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ThinkingBush

Science for managing native vegetation in Australian landscapes

Managing native vegetation *in agricultural landscapes*

The whys and hows of native VEGETATION MANAGEMENT

CONSERVING *genetic diversity*

Getting the most out OF RESTORATION

FROM BUSH BLOCKS *to landscapes*

Crunching the costs of **biodiversity conservation**

PLUS STORIES FROM ***Land, Water & Wool***

NATIVE VEGETATION RESEARCH AND DEVELOPMENT PROGRAM

Contents

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*Thinking*Bush

CHANGING PERCEPTIONS AND VALUES ABOUT NATIVE VEGETATION AND HOW IT CAN BE MANAGED

Welcome to this third edition of *Thinking Bush*, the magazine for those who value Australia's landscapes and vegetation. The theme of this edition is 'managing native vegetation in agricultural landscapes'.

The relationship between agriculture and Australia's bush has not always been a comfortable one. In the early days, the intent was to replace our native vegetation with European plants, layouts and management methods; things more familiar to the new settlers.

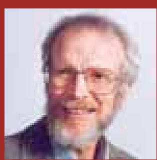
We now have a better understanding of our unique landscapes and how they 'work together' with our climate and native fauna. We are still learning how our agricultural systems can most productively match our native landscapes and vegetation.

This bumper edition of *Thinking Bush* progresses that understanding.

It includes articles on wildlife and biodiversity, fire and vegetation restoration and how these can benefit agricultural production. If you are interested in how you can design and manage your landscapes there are articles which will be of help to you.

The recent Ecological Society of Australia conference included a Symposium on 'Thresholds', which was sponsored by the Native Vegetation R&D Program. The report on the Symposium makes stimulating reading. If you are interested in the wool industry, an eight page lift-out describes the research being undertaken by the Land, Water & Wool Native Vegetation and Biodiversity Subprogram.

I hope you enjoy reading this edition and I'm sure you will find something of value in it.



John Childs
Director, Land & Water Australia
Chair, Native Vegetation R&D Program

THE OVERSTOREY

- The main points from each *Thinking Bush* article are summarised in 'The Overstorey'.
- Look for 'The Overstorey' throughout this issue to get the latest facts and know-how on native vegetation management in agricultural landscapes.

What is the *Native Vegetation R&D Program?*

Australia's leading broker of research into native vegetation management in agricultural landscapes.

It has funded over 50 projects on the ecological, social and economic dimensions of native vegetation management and conservation. The Program generates knowledge through research & development to enable government agencies, community groups and landholders to better understand and manage native vegetation in agricultural landscapes.

Land & Water Australia manages the Native Vegetation Research & Development Program in partnership with CSIRO Sustainable Ecosystems, CSIRO Plant Industry and the Murray-Darling Basin Commission. Land & Water Australia is a statutory corporation established under the Primary Industries and Energy Research and Development Act 1989, within the Australian Government Agriculture, Fisheries and Forestry Portfolio.

Managing native vegetation in agricultural landscapes: why and how?

Farmers, managers and scientists discuss the functioning of remnant vegetation in the WA wheatbelt. Photo: Richard Hobbs

By Professor Richard Hobbs

The articles in this issue of *Thinking Bush* present a broad spectrum of findings and ideas arising from recent research projects. On the face of it, the different articles present a bewildering array of different things to consider in the area of native vegetation management in agricultural landscapes—genetic issues in relation to revegetation, the value of individual paddock trees, the dynamics of native vegetation within remnants, the relative value of conserving remnants versus revegetation, the multiple spatial scales that need to be considered, and ways to decide what needs to be done where. What is to be made of it all? Does it all make sense, and can we do a better job now than we have been able to in the past?

The first point is that we are still coming to terms with how to manage native vegetation in the agricultural landscapes of Australia. Our understanding of what is important and what needs to be done to retain and improve the habitats left within remnants and to revegetate effectively has increased dramatically over the past decade or so. But we still don't know everything. Many of the changes brought about by vegetation clearing or farm development are still working their way through the system, and the impacts on the native vegetation and the fauna it supports can be subtle and surprising. Often we need to know a lot about individual species before we can either detect what's happening or provide management responses. Unfortunately, we don't know very much about most of the species of plants and animals that we want to conserve. That's why there's still a lot to be done. However, we can't wait for all the necessary information to be gathered, because most of what we

THE OVERSTOREY

- Our understanding of the ecological processes that both sustain and degrade native vegetation remnants in agricultural landscapes is still evolving.
- Equipped with existing knowledge and an adaptive approach to management, we need to develop and implement guidelines to better manage native vegetation in agricultural landscapes to address the decline in native species diversity.
- Effective conservation programs have clear, strategic objectives that are developed to meet the needs and circumstances of a given landscape.

'Many of the changes brought about by vegetation clearing or farm development are still working their way through the system, and the impacts on the native vegetation and the fauna it supports can be subtle and surprising.'
Richard Hobbs

want to conserve may have disappeared by then.

So we need to keep gathering the relevant information, but at the same time be clever about coming up with best-bet guidelines and approaches that can be applied straight away. If we're even smarter, we can start applying the guidelines based on what we know today AND use the experience to improve our knowledge further—this is what's known as adaptive management, and it's a great idea, but it's still hard to apply effectively.

So what can we say about managing our agricultural landscapes for biodiversity?

If a series of conservation goals is developed for a region, how do we best achieve these goals? A set of general principles suggests that big patches of native vegetation are better than small patches, connected patches are better than unconnected patches, and so on. This translates into the need to retain existing patches (especially large ones) and existing connections, and to revegetate in such a way as to provide larger patches and more connections.

Important questions concern the sort of landscape-level management and reconstruction that is appropriate for maintaining or developing habitat networks in different landscapes. If we can accept that priority actions involve, firstly, the protection of existing critical areas and the maintenance or redevelopment of landscape connectivity, we then need to set management priorities. The following questions need to be asked in any conservation planning process:

1. Which are the priority areas to retain?
2. Should we concentrate on retaining the existing fragments or on habitat reconstruction, and relatively how many resources (financial, manpower, etc.) should go into each?
3. How much reconstruction is required, and in what configuration?
4. When should we concentrate on protecting existing corridors or providing more corridors, versus protecting blocks of habitat or trying to provide additional habitat?

While we need to know the particulars of the landscape we are in to give clear answers to these questions, we can start by using the following set of guidelines, which have been developed from the array of Native Vegetation R&D Program-funded research reported in this issue of *Thinking Bush*.

1. Maintain existing habitat

Maintain existing condition of habitats by removing and controlling threatening processes. It is generally much easier to avoid the effects of degradation than it is to reverse them. The first priority is thus the maintenance of elements that are currently in good condition. These will be predominantly the remnants that remain in good condition, but may also include paddock trees and other small patches. Maintenance will involve ensuring continuation of population, community and ecosystem processes that result in persistence of the species and communities present in the landscape. Note that maintaining fragments in good condition may also require broader management activities to control landscape processes, such as water flows.

2. Improve degraded habitats

Improve the condition of habitats by reducing or removing threatening processes. Active management may be needed to initiate a reversal of condition (e.g., removal of exotic species, re-introduction of native species) in highly modified habitats. In some landscapes, buffer areas and corridors may be a priority, whereas in more fragmented landscapes, improving the landscape as a whole to reduce threatening processes will be a priority, together with improving the condition of fragments. Improvement may involve simply dealing with threatening processes such as stock grazing or feral predators, or may involve active management to restore ecosystem processes, improve soil structure, encourage regeneration of plant species, or reintroduce flora or fauna species.

3. Reconstruct habitats as a last resort

Reconstruct habitats where their total extent has been reduced below viable size using replanting and re-introduction techniques. Because this is so difficult and expensive, it is a last-resort action that is most relevant to fragmented and relictual landscapes. We have to recognize that restoration will not come close to restoring habitats to their unmodified state, and this reinforces the wisdom of maintaining existing habitat as a priority. Primary goals of reconstruction will be to provide buffer areas around fragments, to increase connectivity with corridors, and to provide additional habitat. The key principles to keep in mind are:

1. Build on strengths of the remaining habitat by filling in gaps and increasing landscape connectivity.
2. Increase the availability of resources by rehabilitating degraded areas.
3. Expand habitat by revegetating to create larger blocks and restoring poorly represented habitats.

Clear goals are the key!

If we are to make a significant impact in terms of conservation, the above questions need to be addressed in a strategic way. Although generalisations on connectivity and so forth are useful to a certain extent, most on-ground application will have to be related to the specifics of the landscape in question and the species involved. What do we want to achieve? Why?

More efficient solutions to conservation problems can be developed if we take a strategic approach rather than a generalised one. This involves developing a clear set of conservation objectives rather than relying on vague statements of intent. One set of objectives relates to the achievement of a comprehensive, adequate and representative set of reserves or protected-area networks. Another, complementary set of objectives relates to the adequacy of existing remnant vegetation (not only reserves); i.e., is the remaining native vegetation enough to ensure persistence of all the species present? The process of setting conservation objectives in any given area needs to focus on the particulars of the landscape and the species present. While scientists can inform this process, it needs to be done by the community as a whole. Clear goals and an understanding of why we've set them are the key first step to effective conservation management.

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'More efficient solutions to conservation problems can be developed if we take a strategic approach rather than a generalised one.'
Richard Hobbs

An aerial view of part of the WA wheat belt showing a remnant, some revegetation and scattered paddock trees - all important elements in our efforts to conserve biodiversity in agricultural landscapes. Photo: Richard Hobbs

From bush blocks to landscapes: wildlife conservation at different scales

By Andrew Bennett & Jim Radford

The strident 'spink' 'spink' 'spink' of a Brown Treecreeper echoes across a dry bushland block in northern Victoria. A movement low on the trunk of a large Grey Box tree attracts our attention, and a bird can be seen hopping up the tree in short jerky movements, with quick pecks at the bark as it progresses. It moves around the trunk out of sight, and then a blur of wings reveals a short flight to a fallen log on the ground. More rapid hops and pecks as it works along the surface of the dead timber, another strident call, and then a short flight to perch sideways on a neighbouring tree.

As we watch, our thoughts turn to the future of this 'declining' species. Will there always be Brown Treecreepers in this bushland block? Are they declining in this district? What is needed to ensure the survival of this distinctive species?

As we carry out our Native Vegetation R&D Program funded project on landscape level thresholds for conservation of biodiversity in rural environments, the importance of recognising the conservation requirements of wildlife at different spatial scales has become increasingly clear.

Brown Treecreeper (Climacteris picumnus) *Photo: Department of Sustainability and Environment/McCann*

THE OVERSTOREY

- Conservation management strategies should address species' habitat requirements at a range of scales, from the immediate habitat, which provides food, nesting sites and shelter, to the diversity of habitat resources available within the patch and other functionally connected patches, to the broader landscape scale.

Habitat scale

First, we need to think about the habitat features that a species requires at a particular site or location. The Brown Treecreeper, for example, does not occur uniformly in all bushland (see graph). When we look at the woodland habitat in which this individual lives, some distinctive features are obvious. The size of the trees at this bushland site stands out—many large old trees, some with dead limbs and obvious tree hollows. The Treecreeper repeatedly returns to one veteran tree and the chirrup of nestlings betrays the location of its nest in a tree hollow. Much of the Treecreeper's foraging occurs on the trunks of these larger trees, and on or around fallen timber on the ground.

Other wildlife species—birds, mammals, reptiles, frogs, invertebrates—each have their own habitat requirements. We can learn what these are by observing where individuals of a species feed, what foods they need, the shelter or refuge they use, and how and where they reproduce. Management at a site scale should aim to enrich the habitat value by restoring these particular components (e.g., native grasses, shrubs, fallen timber) that may have been removed by past practices.

Patch scale

A second scale at which we consider wildlife requirements relates to the block or patch of bush in which they live. Is it large enough for the home range of even one individual, or a breeding unit, or a population? The Brown Treecreeper, for example, occurs in small family groups that require about 6 hectares of woodland habitat. Therefore to provide for a small local population of five family groups, for example, at least 30–50 ha of suitable woodland vegetation is required.

Other aspects of a bushland block that affect its value for wildlife include its shape, the level of isolation from similar bushland, the range of vegetation types represented, and whether or not a stream or wetland is present.

Landscape scale

The third level necessary for understanding the conservation requirements of native wildlife is the 'landscape scale', an area equivalent to a sub-catchment or catchment, perhaps five to 50 kilometres across. This spatial scale is important because the total amount of suitable habitat and the overall size of a species' population determine whether or not a species can persist in a district. For example, a local bushland block may have a suitable habitat structure and be large enough for a family group of Brown Treecreepers, but the species will not survive in the landscape unless there are nearby bushland habitats to which young treecreepers can disperse, find mates and establish their own territories.

The need to consider the requirements of species at multiple scales, from site to block to landscape, illustrates the complexity of issues in wildlife conservation and the management of native vegetation. It also illustrates the need for land managers to work together for a common goal if the 'spink' 'spink' 'spink' of a Brown Treecreeper, and the sight and sounds of our many other native species, are to remain part of the heritage of rural Australia.

'The need to consider the requirements of species at multiple scales, from site to block to landscape, illustrates the complexity of issues in wildlife conservation and management of native vegetation.'

Andrew Bennett & Jim Radford.

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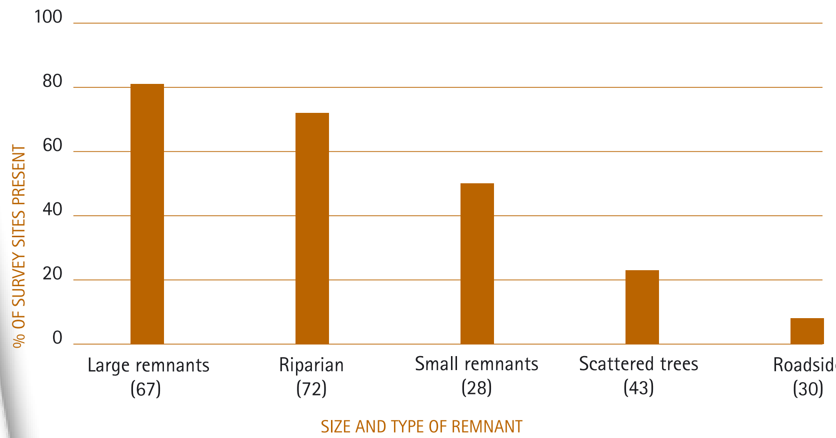
Fallen timber adds structural complexity to the habitat resources provided by a patch of remnant Grey Box (Eucalyptus microcarpa) in farmland along the Boosey Creek, near Tungamah, Victoria. Photo: Jim Radford



The frequency of occurrence of the Brown Treecreeper at 2 ha survey sites in different landscape elements in north-central Victoria. The number of sites in each element is shown in parentheses.

Crunching the costs and contributions of biodiversity on farms

By Ann Jelinek

Is it feasible to manage a farm for profitability and improve its biodiversity value? How can biodiversity conservation benefit farm productivity and how much does it cost?

Jim Moll, Josh Dorrough and Jim Crosthwaite of the Victorian Department of Sustainability and Environment are aiming to answer these questions as they undertake a research project funded by the Native Vegetation R&D Program. The team is delving into the human and environmental aspects of farming to assess the farmers' financial capacity, personal goals and interests, in addition to time and resources necessary to carry out strategic, biodiversity conservation activities.

THE OVERSTOREY

- Small and large farm operations can be managed for biodiversity and production.
- Participant farmers are keen to consider new management options for their farms that integrate assessments of their financial situation and their agricultural and biodiversity potential.

Biodiversity assessments

Initially, ecologist Josh Dorrough, assisted by Claire Moxham and others, carry out vegetation surveys on the eight study farms, which are representative of local farming enterprises and a range of landforms and vegetation types typical of central Victoria. Each farm is assessed within a landscape context, for example, its proximity to remnant vegetation or revegetated areas, and the condition and conservation status of vegetation communities present. Josh and the landholder then identify priority areas on the farm for biodiversity management and discuss options for implementing these activities.

Josh explains that, 'surprisingly, the least cost options may provide the most effective biodiversity outcomes, like implementing a particular grazing regime that promotes natural regeneration rather than excluding livestock altogether and revegetating the fenced out areas'.

Josh suggests that intermittent grazing compared with set stocking promotes a diversity of pasture plants, including a variety of native perennial grasses. 'This is particularly effective in the more sensitive hill country where there is most potential for productivity and biodiversity gains', he says.

Agribusiness perspective

According to Project Leader and Agribusiness Analyst, Jim Moll, 'the best part about the project is working with farmers who are so interested in production and environmental aspects of farming. They are keen to discuss new management approaches that integrate our assessments of financial, agricultural potential and biodiversity for their farm'.

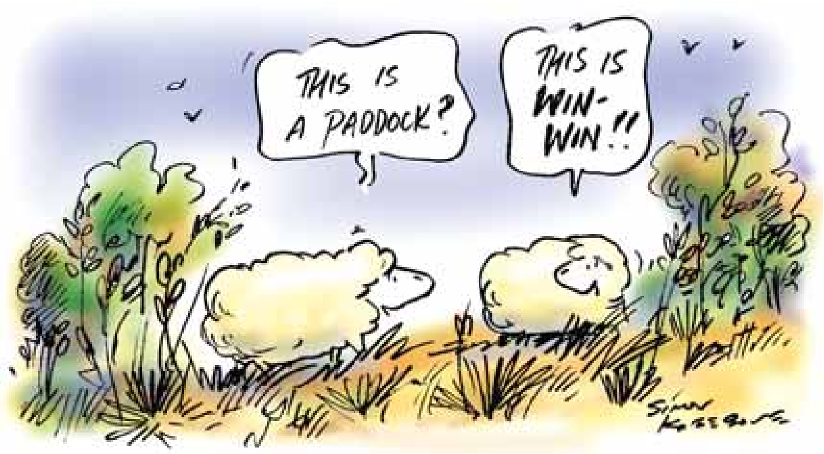
Jim is currently collecting and analysing financial data from the eight case study properties in addition to information on pasture production, utilisation and management, fertiliser applications and stocking rates. Jim will then assess how biodiversity can be enhanced on each farm and how overall farm production can be maintained or even improved. 'If we can get more even pasture utilisation, particularly on sensitive areas of the farm, then there is a better chance of improving biodiversity', says Jim.

Farmer views

Drusilla Green and Allan O'Connor own and manage "Honeysuckle", one of the case study farms near Violet Town in central Victoria. The farm is 214 hectares, of which 14 ha have been fenced out for natural regeneration. It supports 1500 dry sheep equivalent, dual purpose ewes for prime lamb and wool production.

Drusilla says 'participating in the project has helped me to focus more closely on the agribusiness aspects of the farm and also, to look at a range of land management options. I hope other landholders can also benefit from this exciting work'.

Using the whole farm plan they developed for "Honeysuckle", Drusilla and Allan recently reduced paddock



'Participating in the project has helped me to focus more closely on the agribusiness aspects of the farm and also, to look at a range of land management options. I hope other landholders can also benefit from this exciting work.'
Drusilla Green

Jim Moll with some of Doug Dunster's inquisitive sheep and revegetation work in the background. Photo: Ann Jelinek

Jim Moll and Drusilla Green inspect a discharge area with natural regeneration in the background. Photo: Ann Jelinek

'Our challenge is to identify the most effective and practical ways of managing biodiversity while also maintaining farm profitability.'
Jim Moll

size on their property to assist with improved sheep pasture use. From 15 paddocks eight years ago, they now have 25 smaller paddocks as well as three reserve areas that are only intermittently grazed, such as towards the end of the dry. Drusilla adds, 'My main interest is to get a good chemical balance in the soils and understand more about manipulating these to achieve healthy, productive pastures'.

Referring to a persistent erosion area, Drusilla says enthusiastically, 'What really excites me is the extent of natural regeneration in discharge areas subject to salinity where I would least expect it'.

Doug and Chris Dunster run 3500 DSE merino ewes on "Quendale", a larger case study farm in predominantly plains country, north of Violet Town. "Quendale" is 364 ha and the Dunsters lease an additional 243 ha. Some of the ewes are joined to Dorset rams to produce fat lambs for cash flow, while the better quality ewes are joined to merinos for medium to fine (19–20 micron) wool production.

Doug finds the project interesting because he hears about new ideas. 'I may not always agree with them but I am happy to look at options', he says.

With the assistance of various grants, Doug has already fenced out a major creek line and revegetated the area, leaving it for two to three years before allowing light grazing by sheep. 'It is important to graze the area occasionally to minimise the chances of creating fox harbours in the overgrown vegetation', says Doug.

Pointing to the distant hilltop he explains that, 'I would really like to see the tunnel erosion controlled and have more areas for stock shelter after shearing'. 'Some years ago, ten hectares of the badly eroded area was ripped and planted with 5500 trees and shrubs using seed collected from the property and it is now a haven for birdlife. It was an eyesore and I couldn't run much stock there anyway.'

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*See the Land, Water & Wool insert in this edition of *Thinking Bush* for further information on this research.

Contact

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An uncertain future: paddock trees in agricultural landscapes

Blue-faced Honeyeater (Entomyzon cyanotis) *Photo: Department of Sustainability and Environment/McCann*

THE OVERSTOREY

- Scattered paddock trees provide critical habitat resources for a range of wildlife species.
- Paddock trees make up 15–25 per cent of total native vegetation cover in the South Australian study areas, yet over one-third of these trees may be lost by the year 2051 if current rates of decline continue.

By Sandy Carruthers and Mike Hodder

Paddock trees are a visually defining feature of the agricultural landscape across much of temperate Australia. However, we still know very little about the contribution these scattered trees make to regional native vegetation cover and their conservation value at a landscape scale. The continued clearance of paddock trees for agricultural development coupled with their significant lack of recruitment over the past 50 years has prompted Sandy Carruthers and Mike Hodder to study these issues to develop guidelines for better managing this valuable resource in the agricultural landscapes of South Australia.

The number, location and extent of paddock tree cover across two large study areas in the south east of South Australia was mapped in this project, funded by the Native Vegetation R&D Program. In total, 353,853 paddock trees were mapped over a combined area of 378,000 hectares. These trees were estimated to contribute between 15 and 25 per cent of the total native vegetation cover found in the study areas. The majority of paddock trees (between 85 and 91 per cent) exist as single trees, or small groups of trees with almost continuous canopies no larger than 0.06 ha, which are separated by gaps larger than would have existed prior to agricultural development. Across the study area, paddock trees were found to cover between 47 and 56 per cent of the total land area, at a minimum density of one tree per four ha. One of the most important findings of our study to date is that paddock trees currently represent a significant and unrecognised component of vegetation cover that should be accounted for in landscape conservation planning.

A valuable resource

Paddock trees provide resources such as nectar, pollen, fruit, seed, foliage, bark, roots, litter and perches. They also contain cavities or hollows that support many species of Australian vertebrates that use them for dens, roosts or nests. To gain a better understanding of the role of paddock tree density and how it relates to bird use of paddock trees, we undertook a bird survey across 45 private properties, using 4 ha study sites.

One third of all diurnal land bird species previously recorded across the study area were recorded in paddock trees. Forty-two of the 45 species recorded in paddock trees were also found in nearby remnant vegetation sites. Eleven species listed as declining in other regions of southern Australia were observed using Paddock trees. These include the Blue-faced Honeyeater, Brown-headed Honeyeater and White-plumed Honeyeater, and the small insectivorous birds Jacky Winter, Grey Fantail, Restless Flycatcher, Varied Sittella and Yellow Thornbill.

'Our results suggest that 36 per cent of all paddock trees in the southern study area will be lost by 2051 if current rates of authorised clearance and dieback continue.'

Sandy Carruthers & Mike Hodder

Our results demonstrate that bird numbers and species richness increase with increasing tree cover where timber on the ground was low. Species diversity also increases with tree cover where vegetation type had an effect. The results also revealed that the influence of tree cover on species abundance varies for different groups of birds. In general, we found that each site is unique in relation to the birds it contains and their relative numbers.

What might happen

Using records of authorised clearance, past dieback studies and our mapping we were able to predict tree loss over the next 50 years. Our results suggest that 36 per cent of all paddock trees in the southern study area will be lost by 2051 if current rates of authorised clearance and dieback continue, with an estimated 65 per cent of this predicted loss to come from authorised clearance. These estimates highlight the need for a regional strategy for the long term conservation and recruitment of trees in these landscapes.

Management

From a management perspective, the existing cover around trees should be taken into account where paddock trees are assessed for either clearance or as potential recruitment or revegetation sites. Our study demonstrates that in the southern study area, paddock trees undoubtedly contribute to the overall quality of the landscape for birds, and to the habitat value of the region as a whole.

The final stage of our project involves developing guidelines for managing paddock trees for conservation. This includes landscape scale tree management strategies, assessing tree value from a landscape perspective with respect to the clearance assessment process, and the placement and design of revegetation and recruitment areas.

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Contact

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Scattered South Australian Blue Gum (Eucalyptus leucoxylon) *and Pink Gum* (E. fasciculosa) *paddock trees. Fifty visible hollows and thirteen bird species were recorded at this site. Photo: Sandy Carruthers*

Varied Sittella (Daphoenositta chrysoptera) *Photo: Department of Sustainability and Environment/McCann*

Getting the most out of restoration

By Fiona Hall

Restoring native vegetation across vast areas of rural Australia is a time-consuming and expensive business. Do we really know whether we are getting value for our money and efforts? Are we really creating suitable habitat for wildlife, the aim of much restoration planting? Surprisingly, the effectiveness of current guidelines for landscape design and vegetation restoration is largely unknown.

These are the questions exercising the minds of ecologist Professor David Lindenmayer and statistician Associate Professor Ross Cunningham, both based at the Australian National University. Through a research project funded by the Native Vegetation R&D Program they are developing a scientifically rigorous method for measuring the value of restoration (in this case, native tree planting) for wildlife. And they have hit on a ground breaking approach which will become a vital tool for the many organisations and individuals striving to build healthy natural landscapes.

'The main problem is that most restoration occurs in landscapes that already have native remnant habitats. So how do you separate out the effects of the restoration on wildlife, from the effects of presence of existing native vegetation?' ponders David. What they have come up with is a multi-layered design. David enthuses: 'it's a brilliant design. We can look at the value of remnant vegetation on its own, at the value of remnant vegetation versus plantings, at plantings within farms, and at plantings within farms within landscapes. So we can ask, for example, does a planting do better on a farm within a landscape that has lots of remnant vegetation or lots of planted vegetation versus one that has little or none?'

David and Ross have chosen a whole series of landscapes that have varying amounts of native vegetation and varying intensities of planting (see table). They have chosen eight 'control' landscapes, half with low levels of native vegetation and no plantings of native trees, and the other half with high amounts of native vegetation and no plantings. These will be compared with similar landscapes which contain combinations of high and low levels of plantings and remnant vegetation, as shown in the table.

Each 'landscape' is a 10 by 10 kilometre area, chosen from aerial photographs and satellite images combined with the local on-ground knowledge of Landcare coordinators.

These landscapes are spread over two regions of NSW: the Murray (near Albury) and the Murrimbidgee (near Junee and Gundagai). Two farms have been selected from each landscape,

THE OVERSTOREY

- **More wildlife species are supported by the habitat resources provided by a combination of remnant and planted vegetation compared to either planted or remnant vegetation alone.**
- **Different wildlife species have different habitat requirements; providing a diverse range of habitat resources will attract a diverse range of wildlife species.**

Bare rocks and leaf litter provide important basking and foraging opportunities for small reptiles such as the Common Garden Skink (Lampropholis guichenoti). *Photo: Sharon Downes*

one with plantings and one without. On each farm they chose four sites for detailed survey work, a combination of plantings and remnants (either old growth or regrowth woodland). This means that research is going on over 168 sites spread across 42 farms. There are about 100 different questions and hypotheses associated with this research design and it's going to take a good year to run the analysis and really find out what is going on.

Over the last two to three years, David and his team, with invaluable help from community groups like the

	LANDSCAPE REPRESENTATIONS		CONTROL
	High level of planting	Low level of planting	No planting
High level of remnant vegetation	1 landscape	4 landscapes	4 landscapes
Low level of remnant vegetation	4 landscapes	4 landscapes	4 landscapes

A multi-layered study design will allow the researchers to look at the ecological value of planted and remnant vegetation in a range of landscape contexts.

Sugar Gliders (Petaurus breviceps) *nest communally in tree hollows. They feed on insects, flowers, buds and sap. Photo: Department of Sustainability and Environment/McCann*

Canberra Ornithological Group, have been surveying and recording the wildlife at all these sites. They are covering a wide range of animal groups to ensure that the habitat needs of each are captured: birds have different needs to reptiles, and reptiles have different needs to mammals, and so on. What is emerging is an extensive dataset on possums, gliders, small mammals, birds, reptiles, frogs and other animals.

Another strength of the project is the degree of involvement of landholders and Landcare groups on the ground. Three research officers, all with rural backgrounds themselves, are living and working in the study areas and have constant contact with farmers. Many of the landholders are very excited about finding out the benefits of their restoration efforts. 'Each time we do a survey the farmers get the results of what was found on their farm. You get farmers ringing each other up to find out what they each have, "we got a Dollarbird, did you get one?" and so on', said David.

'Another strength of the project is the degree of involvement of landholders and Landcare groups on the ground.'
David Lindenmayer

Although it's still early days, some interesting findings are already apparent. The first is that the presence of planted areas does increase the number of species (of birds at least) by an average of an additional two species on a particular site or on a whole farm. When the farm combines plantings with remnant vegetation, for a given patch of remnant vegetation you'll get an average of five more bird species on the farm. 'So what we're saying is, there's a cumulative benefit of having both plantings and remnant vegetation. You get more species added to the system if you've got both than you do if you've only got remnant vegetation', explains David. And the species found in restored areas are often different to those found in remnants, again increasing the total richness of species on a farm. Bigger plantings are obviously better and the shape of the plantings is also important. Long skinny plantings, for example, are of little value for wildlife.

'There are about 100 different questions and hypotheses associated with this research design and it's going to take a good year to run the analysis and really find out what is going on.'
David Lindenmayer

Mature trees provide hollows, a critical nesting resource for many wildlife species. Photo: Trudi Ryan.

Flooded Red Gum (Eucalyptus camaldulensis) *wetlands provide important habitat for frogs, waterbirds and many other wildlife species. Photo: Trudi Ryan*

Plantations provide habitat resources for wildlife but do not support the diversity of species found where plantations augment remnant vegetation. Photo: Trudi Ryan

They are finding virtually no possums and gliders in the plantings, because of the absence of big, old trees and therefore suitable tree hollows for nesting. The only records of possums and gliders are from where the planting has been done around a large old remnant paddock tree. So already valuable information is emerging about the importance of including structural features within restoration—not just paddock trees, but things like rocky areas for reptiles and small mammals, planting understorey shrubs and herbs for insects and birds, including wetland areas for frogs and so on.

Ultimately, David hopes this research will help people target their restoration efforts better and will help them think through revegetation in the context of the whole farm, and the landscape. What have they already got, what have their neighbours got, and how does that fit together? Where can they best site their new plantings to maximise the benefits to wildlife? He aims to distill the findings into a series of practical guidelines which will be added to his book *Wildlife on farms: how to conserve native animals*, which is already proving popular among farmers and their advisers.

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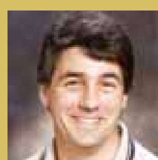

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Health check up for Queensland's Poplar Box Woodlands

The research team assesses landscape function in Poplar Box woodland. Photo: Scott Swift

THE OVERSTOREY

- Land use, climatic conditions and insect attack have contributed to a significant deterioration in the health and viability of Queensland's Poplar Box woodlands
- Less intensively grazed sites supported better moisture retention, nutrient cycling and healthier soils than more heavily grazed sites.
- Remnant vegetation delivers essential ecosystem services to the surrounding agricultural landscape and maintains regional water balances in addition to biodiversity conservation benefits.

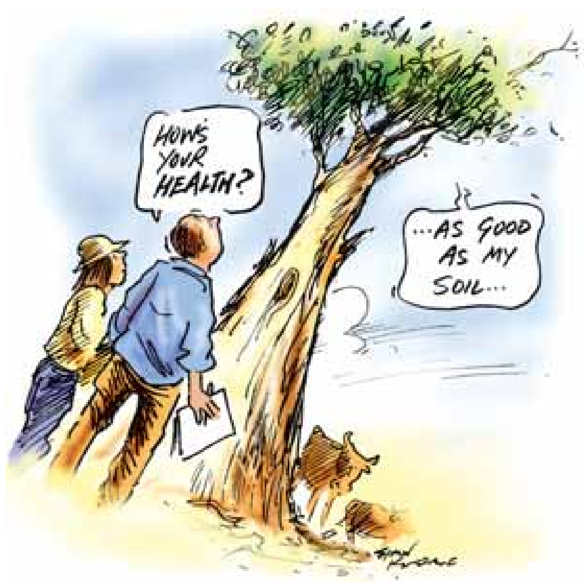
By Julie Hinchliffe

Having remnant vegetation on your property is one thing. Having healthy, functioning remnants that deliver ecosystem services is another. How, and to what extent can remnant vegetation benefit biodiversity conservation and production? And what do landholders need to do to keep their remnants healthy?

These questions have taken Dr Chris Chilcott and a multidisciplinary research team onto participating grazing properties, state forests and stock routes in Poplar Box *(Eucalyptus populnea)* woodland country around Roma, Morven and Injune in the sunshine state's south. The team has studied habitat value, tree dieback and grazing impacts to key ecosystem processes and landscape function.

So far, their findings are not encouraging. The data paints a poor picture of tree health and remnant condition across most of the study area. Overgrazing and other impacts on remnants may have caused declines in key ecological functions such as nutrient and water cycling.

'The health of Poplar Box woodland in our study region has significantly deteriorated over the last twenty years', says Dr Ross Wylie, a vegetation scientist with Queensland's Department of Primary Industries and Fisheries whose work on tree decline spans three decades. 'We are now determining to what extent things like clearing, grazing, climatic extremes and insect attack have contributed to this and how these factors interlink', he explains.



Giselle Whish has both production and conservation outcomes in mind. Photo: Jeremy Whish

Poplar Box dieback in south-eastern Queensland. Photo: Scott Swift

The researchers are also discovering some of the marked benefits that native vegetation can deliver to producers. They hope to devise strategies for promoting healthy remnants and conservation landscapes that, in turn, promote productive agricultural landscapes.

The extensive fieldwork program is now complete and data analyses are underway. But the search for relatively undisturbed remnants with which to make comparisons proved more of a challenge than expected. 'Healthy Poplar Box communities were very hard to find', says Ross. 'We're about to see what our analyses turn up—it may be the case that the condition of the region's remnants is universally poor.'

Active soil is productive soil

Nutrient status, and the movement and cycling of nutrients, plays a critical role in the stability and productivity of remnant ecosystems, according to Giselle Whish, an environmental scientist with Queensland's Department of Natural Resources, Mines and Energy, based in Toowoomba.

Giselle's interest in soil biological activity and nutrient cycling has kept her busy measuring nutrient pools, such as litter and soil, as well as nutrient transfer rates between pools via litter decomposition and soil microbial activity.

She says the turnover of organic matter and nutrients in litter can be used as an index of ecosystem functioning. Moisture, temperature, soil type and litter quality—that is, the litter's sugars, cellulose and other chemical and physical characteristics—all influence the rate of nutrient turnover. High quality litter, such as fallen leaves, degrades quickly compared to material rich in lignin, like twigs and wood.

'It is critical that science improves our understanding of how to best manage remnants for both production and conservation outcomes.'
Giselle Whish

'The health of Poplar Box woodland in our study region has significantly deteriorated over the last twenty years.'
Ross Wylie

A preliminary look at the data suggests the retention of soil moisture is critical to the breakdown of litter and release of nutrients (including nitrogen) back into the soil ready for plant uptake.

In general, less intensively grazed sites recorded higher decomposition rates, more ground cover and litter, and better quality litter. 'Grazing doesn't just contribute faeces and reduce biomass, it compacts the soil and reduces understorey biomass and groundcover. This can lead to decreased water infiltration and soil moisture needed for decomposition, increased runoff and a loss of resources from the system.'

Identifying management thresholds

By quantifying nutrient cycling processes, in combination with biodiversity assessments, the team hopes to identify thresholds for remnant vegetation management. 'It's important to know how far we can change or disrupt systems without going beyond some critical limit or threshold', Giselle says.

But have these thresholds already been crossed? Certainly, low levels of landscape function, patchy ground cover, firm to hard-setting soils, and a low retention of resources (water, nutrients and seeds) were commonplace across all of the sites studied.

A collaborative approach: this project involves scientists from the Queensland Departments of Natural Resources, Mines and Energy, the Environmental Protection Agency, Primary Industries and Fisheries, and CSIRO Plant Industry. Photo: Tracy VanBruggen

Valuing ecosystem services

Remnant vegetation provides a range of services that can assist producers. For starters, it can maintain soil structure, regulate hydrological and nutrient cycles, pollinate crops, reduce microclimatic extremes and offer shade and shelter for livestock.

'These processes rely on an array of plants, animals and microbes and the complex interactions between them', says Giselle. 'Tree clearing fragments habitats, disrupts important ecosystem processes, and can lead to species decline, soil erosion and dryland salinity.'

Exactly how grazing affects nutrient cycling, productivity and the overall functioning of remnants is yet to be determined. Although grazing impacts will probably need to be reduced, the idea, she says, is to promote facilitative effects of remnants on surrounding production systems and regional on-farm conservation. 'It is critical that science improves our understanding of how to best manage remnants for both production and conservation outcomes.'

Chris Chilcott agrees: 'many remnants are surrounded by and are an integral part of production landscapes—their presence can help maintain regional water balances and aid regional on-farm conservation'.

'What we need to work on is how best to manage these areas to maintain their integrity and match them with the production expectations that the landholders have for them.'

'Many remnants are surrounded by and are an integral part of production landscapes—their presence can help maintain regional water balances and aid regional on-farm conservation.'

Chris Chilcott

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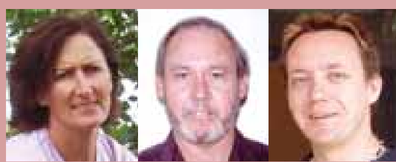

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Dr Ross Wylie (middle) can be contacted at the Queensland Department of Primary Industries and Fisheries or by email: ross.wylie@dpi.qld.gov.au.

Conserving genetic diversity at the species, patch and landscape scale

CSIRO Plant Industry staff collect field data at Adaminaby, NSW. Photo: Carl Davies

THE OVERSTOREY

- Habitat fragmentation affects ecological processes, such as pollination by birds and insects, that maintain genetic diversity at a species, patch and landscape scale.
- Seed collected for revegetation purposes should be gathered from larger patches where possible and within these patches, fewer seeds should be collected from more trees, rather than a large amount of seed being collected from just a few individual plants.
- Seed should be collected over different seasons and during drought years and during more average climatic patterns to ensure collected seed has the genetic potential to cope with a range of conditions.

By Trudi Ryan

Why is genetic diversity so important to the long-term survival of native plant populations and where should native seed be collected from in fragmented agricultural landscapes?

Dr Linda Broadhurst and her colleagues at CSIRO Plant Industry are aiming to answer these questions as they continue their groundbreaking research into the genetic and ecological viability of plant populations in remnant vegetation. This research, sponsored by the Native Vegetation R&D Program, will provide native vegetation managers with practical guidelines for managing plant populations to maintain their long-term conservation value and their value as a source of genetically viable seed for revegetation activities and natural regeneration processes.

Linda Broadhurst speaks passionately about the importance of maintaining genetically variable plant populations. 'Loss of genetic diversity poses an equally significant threat to the long-term survival of remnant vegetation as the more obvious threats of weed invasion, over-grazing and rising groundwater.'

'Genetic diversity provides the building blocks of biological diversity', Linda explains. 'It provides plant populations with the resources to adapt to changing environmental conditions.' 'For example, plant populations that can draw on genetic resources from the remnant, or from the surrounding landscape, may be better able to cope with drought, or adapt to long term climate change', she said.

But many native plant species can no longer access the genetic diversity available at the remnant or landscape scale. A key factor is habitat fragmentation and the consequent breakdown of the ecological processes that help drive the transfer of genetic material such as pollination by birds and insects. Breeding opportunities for plant species dependent on bird and insect pollinators decline where distance between these remnant habitat islands is isolating. This isolation may force inbreeding in some species, a process that reduces the genetic fitness and viability of the next generation. This puts even more pressure on a plant population that may be already stressed by environmental factors such as competition with weed species and grazing pressure.

Sometimes, it's simply a numbers game—there are not enough individuals of the same species for mating to occur. In other cases, nature may conspire to further reduce breeding opportunities, for example, when plants of the same species flower at different times. Inbreeding and hybridisation may occur under these scenarios resulting in a further loss of genetic diversity at the population, remnant and landscape scales.

To investigate these issues, Linda and her colleagues Dr Andrew Young and PhD students, Melinda Pickup and David Field, are building a profile of demographic and genetic traits of several common and rare Australian plant species. These species represent various plant guilds or groups of species that share similar life history attributes and ecological requirements. The CSIRO team is also collecting information on remnant size, degree of isolation and disturbance to see if there is any connection between these factors and the genetic diversity of the remnant plant populations and the quality and quantity of their seed.

Collaborators in Western Australia and Queensland are also undertaking similar research. The team will use the results from these studies to produce practical guidelines for land managers and bush regenerators.

In the meantime, Linda offers some general guidelines and important considerations for managers of remnant and revegetated habitats. 'Even in landscapes with minimal vegetation cover, collect seed from the largest patch of native vegetation available', advises Linda. 'And within this patch, collect smaller amounts of seed from many plants, rather than a large amount of seed from just a few trees—this ensures you sample a greater amount of the genetic diversity available in a given plant population.' 'It's also important to revisit a site to collect seed set in different seasons, and during drought years and more normal climatic years, again to ensure the seed you've collected has the genetic potential to cope with a range of conditions.' 'Of course in drought years, when less seed is produced, it's important not to over-collect from any given patch', she adds.

Linda adds that the genetic quality of the seed will affect the quantity that needs to be collected and sown to achieve a reasonable establishment rate. 'We hope our results will determine how much seed should be collected from a plant population with a given set of characteristics that occurs in a remnant of a given size and degree of isolation', Linda says.

Revegetation activities create huge demand for native seed. The CSIRO team recommend collecting seed from many different trees, over different seasons and from large patches of native vegetation to ensure the seed is genetically diverse and able to cope with a range of conditions. Photo: Trudi Ryan

The team hopes these guidelines will reduce any unintended ecological side effects that result from the over-collection of seed. 'There's a huge demand for native seed out there and if seed is harvested from just one or a few sites, that leaves less seed available for native species like ants that may depend on it for a food source.' 'It also leaves less seed available on-site for natural recruitment processes', she adds.

Linda hopes that active management of genetic diversity will be an integral part of future revegetation and remnant vegetation management strategies. Bush regenerators and native vegetation managers will eagerly await the results of this fascinating research and the accompanying guidelines and recommendations Linda and her colleagues will produce.

'Loss of genetic diversity poses an equally significant threat to the long-term survival of remnant vegetation as the more obvious threats of weed invasion, over-grazing and rising groundwater.'
Linda Broadhurst

Swamped

PhD student, David Field is investigating the reproductive ecology of Black Gum *(Eucalyptus aggregata)*, a relatively common species that is restricted to specific higher altitude habitats along flats and hollows of south eastern Australia. It is known to hybridise with two more abundant species, Candlebark *(E. rubida)* and Manna Gum *(E. viminalis)*.

'In remnants where Candlebark and Manna Gum dominate, pollinators are more likely to carry pollen from these species to Black Gum flowers, increasing the chance of producing hybrid seed.' David explains, 'initial findings have shown that disturbed road verge remnants are producing two times more hybrid seed compared with that produced in undisturbed woodlands, suggesting that disturbance is promoting hybridisation.' David warns 'this has important implications for some remnant species, which may eventually be genetically swamped by more common species.'

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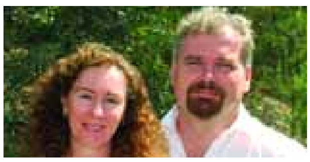

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Stumped by woodland structure? Looking for clues in the NSW wheat belt

By Michael Bedward

What do old tree stumps and new computer models have in common? They both play a part in a detective story being pieced together in the farming landscapes of central New South Wales.

With support from the Native Vegetation R&D Program, a research team led by Michael Bedward and Ross Bradstock from the NSW Department of Environment and Conservation is investigating the ecology of native woodlands in the sheep-wheat belt and the birds and animals that depend on them. This project will use evidence from the past and present day landscape to guide policy makers, Catchment Management Authorities and landholders in planning for future production and conservation outcomes. The computer modelling approach will also identify any new information that should be collected over the next decade to improve both the modelling and planning processes.

THE OVERSTOREY

- Evidence from past and present landscapes can be incorporated into computer models to predict future landscape composition and structure under different scenarios.
- These models assist policy makers, Catchment Management Authorities and landholders with land-use planning.

Clues from the past

To predict the future we first need to consider the past, and this is where the tree stumps come in. They provide clues about the structure and mix of trees that characterised the woodlands of the sheep-wheat belt before European settlement and the changes that have since occurred. Ian Lunt and his colleagues from Charles Sturt University have been developing ways of interpreting these clues using the stumps of cypress pine, a native conifer that can withstand weathering and termites for centuries. Different tree felling methods, from axes and cross-cut saws to modern chainsaws, were used in different decades and leave different scars on the stumps. Scientists are able to put an approximate date of felling on each stump based on how it was cut. Putting this information together with the number, size and spacing of tree stumps and standing trees builds up a picture of a site's pre-European woodland structure and how this has changed over time.

To get some idea of how the historical picture being developed by Ian's team relates to the woodlands that we see in the present day landscape we need to consider both ecological and human processes. In essence, we need to go from snapshots of the past and present to an animation of trees growing and dying and areas being progressively converted to agriculture. We bring this sequence to life using computer modelling.

Building the model

Over the last year we have been developing a detailed computer model of woodland with cypress pine and eucalypt species. The model follows trees as they grow and produce seed and seedlings. Their growth and survival are influenced by rainfall based on long-term weather records for the region. The trees also compete with each other for light and space, giving rise to realistic effects such as 'locked stands' of cypress pine whose growth is almost frozen until the stand is thinned by the death of some individuals.

The greatest challenge in building such a model is our ignorance about many of the important life stages of these tree species. How far do their seeds travel? How strongly affected is each species by competition with other species? What role does drought play in controlling the growth of new seedlings and the survival of mature trees?

Sometimes we can bring the results of previous studies or our own measurements to bear on these questions. For those aspects that we know very little about we can still try to estimate likely effects by running the model with a range of settings and looking at how well the model's predictions match the historical and present-day evidence. Our hope is that the model can produce the picture of woodland structure that is coming from Ian Lunt's tree stump detective work. If so, then we will be in a position to run

Different tree felling methods, from axes and cross-cut saws to modern chainsaws, were used in different decades and leave different scars on the stumps. Scientists are able to put an approximate date of felling on each stump based on how it was cut.

Project team member Lisa Metcalfe taking field measurements in a stand of White Cypress Pine near Forbes, NSW. Photo: Karen Ross

The Brown Treecreeper, which is listed as a vulnerable species in New South Wales. Photo: Department of Sustainability and Environment/McCann

A computer model tracks the movements of young Brown Treecreepers looking for new territories in woodland patches. Image: DEC, NSW

the animation into the future and make predictions about how the woodland patches that are in the farming landscape today will fare over coming decades and beyond.

Computer models are also used to develop and test our understanding of the native birds and animal populations that depend on the woodlands. Once again, we look at how well the picture that we get from these models matches what we can see of these species today.

The Brown Treecreeper: a woodland supermodel?

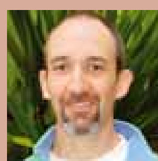
An interesting example is provided by the Brown Treecreeper, a medium sized bird that lives in the eucalypt woodlands of the wheat belt. This species nests in tree hollows and feeds on tree trunks and in leaf letter for ants, beetles and larvae. It has become locally extinct in parts of its former range and is listed as a Vulnerable Species in New South Wales.

We have developed a detailed computer model that depicts territorial groups of Brown Treecreepers living in woodland patches. The model follows how the Treecreeper population is affected by changes in the area and pattern of woodland patches over a number of years. It successfully mimics many of the characteristics that we observe in the field such as how often the birds move between woodland remnants and along corridors, and the size of breeding groups in different parts of the landscape. These early results are encouraging and our hope is that the model will be useful in planning for farming and conservation in the wheat belt in ways that best take account of this and other beautiful and important native species.

Further reading

See Andrew Bennett and Jim Radford's article on pages 4 and 5 for further information on the Brown Treecreeper and the conservation of this species at a range of scales.

Contact



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Trial by fire

By Rod Fensham

Can fire reduce tree density in the grazed eucalypt woodlands of central Queensland? How can fire be integrated with cattle grazing practices? What are the costs and benefits of burning for both production and biodiversity? These are the questions that a new research project, funded by the Native Vegetation R&D Program, seeks to address.

Dr Rod Fensham from the Queensland Herbarium discusses his research on the role of fire in managing the eucalypt woodlands of Queensland's pastoral zone...through thick *and* thin.

Researchers from the Queensland Herbarium are investigating the costs and benefits of burning for production and conservation in the Queensland pastoral zone. Note the extensive drought-induced dieback in this grazed woodland. Photo: Rod Fensham

It is widely believed that aboriginal burning maintained an open park-like structure in the eucalypt woodlands of central Queensland. The cessation of these burning practices over a century of pastoral land use have shifted native vegetation towards a much denser structure with important implications for both production and biodiversity conservation.

The continued thickening of the eucalypt woodlands poses major implications for pastoralists who believe you get less pasture with more trees. Vast expanses of the eucalypt woodlands have been cleared in recent decades and the vegetation thickening argument has been an important driver of this practice. If the existing remnant woodlands continue to thicken then there will be ongoing pressure to clear or at least 'thin-out' these areas to maintain pastoral production.

How much vegetation thickening is occurring and what are the key drivers?

Quantified studies using aerial photography suggest that vegetation thickening has occurred, albeit at rates much lower than folklore might suggest. As to the causes, one line of thought emphasises management. Tree growth is favoured in the absence of burning and with reduced competition from grass species. However, the ecology of the eucalypt woodlands is more complex than is suggested by the management-driven vegetation thickening argument alone.

Long term climatic influences are important

The role of climate in shaping vegetation patterns should not be ignored in a land of notorious climatic extremes. The role of droughts in causing drastic reductions in timber stocks in semi-arid Queensland is well documented and has been recognised by pastoralists since the industry began. An extract from the diary of a central Queensland station manager describing the effects of the major drought of the late 1920s is a poignant example of this understanding.

THE OVERSTOREY

- **The structure and density of eucalypt woodlands in the Queensland pastoral zone is influenced by management (fire), land use (grazing) and climate (especially drought).**
- **Appropriate burning regimes may offer Queensland pastoralists a management option that maintains productivity and is less devastating for biodiversity than tree clearing.**

"...now they confronted the record of five years of drought in the dead trees that still stood up from the silvery grass for miles and miles, black trunks grotesquely abbreviated, for winds had whipped away the branches... Some day when people start burning off the dry grass a bush fire will be started which will destroy these skeletons of ironbark forest, and with them the last traces of the Big Drought will disappear."

M.M. Bennett 1928

This observation and supporting studies suggest that the eucalypt woodlands collapse during extreme droughts and then enter into a gradual recovery phase. It could be that this recovery phase is what land managers have come to view in a negative light as 'vegetation thickening'.

'The role of climate in shaping vegetation patterns should not be ignored in a land of notorious climatic extremes.'
Rod Fensham

Research in progress

The experimental side of this project will be conducted on a grazing lease near Alpha in the Desert Uplands of central Queensland and will involve paddock scale fire treatments. The information from these trials will be combined with landholder experience to produce a Burning Manual for the region. The project also uses the opportunity of a recent drought-induced dieback event to gain a further understanding of these periodic natural thinning events.

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Quote taken from: *Christison of Lammermoor* by M.M. Bennett. 1928. Alston Rivers, London. P.253.

Contact

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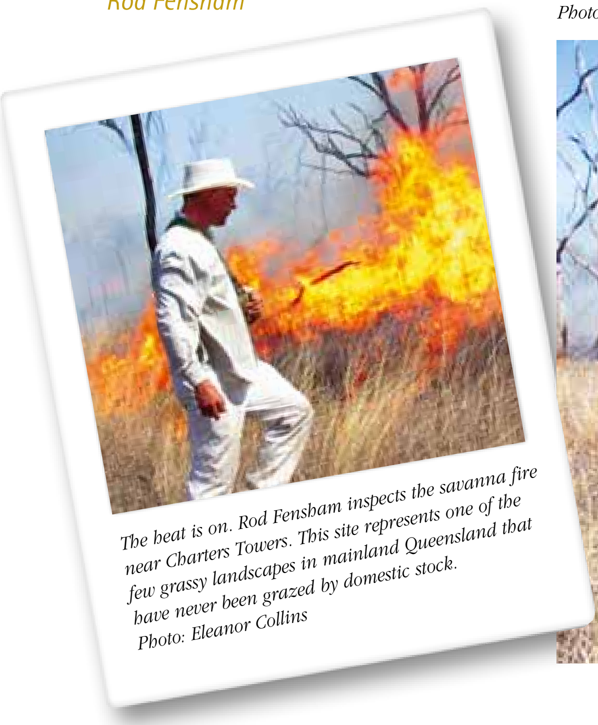

The heat is on. Rod Fensham inspects the savanna fire near Charters Towers. This site represents one of the few grassy landscapes in mainland Queensland that have never been grazed by domestic stock. Photo: Eleanor Collins

Paul Williams, Conservation Officer with Queensland's Parks and Wildlife Service surveys the burning of a savanna 'pocket' within the lava flow of the Great Basalt Wall (near Charters Towers, Qld.) Photo: Eleanor Collins

A design for life: bringing back the birds in our farming landscapes

By Andrew Huggett and David Freudenberger

How big and well connected is your bit of bush? What condition is it in? How and where might you target your revegetation effort to bring back birds and other native fauna? How much land is needed for this work? These are some of the questions that researchers from CSIRO Sustainable Ecosystems are investigating in the Native Vegetation R&D Program project 'Testing approaches to landscape design in cropping lands'.

Dr David Freudenberger and Dr Andrew Huggett of CSIRO Sustainable Ecosystems are studying the spatial requirements of focal bird species in highly fragmented farming landscapes in eastern and western Australia, respectively.

A typical Buntine-Marchagee landscape showing shrubland in foreground then wheat paddock and salt pan. Photo: Blair Parsons

In the northern Western Australian wheat belt (Buntine-Marchagee Catchment), Andrew and his team have used data from extensive field surveys, vegetation analysis, landscape assessment, and statistical modeling to determine the minimum remnant area and habitat patch size, isolation distance, and remnant condition required by focal bird species (see Figures 1 & 2). From this data and community consultation, the team has prepared a ten-step landscape design (see Brooker 2002) to guide and prioritise revegetation efforts in the catchment. This design will allow the WA Department of Conservation and Land Management (CALM) and the local farmers to begin the critical tasks of linking key habitat, enhancing existing remnants, and managing remnant native vegetation to protect and improve biodiversity values across the catchment. Stakeholder 'road-testing' is an important part of the approach adopted by the CSIRO landscape design team in the Buntine-Marchagee catchment.

THE OVERSTOREY

- **CSIRO scientists, natural resource managers and farmers are working together to plan and manage native vegetation in the Buntine-Marchagee catchment, WA.**
- **Revegetation, remnant vegetation management and linking existing remnants creates significant improvements in bird habitat.**

A major finding of the team's Buntine-Marchagee work has been that, for a relatively small investment of land set

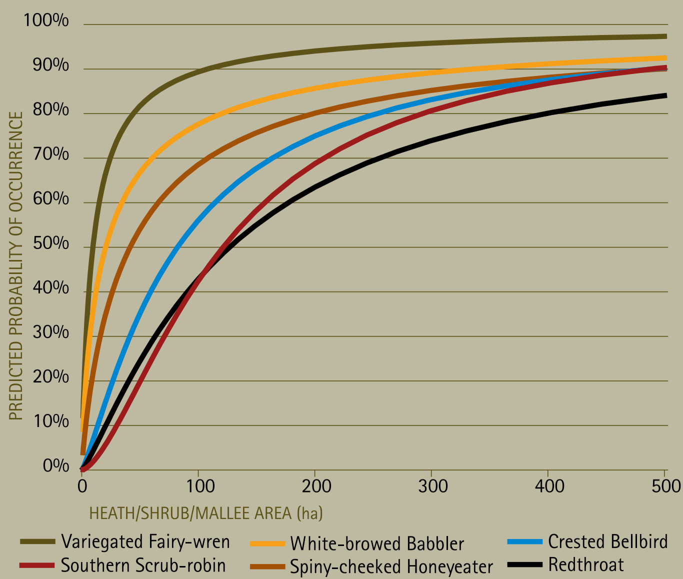

Photo: Department of Conservation and Land Management, WA

Figure 1. Shrubland patch size for six heath/shrub/mallee specialists of Buntine-Marchagee Catchment (note Southern Scrub-robin, pictured above, is the focal species for shrubland patch size with a core area requirement of 29 ha at 10 per cent predicted probability of occurrence).

'Stakeholder "road-testing" is an important part of the approach adopted by the CSIRO landscape design team in the Buntine-Marchagee catchment.'
Andrew Huggett & David Freudenberger

aside for revegetation, linking existing habitats and managing remnants, there can be significant potential gains in the size, connectedness and condition of bird habitats. For example, by establishing 1093 hectares of new habitat and 268 ha of habitat linkages, there will be a high probability of conserving existing populations of declining woodland and shrubland birds. This area of revegetation is only 0.75 per cent of the entire 181,000 ha catchment and will add 1,361 ha (6 per cent of existing native vegetation) to the total amount of native vegetation in the catchment. The identification and improved management of 13,196 ha of existing habitat for nature conservation will contribute significantly to this goal.

The results of this landscape design work have helped establish the basis for strategic natural resource management investment in revegetation for positive conservation and production-related (i.e., salt mitigation, erosion control, etc.) outcomes in the northern WA wheat belt. We are currently working with CALM on a strategic biodiversity conservation plan in the Buntine-Marchagee catchment for 2004–06.

Three other researchers at CSIRO—Lesley Brooker, Jeff Short and Geoff Barrett—are working on an analysis of fragmentation thresholds across the wheatbelt and a study of the applicability of the focal species approach to other wildlife species. All parts of this large project will be completed by July 2004.

Further reading

Brooker L. (2002) The application of focal species knowledge to landscape design in agricultural lands using the ecological neighbourhood as a template. *Landscape and Urban Planning* **60**, 185–210.

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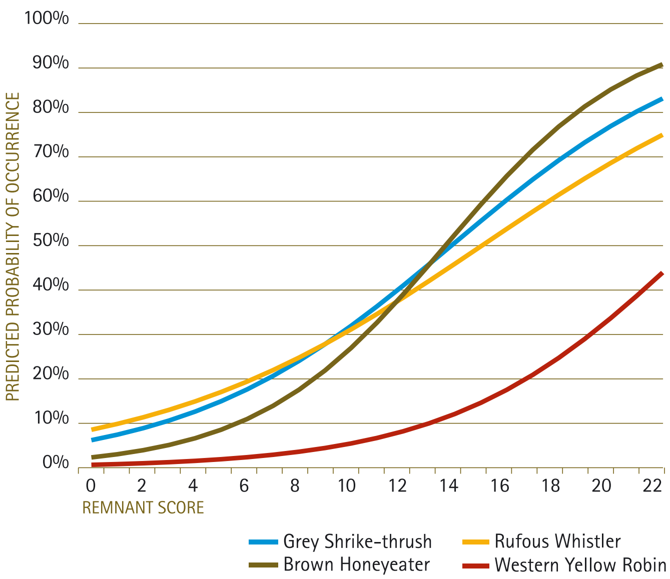


Photo: Department of Sustainability and Environment/McCann

Figure 2. Remnant condition scores for generalist birds in Buntine-Marchagee Catchment (note that Western Yellow Robin, pictured above, is the focal species for remnant condition with a score of 13 at 10 per cent predicted probability of occurrence).

Conference report: a symposium on ecological thresholds in biodiversity conservation

By Andrew Huggett

Scientists working on the identification, value and use of ecological thresholds in biodiversity conservation presented their latest research in a symposium on the topic at the December 2003 meeting of the Ecological Society of Australia held at the University of New England, NSW. The Native Vegetation R&D Program sponsored this successful symposium that was attended by over 300 ecologists, natural resource managers and students. Several researchers currently funded by the Native Vegetation R&D Program gave presentations to this audience.

The symposium kicked off with a scene-setting paper I gave to introduce the concept of ecological thresholds, review the evidence for their existence, and discuss their importance and application in biodiversity conservation in Australia. The eleven papers that followed covered a wide range of landscapes and ecosystems, from treeferns in Tasmanian logged forests, remnant fauna in a Sydney urban landscape, to grazing impacts in Western Australian jarrah and wandoo woodlands. Here are some insights that emerged from some of these talks.

Defining and using ecological thresholds

One of the tricky things about thresholds is defining them—at what point on the curve do they occur and what form do they take—clear 'breakpoints' or zones of transition? Andrew Bennett and Jim Radford (see *Thinking Bush* Issue 2) defined ecological thresholds as points where there is a rapid change from one ecological condition to another. There is also the issue of threshold behaviour—different thresholds are likely to exist for different species with contrasting habitat requirements and degrees of mobility. Scale is also important—changing the scale at which landscape patterns are expressed may breach thresholds for some species but not for others.

So what is the evidence for the existence of ecological thresholds?

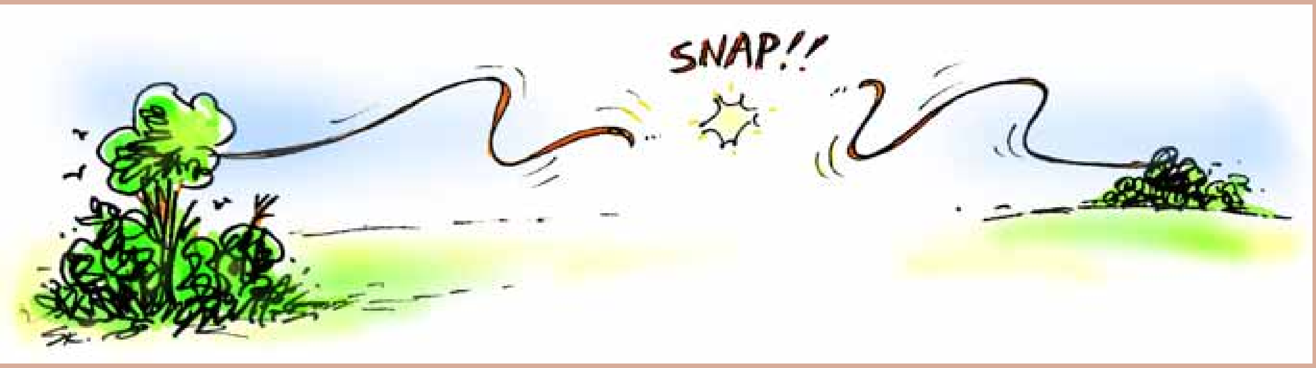
Pearson *et al.* (1996) used simple grid cell modeling to show that connectivity dropped sharply for modeled sedentary species when the amount of habitat fell below 60 per cent. In 'real' landscapes, van der Ree *et al.* (2004) found that squirrel gliders in lightly wooded farmland in Victoria did not cross gaps of more than 75 m (see below). McIntyre *et al.* (2000) derived six thresholds for ecological indicators (soils, pastures, trees and wildlife) in southeast Queensland grazing lands.

Why is knowledge of ecological thresholds important?

Thresholds are markers of the sensitivity of a species to disturbance. They become a tool for landscape planning and management, helping us to manage trade-offs between agricultural production and biodiversity conservation. They also provide targets for landscape design and restoration efforts, for example, by helping conservation managers know how much core habitat a declining bird species requires for persistence in a highly fragmented agricultural landscape (see Brooker & Brooker 2003).

However, there are several issues surrounding the use and abuse of thresholds that we should be aware of. These include the identity and differential response challenges raised above, the need to develop scientifically robust and replicable experiments to test for thresholds, statistical issues, including the need for alternatives to the simple graphical approaches, and challenges in translating regional-scale thresholds to strategic NRM planning and on-ground action.

'One of the tricky things about thresholds is defining them—at what point on the curve do they occur and what form do they take—clear 'breakpoints' or zones of transition?'
Andrew Huggett



'There is also the issue of threshold behaviour—different thresholds are likely to exist for different species with contrasting habitat requirements and degrees of mobility.'

Andrew Huggett

Thresholds in practice: some recent research findings

In a study of arboreal mammal use of 91 small isolated patches of Victorian woodland, Rodney van der Ree and Andrew Bennett detected small gliders (*Petaurus* sp.) mainly in isolated patches less than 75 m from linear strips and other woodland patches. This threshold corresponded with the maximum glide distance of these animals. In a separate Victorian study, Jim Radford surveyed birds in 24 landscapes (100 km^2) with between <2 and 60 per cent tree cover to test for the presence of ecological thresholds at a landscape rather than patch scale. Jim found strong evidence of a threshold in species richness where a marked decline in the number of woodland bird species occurred in landscapes with less than 10 per cent tree cover.

In contrast, David Lindenmayer and Joern Fischer studied the response of mammal, reptile and bird assemblages to patterns of native vegetation cover in the NSW southern tablelands but failed to find evidence of threshold relationships between vegetation cover and species diversity. However, they found gradients of responses to vegetation cover patterns and concluded that further testing in their other large-scale sites was needed to determine if thresholds might occur elsewhere or only for certain species. Joern emphasised some of the difficulties with identifying thresholds at landscape scales.

Chris Chilcott and team are currently searching for landscape function thresholds in southern Queensland grazing lands. Chris presented data collected from 60 Poplar Box (*Eucalyptus populnea*) remnants. He showed that potential exists in this study for the identification of thresholds for landscape functions across paddock (500 ha), property (8,000 ha), and sub-catchment (275,000 ha) scales. This information will be integral to strategic natural resource management planning for a sustainable grazing industry in southern Queensland. Stay tuned for the results of this exciting work.

Further reading

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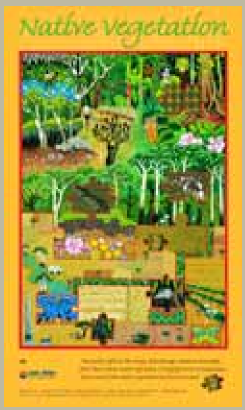
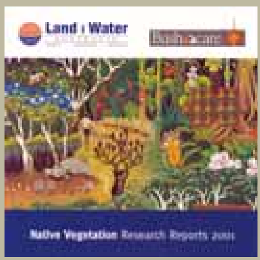


Native vegetation poster
Artwork by Annie Franklin
(42 x 72 cm)



Native vegetation research reports CD-ROM
Various authors (2001)
Compilation of 14 recent research reports from the Native Vegetation R&D Program.

Managing the bush
Jann Williams (2000) A highly readable and useful summary on the conservation and management of Australia's native vegetation from the Native Vegetation R&D Program.

Thinking Bush Issues 1 & 2
Various authors (2002, 2003)
Occasional magazine full of new ways of thinking about, planning and managing native vegetation.

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- Biodiversity dynamics, habitat loss and disturbance in the NSW wheat belt.
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Branch out

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