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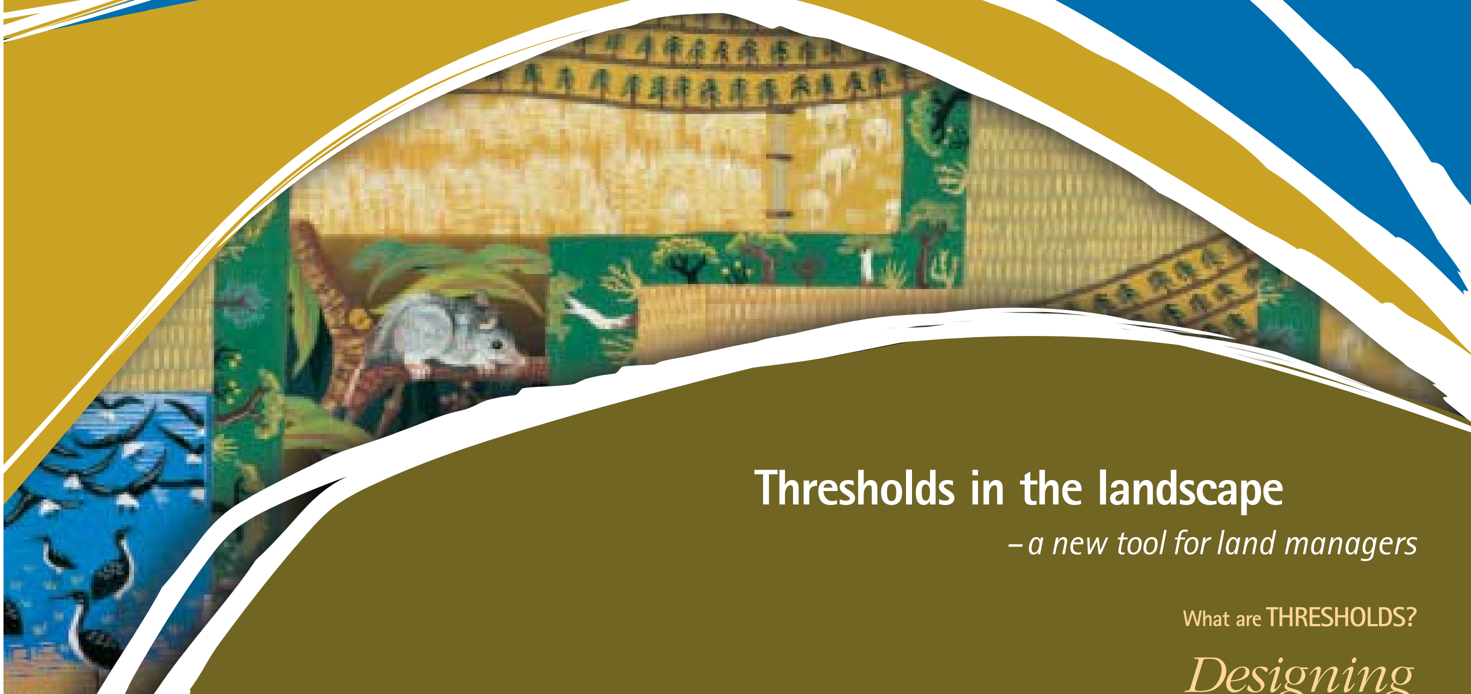
# ThinkingBush

Science for managing native vegetation in Australian landscapes



## Thresholds in the landscape

*– a new tool for land managers*

What are THRESHOLDS?

*Designing* FUTURE REMNANTS

GENETICS IN *isolated bush*

road–testing MANAGEMENT IDEAS

Landholders *talk thresholds*

*Range*land BIODIVERSITY MONITORING

NATIVE VEGETATION RESEARCH AND DEVELOPMENT PROGRAM

# Contents



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UNDERSTANDING ABOUT NATIVE VEGETATION MANAGEMENT AT THE LANDSCAPE SCALE

*Changing perceptions and values about native vegetation and how it can be managed.*

# Thresholds in the bush

Welcome to the second issue of *Thinking Bush*, an occasional magazine full of new ways of thinking about, planning and managing the Australian bush.

We continue to provide people who manage the bush with everything from easy to understand introductory articles to the latest findings from the forefront of research into managing native vegetation.

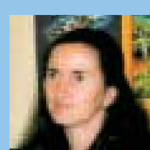
This issue focuses on the concept of ecological 'thresholds' and how these may be used in managing our landscapes. Are there break-points in nature that respond to the ways we manage land, beyond which we should not go? The break-point may be the rapid decline of a species in response to declining levels in key factors, such as sites to shelter and breed. It's a bit like asking 'How much is enough?' Where research establishes that a threshold exists, the implication for managers is that we should stop before we reach that point or we will have gone too far.

Reading through this issue you will find that researchers are approaching the 'thresholds' concept in many different ways. They are very concerned with developing useful findings of relevance to policy-makers and practitioners based on a thresholds approach.

If you are not a subscriber and would like to be, simply fill out the coversheet wrapped with this issue and post it back to us. You can also subscribe at our website. Subscription is free.

I hope you enjoy this issue and find it useful.

*Jann Williams, Program Coordinator*



## What's the *Native Vegetation R&D Program?*

*Thinking Bush* is based on the outcomes of more than 40 research projects under the Native Vegetation R&D Program, funded over the last seven years. It comes as the second phase of the Program gains momentum, with another 14 projects under way that build on the work so far. Fact sheets are available on these new projects—see back page for details. Also keep an eye out on the Program website <www.lwa.gov.au/nativevegetation> for updates on these projects and others commencing soon.

Originally started by Land & Water Australia and Environment Australia, the Program is now managed by Land & Water Australia in partnership with CSIRO Sustainable Ecosystems and Plant Industry and the Murray–Darling Basin Commission. Other contributors to the Program include Greening Australia and state government agencies with the primary responsibility for managing native vegetation.

# Know your ecological thresholds

*By Andrew Bennett and Jim Radford*

**Identifying and using 'ecological thresholds' in land management and conservation may be new for many people, but the idea behind it is familiar to us all. Thresholds are common. We all know that if you lower the temperature of water, it turns into ice at around 0 °C. That's a threshold temperature at which a relatively rapid transition occurs from one state to another—from water (a liquid) to ice (a solid). Ecologists are now looking for thresholds in natural and agricultural systems and starting to apply the principle as a way of better understanding these systems.**

An 'ecological threshold' in natural systems refers to a point at which relatively rapid change occurs from one ecological condition to another. In nature, few relationships show constant change in one thing (attribute) in response to another. Rather, they mostly show points or zones at which marked change in one attribute occurs in response to a small additional change in one or more influential factors.

For example, consider the effect of isolation on the ability of animals to move between habitats (see box on page 3). The threshold may be in the size of the gap between habitats beyond which animals are no longer able to cross. Consider also the relationship between fire frequency and the occurrence of seed-germinating plants. Such plants require a certain amount of time (measured in years) to grow and set seed. If fires are more frequent than the time that plants require to set seed, the species will be lost from the community: a *fire frequency threshold*. Finally, thresholds may also relate to ecosystem processes and functions—consider the example of vegetation on a stream bank and its effect on erosion. As the percentage of ground cover is reduced, erosion is more likely to occur.

As for all natural systems, things are more complex than they might first appear. In the first example, there may be factors other than distance that are relevant to the gaps between habitats, such as the type of vegetation cover in the gap. The isolation thresholds also differ between animal species with different habitat requirements and mobility.

### What happens when thresholds are crossed?

We can see the consequences of crossing ecological thresholds in many landscapes: saline seepages, rising groundwater, eroded soils, 'dieback' of paddock trees, algal blooms in waterways, and loss of plant and animal species. In each case, the 'normal' functioning of the ecological system has been altered by land use, which results in a change in ecological processes or species interactions that maintain the system, leading to a new state.

Such consequences can cap agricultural production, limit the ability for producers to diversify and have a direct effect on profitability. They also can have serious consequences for native plants and animals.

Are these ecological changes reversible? Can we simply change management practices and move the system back to a more sustainable condition on the other side of the threshold? At this stage, experience in landscape restoration is too limited to answer these questions conclusively. Many revegetation programs proceed on the assumption that the effects of excessive clearing can be reversed, and that the values of native vegetation will be restored once sufficient vegetation is returned to the landscape. This may be true for some functions of native vegetation.

We can see the consequences of crossing ecological thresholds in many landscapes.

*Rodney van der Ree laying a trap for Squirrel Glider. Photo by Rodney van der Ree*

However, it is clear that great effort, cost and time are required to reverse across thresholds. Some ecological changes are difficult or impossible to reverse—for example, the loss of soils or change to soil properties. It is also more efficient and economical to take preventative action before thresholds are exceeded.

### How can thresholds assist land managers?

The main contribution is in understanding and managing the trade-offs between agricultural production and conservation. Where we can clearly demonstrate points at which there is major change or breakdown in natural systems, we can more reliably set preventative management goals. Limits or 'safe values' can be determined and guidelines for sustainable management activated at a level *before* thresholds are reached.

Scientific understanding is required of the ecological relationships in the issue of concern; for example, the effect of grazing intensity on composition of native pastures, or the isolation of habitats on native mammals. Quantitative data are important for identifying thresholds. It is then valuable to show the relationship graphically to help identify the point at which rapid change commences.

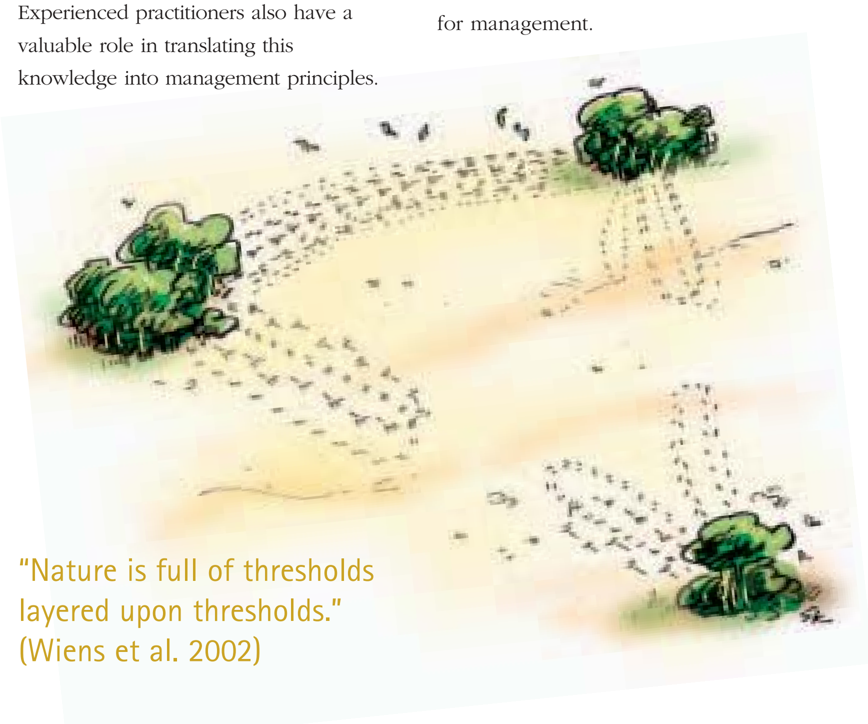
Experienced practitioners also have a valuable role in translating this knowledge into management principles.

CSIRO scientists Sue McIntyre, John McIvor and Neil MacLeod, for example, used a panel of experienced practitioners to identify critical points in the relationships between vegetation cover and ecosystem function in grassy eucalypt woodlands in south-east Queensland. The panel recommended minimum standards, on the 'safe' side of the perceived threshold level of change, for woodland cover, tussock grass cover, and other environmental indicators.

An understanding of ecological thresholds offers new insights into land management because it is based on knowledge of how natural systems work and it informs us about precautions we can take to prevent excessive disturbance and degradation. Identifying thresholds provides potential targets for restoration for which there is some confidence that sustainable ecosystem functions can be achieved. One of the challenges will be translating regional-scale thresholds to on-ground action at the property level.

### Be careful using thresholds

Ecological relationships are complex, often vary regionally, and may be different for areas where predominant land uses vary. So we need to be careful about the use of thresholds for management.



"Nature is full of thresholds layered upon thresholds." (Wiens et al. 2002)

Squirrel Glider. Photo by Lindy Lumsden

First, the changes we observe may be associated with several (or many) interacting factors, rather than a single causal agent. So, there may be seemingly simple thresholds that are complex to manage and we may not be able to modify all the factors or agents.

Second, different species and processes may have different threshold responses to the same disturbance or land use change. So, we need to be careful about making decisions with limited knowledge.

Third, species can respond to the environment in different ways in different regions. So, caution is required in applying thresholds and associated guidelines to geographic areas outside (or different from) those where the relationship has been demonstrated.

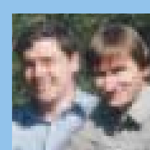
### More information

The Native Vegetation R&D Program of Land & Water Australia currently supports a number of projects that will offer new insights on this topic. Further research is urgently needed to identify threshold responses as a basis for management guidelines and as an input to regional planning.

van der Ree, R, Bennett, AF & Gilmore, DC (in press), 'Gap-crossing by gliding marsupials: thresholds for use of isolated woodland patches in an agricultural landscape', *Biological Conservation.*

Wiens, JA, Van Horne, B & Noon, BR 2002, 'Integrating landscape structure and scale into natural resource management', in: Liu, J, Taylor, WW (eds), *Integrating landscape ecology into natural resource management*, Cambridge University Press, Cambridge, UK, pp. 23–67.

### Contact

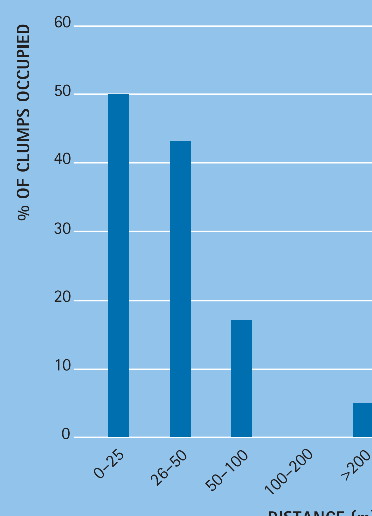


Andrew Bennett (right) and Jim Radford can be contacted at the School of Ecology and Environment, Deakin University, or by email: <bennetta@deakin.edu.au> and <jradford@deakin.edu.au>.



## Isolation threshold for the Squirrel Glider

The effect of isolation on the way in which animal species use habitats is one area in which thresholds are frequently observed. For example, Rodney van der Ree and colleagues at Deakin University investigated the occurrence of Squirrel Gliders in 91 tree clumps in paddocks adjacent to roadside vegetation. Gliders were recorded in around 40–50 per cent of clumps isolated by less than 50 metres of farmland. However, the frequency at which clumps were used dropped dramatically at between 50 and 100 metres and only one tree clump isolated by a distance greater than 100 metres was used (see figure). There is a simple explanation for these results. Squirrel Gliders are known to have a maximum gliding distance of about 80 metres. Therefore, a *threshold* exists at about this distance, beyond which tree clumps are too isolated to reach by gliding. The management implication is clear: to encourage movements of gliders, gaps between trees need to be less than the threshold, preferably less than 50 metres.



# What future our remnants?

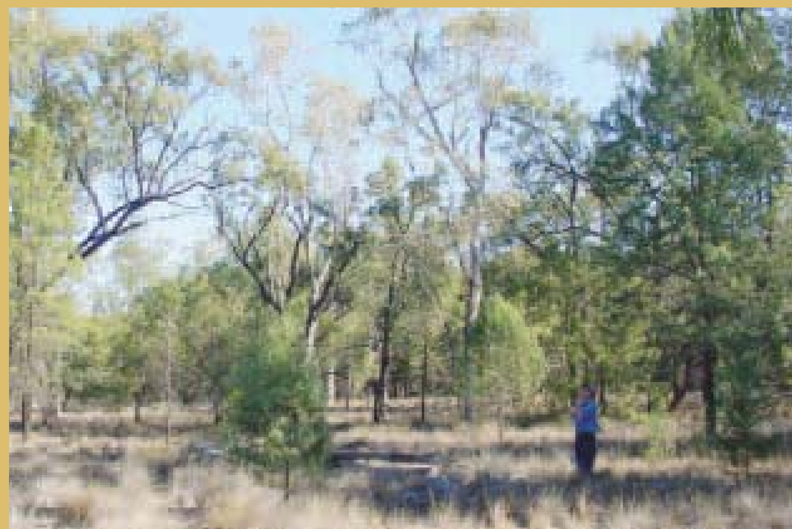
*By Heather Shearer*

**About a third of Australia's native vegetation in the intensively used areas (primarily the agricultural and urban zones) has been cleared or substantially modified and much of what remains is fragmented. Yet we know little about the effects of this fragmentation on the vegetation that remains and the animals that depend on it for survival. At what point in decline do all these fragments suffer major loss of fauna and flora?**

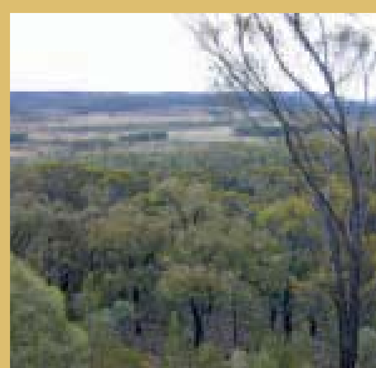
Dr Chris Chilcott, of the Queensland Department of Natural Resources and Mines, is part of the project team for the study, 'Ecological thresholds for native vegetation management in southern Queensland'. As the title suggests, Chris's team is looking at these 'threshold' questions and, crucially, how our management should respond to them.

"We are looking at thresholds that will maintain the remaining native vegetation in an ecologically viable condition. We hope to apply principles and thresholds from past studies elsewhere in Australia such as the following: if less than 10 per cent native vegetation is retained, a landscape is in real danger; 10 to 30 per cent retained is cause for concern; and above 30 per cent should be viable. However, landholders would like us to be even more specific about percentage cover of native vegetation and how they can configure it to maintain production", Chris said.

"Therefore, we're not only interested in the viability of the remnants but also in their location and role in agricultural landscapes. So, if you're going to maintain 30 per cent, we want to find the optimum design for specific types of agriculture for production as well as the conservation value."



*Tonya Hardacker conducting tree health assessments on a Poplar Box remnant on Claravale. Photo by Melanie Venz, EPA*



*Variegated landscape—a view across Long Gully valley on Claravale, 50 km north of Mitchell. Photo by Melanie Venz, EPA*

*(Left to right) Gil Campbell of Claravale, Melanie Venz (EPA) and Tonya Hardacker (Queensland Forest Research Institute, DPI) at Mt Arbor nature refuge on Claravale. Photo by Melanie Venz, EPA*

"It's still a big decision to retain regrowth and lose potential production. It's a pretty big trade-off for a producer."
– Chris Chilcott

The study is based around Roma, where the team has selected three landscape types: mostly uncleared (intact), partly cleared (variegated) and mostly cleared (relictual). In each of these landscapes, the ecological condition of remnants will be assessed at selected sites using indicators and rapid assessment techniques and comparing the results obtained. The sites have similar vegetation and soils, but are otherwise quite varied, with remnants of different size and condition in fragmented and intact landscapes. The team is now in the field undertaking detailed measurements at ten sites, covering habitat condition, landscape function, soil condition and tree health. Examples include litter fall, decomposition rates, soil mesofauna and invertebrate diversity. The detailed results from these ten sites will then be compared with results from the rapid assessment techniques used at a further 60 sites.

"For example, with decomposition rates, we are using litter bags at the detailed sites and a rapid assessment technique called cotton strip assay at the other sites. If we get similar results from the two techniques, we can then use rapid assessment techniques everywhere, saving money and time", Chris said.

Rick Kowitz, a Landcare officer and landowner involved in the study, commented, "The team set up different monitoring experiments in a large Poplar Box (*Eucalyptus populnea*) remnant on our property. As well as catching leaf litter, and setting up pitfall traps, they did a botanical survey, to identify the full range of species that occurred in the remnant".

The study will have a number of positive outcomes.

"There's still some clearing going on, so we have an opportunity to influence the future shape of the landscape", said Chris.

"We also want to see if we can scale up from the detailed sites to develop some relatively quick but accurate assessment techniques that can be used in a broader sense, not only by us but by vegetation management officers, landholders and extension officers.

"There are also opportunities to influence regrowth management in these agricultural areas for the better, but it's still a big decision to retain regrowth and lose that potential production. It's a pretty big trade-off for a producer."

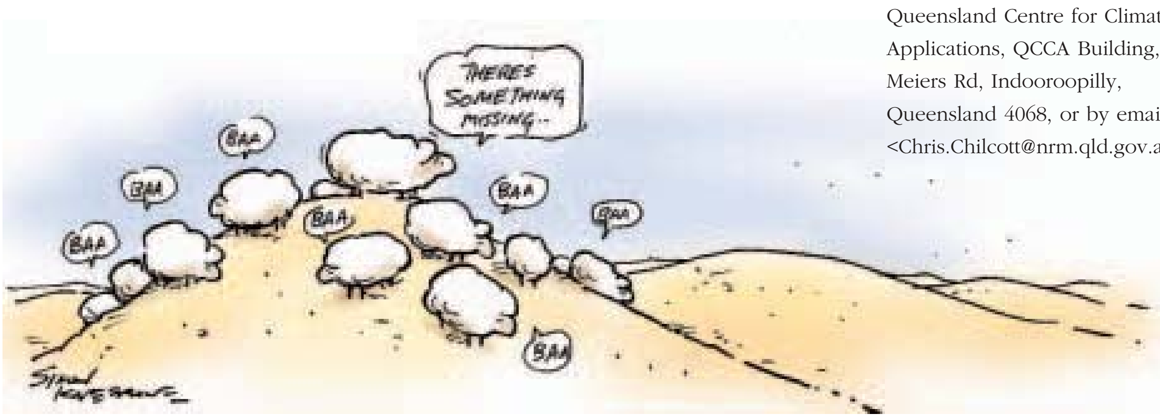
Rick agrees. "When the data are analysed, the study will give us an idea on how to manage our remnants more sustainably. We'll also be able to find out whether our remnants are healthy, or are just the living dead."

The team put a solid twelve months' work into meeting a lot of people and setting up working arrangements with people from past projects or through contacts from Greening Australia and Landcare.

"We found networks were vital. We even have a couple of the Landcare officers' properties as part of the study. Even so, it took us a year at least. Getting the information back to these networks in a useful form is a challenge for the future", Chris said.

"We held a number of useful field days, where we showcased all of our projects. The last two, held around Mitchell, were very successful and more than thirty producers stayed all day", Chris concluded.

"We'll also be able to find out whether our remnants are healthy, or are just the living dead."
– Rick Kowitz




## More information

A fact sheet (PF020195) on this project is available from the Program—see back page for details.

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McIntyre, S, McIvor, John G & MacLeod, Neil D, 'Principles for sustainable grazing in eucalypt woodlands: Landscape-scale indicators and the search for thresholds', in Hale, P, Petrie, A, Moloney, D & Sattler, P (eds) 2000, *Management for Sustainable Ecosystems*, pp. 92–100, Centre for Conservation Biology, University of Queensland, Brisbane.

## Contact

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# Out on a limb: the meaning of isolation for remnants

*By Fiona Hall*

**Many of our most diverse and threatened vegetation communities exist only as a series of fragments dotted around the agricultural landscape. We know very little about what this fragmentation and isolation means for the ecology of these remnant patches. Will fencing in remnants preserve them as reasonably functioning microcosms of their former glory? Research by a CSIRO Plant Industry team led by Andrew Young and Linda Broadhurst is revealing that this is unlikely to be the case. It is also testing some widely held beliefs about the best ways to go about revegetation, and finding some of them wanting. And it's all in the genes!**

Native vegetation communities, such as the grasslands and grassy woodlands of south-eastern Australia and the heathlands of Western Australia, now exist only as isolated fragments dotted around the landscape. For example, the temperate grassland communities of south-eastern Australia once occupied some half a million hectares. Today, they cover only 10,000 hectares, and are confined to a mosaic of patches separated by improved pasture and other land uses. Yet they remain one of the most floristically diverse plant communities in Australia and contain high numbers of both endangered and threatened plant species. The diverse grassy woodlands and heathlands have also been extensively cleared.

Research to date in these systems has mainly looked at birds, but what about the plants, the crucial building-blocks of the habitat? What does isolation do to them?

"We must get their management right if we're serious about keeping these systems", insists Andrew Young, leader of a Native Vegetation R&D Program-funded research project on the genetic and ecological viability of plant populations in remnant vegetation. Andrew's past research looked at how some rare plant species react to isolation. He found that these plants were becoming inbred and were losing their genetic diversity. These were important findings. However, revegetation practitioners, with whom Andrew has close links, needed to understand the more common species in the same ways. "Common species are important in the context of remnant vegetation in Australia, especially if we think of our landscapes in an integrated way that allows for both conservation and production", Andrew says.

Investigating these issues for more common species is the main role for Linda Broadhurst. A former merchant banker who made the transition to conservation geneticist with admirable ease, she feels more comfortable dealing with the tangible assets of trees and seeds than stocks and shares. Linda now works in 16 remnant sites in south-eastern New South Wales, exploring the effects of isolation on common species. The sites range from tiny cemeteries to larger travelling stock reserves, all carefully selected to represent various levels of isolation, disturbance and size. Across these sites she is looking at the genetics and lifestyles of two species to see how they cope with varying degrees of isolation from the next nearest population. *Swainsona sericea*, the Silky Swainson-pea, is a small purple-flowered perennial of the grasslands and grassy woodlands of south and eastern Australia. The Silver Wattle, *Acacia dealbata*, is a common and widespread tree throughout this region.

Linda has just finished collecting seed from the various sites and will now use genetic analysis to understand the genetic variability and 'fitness' of the seed, and their reproductive history. To determine 'fitness' she will grow some of the seed to see if populations vary in terms of their ability to germinate or in

## *Fragments:* a genetic melting pot?

When people talk about genetic threats to species, they generally talk about loss of variation through inbreeding. However, one of the other problems with fragmentation is that isolation and a declining density of plants may disrupt pollinators; there may also be fewer individuals from a species flowering at the same time. This can mean that pollinators are forced to visit other, related species. The result could be increased hybridisation between species. This is now another focus of the team's research work. They want to know whether hybridisation could cause local extinctions, especially through less common species being swamped by a more common one—literally diluted out of existence. Another graduate student, David Field, is exploring this for *Eucalyptus aggregata*, or Black Gum, a fairly widespread species in south-eastern Australia, but with a restricted distribution concentrating along watercourses. It is reported to hybridise with the more common *E. viminalis* and *E. rubida*.

Acacia dealbata. *Photo © Murray Fagg, Australian National Botanic Gardens*

Swainsona sericea. *Photo © Murray Fagg, Australian National Botanic Gardens*

their growth rate. She studies their reproductive history to find out 'who's mating with whom'. Genetic markers are used to determine which 'fathers' are producing all the pollen and how much mating between relatives is going on. These findings will be compared with the degree of isolation, disturbance and size of the study sites. Linda is also trying to determine how much movement of pollen and seed can still occur among remnant plant populations that are separated by pasture—that is, how biologically isolated current populations are. A sister study has also begun in the heathlands of the Dongolocking area in Western Australia, coordinated by the WA Department of Conservation and Land Management.

The early findings of Andrew and Linda's research are surprising and thought-provoking. There will be many repercussions for revegetation efforts. In particular, the pair already have some important things to say about provenance, hybridisation and the genetic quality of native seed.

### Putting science and practice together

Managing and enhancing remnant vegetation is a rapidly expanding area amongst land managers. How will this research contribute to these efforts?

## Provenance: how *local* is *local?*

Provenance has long been the watchword among revegetators—witness the popularity of 'local' seed for revegetation (see More information). The theory is that when replanting, you should source your seed from as nearby as possible. This ensures that the specific adaptations that plants have evolved over centuries to cope with the site's micro-conditions aren't lost. These are valid arguments. However, the CSIRO is finding that gathering local seed may be the worst thing you can do if the patch of bush where you collect your seed is isolated and producing inbred seed of low genetic quality.

Why does isolation lead to poor seed sets? There are many reasons, including:

- *Pollinator activity*: pollinators may not be able to reach isolated sites.
- *Flowering synchronicity*: if population levels reduce there might not be enough plants flowering at the same time to enable a good mix of genes.
- *Competition and disturbance*: weeds and altered nutrient levels can affect the quality and quantity of seed production.
- *Self-incompatibility*: some plants have a genetic barrier that prevents them from self-fertilising. On small isolated sites they will be less likely to encounter a compatible mate through their inability to mate with genetically similar relatives.

Sourcing local seed from small isolated sites risks perpetuating these inbreeding effects. This means you should try to bring in seed from a 'reasonable distance', but we don't know what that reasonable distance is. Too far away, and the plants might be poorly adapted to your local environment. One aspect of this research, therefore, is to try to identify what this reasonable distance might be. Melinda Pickup, a graduate student, is working on *Rutidosis leptorrhynchoides*, a species that needs genetic enhancing from outside sources. She is collecting seed from plants at sites 1km, 10km, 50km, 100km and 600km away from the target species, crossing the target species with this variously sourced seed, and looking at the fitness of the resulting offspring.

*Andrew Young and technical officer Liz Gregory at site near Yass, New South Wales. Photo by Carl Davies*

*Measuring plant densities at a study site near Adaminaby, New South Wales. Photo by Carl Davies*

Andrew and Linda keep close links with revegetation practitioners and their research answers real needs. "Local people on the ground often know a lot about the biology of the system. They don't necessarily know what's behind it, but they've made a wealth of observations", says Andrew.

"For example, Greening Australia officers came to us with a concern that they had noticed that the little patches where they source seed just didn't seem to be giving them good quality material."

Linda and Andrew looked into this, focusing on *Acacia acinacea*, the Gold Dust Wattle, a common species and a target for revegetation in the Murray–Darling Basin. It's a highly variable species across its range and people are very conscious about sourcing seed locally. This often means collecting seed from small remnant patches. Could it be that these patches are too isolated to maintain healthy genetic processes for these populations?

To investigate, in addition to the research described earlier, Andrew and Linda are comparing three sites: one large and two smaller populations of *Acacia acinacea*. One small site is just a couple of kilometres from the big site, the other is more isolated. Early results show little difference between the sites in seed set and germination, but there is difference in genetic fitness, especially in seed from the more isolated site.

The indications emerging from the various research activities are that small remnants near a larger source of genetic material might have a better chance of survival than the more isolated remnants. As Linda explains, **"We plan to use the findings to build models that will be able to say: if a remnant is this size, with this amount of disturbance and with this degree of isolation, then the outlook is not good, but if it is slightly larger in size and closer to other populations of similar species, then perhaps the outlook is a bit better".** These guidelines will help land managers and farmers decide which remnants they should prioritise: should they be fenced, should they be enhanced, and if so how? "This research will help target the conservation dollar to the sites that are worth expending the effort on protecting", comments Andrew.

Where protecting remnants is not enough, we need to help the process along, by putting plants back. This research will help to make that work more effective by identifying the best patch of bush from which to source healthy and viable seed. Andrew continues: "So not only are remnants important in their own right for conservation, they are becoming an important source of revegetation material, for providing seed and as pollination sources. We will be able to say where best to site a new patch, within how many kilometres of an existing site, and how close together new patches should be so they are in range of pollinators or seed dispersers".

This research is an excellent example of partnership between scientists and practitioners. On the one hand, scientists can refine the questions and make recommendations; in turn, the practitioners can decide which recommendations are the most practical.

"Local people on the ground often know a lot about the biology of the system. They don't necessarily know what's behind it, but they've made a wealth of observations."
– Andrew Young

## Seed orchards: the *future* for *revegetation?*

According to a recent survey, there is likely to be a growing need for 'local' native seed and seedlings in the future—a "major consequence of the increasing use of local plants is that 'native seed' as a raw material for revegetation is actually many thousands of separate commodities partitioned firstly by genus and species, and further by geographic origin" (Mortlock 1999). Where is this 'local' supply going to come from? By collecting such volumes of seed from local populations we might be harming the source ecosystems (especially in drought years with so many organisms, from ants to cockatoos, dependent on seed).

Andrew would like to explore genetic provenance for a whole range of species to find out exactly 'how far is too far' for seed collection for remnant revegetation. Then he wants to actually build seed orchards. "If we're serious about revegetation, we need to build seed orchards where we grow plants of high genetic quality. We can ensure these are locally adapted to specific genetic and environmental zones within which seed can be transferred; we should build a couple of seed orchards within each zone."

Seed orchards are common in the forestry industry and some big seed suppliers also depend on them. The same approach can be taken for revegetation. According to Andrew there would be many commercial opportunities if there were a decent-sized native seed industry, as well as the potential for substantial job creation. "So many reveg programs end in failure; whilst seed quality is not always to blame, ensuring quality would at least be a good start. It's the future, it's what we should be doing."

Andrew praises the Native Vegetation R&D Program for the big role it plays in providing a national framework for getting scientists and practitioners together. "We've talked to about half a dozen groups we didn't even know of before because of this…it's a critical role they play in directing the effort through their project selection and ensuring that the wheel isn't reinvented", he says. "Science won't solve the problems, people will solve the problems, but science will provide the leverage to allow people to solve the problems."

… small remnants near a larger source of genetic material might have a better chance of survival than the more isolated remnants.


### More information

A fact sheet (PF020197) is available on this from the Native Vegetation R&D Program—see back page for order details.

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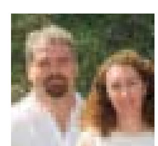
### Contact



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# A fix on changing landscapes

*By Christine Watts*

**Despite many years of remnant vegetation mapping in New South Wales, little research has been conducted into how particular flora and fauna species are affected by different policies, planning and execution. With this in mind the National Parks and Wildlife Service (NPWS) is undertaking research to explore the dynamic nature of native flora and fauna through computer modelling and field studies in the NSW sheep–wheat region.**


"My job [with NPWS] involved sitting on committees trying to develop new policy guidelines to direct regional planning and native vegetation management, and it seemed that what we were really lacking was a framework to test any of these ideas before unleashing them on our rural landscapes", says Michael Bedward, who leads the research project team along with Ross Bradstock.

This two-year project began in February 2002 with funding from Native Vegetation R&D Program.

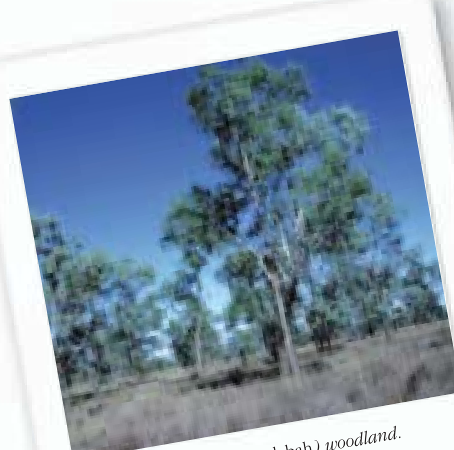
"The general aim of this project is to develop new tools and techniques to support the biodiversity aspects of regional planning and policy development. In particular, we are emphasising dynamics", states Bedward. The team hopes to utilise modelling techniques to predict how changes in regional landscape policy, vegetation disturbance and restoration will affect the biodiversity of a region.

Of the original forested area in New South Wales 58.7 per cent has been cleared or thinned and another 4.3 per cent suffers significant disturbance (EPA 2000). In addition, between 1993 and 2001 the number of extinct, endangered or vulnerable bird and mammal species increased from 118 to 160 (ABS 2002), an increase significantly influenced by habitat alteration.

Landscape modification is especially pronounced in the sheep wheat belt of central and northern New South Wales, an important rural area covering 12 per cent of the state, which has lost 95 per cent of its original woodland cover (EPA 2000). Recent research undertaken by Bedward has also revealed that clearing rates in this area were 8 to 10 times higher than had been previously reported.

There is no single indicator for the measurement of all biodiversity. One method the NPWS research team is using to determine whether the biodiversity of a particular region has been modified is to monitor historical and current vegetation disturbance and changes in functional plant and animal groups. Another is to establish predictors and models to gauge the impact of new agricultural, development, and restoration activities on flora and fauna, including the subsequent advance of regional vegetation and landscape policies.

"...what we were really lacking was a framework to test any of these ideas before unleashing them on our rural landscapes."
– Michael Bedward



*Coolabab (Eucalyptus coolabah) woodland.*
*Photo by Chris Simpson, NPWS*

The team hopes that such models will bring positive changes in policy development and eventually to the rural landscape.

"The project has a number of strands", Bedward says. "We will reconstruct historical sequences of woodland clearance in the sheep–wheat belt to help explain the present distributions of native species. We'll examine fire and grazing impacts on different species, and predict how populations of plants and animals would fare under different regional planning scenarios. We are using computer models to determine the long-term consequences on flora and fauna populations, the loss of habitat, and biodiversity, of different vegetation management or 'scenarios'".

Such research is significant for the current emphasis on policy planning and the development of regional land management strategies. In particular, catchment management boards and regional vegetation committees within the sheep–wheat belt of New South Wales have recently produced blueprints for management, which involve specific vegetation and biodiversity objectives. Good scientific research is required to underpin policy and management decisions, which can have far-reaching impacts on how the landscape can be managed and whether a sustainable outcome is achieved.

This research project will help determine the adequacy of current policy practices and test the effectiveness of innovative planning proposals. The capacity of NPWS to directly influence, develop, and implement on-ground changes in landscape policy will have a significant impact on the management of the state's biodiversity.

The work will also provide regional policy and planning bodies with predictive modelling tools to determine sustainability of various land management scenarios.

*A narrow corridor of Poplar Box (*Eucalyptus populnea*) and White Cypress Pine (*Callitris glaucophylla*) between paddocks near Tottenham. Photo by Chris Simpson, NPWS*

*Aerial view of remnant vegetation near Moree. Photo by Sally King, NPWS*

## More information

A fact sheet (PF020196) is available on this from the Native Vegetation R&D Program—see back page for order details.

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## Contact

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# Conservation: more than fences at stake

*By Heather Shearer*

**[In the last issue of *Thinking Bush* ('Conservation steaks'), Wendy Pyper wrote of the frustration felt by Neil MacLeod and his colleagues at CSIRO Sustainable Ecosystems when they found that implementing optimum environmental practices might be beyond the reach of many graziers, particularly those on extensively cleared properties. Neil's research challenge is to resolve some of the economic and other issues raised by landholders. But what of the landholders concerned—how do they see the dilemma?**

MacLeod's team investigated grazing properties around Crows Nest and Mundubbera, in Queensland, to establish the real costs of options such as replanting trees on recharge sites for salinity prevention, establishing viable wildlife habitat and corridors, and fencing out riparian areas.

Neil sums up the dilemma their research has highlighted: "While everyone wants to be ecologically responsible, without considerable public support to finance remedial works, the results were not encouraging for landholders. While the public stands to gain a lot from private landholders taking on our design principles, in most cases the benefits to the landholders would be very modest. This is a challenge still to be resolved".

Benita Darrow, a Soil Conservation Officer at Mundubbera who was involved in the study, feels the set of principles developed provides a critical guide to the sustainable management of grazing lands, but can also be applied to any land use.

"Local producers saw them as the 'ideal situation to strive for' in their strategic planning, and many elements can already be incorporated into management. The principles draw together the latest research findings, and though many costs cannot be justified, it's useful to know where we should be heading", she says.

She feels that many producers involved thought the final outcomes fell short of what is needed for positive action.

"The work still needs to be fleshed out to achieve more economical and practical win–win solutions. Everybody involved spent a lot of time and gave a lot of themselves, so it's really important to extend the project work to best use the results."

### Farmers' views

"The most important finding was that it would cost us $1.6 million to implement all the environmental principles on our property", says Alex O'Neill of 'Doon Doon', one of the properties used as a case study.

"Producers are here for the long term, so don't want their country degraded. But they've lived through too many 'fads' to uncritically take up a set of land management principles." – Alex O'Neill

*Cattle mustering in ironbark country; a typical pastoral scene in the grassy woodlands of southern Queensland. Photo by Patti Stephenson*

*Landholders and the research team discussing riparian zone management issues and options on 'Yerilla' (Auburn River District). The photo shows limited vegetation structure due to limited control of stock access. Photo by Jan Green*

"It may be possible to undertake some of this work on smaller properties where owners have off-farm income, however this is a working size property (25,000 acres), upon which we depend entirely for our income.

"Commercial producers always look at the cost factor—what will it cost? How much income is affected? Does this limit our ability to expand our business? Will the benefits of long-term sustainability outweigh these costs?

"Producers are here for the long term, so don't want their country degraded. But they've lived through too many 'fads' to uncritically take up a set of land management principles. They're more likely to think it over, see what results others have had, and if they don't end up on their face, they might try it, but it won't happen quickly."

According to the landholders involved, the study was conducted well. "The project included discussion between the environmental 'experts' and groups of local producers. Meetings were held where everyone could have their say, to review and to critique. Of course there were differences of opinion, but this was healthy. It was a learning experience for both sides. At first, sometimes, producers just kept quiet and listened. However, by meeting repeatedly, we could thrash out all the issues", Alex says.

### Not just about fences

John Lindemayer, another landholder who participated, agrees: "After attending the meetings, we're much more aware of the native animals. In the past, nobody gave a thought to the native animals. But both sides learned from each other".

"However, we could never come out ahead economically if we did everything", John says. "We must be aware of the value of the waterways, but fencing is not the only solution. There are other things you can do to take the pressure off. We can put in

"To fence all riparian areas will prove outstandingly expensive...some system, like a levy or tax, has to be developed at a higher level to pay for this." – Benita Darrow


more waterpoints, and let more vegetation regrow. With rain, and with some cattle pressure off, the trees will return without replanting. We're also leaving the regrowth in the hollows and creek areas. Before, you could see for miles, now it's all lines of trees."

Alex agrees: "The proper management of country doesn't require all this fencing off of creeks. The creek areas are often our best grazing, but they're dry gullies for most of the year. The problems created by fencing (wildfires, vermin) were identified but have yet to be satisfactorily addressed".

### Who's paying?

"To fence all riparian areas will prove outstandingly expensive", Benita says. "However, if this is what's needed to protect the catchments, and the downstream users, some system, like a levy or tax, has to be developed at a higher level to pay for this.

"As it was, some results were really worthwhile, because they were fed back into policy. The producers really appreciated that their input was acknowledged."

Neil agrees: "The landholders had no dispute with the scientific basis of the landscape management principles, but rather with the potential cost and who is likely to pay for it. The landholders appreciated that they were engaged in the dialogue, and their opinions respected".

When asked about the future, Alex commented: "Well, with the drought, we're in survival mode, and everything else has to take a back seat. When it rains, then we can seriously look at doing things. The other point is this is only one facet of our business. We have many different issues to work on any given time".

John agrees: "The drought is a bit of a problem. The ground is that bare, and there's no money to do anything. However, the number one point is that enterprises have got to be viable, and if we are viable, we can do something about the environment. Then it's good for the whole country".

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## Managing & Conserving Grassy Woodlands

*S McIntyre, JG McIvor & KM Heard*
*CSIRO Sustainable Ecosystems*


*Managing & Conserving Grassy Woodlands* describes a set of principles that will enable landholders to maintain or increase productivity without compromising ecological sustainability, and at the same time maintain a substantial proportion of the native flora and fauna. The book provides the technical foundations underpinning the principles and explains the importance of planning at a landscape scale.

*Managing & Conserving Grassy Woodlands* is intended for those at the interface of disciplinary research and on-ground application, whether they are working in research, regional planning, extension, landcare or land management.

September 2002, CSIRO Publishing, 262 pp., colour illustrations, $59.95 (hardback) plus postage and handling charges.

To order, call 1800 645 051, email publishing.sales@csiro.au, or visit their web site. <www.publish.csiro.au>.

# When the dry's the limit

*By Julie Olsen*

**Devastating images of drought tug violently at the heartstrings of Australians, but it's not the land that has our sympathy, at least not yet. Rather, our hearts go out to the battling farmers and our loyalties remain with an economic system that supports unsustainable practices. At what point will we have gone too far for these natural ecosystems? What sort of trade-offs between production and conservation should we expect if such loyalty to unsustainable practices were to change to even a small degree?**

Not afraid to tackle the big questions head-on, scientists from CSIRO and Greening Australia have spent the past three years taking a close look at the on-ground implications of the changes required to retain landscape-scale ecosystems and ecosystem processes in rural lands.

"Establishing limits to our exploitation of the rural environment is going to be the key to sustainable land use. For the first time, we are testing our idea that there are thresholds beyond which we should not modify these landscapes", says Dr Sue McIntyre. When faced with images of the drought, she can't help but notice the paddocks 'grazed to dust'. "It concerns me to see farmers grinding down their future profitability", she says.

"Many farmers recognise the need to change the way they manage their land. They are looking for clear and practical advice about the actions they should undertake", says Robert Lambeck.

Sue McIntyre, CSIRO colleague David Tongway, and Greening Australia's Robert Lambeck all know how urgently such information is needed—and sought—by landholders, land managers, extension workers and conservation planners.

### Testing published thresholds

McIntyre's team at CSIRO Brisbane developed and published a 'Principles and Thresholds Approach' (see More information), which now lies at the heart of her research. The approach encompassed soil, grass, trees, wildlife, watercourses and their interactions, and recommended principles and some tentative thresholds for management. The approach has proven a useful tool in the development of regional plans and policy settings. McIntyre's current research project under the Native Vegetation R&D Program will help to identify the early warning signs of impending land and water degradation as well as develop strategies for restoring and rehabilitating degraded areas. "We are now putting some of these principles and thresholds ideas to the test", she says.

### Are there thresholds that provide early warning ?

Are there break-points in the ways we measure biodiversity that provide some early warning of degradation? Early findings of this research are interesting, but still leave some unanswered questions.

Birds were found to require a larger area of habitat than the area found necessary to maintain surface soil water processes in the Western Australian wheatbelt, for example. The research suggests that nutrient and water cycling dynamics are maintained within remnants as small as one hectare, as long as protection from grazing and human disturbances continues. However, in the same location, the birds were found to require remnants of at least 20 to 25 hectares in size. While small, healthy patches of vegetation are still of value to a range of woodland birds and other organisms, they are failing to sustain some more sensitive bird species.

> "Establishing limits to our exploitation of the rural environment is going to be the key to sustainable land use."
> – Sue McIntyre

The team uncovered a sensitive indicator of landscape function on the other side of the continent, in subtropical grasslands. Large perennial tussock grasses tend to be intolerant of grazing in the native grasslands grazed by cattle in south-east Queensland. They were found to be better indicators of soil stability, infiltration and nutrient cycling than perennial grasses in general. It's an important finding in a region where managers need indicators to optimise the condition of their pastures, rather than managing the gross indicators such as severe soil erosion.

Identifying the needs of wildlife presents more of a challenge. Plants, vertebrates and invertebrates all vary in their ability to move about the landscape. Some plants, for example, can only disperse a few metres, while soil invertebrates may operate at the scale of centimetres. While research shows that the range of patch types in the landscape enhances diversity, the relative proportions of these needed to optimise diversity is unknown. Areas of bare ground and short grass swards are used by a variety of organisms, but more plants and invertebrates prefer areas that are ungrazed or lightly grazed by livestock. This suggests that tall grassland patches are likely to be required in greater quantities in the landscape than short patches.

Examining the evidence, the team found little reason to change the earlier proposed threshold: “Graze conservatively to maintain dominance of large and medium tussock grasses over 60–70 per cent of the native pastures” (McIvor 2002). However, in the interests of easier assessment for managers, and in the light of soil condition data, they propose to rephrase the principle and threshold as: “Graze conservatively to allow a maximum of 30 per cent short-grazed patches in native pastures”.

### Applying landscape function analysis

This work also gives the researchers a chance to explore the usefulness of Tongway’s landscape function analysis (LFA) in an environment different to the semi-arid areas in which it was developed. As an informal tool, LFA has proved an excellent way to ‘read’ what is happening out in the field.

“LFA helps us to understand how well the land holds on to and uses the water and nutrients available to it”, says Dr McIntyre.

Although further validation will be needed, data collected by David Tongway support the effectiveness of the soil surface condition indices as indicators of nutrient cycling and infiltration.

### Evaluating ‘focal species’ and ‘principles and thresholds’ approaches

The research is also using landscape function analysis to evaluate the performance of the ‘focal species’ and ‘principles and thresholds’ approaches to vegetation planning. According to the focal species approach, in order to protect all species threatened by a given process, it will be necessary to manage that process at a level that protects the most sensitive species—or *focal species*. The principles and thresholds approach assumes there are thresholds of land use which, if exceeded, will result in major losses of ecosystem function.

The team found that their principles and thresholds approach is more conservative in terms of identifying habitat requirements and therefore an approach more suited to relatively intact landscapes where catastrophic losses of native species have not occurred.

The focal species approach appears better suited to highly modified landscapes, where habitat might need to be restored and productive lands reallocated in order to protect biodiversity.

*Kangaroo grass (*Themeda triandra*)—a ‘large tussock’ species, which indicates low grazing pressure. Photo by K Heard*

*David Tongway and Norman Hindley measure soil surface condition. Photo by S McIntyre*

### Motivation for the future

Dr McIntyre has some challenging thoughts about what she sees as the generally poor recognition of trade-offs between agricultural and conservation. “Today’s landscape designers and managers strive for positive results but only within the constraints of what they are prepared to entertain”, she says. If such constraints were lifted, she believes it would free planners. She argues that “we need to identify all areas of salinity hazard and retain or restore vegetation where required, to restrict cropping, horticulture and sown pastures (the most intensive land uses) to the minority of the landscape and reduce levels of pasture utilisation, particularly during drought”.

“Society as a whole will first need to make a commitment to maintaining biodiversity for changes like these to be effected. We will then have to change the socio-economic situation so that better landscape design *is* a rational decision for land managers, both from a personal and economic point of view”, Dr McIntyre believes.

### More information

A fact sheet (PF020202) is available on this project under the Native Vegetation R&D Program.

McIntyre, S, McIvor, JG & Heard, KM (eds) 2002, *Managing & Conserving Grassy Woodlands*, CSIRO Publishing.

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# Clues to survival in agricultural landscapes

*By Ann Jelinek*

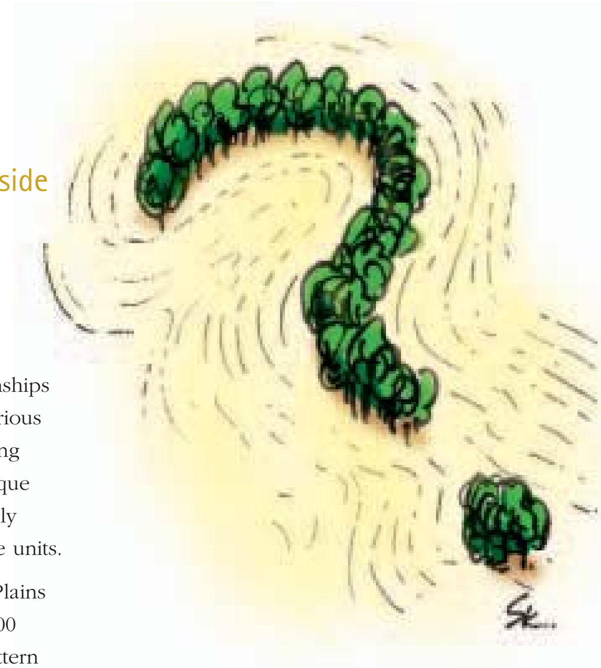
**How does vegetation cover and pattern influence wildlife diversity in fragmented landscapes? Is there a point of no return for some species?**

Looking beyond patches of native vegetation, Dr Andrew Bennett of Deakin University and Research Fellow Dr Jim Radford are taking a whole-of-landscape approach to these questions. Their focus is on identifying potential ‘thresholds’ in native vegetation cover below which there is a rapid decline in wildlife species richness, and also, whether these thresholds are affected by how the vegetation is arranged in the landscape.

According to Andrew, “if critical points or thresholds exist and if they can be quantified, then we can use this scientific basis to develop principles for landscape design and restoration. Importantly, we can then develop practical guidelines for conservation in fragmented, rural landscapes”.

Their study areas are the Gippsland Plains (Figure 1), and the Goldfields and Riverina bioregions of Victoria. Initial analyses of Birds Australia’s Bird Atlas II data, collected from 1997 to 2001, are quantifying the relationships between woodland birds and various landscape characteristics, including land use. The Bird Atlas is a unique resource and its data can be easily incorporated into landscape-scale units.

The overall amount of vegetation cover and diversity of vegetation types, especially streamside vegetation, have the greatest influence on total species richness.



Interestingly, for the Gippsland Plains data set, which covers over 15,000 square kilometres, vegetation pattern does not appear to have as much influence on bird species richness as expected. “The overall amount of vegetation cover and diversity of vegetation types, especially streamside vegetation, have the greatest influence on total species richness”, Jim says.

“The number of woodland-dependent bird species declines as tree cover is reduced and then drops markedly in landscapes with less than 10–12 per cent of remnant vegetation, especially in landscapes with small amounts of dry woodland and grassy woodland. This region is unusual in having large areas of forest close by in the Great Dividing Ranges. To keep viable populations of most woodland birds in the long term, it’s likely that much greater vegetation cover is needed. For ‘declining’ bird species, two significant influences are the total vegetation cover and the amount of tree cover in patches of at least 20–100 hectares (Figure 2). Declining species do better at 40 per cent overall cover and 10–12 per cent cover is just not enough”, Jim adds.

“These early results suggest that, to conserve woodland dependent species, it isn’t enough to maintain or restore remnant vegetation in the landscape above these levels; land managers also need to ensure that there is a diversity of vegetation types across the landscape.”

Jim and Andrew are optimistic that further analyses of the larger Goldfields and Victorian Riverina data set, and closer examination of species-specific responses to landscape change, will give more detailed information about managing these environments. Future investigations will concentrate on field studies in selected landscapes across northern Victoria to complement the

**Figure 1**

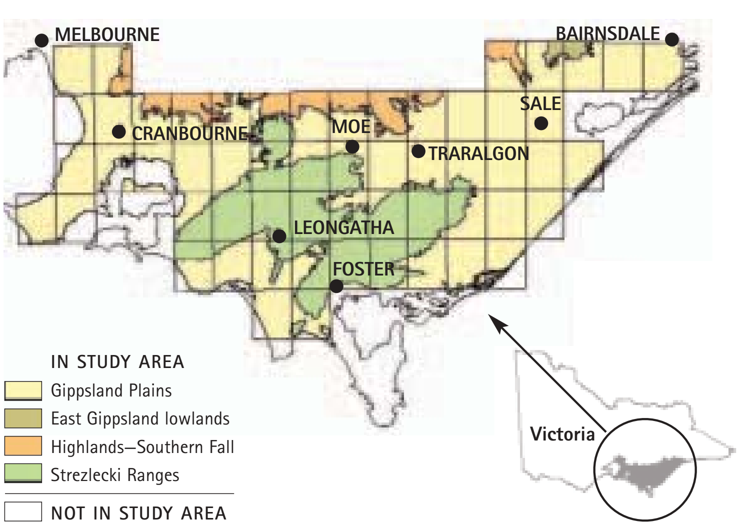
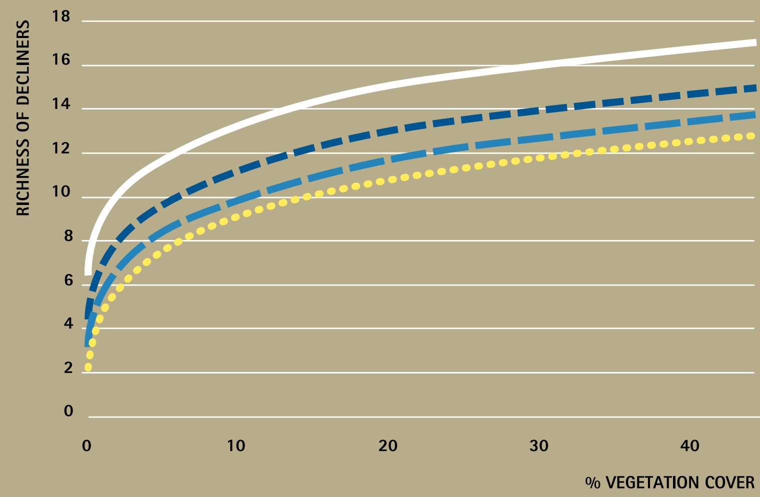


**Figure 2**

Relationship between native vegetation cover and number of 'declining' bird species in landscapes of the Gippsland Plains. The model predicts that a larger number of 'declining' species will be present in landscapes with a higher percentage of cover (horizontal axis) and for landscapes in which more vegetation occurs in patches of at least 20–100 ha (different curves).




20–100ha = 5%
20–100ha = 10%
20–100ha = 20%
20–100ha = 40%

It isn't enough to maintain or restore remnant vegetation in the landscape above these levels; land managers also need to ensure that there is a diversity of vegetation types across the landscape.

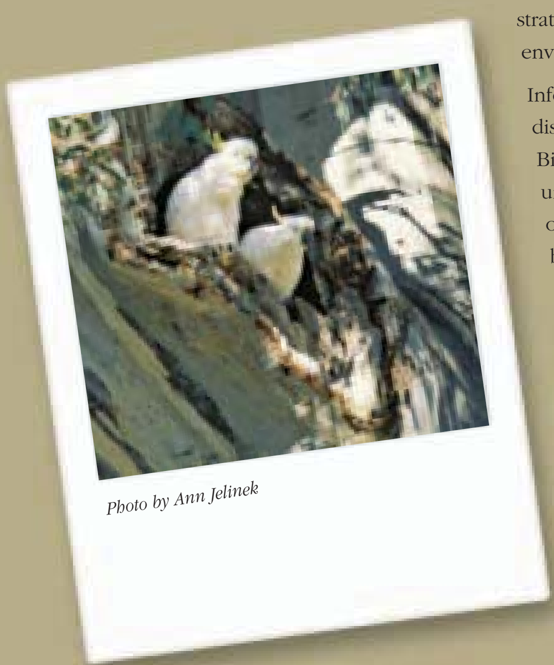


*Photo by Ann Jelinek*

results from the modelling phase of the project.

Tackling similar concepts, also from a landscape perspective, CSIRO's Sustainable Ecosystems team, led by Dr David Freudenberger, is contrasting the influence of remnant vegetation in cropping landscapes on biodiversity in eastern and western Australia. Initially using the focal species approach to landscape design, this project also aims to identify more effective revegetation strategies that will also benefit other environmental issues such as salinity.

Information on bird species distribution will be obtained from Bird Atlas II and existing unpublished data. Patterns of bird occurrence and species decline will be related to landscape scale attributes such as land use change, vegetation distribution, and salinity. Comparisons will be drawn with the Victorian study and an Australia-wide picture will emerge of variation in bird species distribution in response to landscape change over time.

Last spring, Dr Andrew Huggett and his WA team, including Lesley Brooker, John Ingram and Blair Parsons, carried out intensive surveys in 213 bush remnants covering 17,000 hectares. They recorded over 18,000 birds representing 111 species in the Buntine–Marchagee Recovery Catchment of Western Australia's northern wheatbelt.

"The vegetation mapping shows that a surprising number of remnants are in good condition, particularly those in saline and upland environments", Andrew says. "This may reflect that clearing of native vegetation for farming occurred much later (1950s–60s) in this part of the wheatbelt than in catchments to the south. We might also be seeing a landscape that is yet to feel the full impact of dryland salinity. It is mainly the lowland areas that suffer from salt damage. These areas contain saline wetlands that support samphire and saltbush communities, which provide important food, shelter and possibly nest sites for birds such as the White-winged Fairywren (*Malurus leucopterus*) and White-fronted Chat (*Epthianura albifrons*). The level of floristic diversity across the catchment is high.

"A record of the Rufous Fieldwren (*Calamanthus campestris*), in an 1800-hectare privately owned remnant of heath, is certainly a highlight, given

*Upper Goulburn catchment—agricultural landscape showing varied land uses and fragmentation of remnant vegetation, Central Victoria. Photo by Ann Jelinek*

that this species was last recorded in the catchment in 1976. This is one of many bird species considered to be sensitive to habitat loss and fragmentation in this catchment."

The team is now using GIS to analyse the bird and vegetation data (species composition and structural complexity), as well as the spatial arrangement of remnants in the landscape. Andrew explains that "bird data is being correlated with vegetation characteristics to evaluate how plant composition and structure influences different bird species responses to habitat fragmentation across a dryland agricultural landscape".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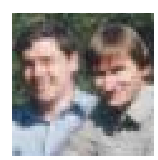

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# Adaptable forest management guidelines

*By Ann Jelinek*

**Ecological principles and management guidelines recently developed for Box–Ironbark in Victoria can be readily adapted to the management of similar forest communities elsewhere in Australia. They are the results of a three-year study of Victorian Box–Ironbark communities, documented in a series of ten information sheets: 'Wildlife in Box–Ironbark Forests—Linking Research and Biodiversity Management'.**

Highlighting important research results, the information sheets are a valuable resource for land managers, land-holders and environmental educators alike. They also provide a focus for conservation efforts in Box-Ironbark and other dry forest communities typical of eastern Australia.

Each information sheet has a summary of key findings, followed by descriptions of a particular topic and the processes that influence this aspect of the Box-Ironbark ecology; each concludes with actions that can be taken by land-holders and managers to minimise loss of biodiversity.

For example, 'A Patchy Resource' (No. 4), emphasises the importance of nectar from flowering eucalypts during winter for many native animals to illustrate why it is so critical that there is a diversity of vegetation types spread across the landscape. This is particularly important for seasonally migrating species, like many honeyeaters. Equally significant are forest gullies and drainage lines that have high species richness.

A common theme to all the information sheets is the need to protect large, old trees. These not only provide more nectar than smaller trees, but they are also more likely to have hollows suitable for nesting by a large range of native animals. As well, fallen limbs from these large trees are valuable habitats for ground-dwelling fauna.

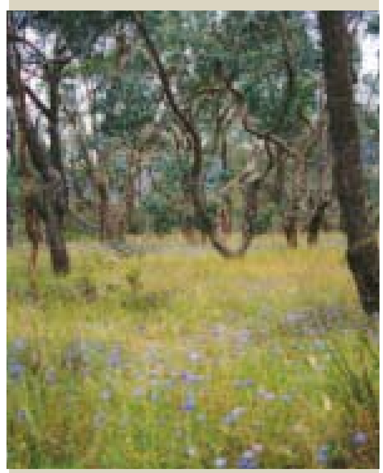
Invertebrates are often overlooked in natural resource management activities because they are not always included in wildlife surveys, requiring more specialist techniques and effort, particularly with identification. 'Bugs in the System' (No. 6) includes detailed sections on spiders and ants characteristic of Box-Ironbark, adding a new perspective on this forest's fascinating ecology.

Taking a broader view of managing dry forest communities in the landscape, 'Networks in the Landscape' (No. 7) discusses the roles of roadside and streamside vegetation and illustrates their particular significance for reptiles. It complements 'Shrinking Patches' (No. 3), which summarises the effects of fragmentation and habitat loss on biodiversity, placing equal emphasis on fragment size and habitat quality.

The final information sheet, 'A Dominant Bird' (No. 10), highlights the competition between aggressive birds (such as noisy miners) with smaller insectivorous birds so evident in areas with small, scattered patches of native vegetation. The clear message applicable to rural landscapes is that noisy miners prefer small areas of open forests adjoining grazed pastures. They tend not to forage in larger remnant patches greater than 10 hectares and vegetation corridors greater than 50 metres wide, especially those with a dense shrubby/grassy understorey.

## The series covers a range of ecological issues:

1. **Forests with Character—**The Box-Ironbark Region of Victoria
2. **Going, Going—**Wildlife Extinction in Box-Ironbark Forests
3. **Shrinking Patches—**Fragmentation and Habitat Loss
4. **A Patchy Resource—**Wildlife and Nectar
5. **Size Does Matter—**Large Old Trees in Box-Ironbark Forests
6. **Bugs in the System—**Ground-dwelling Invertebrates
7. **Networks in the Landscape—**Roadside and Streamside Vegetation
8. **The High Points of Low Areas—**Forest Gullies
9. **When Litter is Good—**The Importance of the Forest Ground Layer
10. **A Dominant Bird—**Habitat Alteration and Noisy Miners



*Herb rich grassy woodland near Broadford, central Victoria, this roadside remnant is less than one hectare in size! Photo by Ann Jelinek*


### More information

'Wildlife in Box-Ironbark Forests—Linking Research and Biodiversity Management'. The complete series of information sheets is available at <http://www.nre.vic.gov.au/notes>, or on 136186.

# Not so easy— biodiversity monitoring in tropical rangelands

*By Alaric Fisher*

**Across the vast rangelands of central and northern Australia, pastoralists and government agencies regularly monitor the condition of rangelands. Monitoring helps to maintain the quality of native pastures for sheep and cattle grazing and is an important part of business for the pastoral sector. But this is only one aspect of the overall 'health' of the rangelands. Can another important, but largely ignored, component—biodiversity—be monitored at the same time?**

Monitoring biodiversity in rangelands is a complex task for which we lack the appropriate tools and indicators—perhaps that's why it's not done at the moment. Through a new research project, we hope to find the simplest ways to monitor biodiversity as an extension to pastoral land condition monitoring programs, which are well established in each of the rangeland states and the Northern Territory (see box). The project is based at the Tropical Savanna Management CRC in Darwin and funded through the Native Vegetation R&D Program.

Most of the native vegetation of the vast central and northern rangelands of Australia is at least superficially intact. So, unlike southern Australia, the opportunity is there to maintain the 'health' of entire rangeland ecosystems, rather than protecting small fragments. But there are also clear threats to the health of rangelands. Vegetation clearing is a significant issue in some areas and substantial environmental damage is evident across most landscapes. This is reflected in, for example, the extinction of arid zone mammals, the decline of many granivorous bird species in northern Australia, and wholesale changes in understorey plant species composition in some areas.

The demand from a broad range of land users for effective and practical monitoring schemes is increasing. Government agencies, land managers and pastoralists want to assess and demonstrate the environmental credentials of their enterprise or programs, sometimes in formal environmental management systems or other forms of environmental accreditation. Biodiversity monitoring is a significant consideration for funding programs such as NAP and NHT II, which need to refine funding priorities and demonstrate that environmental goals are being met.

## New tools

Pastoral monitoring programs aid the sustainable management of the pastoral industry, but do not aim to monitor biodiversity in rangeland landscapes. These programs use a number of tools, such as satellite imagery and ground-based measurements at a network of plots. Our project particularly seeks to assess whether the tools currently used can also provide useful indicators about biodiversity. For example, if assessment of satellite imagery shows large areas of land in good condition, does this also indicate that the biodiversity is in good shape? Similarly, if the cover and composition of perennial grasses is maintained in savanna rangelands, does this also indicate that biodiversity has been maintained? If the current suite of pastoral monitoring tools proves inadequate to inform us about trends in biodiversity status, the project will look for other reliable monitoring tools. For example, which species might serve as the best indicators of rangeland 'health'?

*Mound-building termites are sampled by opening their mounds and collecting workers or by collection from runways on standing and fallen wood. Termites have an important role in ecosystem function and may be a useful indicator group. Photo by Alaric Fisher*

## Biodiversity indicators

**'Biodiversity' is a complex concept that encompasses the diversity of life within a region of interest. It isn't just about the variety of species present, but also the genetic diversity within species, the variety of ecosystems that the species combine to form, and the web of ecological processes that link them together. So a decline in biodiversity may result from the local extinction of some species, but also from changes in species composition, reduction in ecosystem diversity or inhibition of some processes (for example, lack of regeneration in trees).**

It is clearly impossible to monitor all aspects of biodiversity and hence the identification of reliable *indicators* is critical. Such indicators should be easy to measure, sensitive to changes in the landscape and informative about changes in biodiversity. Some proposed indicators for rangeland biodiversity include the cover of native perennial ground layer vegetation; landscape function metrics (for example, landscape function analysis, leakiness index); trends in declining mammal and bird species; and the extent of vegetation clearing.

## Research commences

Fieldwork has commenced at a large number of sites in two important pastoral regions of the tropical savannas—the Victoria River District in

## Land condition monitoring *in the* rangelands

A number of techniques are used to monitor land condition or the state of pastures in the rangelands. Pastoralists assess the condition of their property from:

- the condition of their stock
- the total cover of grasses and other pasture species
- the composition of the pasture (the relative amounts of desirable and undesirable species)
- other factors such as erosion, weeds and feral animals.

In the Northern Territory, pastoralists use photographs and written descriptions of pasture condition taken periodically at fixed points in most paddocks (Tier 1 monitoring). Most states also have a pastoral monitoring scheme overseen by the relevant government agency (such as WARMS in Western Australia), where detailed measurements of species composition, plant cover and plant size are made at fixed sites scattered throughout the rangeland areas.

Under new developments with the National Land and Water Resources Audit, data from all these schemes will be collected into the Australian Collaborative Rangeland Information System (ACRIS). State agencies are now examining how biodiversity data can be incorporated into the pastoral monitoring programs and ACRIS.

the Northern Territory (south-west of Katherine) and the Dalrymple region of Queensland (west of Townsville). These sites are in representative eucalypt woodlands and include areas in relatively good condition and similar areas in poor condition. A detailed biodiversity assessment is under way at each site, including sampling plants, birds, mammals, reptiles, ants and termites. The condition of each site is also assessed using landscape function analysis, indices derived from satellite imagery and conventional plot-based methods applied by existing pastoral monitoring programs. Sampling such a broad range of biota is both tedious and time-consuming, and is clearly not a realistic option for a successful monitoring program. Rather, our project aims to define the minimum dataset that must be collected to give a robust picture of biodiversity status.

### Research challenges

A universal challenge in monitoring is to separate real change from background variation. Any comparison of 'good' and 'poor' rangeland sites will always be relative since few, if any, substantial 'reference' areas exist unaffected by the last century of environmental change. Another challenge is coming to grips with the issue of scale in relating patterns of land condition to biodiversity. Does the biodiversity status of a site largely reflect the condition of the immediate area, or does it depend on patterns of land condition over a much larger region?

Our biggest challenge is to develop biodiversity monitoring tools that are simple enough to ensure wide uptake by both government agencies and land managers, but sufficiently robust to provide meaningful, reliable information.

*Skilful use of local materials to record ground layer cover in a half-metre square 'quadrat'. The cover and composition of the grassy layer is a good indicator of pasture condition in tropical savanna rangelands—is it also a good indicator for biodiversity status? Photo by Jenni Risler*

### More information

This project is funded through the Native Vegetation R&D Program managed by Land & Water Australia in Canberra. Collaborators in the project include the NT Department of Infrastructure Planning and Environment, Queensland National Parks & Wildlife Service, and CSIRO Sustainable Ecosystems.

A fact sheet (PF020206) is available on this project from the Program—see back page for ordering details. Also see the following websites: Land & Water Australia at <www.lwa.gov.au>, Tropical Savannas CRC at <www.savanna.ntu.edu.au>, and the National Land & Water Resources Audit at <audit.ea.gov.au/ANRA/atlas_home.cfm>.

A useful report available from the Audit website is Whitehead et al. 2001, 'Developing an analytical framework for monitoring biodiversity in Australia's rangelands', Tropical Savannas CRC, Darwin.

### Contact

Alaric Fisher, project leader, can be contacted at Tropical Savanna Management CRC or NT Department of Infrastructure, Planning & Environment, Darwin, or by email: <alaric.fisher@nt.gov.au>.

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