the leaf litter is ideal for malleefowl to construct their gigantic nest mounds
- various animals, including numerous insects, construct nesting burrows in the soil
- trapdoor spiders construct camouflaged burrows, often with trip-threads attached to warn the inmate of the approach of suitable prey
- sheltered sites beneath logs or fallen trees may be used for burrows by goannas or numbats
- rainbow bee-eaters construct nesting burrows in relatively open ground.

HOLLOW LOGS

- hollow logs provide den sites for numbats, echidnas and carpet pythons
- smaller hollows provide dens for dunnarts and shelter for skinks and geckos.



Echidnas need to eat about 10 000 termites a day. The way they dig is unmistakable. Bolgart.

Fat-tailed dunnart. Photo: Bert Wells.

Malleefowl on mound. Dryandra.

WET AREAS

Drainage in wandoo areas is often poor, and the valleys may not contain defined creeklines. Instead, the whole valley floor may become wet in winter, and these open flats have a characteristic vegetation. Shrub cover is sparse, though balgas and variable-leaved hakea can cope with these conditions. The ground layer is, however, very diverse. It includes many perennials such as curly grass and other 'reedy things'; geophytes (plants which die down to an underground storage organ over summer) such as sundews, orchids and chocolate lily, as well as a wide range of colourful annuals like triggerplants and daisies. It is well worth looking at these areas in detail - one 'half-tennis-court-sized' patch in Dryanda Forest, for example, had 16 different species of orchid.

At some sites swamps, which usually only hold water during the winter and spring, may occur. They are usually completely covered with specialised shrubs, such as robin red-breast bush, with a reedy understorey. Water plants such as violet bladderwort, aquatic pennywort and villarsia give way as the swamp dries, to carpets of annuals, including minute triggerplants such as hundreds and thousands. These swamps are vital for aquatic animals such as frogs, gilgies and dragonflies. Herons and snakes may hunt them.

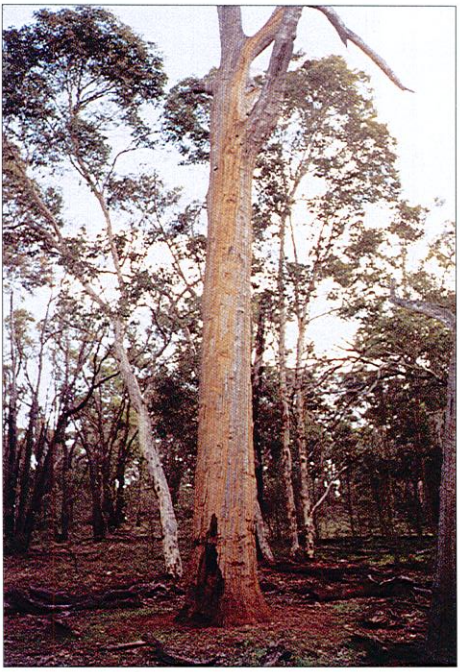
Once clearing of adjacent areas has taken place, these wet flats soon become waterlogged and go saline. The understorey is replaced by salt-tolerant species and eventually even the wandoos die. It is impossible to return them to their original state.

Pincushions, sundews and curly grass carpet this wet flat, with wattle and teatree thickets behind. Mount Kokeby.

Rainbow bee-eaters often construct nesting tunnels in the sandy banks at the edge of wet flats. Photo: Bert Wells.

WANDOO WOODLANDS AND ABORIGINAL PEOPLE

As they did throughout the whole landscape, Aboriginal people would have utilised the resources of the wandoo woodlands when they came into season. Campsites would most likely have been located close to water holes although hunting and gathering would have taken place throughout the woodland. There are likely to be little signs left of these activities. Occasionally, however, very old wandoo trees can be seen with hand and toeholds cut into them, which would have enabled a person to climb to a hollow limb and so take birds' eggs, nestlings or possums.



Possum tree – note the scars which were toeholds for climbing to reach the hollows. Capercup.
Photo: Avril Baxter.

The open nature of woodlands would make them a suitable place to practice the 'hunting with fire' technique as described by early settlers. This involved a group of people lighting a fire to drive game towards the hunters, while the firelighters rushed around the edges putting out the blaze. Its effect would have been to create a mosaic of smallish burnt patches within the woodland.

WANDOO WOODLANDS AND EUROPEAN SETTLEMENT - ECONOMICS

WILDLIFE HABITAT

It is only recently that the wildlife value of a healthy woodland has been appreciated as the need to maintain biodiversity has reached the general consciousness. Conservation of flora and fauna can be integrated with management for other aims, to the benefit of all.

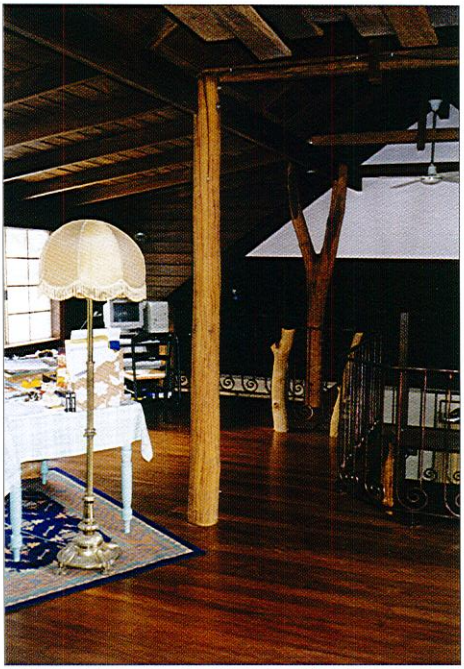
TIMBER AND WOOD PRODUCTS

Wandoo timber was used from the earliest days of settlement for purposes where strength and durability were important - as structural timber in buildings, bridges and wharves, and for heavy-duty flooring, eg in shearing sheds. Wheelwrights used it for all portions of wooden wheel construction. Tool handles were made from it. But it was as a termite-resistant fence post and railway sleeper that wandoo was most prized. Both were cut throughout the woodland, often using spot mills.

Wandoo is very durable, and is given the highest rating for its resistance to attack by both fungi and termites. This rating is based on the outer heartwood being able to last more than 25 years when used in the ground. Many existing wandoo strainer posts attest to a useful life of double, if not even quadruple, that. It makes sense for all landholders in the wandoo belt to be growing their own supplies of posts.

Wandoo timber is yellow to light brown in colour, and the sapwood band is very narrow. The timber is difficult to work because of its high density, but it machines to a smooth surface. The grain is interlocked or wavy and careful drying is required to avoid cracks and end splits. Strength properties are very good and the hardness is excellent, with great resistance to indentation, which is a major advantage for use in flooring. Wandoo timber burns well, but it is extremely hard to cut and split.

The bark and wood of wandoo and powder-bark contain quantities of tannins, which can be extracted by boiling up the chips in vats and evaporating the liquors. This was once a medium-sized industry which cut over much of the wandoo woodland between Toodyay, Northam and Narrogin. Wandoo was also used to produce charcoal for use in the blast furnaces at Wundowie.



Wandoo in use – floorboards, roof timbers and support poles. The floorboards are recycled, the rest was cut from the property. "Northumbria", Boyup Brook. Photo, Julian Sumner.

Within the wandoo belt, other trees were also used. Jam (*Acacia acuminata*), which often grows with wandoo, was cut as a fence post, though sizeable stems produce an attractive timber - see the glorious handrail on the stairs at Buckland House, Northam, for example. Tannin from mallet bark supported a small industry and in several places - Dryandra, for example - plantations of mallet were established on land which formerly supported wandoo. Mallets make good poles and firewood, and excellent tool handles.

Wandoo is thus one of the heaviest of eucalypt timbers and one of the most durable, and the timber is now in relatively short supply.

LANDCARE - WATER USE, SHELTER, EROSION CONTROL

Woodland performs an essential role in landcare. Its perennial vegetation uses water where it falls and so reduces both runoff and recharge, decreasing the problem of erosion, rising water tables and salinity. A healthy understorey is very important here, since it may use up to 40% of the water which falls on the site. The woodland will also help to combat wind erosion and provide shelter, both from heat and cold. These effects are hard to quantify, but in the long-term will add up to substantial amounts.

As Mr S.L. Kessell, Conservator of Forests, wrote in 1929 in the Centenary publication 'A Story of a Hundred Years': "... it is for citizens of the State to realise the direct and indirect value of trees and wood-lots in regions outside the main timber country. Shade for man and beast in summer, and shelter from cold winds in winter, are often lacking in our more progressive country districts, where the axe and fire stick have done their work too thoroughly. In a hundred years we have sacrificed forests which Nature has built up through the centuries, and one of the lessons waiting to be learned from older civilisations of Europe and Asia is the wisdom of maintaining crops of trees side by side with fields of wheat."

NATURE-BASED TOURISM AND RECREATION

The demand for nature-based tourism is increasing throughout the world. In Western Australia, many properties are opting for a 'farmstay' operation to diversify their income. Most of the visitors are looking for gentle recreation in a peaceful, attractive, natural setting. Woodlands where they can walk, cycle or horse-ride appeal strongly to such visitors, especially those from Europe. Being able to promise a variety of wildflowers and native fauna is a positive attraction. However, the open vistas and ever-changing colour of the trees' bark, mean that a woodland does not rely entirely upon a season of 'wildflower colour' for its appeal, thus extending the period in which it can be enjoyed.

Some activities, however, are not compatible with woodland conservation. Fast or noisy motorised recreation is highly disturbing to fauna, as well as eroding tracks and causing clouds of dust which coats vegetation. Horse-riding can also cause erosion, and has the potential to spread weeds, but if managed carefully and undertaken by responsible riders, it can be fitted into the woodland along existing or specially designed tracks. Official Pony Club treks, for example, carry sacks and a 'pooper-scooper' for the removal of droppings.

HONEY, CUT FLOWERS, FOLIAGE AND SEED

Wandoo flowers produce an excellent light honey.

A healthy understorey may produce saleable products. For example, in the northern jarrah forest area, many-headed dryandra is highly valued as a cut flower and some 40-50,000 stems are exported annually. On gravelly soil under powderbark, establishment of this plant would be a good commercial option. Collection and sale of native plant seed may also yield some commercial return, especially if they are more unusual species with horticultural potential. Seed collection for revegetation projects on farmland is also increasing in demand.

Many-headed dryandra under wandoo and marri. New Norcia.

Native grasses and saltbushes are a natural feature of the understorey in some wheatbelt woodlands and so, if no poison bushes were present, many wandoo woodland remnants have been grazed for years. This has changed the vegetation community, often to one dominated by weed grasses.

However, if native forage plants remain, careful stock management can permit grazing as well as maintenance of the remnant for conservation, landcare and timber. Set-stocking is never compatible with long-term management of remnant woodland, but stock access for limited periods of time may be.

EFFECT OF GRAZING

Prolonged grazing by stock or rabbits has four main effects on the plant communities that occur in wandoo woodlands:

- reduction of understorey
- inhibition of regeneration
- introduction of weeds
- increase in stress and disease.

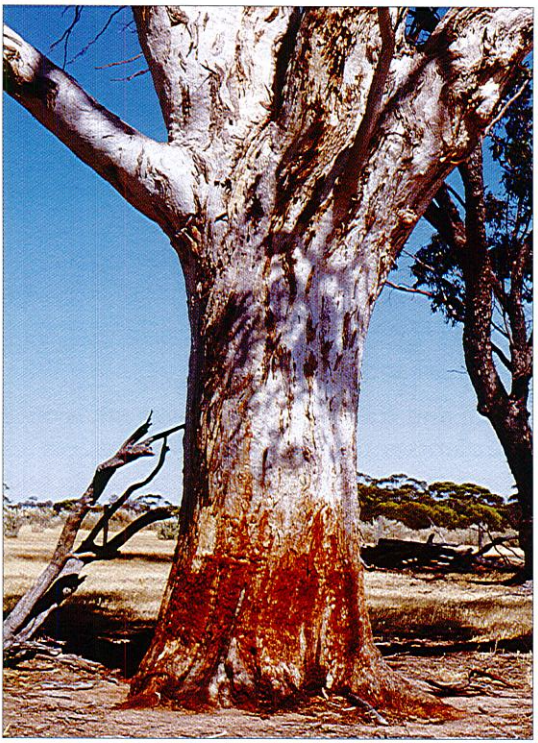
Stock grazing and trampling by hooves takes out firstly the most palatable plants and the most easily damaged, until shrubs show a clear browse line and ground layer plants seldom reach maturity. The soil seed bank begins to decline. When seedlings do germinate, they are very vulnerable to grazing and trampling, so natural regeneration is severely inhibited. Plants resistant to grazing increase in numbers. These might be prickly native shrubs, such as standback and needlebush, but they are often introduced weeds such as Cape tulip and wild oats. Competition from these weeds decreases the survival of most native species.

Stock follow regular trails and soil erosion starts to occur along them. As the ground layer becomes bare and trampled, the surface roots of plants may be damaged. Leaf litter no longer accumulates to the same extent. Thus recycling of nutrients

slows, inhibiting plant growth. The stock may contribute an excess of nutients to some sites, encouraging weed growth.

As the resources of the grazed woodland decrease, it can no longer support many bird and mammal species, so they are lost from the foraging pattern. However, the insects on which they used to feed will still be there, and so, with less predation, the insects may reach plague proportions. In the wandoo belt, flooded gums show this very clearly, as each year they are partially defoliated by a leafminer. The wandoos themselves show increasing rates of attack by borers and fungal canker.

In all, the 'biological productivity' of the woodland decreases.



Stock (especially rams) will rub against and eventually ringbark paddock trees like this massive wandoo that has been alive for longer than sheep have been in Australia. An easy management action is to pile dead branches around the trunk so that stock cannot reach it. York.

MANAGEMENT

Before deciding how to manage your wandoo woodlands, first decide the values and uses you intend for the area. These become your management objectives.

Some examples might be:

- to protect and conserve the existing native plants and animals and regenerate degraded areas
- to contribute to the management of rising water tables and salinity by maximising the water use by the remnant vegetation
- to preserve an attractive picnic area
- to provide a supply of poles, posts, sawn timber and native plant flowers/seed
- to provide some grazing and shelter for stock.

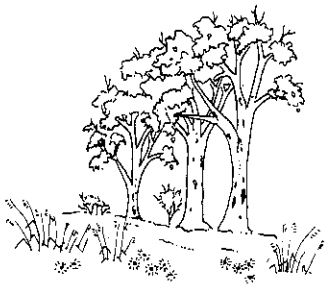
(Note, the first three are compatible. Timber production can also be, if done correctly, but stock grazing needs very careful management if it is to be included in multiple-use without severe degradation of other factors.)

Next, assess the quality of the remnant vegetation, since the better quality it is, the less management you will have to do. (We assume here that good quality plants will provide good quality animal habitat.) For your site, consider whether the various habitat features (as listed on pp 20-26) are present, and whether they show signs of disturbance or stress, and then assign it to category 1 to 4.

When deciding upon management actions, aim to go up one step in quality at a time.

EXCELLENT
trees
shrubs
understorey
few weeds

GOOD
grazing damage
some weeds
little regeneration



MODERATE
trees may be stag-headed
few shrubs
many weeds
no regeneration

FAIR
trees stressed
soil erosion or salinity evident
weeds mainly

1 EXCELLENT QUALITY SITE - NEARLY UNDISTURBED REMNANT

This would be an area that has received minimal impact, perhaps a reserve for water or nature conservation, or a private remnant that has long been securely fenced. (It is a good idea to look at such a place to see what a local wandoo woodland should look like.)

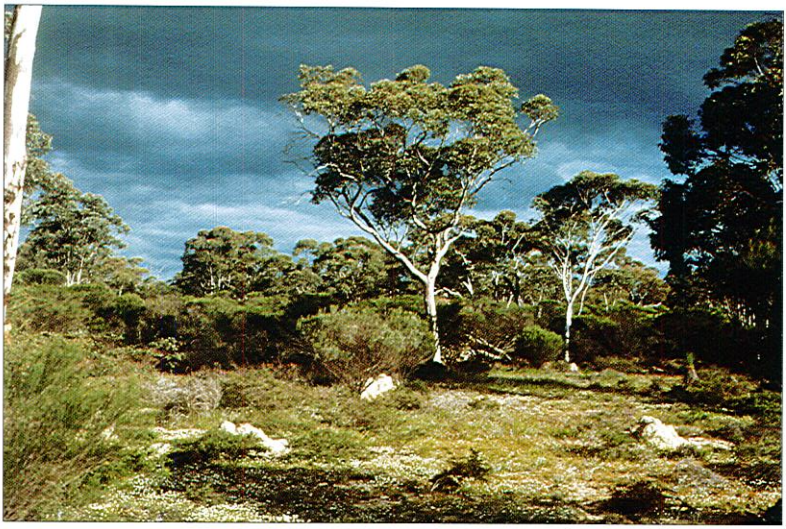
Basically, this sort of site will look after itself, you merely need to minimise outside degrading influences.

CHARACTERISTICS

- intact site, all expected plant communities - trees of all ages, shrubs, ground layer, leaf litter - present and healthy
- native plant seedlings in appropriate sites show regeneration is occurring
- logged trees show coppice regeneration, or replacement saplings are present
- little or no history of stock grazing
- little or no disturbance, or disturbance confined to a small area of the whole
- few weeds, or along edges only

MANAGEMENT NEEDED

- minimise disturbance, or, confine it to already-disturbed areas
- maintain fence to exclude stock
- monitor and control exotic animal occurrences
- monitor and control problem weed outbreaks
- ensure that external factors do not contribute to degradation



Excellent quality wandoo woodland – note health of trees and diverse understory with profuse annuals and no weeds. "Jonlorrie", York.

Good quality wandoo woodland - note reduction in number of shrubs, no native plant regeneration and annual weeds dominating the ground layer downslope of the stock trail which is starting to erode. West Dale.

2 GOOD QUALITY SITE - SOME DISTURBANCE

This might be an area that has received only occasional low intensity grazing by stock, or unmanaged timber removal. With a small management effort, it can be returned to excellent quality.

CHARACTERISTICS

- all expected plant layers present, but sparse and may show signs of stress
- few signs of natural regeneration
- signs of grazing damage to shrubs and ground layer
- soil erosion starting on sloping areas
- change in soil structure evident, but not widespread
- weeds noticeable, may be up to 50% of ground layer

MANAGEMENT NEEDED

- fence to exclude stock
- control exotic animals
- control major degrading weeds
- encourage natural regeneration, including using ashbeds
- ensure that external factors do not contribute to further degradation

3 MODERATE QUALITY SITE - CONSIDERABLE DISTURBANCE

These sites will have had a long history of grazing, too frequent fires or severe overcutting. They may also be affected by rising water tables. By working outwards from the least affected areas, the quality can be raised to good.

CHARACTERISTICS

- plant community simplified, often with shrub and native ground layer sparse or absent
- some trees show stress - even young trees are stagheaded, or with thin crowns
- no signs of natural regeneration
- any remaining palatable shrubs show heavy grazing damage
- logs and leaf litter absent or much reduced
- change in soil structure evident - loss of soil crusts
- clear signs of soil erosion and wash
- weeds dominate ground layer

MANAGEMENT NEEDED

- fence to exclude stock
- control feral animals
- control major degrading weeds
- encourage natural regeneration, including using ashbeds
- replace key elements of the tree, shrub and ground layer by a combination of planting and direct seeding
- consider action within the catchment to mitigate stress-causing factors, eg. planting buffers

Moderate quality inland wandoo woodland – note heavy grazing of the few remaining shrubs and ground layer becoming dominated by weed grasses. Bruce Rock.

Moderate quality powderbark woodland – note browse line on remaining tall shrubs, total removal of low shrubs and ground layer and considerable soil erosion. Toodyay.

4 FAIR QUALITY SITE - DEGRADED REMNANT

These sites will have had a long history of uncontrolled stock access. They may also be affected by rising water tables and salinity caused by clearing on a landscape scale. A major revegetation effort will be required.

CHARACTERISTICS

- plant community severely altered, the few remaining original species may show severe stress, may be dying or dead
- plant community dominated by weeds, crop or pasture species, often annuals rather than perennials
- plant community dominated by salt-tolerant plants such as samphires
- apart from samphires and other salt-tolerant plants, no native plant regeneration
- ponding of water and/or saline soil crust developing

MANAGEMENT NEEDED

If degradation is not due to rising water tables:

- fence to exclude stock
- control feral animals
- control major degrading weeds
- encourage natural regeneration, including using ashbeds
- revegetate with species appropriate to the present nature of the site and aims for its use

If degradation is due to rising water tables:

- plant to increase water use elsewhere in the catchment
- then take the above actions
- consider - carefully! - drainage

Fair quality wandoo woodland – note healthy trees over introduced grasses and clovers. This site demonstrates extreme reduction in biodiversity, since only one of the woodland's original 200 or so plant species still remains. Popanyinning.

Fair quality wandoo woodland on wet flat going saline – note salt scald, samphires and stressed appearance of trees. This site will inevitably decline unless the factors which are causing the rising saline watertable are controlled. York.

MANAGEMENT ACTIONS

1 Fence
2 Control exotic grazers
3 Control introduced predators
4 Control weeds
5 Encourage natural regeneration
6 Use fire for regeneration
7 Replant seedlings of key species
8 Use direct seeding
9 Prune stressed tress
10 Install specific fauna habitat features
11 Install buffers
12 Manage or create bush corridors
13 Silviculture
14 Recreation sites

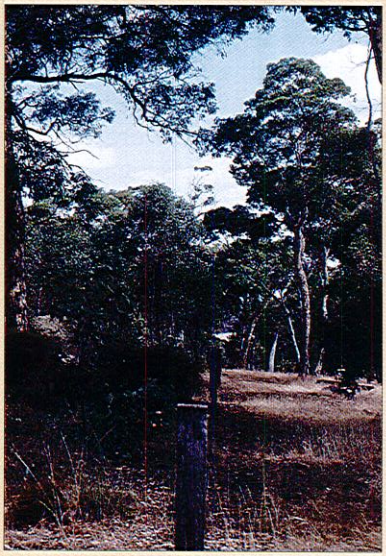
1 FENCE

The first action often made to protect remnant vegetation is to fence it to exclude stock. Whether regeneration of native plants then occurs depends upon several things:

- what seed is present on site - produced by living plants or stored in the soil
- how strong the weed competition is
- whether a 'disturbance event' occurs which triggers germination
- whether grazing pressure from other herbivores (rabbits, kangaroos) removes seedlings.

Seed on site could come from existing plants, or be carried in from outside, or be held in the soil as part of the 'soil seed bank'. Some plants, such as WA Christmas trees and many eucalypts, have seeds which lose viability quickly, and thus need to come from living plants, but others may be very long-lived. Wattles and peas are of this kind, for example, jam may appear up to 60 years after it was last known from a site, once an event occurs (such as seed scarification during the creation of a contour bank) to stimulate germination. However, as a general rule, the longer the seed remains in the soil the less likely it is to remain viable. In addition, on sloping sites, soil erosion may have removed the soil-stored seed. Soil salinity inhibits germination, and changes of soil acidity may also affect it. Predation by insects, especially ants, may also be a factor to be considered. Thus the extent of the soil seed bank will depend on the length of time since the various plants produced the seed, whether there have been changes in soil condition, including erosion, and whether local populations of seed-eating ants have increased.

If seed remains on site, then all that may be needed for adequate regeneration is time. For example, this remnant had healthy trees but an understorey dominated by paddock grasses (as on the right side of the fence). Now, some 20 years after stock exclusion, it has moderately dense native shrub understorey and no weed grasses (left side of fence). The diversity of the understorey species is, however, lower than in a nearby never-grazed reserve. "Daneholme", Boyup Brook.



2 CONTROL EXOTIC GRAZERS

Rabbits graze the vegetation, especially regenerating seedlings, and in drought will also ringbark shrubs and burrow to eat roots. In addition, their dung piles provide ideal sites for weed establishment.

Feral pigs are a major problem in higher rainfall areas, especially along watercourses adjacent to large areas of forest. Not only do they graze vegetation, pollute water sources and rootle around disturbing the soil and spreading *Phytophthora* dieback, but they also actively hunt and kill other animals. In addition, they carry disease that can be transmitted to humans and domestic livestock.

Rabbits and feral pigs should be eliminated wherever possible. Consult Agriculture Western Australia (AgWA) for methods of control.

3 CONTROL INTRODUCED PREDATORS

When agricultural settlement began in the wandoo woodlands, medium-sized mammals and large, ground-nesting birds were quite common. Bustards and malleefowl were widespread, while the haunting call of the bush stone-curlew was often heard at night. Woylies, tammars and boodies dug up vegie gardens and were themselves often eaten by early settlers. Chuditch and phascogales caused havoc in the hen runs. Then, in the 1930s, they disappeared quite quickly. Partly this was because of loss of habitat as more and more land was cleared for farming, but the main cause was predation by foxes.

Control of foxes in wandoo woodlands such as Dryandra, Perup and Tutanning has led to such an increase in medium-sized mammals that some have now been translocated to areas of suitable habitat (well fox-baited) where they had previously become extinct. Even some animals that only survived on off-shore islands, such as the boodie and the western barred bandicoot, are being brought back on to the mainland.

Numbers of foxes and feral cats should be kept as low as possible. Contact AgWA, CALM or *LFW* for details of control methods.

brush-tailed possum

tammar

woylie

boodie

Fox control has enabled populations of these animals to increase in numbers and expand naturally into appropriate areas. Translocation programmes are also bringing some back onto the mainland.

If you have suitable habitat in good to excellent condition, 100 ha or more in size, and you can establish or maintain an efficient predator control programme, you might like to register with *Land for Wildlife* as a possible translocation site.

4 CONTROL WEEDS

If the woodland is an island in the middle of paddocks, the seeds most likely to enter from outside will be crop or paddock weeds. Seed of silver grass, wild oats, capeweed, lupins or radish may be blown in, while subclover germinates from sheep droppings - and these also increase the soil nutrient level, making it easier for weeds to survive. Birds eat fleshy fruits, such as those of bridal creeper and African boxthorn, and may carry the seeds a considerable distance before excreting them in their droppings.

When a dense cover of weeds has become established, it not only perpetuates itself, it also makes it difficult for other plants to establish. Grass weeds form a dense thatch over the ground, preventing native seeds from reaching the soil. Weeds also outcompete native plant seedlings, so that only large-seeded plants, such as the big wattles, are able to cope.

On the Darling Scarp, as elsewhere, invasive weeds can dominate an area unless controlled when they first appear and are few in number. Here, watsonia has almost totally outcompeted the original shrub and ground layer under the wandoos. Greenmount.

Another problem that weeds - especially grasses - create, is that they alter the fuel characteristics of the vegetation. They provide an annual load of very flammable fuel, with a continuous fuel-bed, which ignites easily and burns very hot at ground level. Burning of this fuel - either accidentally or to reduce the wildfire threat - usually kills the native plants and stimulates increased weed growth in the following year. To reduce the possibility of fire entering the remnant from outside, a firebreak should be maintained around the edge.

The best defence against weeds is to prevent establishment. Do not permit rubbish dumping in the bushland. If wind blows soil and seed in from a paddock, plant a buffer of dense native vegetation between the source of the weed seeds and the remnant. This buffer could contain fodder shrubs such as wattles and palatable native grasses such as weeping grass and wallaby grass. The native grasses have an advantage in that they will establish even under the crowns of mature wandoo.

If there are few weeds, it is worth considering eradication. Work from the least weedy areas outwards. If total eradication is not feasible, remove weeds from the most important areas first. If a new weed is noticed as it first becomes established, remove it when it is few in numbers. Tackle the most invasive and degrading weeds first, eg bridal creeper or watsonia, and attempt complete eradication. If large areas are involved, remember to have native seed ready to fill the space left by the weed.

References for weed management can be found at the rear of this booklet.

5 ENCOURAGE NATURAL REGENERATION

Many native plants require a 'trigger' to initiate germination - but the problem is that we often don't know what that trigger - or combination of triggers - might be! Mechanical cracking of the seed coat, by a grader, for example, can stimulate wattles and peas into growth. Heavy summer rains, held in temporary ponds, may be the key for some species, while others may respond to fire. Bushfires bare the ground, release easily-available nutrients and their heat opens woody fruits such as banksias and hakeas. Even more importantly, the chemicals released in the smoke, falling on the soil and then leaching down into it, stimulate the seed bank into growth.

Even assuming that the plants on site are producing viable seed - this may not always be so, for example the appropriate pollinator might not be present - the seed falling to the ground needs to find a niche to germinate in. A thatch of weeds will prevent it reaching the ground at all. If the soil is hard-packed, it is less likely to be able to survive, so cultivation might be useful. Where there is dense weed infestation, e.g. of Cape tulip, scalping the topsoil away could be tried, but appropriate seed should be collected first, ready to spread onto the bare soil areas created. (Do not try these techniques under the crown of a living wandoo, it is too efficient a competitor.)

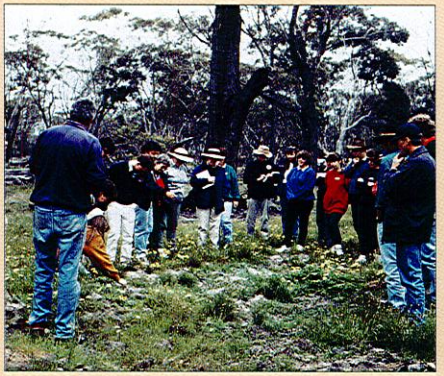
The best encouragement for natural regeneration is to control weeds and then wait for nature to take its course. This may be many years ....

6 USE FIRE FOR REGENERATION

The type of fire, mainly the season of burning and length of time between successive fires, has a considerable effect upon the regeneration that occurs afterwards.

A 'cool' (low intensity) fire, running underneath the wandoo, can remove the weed thatch left after herbicides have been used to control weeds during the previous growing season, ready for

ASSISTED REGENERATION WORKS, BUT TAKES TIME ...



Oct. 93

Apr. 99 (photo: Jack Mercer)

Stock were removed from this Wandoo and Flat-topped Yate remnant in the North Stirlings, but there was no tree regeneration. An 'ashbed trial' was initiated in May 1993. Participants at the LCDC Field Day in Oct. 93 look a bit sceptical! But the seedlings are there, as the pics of May 99 show.

Note that all these seedlings are doing what nature designed them to do, building up a lignotuber and putting down roots, before they send up a trunk – only if this happens can they be sure of surviving a drought. Planted seedlings may be quicker to grow tall, but they may be quicker to succumb to stress, too.

View across woodland, showing a number of 'assisted regeneration' sites. "Low Chaparral" North Stirlings (photo: Jack Mercer)

cultivation and direct seeding. The best time to do this is after the first rains have damped everything down, making an easily controllable fire with lots of smoke which will stimulate seedfall from the wandoos. Note that such a 'cool' fire does not stimulate growth of the soil-stored seed bank. This needs a 'hot' fire.

'Hot' (moderate - high intensity) fires severely damage existing trees and can exterminate fauna. In relatively small remnant woodlands they are neither practical nor desirable. However, the effect can be created in a manageable way by creating 'heaps'. These are piles of logs and debris which burn out to create an ashbed. It is ideal for wandoo establishment, and also stimulates wattles and peas around its edge. Place the heap away from existing good vegetation, and outside the crowns of trees. If you are not sure whether there will be good seed rain from existing trees, collect seed-bearing branches and lay them on top of the ashbed, three or four days after the fire. This technique is called 'brushing' - and its good insurance to do it anyway!

Pat Dare remembers her father having a large clearing fire on this site in 1953 or 54. This clump is thus about 45 years old. "The Mallets", Wagin.

Sometimes remnant woodlands are burnt as part of a bushfire hazard reduction programme. As a general rule, if you consider that fire is necessary, only burn small areas in any one year - no more than one-fifth of an individual remnant, for example.

Refer to 'Managing Your Bushland' for greater detail about fires, fire effects and techniques.

The presence of grazing animals can make a huge difference to the vegetation which develops after a fire. Palatable seedlings will be grazed out. Sheoaks, being nitrogen-fixing, are very high in protein and often preferentially grazed. In Tutanning Nature Reserve, tammar wallabies were still present when a big fire burnt the reserve in the 1960s. They preferentially grazed tamma seedlings, leaving white myrtle to dominate the regenerating heathy understorey. Many years later, after foxes had caused the tammars to go locally extinct, another fire burnt the area. This resulted in a shrub layer dominated by tamma, although there were roughly equal numbers of tamma/white myrtle seedlings at the start. Perhaps the dominance of tamma thickets in the wheatbelt now, is related to the lack of tammar wallabies to eat the seedlings?

7 REPLANT SEEDLINGS OF KEY SPECIES

If a particular key element of the vegetation is missing from the site - perhaps it no longer carries nitrogen-producing wattles or peas - appropriate seedlings could be replanted. It might also be a suitable technique for adding specific beautiful or bird-attracting plants whose seed is difficult to obtain, so unlikely to be used for direct seeding, for example golden dryandra. Remember that seedlings will not flourish if they are planted beneath the canopy of existing trees.

8 USE DIRECT SEEDING

Use direct seeding, perhaps in combination with seedling planting, to create 'habitat islands' of dense shrubs/trees/ground covers in open areas within the woodland. (References with details of the technique at given at the end of this booklet.)

Creation of a 'habitat island' at St Ronan's Well Reserve, York. Sequence used: Sept 94, herbicide ground layer (wild oats and Cape tulip). Nov 94, mow to reduce fire hazard. Burn to remove thatch, April 95 – note smoke promoting seed release from wandoo canopy. May 95, cultivate to break up Cape tulip bulb mass and prepare soil for seed. June 95, hand direct seed onto prepared surface with mix of 25 tree, shrub and understorey species at approx 2 kg/ha. March 99, habitat island established.

Success with direct seeding relies upon three features

- being able to collect suitable seed
- good site preparation, including removing weeds
- controlling predators such as red-legged earth mites and grazers such as rabbits.

When attempting to regenerate wandoo woodlands, it is important to use species that are adapted to grow under the specific site conditions. Choose plants that are local to the area and occur on the correct soil type. For example, one-sided bottlebrush (*Calothamnus*) occurs throughout the wandoo woodlands, but there are eight different species involved, only one of which, *C. quadrifidus*, is found throughout - and even that has different forms in different areas. The place where seed is collected from is called its 'provenance'. If the site to be revegetated is at, say, Bruce Rock, it is quite likely that *C. quadrifidus* seed collected from, say, Boddington, being adapted to a higher rainfall, would not do well. This is why it is recommended always to use 'local provenance seed'.

Calothamnus sanguineus, *low shrub, characteristic of powderbark sites.*

Calothamnus brevifolius, *low shrub, characteristic of inland wandoo sites.*

Because wandoo is such a competitive tree, it is important to use understorey species that are adapted for your conditions. Here, Acacia merrallii *and curly grass grow under inland wandoo. Boolanelling.*

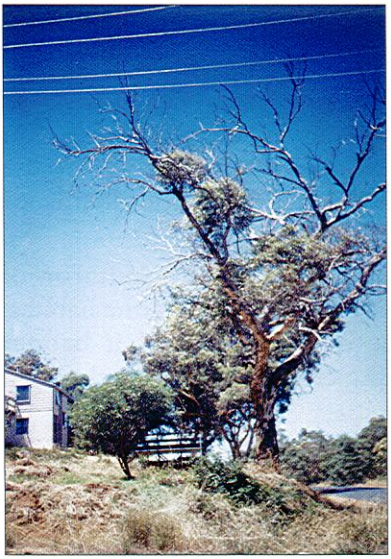
If direct seeding is being done, then the full mix of trees, shrubs and ground layer should be put in at the same time. It is much harder to add understorey later, after planted tree seedlings have established.

9 PRUNE STRESSED TREES

In many areas, a combination of borers and fungal attack is causing dieback of mature wandoos. Individual trees can be 'rescued' by pruning off all branches into healthy timber below the site of the infection. Although this looks ugly at the time, the new growth will be healthy, disease free, and fast-growing. However, the regrowth branches may be more subject to breaking off during times of water stress.

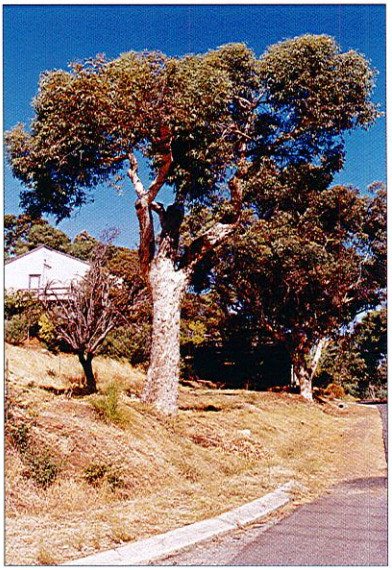
Mistletoes are native plants and some are parasitic on wandoo. In the absence of crown fires, which kill them, the plants will increase in number and some trees can become heavily infested. If desired, cut the branch below the mistletoe to remove it.

Note: only prune branches that carry disease or parasites, and so threaten the survival of the tree. Apart from these cases, dead limbs are important for hollow formation.



Wandoo in Boya dying from borers and aerial canker, June 92. Photo: Joanna Seabrook

After pruning, Sept 93. Photo: Joanna Seabrook

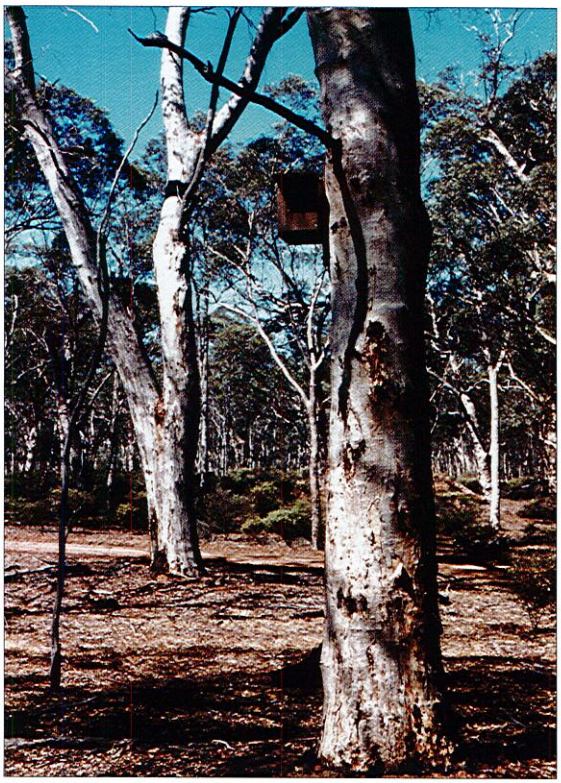


Regrowth, Feb 99.

10 INSTALL SPECIFIC FAUNA HABITAT FEATURES

If any of the specific habitat features, such as mature trees with hollows, are not present in your remnant woodland, you can try to replace the feature with something which will do the job. See Wildlife Note No 3 'Nest Boxes' for details of construction.

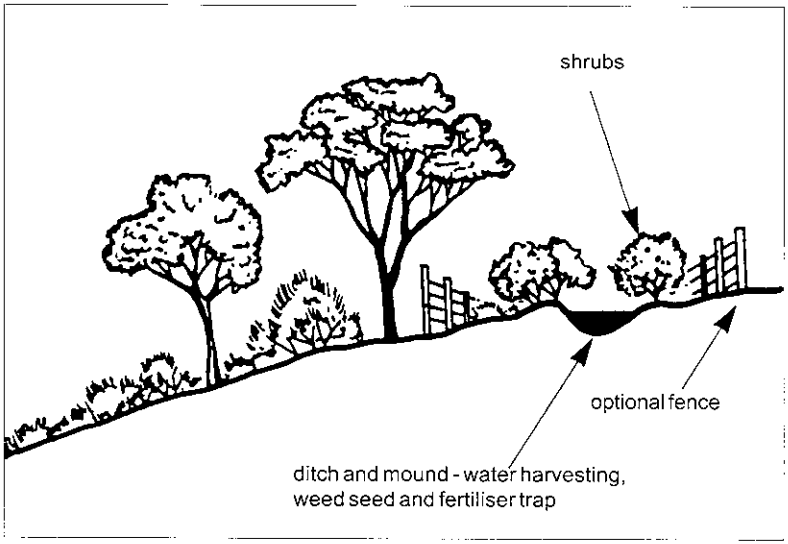
If hollow logs become available - perhaps after windthrow of paddock trees - they can be placed in the bush for fauna habitat. These and nest boxes could be especially useful if habitat islands or bush corridors are being created from scratch.



Nest box on wandoo. Dryandra.

11 INSTALL BUFFERS

If material is being blown or washed in from surrounding areas, it would be possible to install a buffer to trap the incoming soil and weed seeds, and strip out the nutrient. This buffer might well be a native wattle with a native grass understorey.



Minimising nutrient and weed seed input into remnant vegetation.

12 MANAGE OR CREATE BUSH CORRIDORS

Prior to agricultural clearing, fauna could move throughout the landscape to obtain resources when in season, or to escape a fire, for example. To keep the woodlands as healthy as possible, it is important to try to recreate these linkages.

Try to connect all remnant vegetation in the local region with a network of bush corridors which can be used by the small birds that are vital for pollination, and other fauna such as honey possums and lizards, both to live in and to move across the landscape. In many areas the only bush corridors left are

along roadsides, but revegetation areas, whether they be for windbreak, shelter belt or water table management, can provide a corridor function if they are properly designed. Try to mimic the species composition and structure of the local native vegetation on the soil type you are planting. A mix of species, including a variety of shrubs which flower at different seasons, and some of which form dense cover from ground level to one meter high, would be a good start. Also valuable are prickly shrubs to provide nesting habitat that will deter feral cats. Finally, the wider the corridor, the better!

13 SILVICULTURE

Timber is produced from wandoo woodlands by selection cutting, that is, trees to be harvested are individually selected and removed. It is important that this process is undertaken with minimum disturbance to other parts of the ecosystem. If it is done carefully, it can be compatible with other uses such as nature conservation and landcare.

The prime wandoo timber production areas are on the eastern side of the Darling Plateau, from Toodyay to Darkan. In this area, the objective of CALM's wandoo silvicultural treatments is to produce three age/size classes: veterans > 50 cm diameter at breast height (dbh) - this will include fauna habitat trees - intermediate trees 25 to 50 cm dbh, and regrowth < 25 cm dbh. Diameter at breast height is a standard forestry measure at 1.3 m above ground level.

HOW TO MEASURE DBH AND BASAL AREA

- Use a tape to measure circumference at 1.3 m above ground level.
  Diameter = circumference/π
- To calculate basal area, use the formula πr^2
  where r = radius (= half diameter)
- Stand basal area is the sum of individual basal areas.

The density of a stand is defined by basal area, which is the sum of the cross-sectional areas of each tree stem at the 1.3 m above ground. A stand is regarded as 'fully-stocked' if it has 15 square metres of basal area per ha, made up of 5 sq m/ha in each of the three age/size classes - whilst at the same time protecting water, fauna and aesthetic values. In the case of regrowth, the stand would be fully-stocked if it had the capacity to eventually produce the 15 sq m/ha. This stand density is applied to the main wandoo forest belt. It would be less in lower rainfall areas and on poorer soil.

Different strategies may be needed to achieve this stand density, and selective cutting or regeneration may be needed. Retained trees must be healthy with well-formed crowns, and veterans in particular are required as seed trees for regeneration and as fauna habitat. A minimum total basal area of 8 sq m/ha is required, allowing for future regrowth. Regular thinning is needed because wandoo crowns are susceptible to overcrowding. This thinning will produce poles and posts, while allowing the best trees to continue growth into sawlogs. Note that coppice stems, being more subject to windthrow, are less likely to reach sawlog size, and so should be targeted for early thinning.

Retained trees, and as much understorey as possible, must be protected from damage when cutting is required. The dead tops from felled trees may have to be dragged away from retained trees into open areas and cut or crushed so that they form low heaps. They can then be individually burnt to create ashbeds for regeneration.

Fire must be excluded from a stand for ten years after regeneration to give the trees time to establish well and reduce the risk of fire damage, which can occur even with controlled, low-temperature burns. Ideally, trees should be protected for longer, because wandoo crowns are very susceptible to fire damage, and wandoo which is burnt at the butt is not suitable for milling. Thus, if local bushfire policy dictates that fuel reduction burning to minimise the risk of wildfires is required on the site, it needs to be done very carefully. Contact CALM for further advice.

14 RECREATION SITES

Because of their open, attractive appearance, wandoo woodlands appeal to people as places to enjoy being in the bush. But unmanaged recreation activity can damage the very thing people come to enjoy. If recreation is to be part of the purpose of an area, a number of simple steps need to be followed.

- Location of facilities - campsites or picnic sites with parking and toilets - should be confined to specific areas and maintained to a high standard of cleanliness. Barriers should be installed to prevent driving off the designated area.
- BBQ sites should only be installed in open areas, and be designed so as to minimise the risk of fire escaping. Gas BBQs are preferable, if installation is feasible.
- Firewood should be provided, or visitors will scavenge dead wood or fell living trees - to the detriment of the ecosystem.
- Firebreaks should be installed and maintained around the facilities area.
- Information signs should be located only where they are not visually obtrusive.
- Tracks and trails for bushwalking, trail riding or recreational driving should follow easy gradients and have minimum visual impact on the woodland.
- Trail markers should be unobtrusive and visible only to those actually using the trail.
- No driving should be permitted through the woodland except along designated tracks. This is essential because woodland is open, and the understorey easy to drive through. However, the plants are fragile and the soil quickly becomes compacted, erosion starts and regeneration ceases - ie off-track driving causes degradation.
- For the safety of native animals, and so that 1080 poisoning can be used for fox control, no dogs should be allowed.

MONITORING

It is important to record what you do and its effect on the remnant. Keep a note of all management actions such as when herbiciding was done, what chemical was used, and at what rate. You can then pass on to other landholders the the knowledge you have gained. To record the effect of fencing, fire or other specific management actions, the easiest way is to take a photograph from the same spot each year.

For further details, refer to 'Managing Your Bushland'.

MORE INFORMATION

For more information about local wandoo woodlands, their management, flora and fauna, contact your local *Land for Wildlife* Officer or CALM office.

ACKNOWLEDGEMENTS

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Wandoo floorboards. West Perth.

FURTHER READING

'Bushland Plant Survey'. 1994. B. Keighery. Wildflower Society of Western Australia.
Explains how to conduct a scientific survey of plant communities.

'Dryandra: the story of an Australian forest'. 1970. V. Serventy. Reed.
Detailed account of the flora and fauna during a year in Dryandra Forest.

'Exploring Wheatbelt Woodlands'. 1995. M. Bamford. CALM.
Information of flora, fauna and their interactions.

'How to Conduct a Community Fauna Survey'. 1999. A. Sanders. *Land for Wildlife* Booklet No 3.
Details how to observe and study your local animals.

'How to Create a Local Herbarium'. 1997. S. Patrick. *Land for Wildlife* Booklet No 1.
Details how to collect and preserve plants for identification.

'How to Manage your Granite Outcrops'. 1998. B.M.J. Hussey. *Land for Wildlife* Booklet No 2.
Delails of managing granite areas.

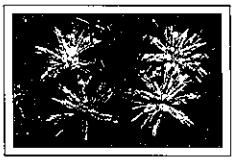
'Managing Your Bushland'. 1993. B.M.J. Hussey & K.J. Wallace. CALM.
Detail of bushland management, theory and techniques.

'Managing Perth's Bushland'. 1995. Ed: M. Scheltema & J. Harris. Greening Western Australia.
Excellent for weed management.

'Revegetation on Farms Information Kit: Direct Seeding'. 1998. Anon. AgWA.
A compilation of information sheets on direct seeding.

'Revegetation on Farms Information Kit: Southern Sandalwood for Western Australia'. 1998. Anon. AgWA.
A compliation of information sheets on sandalwood.

'Western Weeds'. 1997. B.M.J. Hussey, G.J. Keighery, R.D. Cousens, J. Dodd & S.G. Lloyd. Plant Protection Society.
Comprehensive weed identification.



FLORA AND FAUNA LISTS

(Note: not all of the flora and fauna named here will be found across the whole range of the woodlands covered in this book.)

LIST 1

BIRDS THAT ARE COMMON IN WANDOO WOODLAND
* = introduced to Western Australia

Australian magpie
Australian raven
barn owl
black-capped sitella
black-eared cuckoo
black-faced cuckoo shrike
black-faced woodswallow
black-shouldered kite
blue-breasted fairy-wren
boobook owl
broad-tailed thornbill
brown falcon
brown goshawk
brown honeyeater
brown-headed honeyeater
brown quail
bush stone-curlew
Carnaby's cockatoo
crested shrike-tit
common bronzewing
crested bellbird
crested pigeon
domestic pigeon *
dusky woodswallow
elegant parrot
emu
fan-tailed cuckoo
galah
golden whistler
grey butcherbird
grey currawong
grey fantail
grey shrike-thrush
hooded robin
Horsfield's bronze cuckoo
jacky winter
laughing kookaburra *
laughing turtledove *
little wattlebird
long-billed corella

magpie-lark
Major Mitchell's cockatoo
malleefowl
mistletoe bird
nankeen kestrel
New Holland honeyeater
owlet nightjar
pallid cuckoo
painted button quail
peregrine falcon
pied butcherbird
Port Lincoln/ringneck parrot
purple-crowned lorikeet
rainbow bee-eater
red-capped parrot
red-capped robin
red-tailed black cockatoo
red wattlebird
regent parrot
restless flycatcher
Richard's pipit
rufous treecreeper
rufous whistler
scarlet robin
silvereye
singing honeyeater
splendid fairy-wren
striated pardalote
stubble quail
tawny-crowned honeyeater
tawny frogmouth
tree martin
wedge-tailed eagle
weebill
western rosella
western spinebill
western thornbill
western warbler
western yellow robin
white-browed babbler
white-browed scrubwren
white-cheeked honeyeater
white-eared honeyeater
white-naped honeyeater
willie wagtail
yellow-plumed honeyeater
yellow-throated miner
yellow-rumped thornbill

LIST 2

FROGS AND REPTILES
COMMON IN WANDOO WOODLANDS

FROGS
Guenther's toadlet
humming frog
spotted burrowing frog
western banjo frog

REPTILES
clawless gecko
wheatbelt stone gecko
speckled stone gecko
variegated dtella
reticulated velvet gecko
marbled gecko
barking gecko
Burton's legless lizard
thorny devil
western bearded dragon
Gould's monitor/bungarra
black-tailed monitor/black goanna
fence skink
common dwarf skink
bobtail lizard
carpet python
mulga snake
dugite
gwardar

LIST 3

MAMMALS FOUND IN WANDOO WOODLANDS

NATIVE MAMMALS
echidna
red-tailed phascogale
chuditch
fat-tailed dunnart
little long-tailed dunnart
Gilbert's dunnart
western pygmy-possum
brush-tail possum
Mitchell's hopping-mouse
numbat
woylie
tammar wallaby
brush wallaby
western grey kangaroo
bats (several species)

INTRODUCED MAMMALS
house mouse
black rat
rabbit
sheep
pig
cat
dingo/dog
fox

Up until 1900, the following medium-sized mammals probably also lived in wandoo woodlands:

banded hare-wallaby
rufous hare-wallaby
marl/western barred bandicoot
dalgyte/bilby
boodie/burrowing bettong
quenda/southern brown bandicoot

LIST 4

PLANTS CHARACTERISTIC OF WANDOO WOODLANDS

It would be quite impractical to write a list of all the plants found in wandoo woodlands in the south-west - it would be far too long, over 600 species have been recorded in the Wandoo Conservation Park alone, for example.

Therefore, for this booklet, the main genera of plants of each type are listed. Species local to the area could then be noted by observation, and perhaps by enlisting the help of the local Community Herbarium (ring the WA Herbarium 08 9334 0500 for local contacts).

However, to help with rehabilitation, species that are fairly widespread, can be grown easily from seed, and are usually available commercially, are given in List 5.

TREES

Allocasuarina	rock sheoak	widespread throughout area, usually associated with granite outcrops
Casuarina	salt sheoak	found in brackish/saline areas
Eucalyptus	gums/mallees	wide variety over geographic range
Santalum	quandong/ sandalwood	semi-parasitic, often on wattles

SHRUBS

Acacia	wattles	major component of understory, nitrogen-fixing
Allocasuarina	tamma/scrub sheoak	nitrogen-fixing
Atriplex	salt bushes	low greyish shrubs, may be salt-tolerant, good forage

Bossiaea	bossiaeas	nitrogen-fixing
Brachysema	bush peas	nitrogen-fixing
Calothamnus	one-sided bottlebrushes	bird pollinated, important nectar producers, colourful
Chorizema	flame peas	nitrogen-fixing, colourful
Daviesia	bitter peas	nitrogen-fixing, colourful
Dryandra	dryandras	often form thickets, important nectar producers
Enchylaena	ruby saltbush	succulent, red/yellow berries
Gastrolobium	poison peas	nitogen-fixing, colourful, contain 1080 poison
Grevillea	grevilleas	attractive, mostly bird pollinated
Hakea	hakeas	attractive, nectar producers, often prickly
Hibbertia	hibbertias	low-growing, attractive in flower
Hypocalymma	white myrtle	low-growing, pretty in flower
Jacksonia	jacksonias	nitrogen-fixing, often prickly
Leptospermum	teatree	attractive in flower
Melaleuca	honeymyrtles/ paperbarks	often form thickets, some are salt-tolerant
Mirbelia	mirbelias	nitrogen-fixing, often colourful
Pimelia	banjines	very pretty in flower
Rhagodia	berry saltbushes	tangled greyish shrubs, good forage
Sclerolaena	bindiis	low succulent plants, often prickly
Synaphea	synapheas	low-growing, yellow flowers
Verticordia	featherflowers	very pretty in flower

PERENNIALS

Anigozanthos	kangaroo paws	most visible after fire
Borya	pincushions	characteristic of shallow soil
Conostylis	cottonheads	low tufts with yellow flowers
Dampiera	dampieras	always blue, form carpets
Dianella	flax lily	tufts with blue flowers
Glischrocaryon	pop flower	in disturbed areas, yellow flowers
Lechenaultia	leschenaultias	often colouful - blue, red, yellow - forms carpets
Macrozamia	zamia	palm-like leaves, huge cones, young growth can be poisonous to cattle
Patersonia	native irises	reedy tussocks, mauve or yellow flowers
Plactysache	konnors	inconspicuous, tuber was 'bush tucker'
Stackhousia	stackhousias	spikes of cream flowers
Sowerbaea	purple tassels	tufts with purple flowers
Stylidium	triggerplants	interesting pollination mechanisms
Xanthorrhoea	balgas	mostly higher rainfall areas

GRASSES AND REEDY THINGS

Amphipogon	greybeard grasses	small, delicate tussocks
Austrodanthonia	wallaby grasses	small, delicate tussocks
Austrostipa	spear grasses	medium tussocks
Lepidosperma	sword sedges	reedy clumps
Loxocarya	curly grass	forms tangled mats
Microlaena	weeping grass	can form sward
Neurachne	mulga grass	small tussock, widespread

GEOPHYTES - PLANTS WHICH DIE BACK EACH YEAR TO AN UNDERGROUND STORAGE ORGAN

Arthropodium	chocolate lily	common on shallow soil
Caladenia etc	orchids	found in all areas
Chamaescilla	blue squill	often very common
Drosera	sundews/ rainbows	carnivorous, trap insects on sticky leaves
Haemodorum	bloodroots	black flowers, red juice in root

ANNUALS

Angianthus	-	tiny flowers on often tiny plants
Brachyscome	Swan River daisies	white or mauve
Brunonia	blue pincushions	blue
Isotoma	Woodbridge poison	white or mauve
Lobelia	lobelias	blue
Podolepis	-	colourful daisies
Podotheca	longheads	yellow
Rhodanthe, Waitzia etc	everlastings	white, yellow or pink
Stylidium	triggerplants	very colourful

LIST 5

COMMON SPECIES WHICH COULD BE USED FOR REHABILITATION

All of these are relatively widespread and grow well from seed, which should be available commercially. Use local provenance seed.

Note: the distribution is given in broad terms only as 'western', 'central' and 'eastern'.

TREES

Plant the trees which would naturally occur with wandoo in that location, see pages 2 - 6

LARGE SHRUBS - NITROGEN FIXERS

Acacia acuminata	jam	central and eastern
Acacia celastrifolia	shining wattle	central
Acacia colletioides	wait-a-while	central and eastern
Acacia hemiteles	tan wattle	eastern
Acacia ligustrina	-	central and eastern
Acacia meisnerii	blue wattle	central (north)
Acacia microbotrya	manna wattle	central and eastern
Acacia myrtifolia	-	central and eastern
Acacia saligna	golden wreath wattle	all areas
Allocasuarina acutivalvis	black tamma	central and eastern
Allocasuarina campestris	tamma	central and eastern
Allocasuarina humilis	scrub sheoak	western and central
Jacksonia furcelata	grey stinkwood	western and central
Viminaria juncea	golden spray	western and central

SMALL SHRUBS - NITROGEN FIXERS

(Note: **P** = poisonous, not compatible with stock grazing)

Acacia bidentata	-	central and eastern
Acacia costata	-	central
Acacia drummondii	Drummond's wattle	western and central
Acacia erinaceae	-	central and eastern
Acacia lasiocarpa	wandoo prickly moses	western and central
Acacia pulchella	prickly moses	all areas
Acacia spinossima	-	central and eastern
Acacia stenoptera	wing-fruited wattle	all areas
Acacia wildenowiana	grass wattle	western and central
Bossiaea ornata	-	western and central
Brachysema praemorsum	-	central (south)
Gastrolobium calycinum **P**	York Road poison	central and eastern
Gastrolobium microcarpum **P**	sandplain poison	central and eastern
Gastrolobium parviflorum **P**	box poison	all areas
Gastrolobium polystachyum **P**	horned poison	central
Gastrolobium spinosum **P**	prickly poison	all areas
Gastrolobium trilobum **P**	bullock poison	central and eastern
Mirbelia floribunda	purple mirbelia	central
Nemcia capitata	bacon and eggs	western and central
Templetonia sulcata	tapeworm bush	central and eastern

LARGE SHRUBS

Dryandra carduacea	pingle	western and central
Dryandra polycephala	many-headed dryandra	central (north)
Dryandra sessilis	parrot bush	all areas
Grevillea insignifera	-	central, on laterite
Grevillea paniculata	-	central and eastern
Hakea preissii	needlebush	central and eastern
Hakea prostrata	harsh hakea	all areas
Hakea recurva	standback	central and eastern
Hakea trifurcata	two-leaved hakea	all areas
Hakea varia	variable-leaved hakea	central and eastern
Leptospermum erubescens	roadside teatree	all areas
Melaleuca lateritia	robin red-breast bush	western and central, wet sites
Melaleuca uncinata	broombush	central and eastern
Santalum acuminatum	quandong	all areas
Santalum murrayanum	bitter quandong	central and eastern
Santalum spicatum	sandalwood	all areas

SMALL SHRUBS

Atriplex paludosa	swamp saltbush	central and eastern
Atriplex vesicaria	bladder saltbush	central and eastern
Calothamnus quadrifidus	one-sided bottlebrush	all areas
Hakea commutata	-	central
Hakea incrassata	marble hakea	all areas
Maireana brevifolia	small-leaved bluebush	central and eastern
Rhagodia pressii	red-berry saltbush	central and eastern

CREEPERS

Kennedia prostrata	running postman	all areas
Sollya heterophylla	Australian bluebell	western and central

LIST 6

WEEDS

Major problem weeds - should be eradicated if possible

Asparagus asparagoides	bridal creeper	will smother low vegetation, birds spread seed
Chamaecytisus palmensis	tagasaste	replaces large wattles
Echium plantagineum	Paterson's curse	replaces other annuals
Homeria spp	Cape tulips	dominates ground layer
Lycium ferocissimum	African boxthorn	fierce thorns, birds spread seed
Watsonia spp	watsonias	replaces all ground layer

Widespread weeds, eradication probably impractical

Aira spp	hair grasses	delicate annuals
Arctotheca calendula	capeweed	common paddock weed
Avena spp	wild oats	replaces annuals such as everlastings, increases fire hazard
Briza spp	blow fly/ shivery grasses	annual, very widespread

Ehrharta spp	veldt grasses	annual and perennial, very widespread, increases fire hazard
Freesia hybrids	freesia	spreads from settlement sites
Gynandriris setifolia	thread iris	geophyte, wheatbelt woodlands
Hypochaeris spp	flatweeds	annual, replaces everlastings
Lupinus spp	lupins	spread from paddocks, adds nutrient, increases fire hazard, replaces everlastings
Oxalis spp	woodsorrels	colourful geophytes
Romulea rosea	Guildford grass	ubiquitous
Ursina anthemoides	ursina	annual, very widespread, replaces everlastings

NOTES