Biodiversity in the paddock

a land managers guide

by
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FUTURE FARM INDUSTRIES CRC

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Contents

An Australian Icon

The grassy woodlands of the south-east are an Australian icon. The widely-spaced eucalypt trees, dry grass, stockmen, sheep, cattle, and remote homesteads are part of Australia's national identity.

Early artists captured and promoted the image of pastoral Australia. (Hans Heysen "Droving into the Light" 1921, Courtesy of State Art Collection, Art Gallery of Western Australia).

Today, the once vast, grassy woodland landscape has become a mosaic of crops, sown pastures, native pastures and remnant woodlands. The massive old gums are in retreat and scattered paddock trees are being replaced by straight lines of dense plantings.

The changing rural landscape

This booklet is about the role that native pastures have in a landscape that was once grassy woodland but which now supports a range of land uses. On many south-east Australian properties, native pastures make up 65% or more of the grazing area and are the most widespread form of native vegetation. They are important for commercial production but also play a vitally important role in maintaining native biodiversity and healthy landscapes.

How do grassy woodlands become native grasslands and pastures?

Grassy woodlands and grasslands once occurred throughout the tablelands and inland slopes of NSW and Victoria and extended into Queensland, South Australia and Tasmania.

They were home to a myriad of plants and animals, all having particular roles in capturing solar energy and water, recycling nutrients and regulating populations and energy flows. The woodlands supported a diversity of grazing and browsing marsupials including bettongs, wallabies and bandicoots. Indigenous people influenced the functioning of woodlands though food gathering, hunting and the use of fire.

The Rufous Bettong was a common species in grassy woodlands across eastern Australia.

Since the mid-1800s, sheep and cattle have been the main grazing animals. Livestock numbers continued to increase with the introduction of fencing, tree clearing, predator control, permanent water supplies and fire suppression. Rabbits also had a significant additional impact.

The woodlands have continued to be modified by more intensive management including phosphorus fertilisation, cultivation, plant introductions and fodder

storage. Now much of what remains is 'native pasture' where some perennial native species persist alongside introduced grasses, legumes and broad-leaved weeds. Trees are often absent, or present as scattered paddock trees, while on some of the steeper hills dense woodland or dry forest has regrown.

Many of the original woodland species have not tolerated these changes. Habitat loss, soil erosion, secondary salinisation and exacerbated soil acidity are outcomes of both changes in management and the ensuing loss of native species. If we fail to accommodate the needs of remaining native plant and animal species, we risk further loss of the services they provide.

Native pasture types

There are a range of native pastures which can be broadly grouped into three types, each the result of their past history of management. This booklet concentrates on the two most widespread types – low and high input native pastures.

Native grasslands with little history of grazing or fertiliser can be very diverse.

Native grasslands occur in a few places such as cemeteries, travelling stock reserves and roadsides that have had very little grazing and no fertiliser. These areas can have many species of native plants including those intolerant of heavy and prolonged grazing or fertilisers. Diversity is maintained by the use of fire, mowing or occasional grazing. This enables a variety of flowering species to thrive amongst the tall grass tussocks.

Low input native pastures often have less diversity than grasslands but are important for both biodiversity and production.

Low input native pastures are the result of prolonged grazing with little or no fertiliser use. Productivity is low, and low stocking rates are typical. They can support a high plant diversity as they may contain a mix of grazing-dependent as well as grazing-sensitive species. There may be a wide range of life-forms including tall and short grasses, flowering herbs and low shrubs.

Some low input native pastures have previously been heavily grazed and fertilised. These pastures differ from those with little fertiliser use because they typically have low diversity and can be dominated by low productivity annual weeds.

High input native pastures have developed through greater levels of fertiliser and the resulting increase in stock grazing pressure. These support a small group of native grass species and can be highly productive. Exotic annual clovers, grasses and broad leaved weeds are often common components of the pasture.

Weeping Grass (Microlaena stipoides) is a highly productive native grass.

A shift in farm thinking…

"we can't control the climate or fuel, fertiliser and commodity prices but we do have control over the decisions we make on our landscape"

cattle producer, Boorowa, NSW

The history of pasture management has been a quest to increase productivity. While native pastures are still being replaced by sown pastures, in the last fifteen years there has been growing interest in low-input grazing systems.

"we don't want to be renewing pastures all the time"

cattle and merino producer, Alexandra, Victoria

A shift in farm thinking has led to greater recognition of the role native pastures play in whole farm management.

There is also growing recognition of the role of native pastures in landscape health, including soil protection, water quality and low risk management in the face of climate change. They are also important for the survival of many native plant and animal species – the biodiversity of these landscapes.

"our aim is to be a commercial enterprise, with good groundcover and biodiversity"

merino producer, Boorowa, NSW

This growing awareness is associated with changes in how the remaining native pastures are managed. In the past, continuous grazing of native pastures, often with wethers, was common practice. In many cases wethers have now been replaced by cattle and cross-bred ewes. As well, natural resource management concerns and a desire for lower input costs have seen a rapid uptake of land class fencing and rotational grazing systems.

"fertiliser is so expensive now. . .we put dollars into landcare, rather than fertiliser, to increase productivity"

cattle producer, Holbrook, NSW

What this booklet aims to achieve

This booklet aims to help livestock producers assess alternative approaches to biodiversity management in native pastures. The information provided here does not present a recipe for managing native pastures but rather a starting point for helping producers consider alternative strategies. The information is based on past and current research and the personal experience of producers with whom the scientists have been working.

The information provided covers a range of topics relevant to two key questions:

What might changes in management mean for the plant composition of native pastures and their ecological function and animal species which they support?

Can native pastures deliver enhanced farm profitability, maintenance of key natural resources as well as biodiversity conservation?

Not all of the answers to these questions can be provided, and while general patterns are emerging through the science, implementation and management are likely to vary according to the specific situation. The information must be considered within the aspirations and objectives of the farm business, recognizing that there is a variety of locations on farms that may require alternative management. In many cases, scientific knowledge of the native pasture ecosystems are rudimentary and more research is required. Continual monitoring of pastures and other aspects of the ecosystem will be essential to help guide decision making.

"we can't claim to know the best way to manage these ecosystems but with monitoring we can at least see where we are going"

cattle producer, Boorowa, NSW

Research on the Farm

The quotations in this booklet come from 24 producers on the south western slopes of New South Wales and inland slopes of Victoria. Their direct experience is a major component of the research context and conclusions.

Research surveys on these properties were undertaken during 2006 and 2007, seasons of well below average rainfall. As these properties are part of a dynamic landscape, surveys on pastures, plant and animal abundance and diversity reflect

conditions at that time as well as responses to historical management. This booklet presents a snapshot of these landscapes within a framework of other past and current research.

Research data were collected on 24 farms and incorporated producers experiences in managing grazing systems on native pastures.

Current approaches to managing native pastures from a survey of 24 properties in south-eastern Australia

Twelve of the properties use rotational systems while 12 are continuously grazed (set stocked). Rotational graziers use a recurring pattern of grazing and rest, with relatively long rest periods and a short, high intensity grazing period, often in smaller, sub-divided paddocks. In continuous grazing systems pastures are stocked throughout most of the year and are rarely spelled. There is no 'one way' of rotational grazing. In some cases paddocks are rested for as little as three-five weeks followed by one-three weeks grazing. On a number of properties rest ranges from three-five months followed by only one-two days of grazing. Many graziers use a single mob while others use complex systems to juggle different flocks and classes of animal.

Ten of the properties run both sheep and cattle, seven graze their native pastures with cattle only, while seven run sheep only. Of those with sheep, eight run merinos while the rest are 1st cross / crossbred operations with only one running any wethers. A number of those running sheep intend to add cattle to the mix, or to switch solely to cattle. Most properties run self-replacing or stud operations, although agistment and trading are becoming increasingly important.

Stocking rates on native pastures vary from 2 to 12 DSE / ha (1 DSE = dry sheep equivalent, a 40kg merino wether). Although most producers regularly fertilise their sown pastures, 50% do not fertilise native pastures. Of those that do, most use single super at a rate of 125 kg/ha,

Rotational grazing typically uses very high stocking density for short durations with a long rest period however there are a wide range of grazing systems.

varying between one application every five years, to annual applications. Rotational graziers are less likely to use fertilisers on their native pastures.

Drought management of native pastures also varies. In the 2006 drought, most producers using continuous grazing systems did not fully destock and used supplementary feeding. Many rotational graziers destocked for six or more months and of those that retained stock, none used supplementary feeding.

Most producers view native pastures as an important part of their farm, but in the past two decades, the area of native pastures has substantially declined on half of the properties. A quarter of the producers intend to continue to replace native pastures with sown pastures over the next ten years.

Grazing

Grazing pressure is important

Native pastures can have considerable plant, bird and reptile diversity

Scientific research to date has not found native plant or animal diversity is increased by any particular grazing regime, although other benefits can be gained through planned grazing systems that provide long pasture rest periods. What is clear is that the long-term grazing pressure, often measured as stocking rate, is important.

Key messages:

- **Grazed native pastures have significant plant, bird and reptile diversity**
- **Monitor pasture composition and grazing pressure to track change**
- **High diversity occurs with low stocking rates**
- **Seasonal rest can be an important strategy for increasing perennial groundcover**
- **Rotational grazing can provide managers with better control over stock pressure and distribution**
- **Continuous grazing at low density (<4 DSE/ha) can provide important habitat and plant diversity**
- **A diversity of management = a diversity of species**

Pastures that support the highest diversity of native species tend to be lightly stocked.

A wide diversity of native plant and animal species still persist in grazed native pastures. Recent research during the severe drought of 2006 found up to 46 different native plant species and seven reptile species in 1ha (2.5 acres) of grazed native pasture. Up to 37 different bird species were observed within 4ha (10 acres) of native pasture.

Biodiversity changes with grazing and associated farm management practices

Most of the native plant and animal species that occur in grazed pastures tolerate or prefer some livestock grazing. The birds tend to be dominated by those that forage in open short pastures (e.g. Magpies, Willy Wagtails). Species such as quail that require tall tussocks and ungrazed areas are absent or rare.

Stubble Quail require tall tussock grasses as part of their habitat.

For reptiles, the groundlayer diversity is critical. Most of the common reptiles are small skinks that can find shelter even in closely grazed pastures. Larger reptile species are largely absent. Ground-dwelling marsupials that shelter and nest at the base of large tussocks, such as the Rufous Bettong, are now extinct.

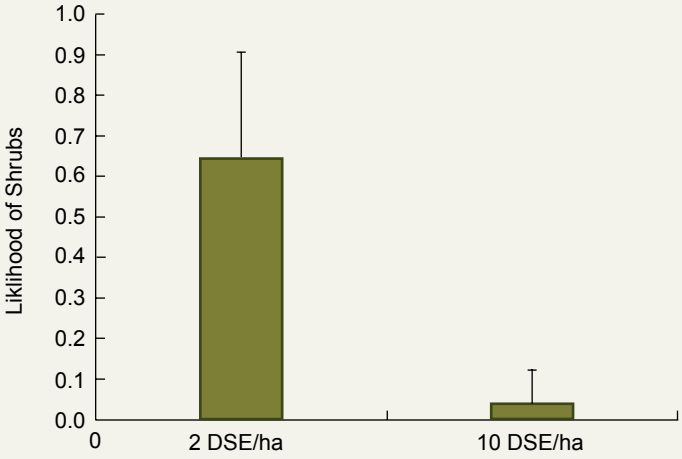
Plant diversity also differs between areas that have a long history of grazing and those that by historical coincidence have been rarely grazed. These latter areas include some cemeteries and road reserves that may support tall grasses, daisies, shrubs and lilies that are now rare in regularly grazed pastures.

The highest diversity of species occurs with low stocking rates

Frequent, sustained, heavy stocking rates (>6 DSE) eliminate grazing-sensitive plant species and simplify habitat for animals by removing tall tussocks and shrubs and preventing tree regeneration.

"the old grazing system placed too much pressure on natural grasses — it was wrong"

sheep and cattle producer, Holbrook, NSW



Shrubs are more likely to persist in paddocks with low stocking rates.

Lightly stocked paddocks (<4 DSE/ha) often have a greater cover of native perennial grasses and fewer exotic annual plants. Continuous heavy grazing can eventually kill perennial plants and opens up the ground surface to weed invasion.

"we have managed our stock to control many of our weeds, such as patto, St John's wort and wiregrass"

merino & cattle producer, Binalong, NSW

The highest diversity of species occurs at lower stocking rates.

Light continuous grazing can provide for high biodiversity

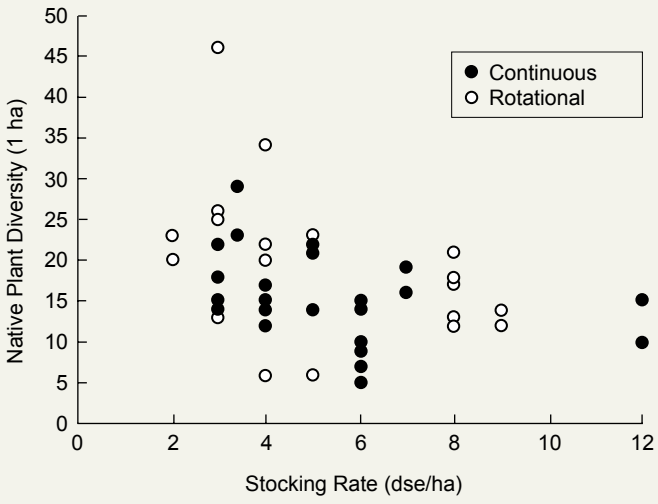
The most diverse pastures tended to be continuously grazed, but at light stocking rates (no more than 4 DSE/ha). In large, lightly stocked paddocks, some areas regularly get a rest from grazing and tall ungrazed patches persist. Other areas are subject to frequent grazing. These pastures are diverse because in a single paddock they can contain both grazing tolerant and grazing-sensitive species.

However, even lightly stocked pastures, without rest, can become severely overgrazed during drought. In addition, continuous grazing encourages stock camping under trees which can contribute to tree decline.

Native pastures can still be overgrazed at low stocking rates.

Rotational grazing is flexible but not necessarily better for biodiversity

Rest from grazing may be important for providing opportunities for less grazing-tolerant plant and animal species. Native plants will benefit from rest during flowering, seeding and establishment.



Plant diversity is often higher at low stocking rates but not influenced by grazing regime.

Research has yet to show whether rotational grazing is better for biodiversity at equivalent grazing pressure. However, rotational grazing can provide managers with greater control over stock densities and movement. With appropriate monitoring and planning, it can help managers determine carrying capacities and predict the potential for overgrazing.

"rotational grazing is better than set continuous stocking for feed prediction and timing when you are buying & selling"

merino producer, Alexandra, Victoria

"having lots of paddocks and one mob enables you to manage for long recovery (of the pasture) and gives you a head start on detecting whether regrowth is happening or if to start destocking"

cattle producer, Yackandandah, NSW

Rotational grazing, if managed with high grazing pressure, also carries risks as areas previously lightly or infrequently grazed (often southerly facing slopes) can become more intensively grazed. This may be detrimental to grazing-sensitive species.

Grazing to increase native perennial ground cover

Some perennial native grasses are very responsive to grazing management and producers' comments testify to this.

"we rest country for seeding, and the use of subdivisional fencing will also help"

merino producer, Boorowa, NSW

Weeping grass (Microlaena stipoides) is very responsive to grazing management.

"if the Microlaena is stocked all the time, you won't get any seed and regeneration"

sheep & cattle producer, Gundagai, NSW

"we're finding the native grass seed from these upper fenced areas is spreading to the lower slopes--the seedbank is improving and spreading"

sheep & cattle producer, Gundagai, NSW

The key elements are:

- strategic rest from grazing to allow the desired grasses to seed;

- the need for seed dispersal, either natural or assisted, to enable re-colonisation.

New trees and shrubs need a longer period of rest from grazing to allow establishment.

A diversity of management strategies is required

Diversity begets diversity. Across landscapes, properties and even within paddocks, the greater the variation in management strategies the greater the number of species that will occur. This may include retaining large, lightly stocked paddocks, some ungrazed pastures and more heavily stocked and fertilised native pastures. Variation in grazing strategies (i.e. rotational or continuously stocked), being responsive to seasonal conditions and providing adequate duration of rest is also important.

A diversity of species will benefit from a range of management strategies.

Strategies to increase perennial grass cover and maintain plant diversity

Limit stock pressure in dry times – stock grazing pressure affects the ability of a plant to survive drought by reducing leaf area and its ability to store carbohydrates and acquire water. Research has shown that perennial plants may be most susceptible just prior to severe drought. A general rule is to maintain pasture biomass above 1500 kg of dry matter per hectare and keep ground cover between 70% - 100%. Pastures should be regularly monitored so an early prediction of feed supply can be made and overgrazing can be prevented.

Apply heavier stock pressure during early spring to target annual weeds and reduce competition on the native perennials, which begin growth later in the season.

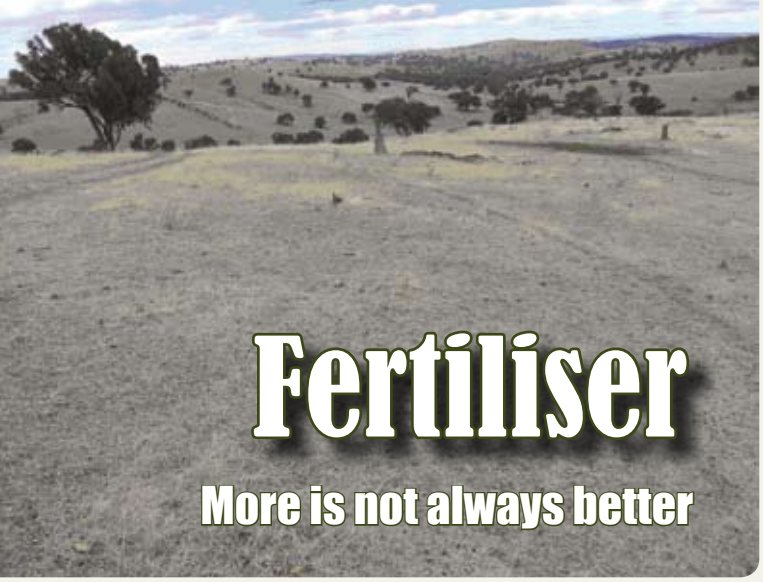
Reduce stock pressure following good summer and autumn rain – to allow plants to recover and encourage seedling establishment.

Rest from grazing during periods of good flowering and seeding – to build up the seedbank.

Provide longer rest when plants are growing slowly. When soil temperatures are low and during drought plants regrow slowly after being grazed. Less rest is required when soils are warm and have adequate moisture.

How to retain and improve plant diversity:

- identify areas on the property with high native plant and animal diversity and fence these areas to control stock access.
- prevent fertiliser drift or run-on to areas with a low fertiliser history (see *Fertiliser & Plants chapters*).
- limit total stock grazing pressure on areas of good diversity.
- diverse native pastures may support from 20 to 60 native plant species, all with different growth, flowering and establishment patterns. Regular rest from grazing, of varying seasons may be the best approach to mainitain diversity in these pastures.
- provide longer periods of rest if tree or shrub recruitment is evident, to allow establishment.



Fertiliser

More is not always better

Australian producers have typically used fertilisers, especially phosphorus, to increase productivity which, in conjunction with the higher stocking rates, can replace native plants with introduced grasses and clovers. While this has been a highly successful strategy and continues to be a key part of enterprise profitability, the use of fertilisers is now under more scrutiny for economic and ecological reasons.

Half the producers surveyed in our research did not fertilise their native pasture. By concentrating fertiliser inputs on sown pastures and crops they have found it beneficial to reduce or stop fertilising native pastures.

"we don't want to spend too much money on those paddocks that don't return much by themselves"

sheep & cattle producer, Holbrook, NSW

Key messages:

- **High input pastures are productive but require careful grazing management to avoid dominance by annuals**
- **Low input diverse pastures are lower risk and low cost pastures**
- **It can be more profitable to reduce fertilisers in native pastures and concentrate use in sown pastures**
- **Increased nutrients lead to decreases in native plant diversity - diversity can only be increased when fertility is low**

"fertiliser is so expensive now and we used to super every year but to reduce the costs we only super now every 2 – 3yrs"

cattle producer, Holbrook, NSW

Rising fertiliser costs are clearly a major concern that is likely to persist into the future. Loss of stability in plant composition in fertilised pastures is also an issue, as more exacting management is needed to maintain the exotic species which may be highly productive but not necessarily persistent under grazing.

"we established some improved pasture and maintain it with higher fertiliser rates but it needs careful grazing management"

sheep producer, Albury, NSW

Higher inputs can therefore be associated with higher risks and drought can challenge the best intentions when it comes to grazing management.

Fertilisation coincides with a marked drop in the diversity of plant species, with replacement of native perennial plants by exotic annual species.

"when we started to add super the native wildflowers went and the annual weeds took over"

sheep producer, southern tablelands, NSW

Low levels of fertiliser help maintain plant diversity with both perennial native grasses and wildflowers.

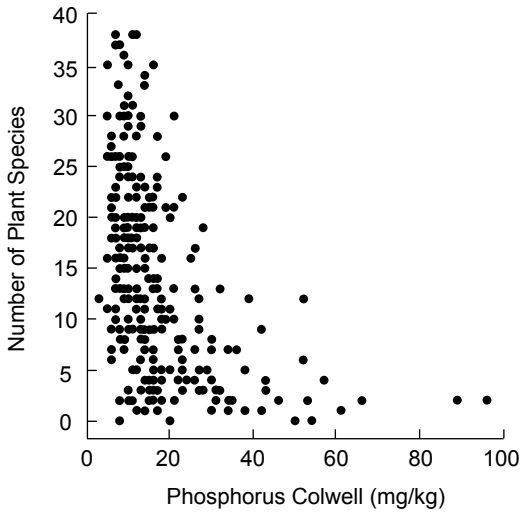
Research indicates that diverse perennial native pastures only persist when the available soil phosphorus is below approximately 20 mg/kg (Colwell).

Why does adding phosphorus reduce native plant diversity?

Many Australian soils have naturally low soil phosphorus and many native plants have mechanisms to cope with this limitation. Most native plants take up nutrients slowly and some also rely on specialised fungi growing on their roots (mycorrhiza) to help obtain scarce nutrients from the soil. Compared to sown species and exotic weed species, native plants have slow growth rates to match their conservative use of nutrients.

As soil phosphorus increases with fertiliser use, the associated mycorrhiza declines and the increased soil fertility favors short-lived fast growing plants (typically exotic species). The rapid growth by exotic annual grasses and legumes in spring can also use up soil moisture that would otherwise have been available for native plants in summer.

The inevitable outcome of all this has been the loss of much of the diverse long-lived native plants that originally dominated Australia's woodlands.



This graph shows how diversity of native plants (as measured by number of species) declines as available soil phosphorus increases.

"as soon as you need to rely on annuals, you're in overdrive"

sheep producer, Yass, NSW

A regularly fertilised annual dominated pasture is far more at risk from drought than one having a diverse mix of native and exotic plants, which can provide the farmer with a useful shield against dry conditions.

Management strategies to restore native plant diversity

In the long-term, fertility levels will decline in native pastures once fertiliser applications cease. Only when this occurs can the cover and diversity of native plants improve, assuming that seed is available. Strategically resting pastures from grazing during active plant growth, flowering and seeding can encourage the consolidation and spread of native plant species.

Restoration and revegetation

Focus on areas with a history of little or no super for revegetation and restoration.

Why do tree planting areas become full of weeds? Trees planted into previously supered, or supered and sown pastures, become dominated by perennial grasses and weeds with an accumulation of dense litter. These plantings will require considerable weed control. Natural regeneration from these stands may fail in later years due to the competition from the perennial grasses.

The likelihood of eucalypt regeneration is higher in paddocks with no or little-fertiliser history. Recovery of native ground layer plants will also be better if low fertility areas are targeted for changed grazing management.

If revegetation or restoration is desired in areas with a long history of super, the best strategy may be to cease fertiliser inputs and wait for soil fertility levels to drop.

When fenced to exclude grazing, a high-fertility sown pasture is rapidly dominated by exotic perennial grasses which often out-compete tree plantings and potential regeneration.

Plants

Helping them, help you

Plants are the primary producers of ecosystems. The types and variety of plants underpin the productivity of pastures and livestock. Plants also influence landscape functions important to sustainability.

'Ecosystem function' refers to basic processes such as the capture, use and storage of critical resources such as light, water and carbon, the stability of soil surfaces, and nutrient and water cycling. Many of these basic processes are critical to sustaining life, for example through provision of clean drinking water or pollination of crops. These 'ecosystem services' are often taken for granted but contribute substantially to the wellbeing of human society.

Key messages:

- **Management determines the composition and the ecological function of pastures so always monitor for changes**
- **Plants underpin production and other key ecosystem functions that are important for enterprise and catchment sustainability**
- **Maintaining a diverse native pasture is a low risk approach to pasture management, through efficient capture and use of water and nutrients and a permanent biomass**
- **Diversity of plant species and life-forms is reduced by fertiliser use and heavy, prolonged grazing**
- **Trade-offs between high and low-input pastures mean low fertiliser inputs and conservative grazing don't maximize productivity, but do provide functions such as soil protection and drought resistance**

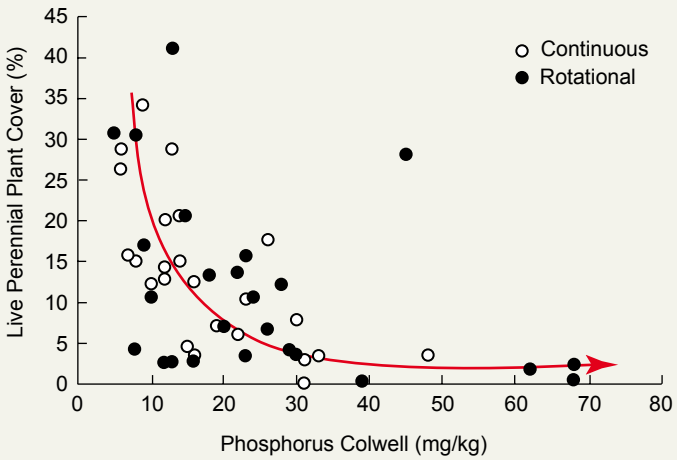
Management affects plant types

The way that pastures are managed determines the types of plants that occur within a particular pasture, and these in turn determine how that pasture ecosystem functions and the ecosystem services that are provided.

Some examples of plant characteristics that are important in influencing ecosystem functions are: life-span (annual or perennial), growth season (cool season or warm season), growth rates and water use, leaf toughness and growth form (tussock, shrub, twiner etc).

Plant types affect productivity and ecosystem function

The most simple example of the link between management, plant response and function, is the shift from perennial pastures to annuals through fertilising and frequent heavy grazing. Annual pasture provides good productivity during their growing season but the death of the annual plants leaves the ground exposed to soil erosion during late summer – autumn with associated feed shortages. The common belief, that "rain in late summer spoils the dry feed" comes from these more annual dominated pastures.



The amount of live perennial ground cover in native pastures during the 2006 drought decreased with level of phosphorus in the soil, a direct function of fertiliser history.

Annuals are less effective at preventing deep drainage of water which can affect groundwater and contribute to salinity problems. The essential ecosystem services of soil protection and salinity prevention are therefore not as well provided by annual plants.

"the whole thing is driven by the perennial proportion of your pastures"

sheep producer, Yass, NSW

If perennial native or sown grasses drive much of the productivity and key ecosystem functions such as soil protection, why would a producer want to bother with the hundreds of additional grasses and herbs that can grow in a low input native pasture?

One argument is that a diversity of plants drives a diversity of animals, and many people value the sheer existence of this variety in nature.

From a more practical view point, plant diversity can provide a reliable and resilient long-term feed supply. A large array of plants can provide a growth response to almost any soil type, landscape position, moisture pattern and seasonal opportunity. While the peaks of production are never as high as a fertilised annual pasture, the chance of having production throughout the year is greater, and response to rain after drought is reliable.

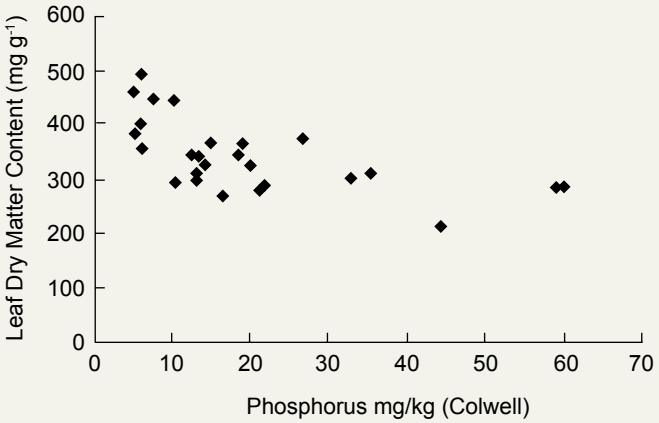
The rockiness of this site prevented pasture sowing, allowing a variety of plants to persist.

Grazing and adding fertiliser change the nature of the plants

Unfertilised, lightly-grazed native pastures are typically dominated by plants with tough, long-lived and slow growing leaves. These pastures tend to be less palatable to stock but are highly resilient to drought, provide soil protection and animal habitat, and resist weed invasion.

When fertiliser is used to increase plant growth, tough native species are replaced by species with short-lived, softer leaves. These are more palatable but the forage does not persist into dry periods.

High-fertility pastures can be challenging to manage and are susceptible to weed invasion and loss of the productive perennial plant species. Controlling stock pressure and using rest is important in maintaining fertilised pastures.



This graph shows how leaf dry matter declines with increasing fertility and disturbance. Leaves with high dry matter are more protective of soil and less vulnerable to drought but less palatable.

Plant management strategies for maintaining diverse perennial native pastures

Plant diversity in pastures is easy to lose through use of fertilisers but hard to regain. Phosphorus levels of over 20 mg/kg (Colwell) appear to be incompatible with high native plant diversity and ground cover.

Phosphorus levels take years to decline after fertiliser inputs stop. Also, many native species are slow to re-colonise as they produce few seeds which are poorly dispersed. This is why some low input pastures with a history of heavy grazing and fertilisation can have low diversity – the plants and their mycorrhizal fungi have been slow to re-colonise after fertiliser application ceases.

Fertilising a native pasture that already supports the full complement of plant types will result in almost irreversible change, as the most sensitive plants such as orchids, lilies and some shrubs may not return.

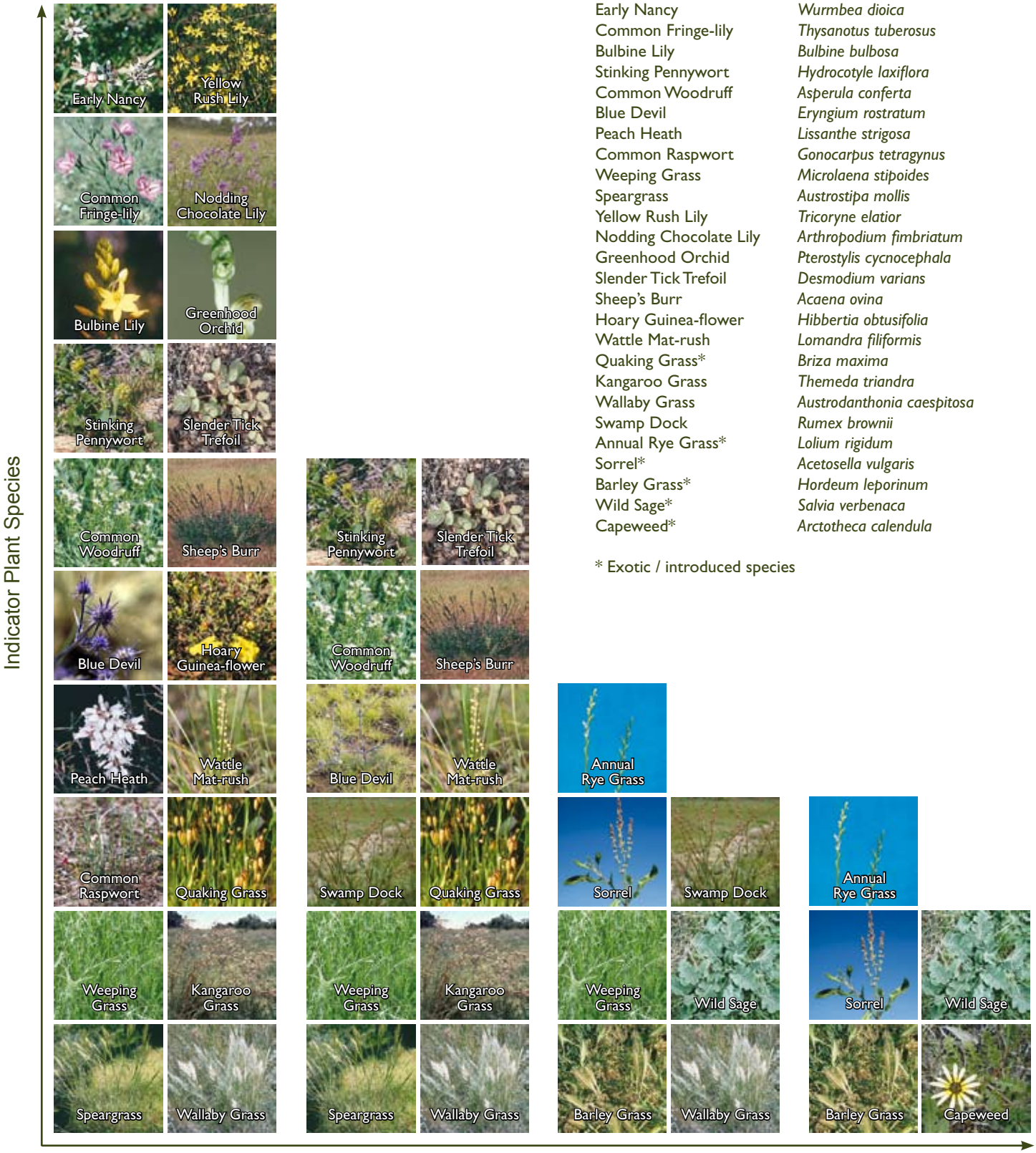
Orchids are often the first types of plants to be affected by fertiliser.

Heavy, prolonged livestock grazing is a second factor that should be avoided. High diversity appears to be compatible with low levels of continuous grazing (4 DSE/ha) or more intensive grazing with rest periods sufficient for all species to flower and set seed.

"we rest country for seeding, and the use of subdivisional fencing will also help this to occur"

sheep producer, Boorowa, NSW

Typical plant species associated with varying levels of soil phosphorus



Early Nancy	*Wurmbea dioica*
Common Fringe-lily	*Thysanotus tuberosus*
Bulbine Lily	*Bulbine bulbosa*
Stinking Pennywort	*Hydrocotyle laxiflora*
Common Woodruff	*Asperula conferta*
Blue Devil	*Eryngium rostratum*
Peach Heath	*Lissanthe strigosa*
Common Raspwort	*Gonocarpus tetragynus*
Weeping Grass	*Microlaena stipoides*
Speargrass	*Austrostipa mollis*
Yellow Rush Lily	*Tricoryne elatior*
Nodding Chocolate Lily	*Arthropodium fimbriatum*
Greenhood Orchid	*Pterostylis cycnocephala*
Slender Tick Trefoil	*Desmodium varians*
Sheep's Burr	*Acaena ovina*
Hoary Guinea-flower	*Hibbertia obtusifolia*
Wattle Mat-rush	*Lomandra filiformis*
Quaking Grass*	*Briza maxima*
Kangaroo Grass	*Themeda triandra*
Wallaby Grass	*Austrodanthonia caespitosa*
Swamp Dock	*Rumex brownii*
Annual Rye Grass*	*Lolium rigidum*
Sorrel*	*Acetosella vulgaris*
Barley Grass*	*Hordeum leporinum*
Wild Sage*	*Salvia verbenaca*
Capeweed*	*Arctotheca calendula*

* Exotic / introduced species

Different plant species have a range of tolerance to soil phosphorus. Orchids, lilies and shrubs found in the left hand columns are quickly lost from grasslands when even low levels of fertiliser are applied. Some native and exotic grasses and herbaceous plants are tolerant of a wider range of soil phosphorus levels. Pastures with high levels of soil phosphorus support few, mostly exotic annual, species.

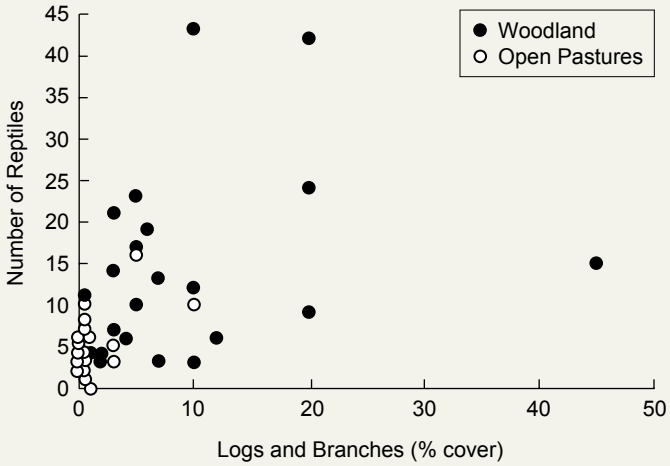
Typical birds and reptiles of native pastures and associated woodlands

Sulphur Crested Cockatoo	*Cacatua galerita*
Olive Legless Lizard	*Delma inornata*
Australian Pipit	*Anthus australis*
Australian Kestrel	*Falco cenchroides*
Eastern Three-lined Skink	*Bassiana duperreyi*
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
Eastern Rosella	*Platycercus adscitus*
Red Wattlebird	*Anthochaera carunculata*
Cunningham's Skink	*Egernia cunninghami*
Superb Fairy-wren	*Malurus cyaneus*
Magpie-lark	*Grallina cyanoleuca*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Common Blue-tongued Lizard	*Tiliqua scincoides*
Yellow-faced Honeyeater	*Lichenostomus chrysops*
Brown Treecreeper	*Climacteris picumnus*
White-winged Triller	*Lalage tricolor*
Peaceful Dove	*Geopelia placida*
Rufous Songlark	*Cincloramphus mathewsi*
Three-toed Skink	*Hemiergis decresiensis*
Laughing Kookaburra	*Dacelo novaeguineae*
Noisy Miner	*Manorina melanocephala*
Striated Thornbill	*Acanthiza lineata*
Crimson Rosella	*Platycercus elegans*
Striated Pardalote	*Pardalotus striatus*
Jacky Lizard	*Amphibolurus muricatus*
Boulenger's Skink	*Morethia boulengeri*

The abundance and diversity of birds and reptiles of native pasture with woodland trees (right hand columns) is greater than in open pasture. Open pastures (left hand side), although supporting lower abundances, are still important for the specialist grassland species. A number of birds and reptiles are more generalist and can be found in both open pastures and woodlands (middle columns).

Animals

Habitat diversity = animal diversity



Reptile numbers tend to be higher where there are greater amounts of logs and branches on the ground.

Grazed native pastures can play a vital role in conserving a diversity of native animals.

"all our native grass species have an important role to play on our property in providing habitat for small mammals, reptiles, birds and invertebrates"

sheep producer, Albury, NSW

The diversity and abundance of birds and reptiles in native pastures is highest where trees are present, there is lots of bark, leaf litter and logs on the ground and a range of pasture heights, from tall to short tussocks.

Birds in native pastures

Birds bring benefits to pasture landscapes by providing ecosystem services such as pest insect control, pollination of trees and reduction of eucalypt dieback, by preying on psyllids (sap sucking insects related to aphids) and scarab beetles. These benefits are not always obvious to managers, however many people simply enjoy having wildlife around the property.

Retaining woodland trees, and replanting and encouraging natural regeneration of trees and shrubs also helps maintain animal diversity in pastures.

"bird populations have increased since we've planted all those trees"

merino ewe & cattle producer, Gundagai, NSW

Many of the birds observed in native pastures are not common, and have been identified as declining woodland species. Although trees are essential for the presence of these birds they use the native pastures for foraging. The open cleared areas of native pasture are also important habitat for a number of more specialist grassland birds, such as the Australian Pipit and Stubble Quail.

Key messages:

- **Native pastures can support a significant diversity of birds and reptiles**
- **Paddocks with greater tree and ground cover will have greater diversity and abundance of animals**
- **Rotational or continuous grazing with low to moderate stocking will favour appropriate habitat structure and ground cover**

Reptiles

More than 20 different reptile species were found in surveys of native pastures in 2006/2007. Most of these were small skink species, such as the Three-toed Skink, Garden Skink and Boulenger's Skink, which are well adapted to agricultural environments. Many of the tree-dwellers, such as geckos, goannas, and the Tree Skink are rare in these pastures. Increasing the cover of woodland on the farm and in the landscape will benefit these reptiles.

Many animal species are favoured by the presence of permanent water, such as pools in streams or dams. Retention or replanting of trees and shrubs and maintenance of a diverse groundlayer around water can be beneficial for a large diversity of species.

Trees and fallen timber are linked to greater bird and reptile numbers.

"we want to create a profitable and regenerative farming system that has healthy livestock, a high diversity of plant and animal life and well vegetated creek areas"

sheep producer, Gundagai, NSW

Grazing

Grazing management is important in determining which animal species are abundant in native pastures. Many of the woodland birds are favoured by moderate, continuous grazing, which creates open short areas within which they can forage. Some of the small skinks are also most abundant in these pastures. Rotational grazing with long rests can reduce bird diversity and abundance, although it does favour some of the less common birds that feed on long grasses.

Recommendations for integrating management of bird and reptile diversity into farm management

1. Maintain or increase areas with different habitat – trees and woodland patches, open pasture and large dead trees. Provide ground cover with good leaf litter but also with some bare patches, rocks and rocky outcrops as well as fallen timber, perennial grasses, wildflowers and shrubs.
2. Avoid cultivation in areas where ground layer may be providing reptile habitat.
3. Provide a variety of grazing management strategies across farms and regions.
   - selective patch grazing through continuous grazing at low stocking rates, can provide a variety of ground cover types and grass structures
   - grazing at low stocking rates can help maintain a diversity of plant types - shrubs, tussocky grasses, herbaceous plants such as wildflowers and orchids, perennial grasses. Each is a potentially different source of food for animals
   - use long rests to favour less common birds that use long grasses
4. Encourage tree and shrub recruitment. Crash graze or burn in late summer/early autumn to create gaps for seeds to germinate, and rest paddocks following periods of above average summer rainfall.
5. Control feral predators such as foxes and cats.

How to identify your best native pasture paddocks for bird and reptile biodiversity

Are there areas of scattered tree cover? There are significantly higher numbers of birds and reptiles found in association with paddock trees because of greater habitat (food, shelter, shade, refuge from predators). However, open areas of pasture are also important for a small range of specialist species.

Has the paddock been cultivated ie. ploughed or scarified? Minimal soil disturbance will allow ground layer elements to remain intact and so provide suitable habitat, including soil and leaf litter layers, logs, rocks and rocky outcrops, shrubs and tussocky grasses.

Has the paddock been fertilised? If little or no superphosphate has been applied, it is likely to contain a higher diversity of native plant species, such as tussocky grasses, enhancing animal habitat.

Has the usual grazing regime been at low to moderate stocking rates? If so, it is likely to have better groundcover such as shrubs, tussocky grasses, herbaceous plants such as wildflowers and orchids, perennial grasses and leaf litter.

On the ground

The ground layer teams with life

Birds, mammals, reptiles and insects thrive in the 'ground layer' where they forage, feed, build their nests, and shelter from predators. A diverse ground layer habitat is composed of a variety of grass tussocks, a diversity of wildflowers, shrubs, ground litter, fallen timber, surface rocks and even bare earth. These are all critically important elements for the maintenance of biodiversity and a well functioning pasture ecosystem.

"My aim is to increase the native ground cover, biodiversity and the trees up in the hills"

sheep & cattle producer, Holbrook, NSW

Key messages:

- **Birds, mammals, reptiles and insects require habitat that includes a diverse ground layer**
- **Biodiversity on the ground results from management decisions affecting ground layer habitat**
- **Manage for production and biodiversity with 70-100% cover of native grasses, litter, logs etc.**
- **A diverse range of ground layer structures is the best underpinning for long-term, low-input, low-risk grazing**

A diverse ground layer of tussock and creeping grasses with native legumes and wildflowers shrubs, fallen timber, leaf litter, bare ground and tree regeneration.

More than half of the birds classified as declining woodland species are dependent on the condition of the ground layer where they forage amongst leaf litter and grasses for invertebrates and other food. Other bird species, such as skylarks and quail, nest on or near the ground layer. Some animals such as the Olive Legless Lizard are only abundant in areas with little or no tree cover and a dense layer of native perennial grasses.

The Olive Legless Lizard is found in open pastures where it uses groundcover such as rocks and tussocky grasses for shelter.

"my main goal is to improve the biodiversity, get the plants back, keep good groundcover and be profitable but not damage the country"

merino producer, Alexandra, Victoria

Ground layer for production and biodiversity – tussock grass

Large tussock forming grasses such as Poa tussocks, Wiregrass (*Aristida*), Red-anther Wallaby Grass (*Joycea pallida*) and Kangaroo Grass (*Themeda australis*) when not heavily grazed, give the ground layer an inherent diversity of structure.

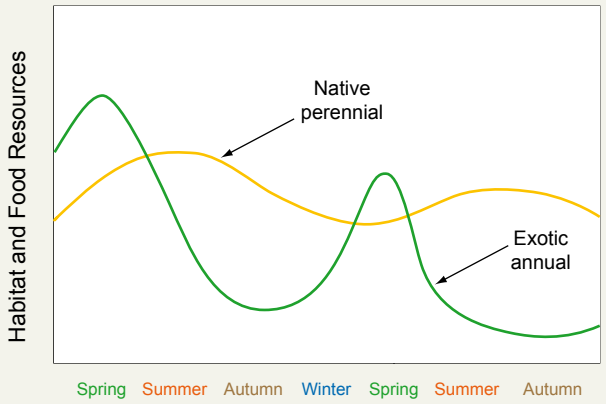
These tall tussocks can also have production benefits. Soils are warmer in winter and wind speeds are reduced near the base of tussocks. This can extend the growing season of plants between the tussocks and provide shelter for young livestock.

"our aim is to be a commercial enterprise, with good groundcover and biodiversity"

merino producer, Boorowa

Manage for long-lived perennial pastures

Perennial dominated pastures provide resilient animal habitat – producing some food (seed, pollen and insects) and shelter throughout the year. Exotic annual pastures can provide lots of food resources and cover in spring. In summer however, the dense annual pasture of springtime almost disappears, leaving little shelter for ground-dwelling species or forage for ground feeders.



The predicted availability of habitat and food resources in the groundlayer over two years in a diverse native pasture and a low diversity annual dominated pasture.

Grazing modifies ground layer habitat structure

Light stocking - In large, lightly stocked paddocks a range of pasture structures are created – some areas are heavily grazed and preferred by livestock ("grazing lawns") while others are rarely grazed and support tall tussocks or low shrubs.

This patchiness is important for animal species that use a range of pasture structures. It also provides a range of microclimates (e.g. a variety of soil temperatures, soil moistures and light availability) that can be important for plant diversity.

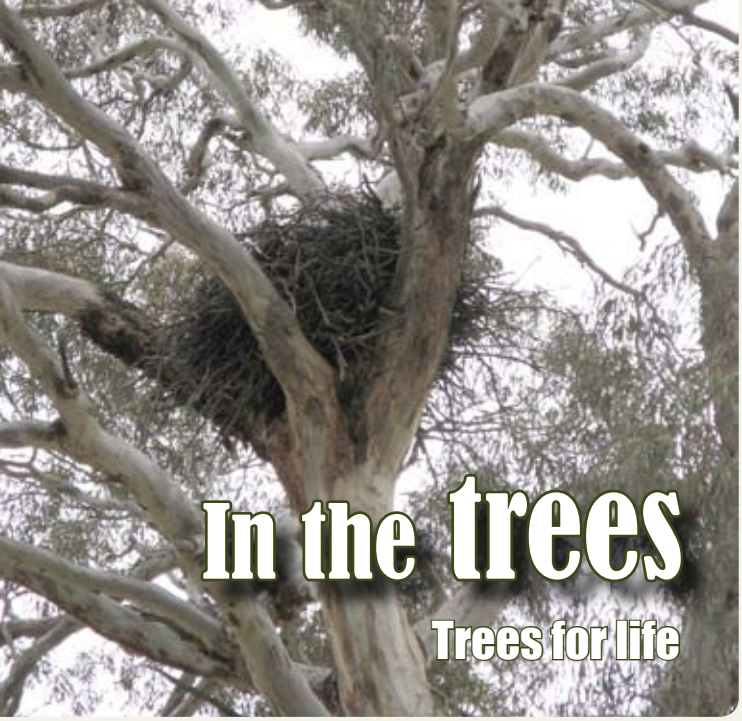
This lightly continuously-stocked pasture has a good cover of creeping grasses between tussocky plants.

Intensive regular grazing can eliminate this patchiness, removing lightly grazed areas. Such pastures provide little shelter and a homogeneous habitat favoured by fewer plant and animal species.

Rotational grazing can create a quite different habitat structure. Rotational grazing practices that aim for 100% cover year round, particularly through short grazing times and long rests, can produce a fairly even habitat structure, dominated by tall perennial grasses, with inter-tussock spaces covered in litter.

Some rotational paddocks have very high litter cover between tall perennial grasses.

Tall pastures can provide important habitat for some species (e.g. quail or legless lizards), but most birds and reptiles in pastures need some open bare spaces in which to forage or bask. Our research found fewer birds foraged in pastures with little bare ground.



Paddock trees such as these could be gone within 100 years, and so need careful management.

"on the steep hill country our aim is to increase the trees, not production"

sheep producer, Alexandra, Victoria

Trees are an essential part of productive and biodiverse native pasture landscapes

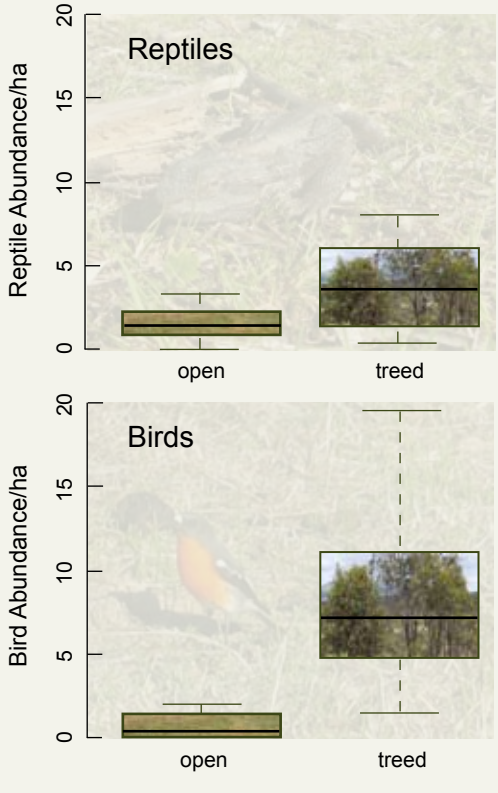
Paddock trees, such as Yellow Box (*Eucalyptus melliodora*), White Box (*E. albens*), River Red Gum (*E. camaldulensis*), Red Box (*E. polyanthemos*) or Red Stringybark (*E. macrorrhyncha*), provide an important cultural and ecological link to earlier extensive woodland systems. They support wildlife and contribute more than just beauty to grazing properties. But paddock trees are declining and most could be gone within the next century. As a result, remaining trees need careful management for the long term.

Native pastures with scattered trees are more diverse

Native pastures with scattered paddock trees support a greater diversity and abundance of birds, reptiles, invertebrates and plants. Trees create variation in light, water availability and nutrients providing a range of microhabitats for reptiles, plants and invertebrates.

Key messages:

- **The number of species of native plants, bird and reptiles increase where trees occur in paddocks**
- **Tree cover can improve productivity by providing livestock with shade and shelter**
- **Native pastures with open grassy areas, scattered trees and woodlands contribute to landscape health through deep nutrient cycling, improving soil condition and reducing the risks of dryland salinity**



The abundance of birds and reptiles is greater in uncleared native pastures with paddock trees.

Trees are important for maintaining landscape health

Research has shown that woodland trees can increase infiltration of water into soils by up to seven times. They can increase soil fertility by extracting soil nutrients from depth and making them available through leaf fall.

Trees dramatically alter local climate, providing shade from sun and shelter from wind. Tree shelter markedly increases lamb survival, wool production and livestock weight gain.

"they went into the bush and came out in really good condition in spring time"

cattle producer, Jugiong, NSW

Paddock trees offer shelter and shade for livestock, increase water infiltration and soil fertility, while benefiting native plant and animal diversity.

Trees also have an important role in reducing ground water levels and preventing dryland salinity.

A diversity of woodlands

The most diverse native pastures will be those with mosaics of open and treed areas, scattered and clumped trees, young regenerating trees and old paddock trees with hollows. To promote biodiversity, manage for a range of tree densities, from scattered paddock trees to dense remnant woodland.

Maintaining paddock trees in productive areas as well as on the hills is important. For example, Blakely's red gum (*Eucalyptus blakelyi*) is restricted to better soils and is often used for nesting by the Superb Parrot.

The most precious resource for wildlife on properties is mature eucalypts with hollows. These take hundreds of years to establish, but can be easily killed through benign neglect.

"we have more tree lanes now, which are adding to the environment "

sheep producer, Yass, NSW

How to maintain trees in the landscape

Paddock trees are an important source of seed for regeneration – natural regeneration can be more cost-effective than planting or direct seeding. Continuous year-long grazing and high soil nutrient levels reduce the health of adult trees and prevent regeneration.

However, the right combination of grazing management and seasonal conditions will increase the chances of getting seedlings established. The best chance of regeneration will be when the following elements are all present:

- seed fall from parent tree
- gaps in pasture (grazing or a good drought helps!)
- reduced competition from pasture (lower soil nutrients)
- good soil moisture for germination (so they grow in the gaps)
- a wet summer (to keep the seedlings going)
- no grazing until seedlings well established

"we also have 20% of the property for conservation and biodiversity management, and with tree and shrub regeneration"

sheep producer, Gundagai, NSW

Heavy grazing prior to autumn can create ideal seed bed conditions, free of competition. Rest from grazing, particularly during years of good rainfall, is required to give germinating seedlings a chance to establish. Temporary fences can be erected around existing trees, providing the fence is at least 30 m beyond the tree's canopy (seedlings do not tend to establish under the canopy of a mature tree). For best results, target paddocks with a good population of scattered trees and a low fertiliser history.

"we have fenced ridgelines for natural regeneration on this marginal country"

sheep producer, Gundagai, NSW

Soils

Healthy soils on a healthy farm

With so many economic and climatic pressures on grazing enterprises it is easy to forget just how important soil health is to farm sustainability.

"we're looking after the microbes as well"

cattle producer, Yackandandah, Victoria

The 2006 drought imposed enormous pressures on farming businesses and on soils.

Soils, together with plants, determine the productive capacity of pastures. A healthy soil needs to provide adequate water, air, nutrients and physical support for healthy pasture growth.

In a biodiverse pasture, a soil also needs to support animal life (eg. mammals, birds, reptiles and invertebrates) that contribute to the overall ecological health of the system.

Key messages:

- **Soil biological activity supplies nutrients to plants but depends on sufficient carbon in the soil**
- **Maintaining a healthy, well protected soil depends on the right balance of grazing with plant production**
- **Unfertilised soil is fungal-dominated and nutrients are tightly recycled within plant tissues**
- **Fertilised, heavily-grazed soils are more prone to nutrient loss and erosion**
- **In low fertility environments biological soil crusts protect soils from erosion but can be disrupted by grazing**

Managing pastures = managing soils

Issues for healthy soil management have much in common with those of pasture management. Heavy grazing reduces the amount of organic matter that is available for recycling back into the soil and reduces the food source for soil life. Good quality and quantity of soil organic matter is fundamental to the diversity and abundance of invertebrates (e.g. beetles, worms), fungi, bacteria and algae, which in turn assist with nutrient access and improve soil structure for adequate air and water supply to plants.

Soil micro-organisms, using organic carbon as a food source, form aggregates of soil particles that retain sufficient soil moisture for plant use while creating space between aggregates for air and drainage of excess water. Burrowing activities of larger soil invertebrates (e.g. earthworms, termites) mix organic matter and mineral soil increasing the depth of improved soil conditions.

"I want to get the topsoil back by getting the soil microbial activity going and creating strong perennial grasses"

sheep producer, Alexandra, Victoria

Keeping microbes = keeping nutrients

Australian soils are naturally poor in phosphorus and low in available nitrogen. Pasture plants in low nutrient soils obtain up to 80% of their

nitrogen and phosphorus through symbiosis - a close association between two organisms. Pasture plants can have symbiotic associations with fungi or bacteria. Legumes commonly have bacterial associations while grasses, trees and shrubs often have mycorrhizal fungi attached to their roots. These symbioses can also increase the ability of plants to obtain water and repel disease and insect attacks.

Mycorrhizal fungi hyphae (fine white threads) on plant roots assist plant uptake of nutrients.

In low fertility soils, the plants and microbes retain nutrients in their tissues. This can change when fertiliser and heavy grazing are imposed, with bacteria becoming more dominant and mycorrhizal fungi declining. This leads to more rapid cycling of nitrogen and, instead of being recycled in tissues, it become freely available in the soil. Grazing will also contribute by creating a greater availability of nutrients due to cycling though dung and urine. This is why heavily fertilised and grazed pastures are more prone to loss of nitrogen; being more available in the soil water, it is more readily washed away into dams and creeks.

"we don't use traditional fertilisers because we want to stimulate the soil microbial activity to drive the pasture growth — we are trying to increase this on our hills."

sheep producer, Alexandra, Victoria

Nutrients are also transported out of paddocks on soil particles as a result of soil erosion. Low-nutrient soils support plants with persistent, long-lived leaves and stems. Cover is easier to retain, leading to soil protection and better water infiltration and water capture.

Using grazing to manage soils

Building up fine and coarse litter on the soil surface and managing grazing to promote perennial plants can slow down nitrogen cycling and loss, reduce annual plant abundance and encourage fungal activity.

Although using stock to assist rapid breakdown of plant material is common, there are trade offs. At times, plant cover can be low on unfertilised soils, and biological soil crusts (mosses, algae, liverworts and lichen) play an important role in stabilising the soil surface between plants and preventing soil erosion. Soil crusts "bind" loose soil particles together.

"we like to keep good ground cover, and look after the water quality and riparian areas"

merino producer, Boorowa, NSW

In dry, low nutrient areas, soil crusts are crucial in protecting soils from water and wind erosion, improving soil water infiltration and providing places for germination of plant seedlings. Any grazing that disturbs the soil surface can rapidly remove these fragile organisms.

Even when biomass is low soil crusts can stabilise soils if they are not disrupted by trampling. Here the soil crust consists of moss, algae and lichens.

Farm planning for soils

Land managers need to identify places on a farm or in a catchment that are most prone to soil surface erosion and rapid water run-off. Protecting these areas from heavy grazing, encouraging soil crusts and the build up of litter and perennial plant cover will help retain water, soils and nutrients on the farm.

Climate

Managing change to minimise loss

Over the next 20-50 years the Murray Darling Basin can expect decreased rainfall, higher average temperatures, more evapotranspiration, more dry days, increased drought and intensified fire weather. With past weather patterns no longer providing a reliable guide, where a manager adapts to prevailing conditions, risks can be reduced and opportunities increased.

"we had no feed on any of this place during the drought – it was a dust bowl"

cattle and sheep producer, Gundagai, NSW

It makes sense to plan for an uncertain climate and native pastures can play an important role in any climate risk strategy.

Key messages:

- **Climate change is real – but there will be local variations**
- **Monitor for change to provide opportunity for faster response**
- **Perennial native pastures provide resilient paddocks during dry conditions**
- **Trees may become increasingly important for livestock and pasture protection**
- **Rotational grazing may provide more options and greater flexibility during drought**
- **Agistment and trading can be important strategies for increasing flexibility in the system**

"we are not prepared to go through another '82, '94, or '02 and we are adapting our management to be certain of this – where I have been I am not prepared to go back to"

cattle producer, Boorowa, NSW

Native perennial plants can survive and persist under severe drought conditions. For example native grasses survive on the few showers that may fall during drought, and are quick to respond to drought breaking rains.

Redleg grass (Bothriochloa macra) and native lovegrasses (Eragrostis spp) responding to late summer showers during the 2006-2007 drought.

"our length of growing season has increased with the native perennials – we never used to get feed in summer after rain"

sheep producer, Alexandra, Victoria

A diversity of plant species will be critical for managing climatic variability. No two paddocks should be alike. Long-lived plants, including trees, shrubs and tussock grasses may be the most resilient to dry conditions.

Good perennial cover prevents wind and water erosion on hills, lessens the impact of summer storms, limits the fouling of dams and waterways and reduces loss of vital nutrients and topsoils.

Continuous grazing in dry times can lead to soil surface degradation, loss of perennial plants and break-down of litter cover.

Loss of litter and plant cover and severe soil surface degradation caused by continued grazing during the 2006 drought.

An early reduction in stock numbers, and as much rest from grazing as possible are essential drought management techniques, which also makes good business sense – forced selling as drought worsens is seldom profitable.

"we had too many sensitive (stud) livestock during the drought"

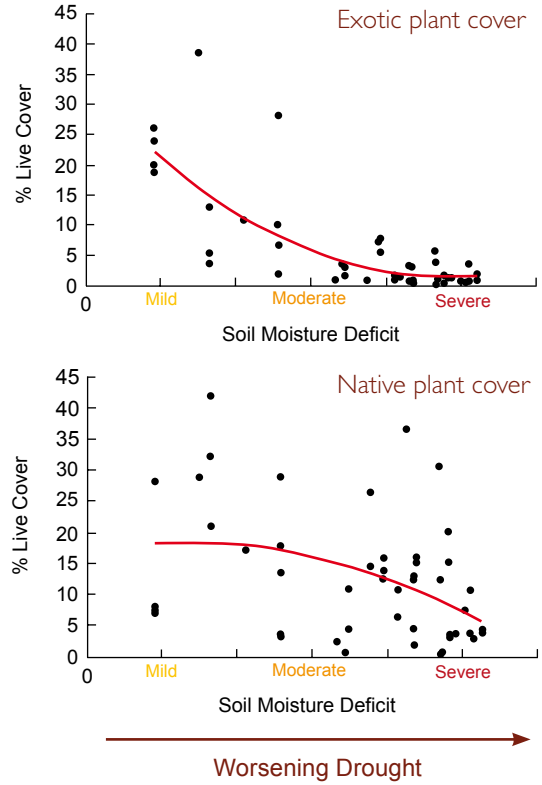
cattle producer, Holbrook, NSW

"you can sell steers if there's no Spring – can lengthen your rest period then"

cattle and sheep producer, Yass, NSW

Management, drought and pastures

During the 2006 drought, live native perennial plant cover on the slopes of southern NSW and NE Victoria was little affected by drying conditions. Native perennial plant abundance was largely determined by grazing pressure and past fertiliser use. Exotic dominated pastures quickly collapsed under the worsening conditions.



Many of the native dominated pastures had good levels of live cover despite severe soil moisture deficits.

During the same drought, properties with rotational systems with few grazing days and long rest periods retained greater 'bulk' with more litter between tussocks. This litter is not as resilient as live plants, but it insulates soils and helps retain moisture, and provides some protection against wind and water erosion.

Litter between tussocks in a rotationally grazed pasture.

Coping with change

Example: minimise the proportion of key breeding stock and maximise the number of saleable stock, such as steers or wethers.

"owning stock that can be sold easily is the key"

cattle producer, Boorowa, NSW

"the all wether operation enables me to easily reduce stock numbers so pastures get a rest in summer, and if it doesn't rain in autumn I don't restock"

wool producer, Yass, NSW

Example: invest in trading and agisting. Of the 24 farms studied 8 use trading or agistment to provide flexibility in stock numbers.

"agistment gives us flexibility in the system"

sheep producer, Gundagai, NSW

"cattle trading allows us to bring them on and take them off when we want"

cattle and sheep producer, Gundagai, NSW

Example: use rotational grazing to predict feed usage and therefore market advantage.

"Having the flexibility to manage rest and recovery is essential to predict when to destock – lots of paddocks and a single mob is the key"

cattle producer, Yackandandah, Victoria

Example: create containment areas for maintaining core breeding stock on country that is arable, easily re-sown and not prone to erosion.

CSIRO and Bureau of Meteorology, Climate Change in Australia, Technical Report (2007):

If CO_2 emissions are low, warming of between 1 °C and 2.5 °C is likely by around 2070. Under a high emission scenario, warming by 2.2 °C to 5 °C is predicted.

There will be changes in temperature extremes, with substantially more days above 35 °C.

Rainfall will decrease by up to 10% in southern areas during winter, in the south and east during spring, and along the west coast during autumn. When it does rain, rainfall is likely to be more intense.

Under a scenario of a 2.7°C temperature increase the average number of days per annum that livestock suffer from heat stress will increase. For example, in the Yass district, heat stress days are currently less than 10% but will increase to 20-30%.

Business matters

Native pastures can be profitable

Maintaining and managing native pastures can be a more profitable long-term strategy than establishing and maintaining sown pastures. Gross margins on native pastures can range from $30 to $250 per hectare. Importantly, low input native pastures can be profitable in areas where the persistence and profitability of sown pastures is poor. High input pastures are most suited to arable, productive soil landscapes.

"it appears that native pastures will fill the niche"

cattle producer, Boorowa, NSW

Key messages:

- **Biodiversity can complement farm business**
- **Native pastures can be profitable and productive**
- **Managing for high productivity and biodiversity requires identifying the most suitable paddocks**

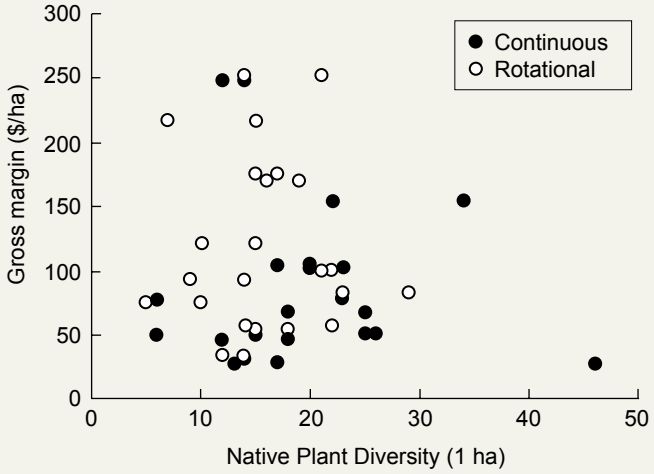
Highly productive native pastures are rarely diverse

Some native pastures, notably those dominated by Weeping Grass (*Microlaena stipoides*), respond to fertiliser inputs and can be highly productive (up to and greater than 12 DSE per hectare). But these pastures are rarely diverse and are unlikely to provide all of the ecosystem values of more diverse low input native pastures.

Highly productive weeping grass pasture.

Productivity does not always = profitablity!

Lower input, diverse native pastures can also be profitable – either in their own right or as part of a whole farm management strategy.



The profitability of native pasture paddocks (as gross margin per hectare) is not related to their diversity.

"the whole thing revolves around trying to keep costs down"

sheep & cattle producer, Gundagai, NSW

Diverse low input pastures cannot support high densities of livestock, but if grazed appropriately to maintain high plant cover and diversity, they should continue to sustain grazing animals indefinitely.

"cattle always do well out there in that native pasture paddock"

sheep & cattle producer, Boorowa, NSW

Alternative income

In the near future diverse low input native pastures and grassy woodlands could provide alternative income sources through payments for biodiversity management, ecosystem services and carbon capture and storage. The federal and various state governments have already trialed market-based incentive payments to purchase the provision of a range of ecosystem services, including habitat enhancement, and management to encourage eucalypt and native pasture recruitment.

"ecosystem services, salinity, carbon, water quality and biodiversity credits would ideally provide us with passive income in the future"

sheep & cattle producer, Gundagai, NSW

Graziers and land managers are recognizing that integration of native perennial plant species into grazing regimes makes good economic sense.

Integrating native pastures into the whole farm system

"the landscape is the most important thing–it's the support base for the whole system"

cattle producer, Boorowa, NSW

Whole farm planning requires identifying key lifestyle, business and environmental goals so that production and ecological benefits can be achieved on a single property.

"my overall goal is not to be too hard on the country — taking on holistic management principles means I sleep much better now and have more spare time"

merino/ l st cross producer, Binalong, NSW

Fencing and other management decisions can enhance and use natural variation such as soils, aspect and pasture types. For example, rather than spreading inputs over the farm, intensive management (fertilisers, labour, pasture sowing and tree lanes) may be most profitably directed towards more arable soils (Landclass 1-3).

"we have a mix on the place from some sown areas to areas we have never touched"

cattle, merino/crossbred producer, Boorowa, NSW

"we would consider utilising the lower country more intensively"

sheep & cattle producer, Alexandra, Victoria

Identify 'leaky' sites

Areas such as steep slopes or drainage lines, have potential for leakiness, where high rates of water flow cause nutrient and soil loss. Identify these sites on farm and capture or prevent any water, soil or nutrient losses by managing grazing for maximum perennial ground cover and including more extensive planting of trees and shrubs. Areas with a history of little or no fertiliser, cropping or pasture sowing and with scattered paddock trees are likely to support high plant diversity and provide good habitat for native animals. These areas may be best managed using low stocking rates and regular resting - fencing of these areas will make management simpler.

Balancing production, profit and biodiversity?

Many of the most diverse native pastures and woodlands occur in large low fertility pastures that were traditionally managed through light, year round grazing with wethers. This management has often lead to soil degradation and prevented tree regeneration.

Traditional wether country often has highly diverse pastures.

Despite the low labour costs of an all wether operation, numerous factors (eg. poor wool prices, drought, labour shortages, infrastructure decline and occupational health and safety requirements) have led to many graziers concluding that wool production, and wethers in particular, are too much trouble. Now cattle or ewes are typically run in the wether paddocks. This brings trade-offs. Cattle and ewes have higher quality feed requirements than wethers, necessitating either lower stocking rates, sub-divisional fencing, spreading of fertiliser or pasture sowing. Fertiliser and pasture sowing result in biodiversity losses, although if combined with lower stocking rates, subdivisional fencing and strategic rest, pasture cover could be improved. Balancing biodiversity, other environmental outcomes and production in these changing landscapes will be challenging.

Further Information

MANAGEMENT GUIDES

Eddy, D.A. (2002) *Managing Native Grassland: a Guide to Management for Conservation, Production and Land Protection.* World Wide Fund for Nature, Sydney.

Langford, C.M., Simpson, P.C., Garden, D.L., Eddy, D.A., Keys, M.J., Rehwinkel, R. & Johnston, W.H. (2004) *Managing Native Pastures for Agriculture and Conservation.* NSW Department of Primary Industries, Orange.

McIntyre, S., McIvor, J.G. & Heard, K.M. (2002) *Managing and Conserving Grassy Woodlands.* CSIRO Publishing, Melbourne.

Mokany, K., Friend, D., Kirkpatrick, J. and Gilfedder L. (2006) *Managing Tasmanian Native Pastures - a Technical Guide for Graziers.* Tasmanian Institute of Agricultural Research, Tasmania.

MONITORING

'PROGRAZE' grazing management skills course. Meat and Livestock Australia & State Agricultural Departments:

www.mla.com.au

Sharp, S., Dorrough, J., Rehwinkel, R., Eddy, D. & Breckwoldt, A. (2005) *The Grassy Ecosystems Management Kit: a Guide to Developing Conservation Management Plans.* Environment ACT, Canberra. Go to the ACT Department of Territories and Municipal Services website for information and order details at:

www.tams.act.gov.au/live/environment/native_plants_and_animals/grassy_ecosystems_management_kit

Environmental Monitoring Tools (download PDF's on land condition, farm management and water quality) at the Department of Primary Industries Victoria website at:

www.dpi.vic.gov.au/science/ems

Save the Bush Toolkit (1998). Environmental Studies Unit, Charles Sturt University, Bathurst and Orange Agricultural College, The University of Sydney.

ORGANISATIONS AND WEBSITES

Meat and Livestock Australia

Strategies to Boost the Productivity of Native Pastures;

Grazing Management for Productive Native Pastures;

Grazing Management of Danthonia *and* Microlaena*-based Native Pastures;*

Tips and Tools, Natural Resource Management series:

www.mla.com.au/

The Pasture Health Kit:

www.mla.com.au/pasturehealthkit

Making more from Sheep – a best practice package of information, tools and learning opportunities for Australian sheep producers:

www.makingmorefromsheep.com.au/

Future Farm Industries Cooperative Research Centre

Enhancing Biodiversity in Salinising Landscapes:

www.futurefarmcrc.com.au

Land Water and Wool

Extension Note 1: *Farm Business, Wool Production and Biodiversity*;

Extension Note 2: *How can Hill Country be Managed to be more Profitable*;

Extension note 3: *Using Natural Regeneration to Establish Shelter on Wool Properties*;

Northern Tablelands Fact Sheet 9. *Biodiversity & Wool Production - Answers to the Ten Big Issues*;

Northern Tablelands Fact Sheet 10. *How to Lift Wool Profits and Improve Biodiversity*;

www.landwaterwool.gov.au/

Land & Water Australia

www.lwa.gov.au/nativevegetation/

Stipa Native Grasses Association

www.stipa.com.au/

Grassy Box Woodland Conservation Management Network

www.gbwcmn.net.au/

Grasslands Society of Southern Australia

www.grasslands.org.au/

FACTSHEETS

How much habitat is enough?

www.lwa.gov.au/nativevegetation/library/scripts/objectifyMedia.aspx?file=pdf/61/26.pdf&siteID=6&str_title=How%20much%20habitat%20is%20enough.pdf

Bats and Paddock Trees

www.dse.vic.gov.au/CA256F310024B628/0/2F74FF9087FB9014CA25714B0010C0FC/$File/Bats+and+Paddocks+fact+sheet+May+2003.pdf

Farm Planning and Wildlife

www.dpi.vic.gov.au/dpi/nreninf.nsf/FID/-4B3008B8B29702C2CA256BCF0008881F?OpenDocument

SELECTED SCIENTIFIC RESEARCH

Barrett, G. (2000) Birds on Farms-Ecological management for agricultural sustainability. *Wingspan,* **10** (4).

Brown, G.W. (2001) The influence of habitat disturbance on reptiles in a Box-Ironbark eucalypt forest of south-eastern Australia. *Biodiversity and Conservation*, **10**, 161-176.

Chapman, S.K., Langley, J.A., Hart, S.C., & Koch, G.W. (2006) Plants actively control nitrogen cycling: uncorking the microbial bottleneck. *New Phytologist,* **169**, 27-34.

Dorrough, J., Yen, A.L., Turner, V., Clark, S., Crosthwaite, J. & Hirth, J.R. (2004) Livestock grazing management and biodiversity conservation in Australian temperate grassy landscapes. *Australian Journal of Agricultural Research*, **55**, 279-295.

Dorrough, J., Moxham, C., Turner, V. & Sutter, G. (2006) Soil phosphorus and tree cover modify the effects of livestock grazing on plant species richness in Australian grassy woodland. *Biological Conservation*, **130**, 394-405.

Garden, D.L., Lodge, G.M., Friend, D.A., Dowling, P.M. & Orchard, B.A. (2000) Effects of grazing management on botanical composition of native grass-based pastures in temperate south-east Australia. *Australian Journal of Experimental Agriculture*, **40**, 225-245.

Garden, D.L., Dowling, P.M., Eddy, D.A. & Nicol, H.I. (2001) The influence of climate, soil, and management on the composition of native grass pastures on the central, southern, and Monaro tablelands of New South Wales. *Australian Journal of Agricultural Research*, **52**, 925-936.

Garden, D.L., Ellis, N.J.S., Rab, M.A., Langford, C.M., Johnston, W.H., Shields, C., Murphy, T., Holmberg, M., Dassanayake, K.B. & Harden, S. (2003) Fertiliser and grazing effects on production and botanical composition of native grasslands in south-east Australia. *Australian Journal of Experimental Agriculture*, **43**, 843-859.

Johnston, W.H., *et. al.* (2003) The impact of pasture development and grazing on water-yielding catchments in the Murray-Darling Basin in south-eastern Australia. *Australian Journal of Experimental Agriculture,* **43**, 817-841.

Kirkpatrick, J. and Bridle, K. (2007) *People, Sheep and Nature Conservation: a Tasmanian Experience.* CSIRO Publishing, Melbourne.

Lunt, I.D., Eldridge, D.J., Morgan, J.W. & Witt, G.B. (2007) TURNER REVIEW No. 13. A framework to predict the effects of livestock grazing and grazing exclusion on conservation values in natural ecosystems in Australia. *Australian Journal of Botany*, **55**, 401-415.

Manning, A.D., Fischer, J. & Lindenmayer, D.B. (2006) Scattered trees are keystone structures - Implications for conservation. *Biological Conservation*, **132**, 311-321.

McIntyre, S., Heard, K.M. & Martin, T.G. (2003) The relative importance of cattle grazing in subtropical grasslands: does it reduce or enhance plant biodiversity. *Journal of Applied Ecology*, **40**, 445-457.

McIntyre, S. (2005) Biodiversity attributes of different sward structures in grazed grassland. *Ecological Management and Restoration*, **6**, 71-72.

Michalk, D., *et. al.* (2003) Sustainable grazing systems for the Central Tablelands, New South Wales. *Australian Journal of Experimental Agriculture*, **43**, 861-874.

Prober, S.M., Lunt, I. & Thiele, K.R. (2002) Determining reference conditions for management and restoration of temperate grassy woodlands: relationships among trees, topsoils and understorey flora in little-grazed remnants. *Australian Journal of Botany,* **50**, 687-697.

Prober, S.M., Thiele, K.R. & Lunt, I. (2002) Identifying ecological barriers to restoration in temperate grassy woodlands: soil changes associated with different degradation states. *Australian Journal of Botany*, **50**, 699-712.

Prober, S.M. & Thiele, K.R. (2005) Restoring Australia's temperate grasslands and grassy woodlands: integrating function and diversity. *Ecological Management and Restoration*, **6**, 16-27.

Vesk, P.A. & Dorrough, J. (2006) Getting trees on farms the easy way? Lessons from a model of eucalypt regeneration in pastures. *Australian Journal of Botany*, **54**, 509-519.

- **Management guides**
- **Monitoring**
- **Organisations and websites**
- **Factsheets**
- **Selected scientific research**

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