Restoring Landscape Resilience

Swift Parrot (Photo: Geoff Dabb)

Effective Landscape Restoration for Native Biodiversity in Northern Victoria

"There is an urgent need for remedial work in agricultural landscapes to restore ecosystem processes that underpin sustainable agriculture and natural ecosystems."

Above:
Aerial view of the riparian buffer zone on the Twigg's 'Elmswood' property on the Loddon River, near Serpentine (Photo: Mal Brown).

Chequered Cuckoo Bee
(Photo: John Grylls)

In Victoria, over a century of agriculture based on European farming traditions has driven many native plant and animal species to the brink of extinction, severely damaged natural ecosystems and compromised agricultural sustainability.

Restoring native plant and animal populations and ecosystem processes in the agricultural landscapes of northern Victoria requires a concerted focus on private land. This is because while the public reserve system protects irreplaceable core areas, it is inadequate in extent and diversity to sustain all species or maintain broad-scale ecosystem processes. Many of the most ecologically productive parts of the landscape remain on private land.

This brochure summarises the principal approaches to planning landscape restoration. Two northern Victoria property case studies help to illustrate both the values and limitations of a range of restoration approaches.

Below:
Large-scale revegetation on saline agricultural land at Kamarooka (Photo: Mal Brown).

(Photo: Mal Brown)

Introduction

Images (from L- R): Chequered Cuckoo Bee (Photo: John Grylls), Young dragon lizard (Photo: Mal Brown), Grey-crowned babblers (Photo: Adrian Martins), Termites.

"More emphasis needs to be placed on restoring resilient ecosystems at large spatial scales with long-term timeframes."

Agriculture has made a significant contribution to Australia's prosperity. But such wealth has come at a cost. Farming practices and altered hydrological regimes have degraded the biophysical environment upon which agricultural production depends: dryland salinity, increasing soil acidification and erosion, loss of soil biota, nutrient pollution of waterways and wetlands, and the spread of exotic animals and weeds are symptomatic of dysfunctional landscapes.

Such threats have generated an urgent need for remedial work in agricultural landscapes to restore the ecosystem processes that underpin sustainable agriculture and natural ecosystems.

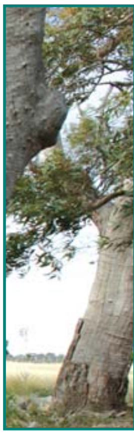
Sections of the farming community in northern Victoria acknowledge that current farming practices are not sustainable and this has stimulated a groundswell of local revegetation activities. The primary motivation for revegetation has been to provide shade and shelter for stock and to rehabilitate degraded land. However, many revegetation programs will be too small in scale, and of inadequate design and quality, to address biodiversity loss and ecosystem degradation. More emphasis needs to be placed on restoring resilient ecosystems at large spatial scales with long-term timeframes.

Actions to improve ecosystem resilience may take many forms, including revegetation, changes in farming practices, manipulation of natural disturbances, education, control of exotic species, and manipulation of biophysical habitats. Because restoration ecology is a relatively young science it lacks a cohesive conceptual framework. This has limited the effectiveness of many projects and the development of better ways to repair landscapes. Land managers seeking to undertake restoration are confronted with an unfamiliar array of approaches, best described as 'guidelines' or 'rules' for restoration.

Landscape Vision

- Constructing a 'landscape vision' is fundamental to planning, implementing and restoring landscapes.
- Define 'big-picture' restoration goals. (Ask: how do we want this landscape to look and function?)
- Select a reference site(s) or condition. (Ask: when will restoration be successful? Seek historical data from the same site or contemporary data from reference sites to set benchmarks for success. By combining information from multiple reference sites, restoration goals should reflect a range of ecological conditions rather than a single reference condition)
- Develop indicators for that condition. (Ask: how will we measure restoration success?)
- Consider multiple restoration scenarios (Ask: which options are feasible and will they achieve the restoration goals?).

(Photo: Mal Brown)



Ecosystem resistance is the ability of an ecosystem to withstand disturbances and threatening processes, such as weed invasion.

Ecosystem resilience is the ability of an ecosystem to recover following disturbances and threatening processes, such as grazing or fire.


(Photo: North Central CMA)

A Conceptual Framework for Landscape Restoration

(For NRM managers and policy makers)

A set of core principles has emerged that together comprise a general framework for restoration applicable in most landscapes.

1

Define the ecosystem or landscape to be restored

Define the biophysical boundaries (e.g. bioregion, sub-catchment or neighbouring properties), the social landscape (e.g. pastoralists, dairy farmers or lifestyle landholders), and the politico-economic context (e.g. regulatory obligations, economic constraints, incentives and voluntary agreements).

2

Assess the current condition and trends of the ecosystem or landscape to be restored

Identify natural and human-induced disturbances. Develop indicators of ecological and biophysical condition. Identify parts of the system that need restoring as well as degrading processes that need to be reversed.

3

Construct a 'landscape vision'

Develop specific, ecologically informed and feasible restoration goals that consider the current state of the system. Consider goals for biophysical processes (e.g. hydrology, soil condition), fauna-mediated processes (e.g., pollination, pest control), species recovery (e.g. threatened or declining species), community integrity (e.g. fauna and flora) and landscape structure (e.g. extent of native vegetation).

4

Articulate a set of restoration actions that link the current state to the landscape vision

Develop an action plan of how to move from the current state to the desired state. Base actions on sound ecological knowledge and draw on local knowledge, where available. Consider social and cultural context, cost of restoration, methods of payment, risk assessment and technical aspects of the proposed actions.

5

Establish transparent and measurable success criteria (ecological outcomes) **based on relevant ecological and biophysical indicators**

Success criteria must reflect the restoration goals, be responsive to restoration actions and lack ambiguity, and ideally, be relatively easy and cheap to sample (e.g. recovery of threatened species, increase in native pasture, movement of fauna).

6

Implement restoration actions in a manner consistent with adaptive management

Build in opportunities to test theory and learning, and feedback mechanisms for adjusting activities arising from restoration outcomes. This includes collecting baseline (pre-restoration) data, replicating the same action at independent (treatment) sites, establishing control (degraded, not restored) and reference (not degraded, not restored) sites.

7

Monitor outputs and outcomes at scales appropriate for the restoration actions

Adopt a long-term monitoring perspective. Measure outputs of restoration actions (e.g. extent of revegetation, decline in area infested by weeds) along with external factors (e.g. climate) and ecological outcomes (see Box 5) to establish relationships between restoration and ecological responses.

8

Adjust management based on cost-benefit assessment of restoration inputs (costs) and ecological and/or biophysical responses (benefits)

An ongoing process of implementation – monitoring – evaluation – adjustment must be established. Build on learning from well-planned 'experiments' during implementation phase. Re-visit the landscape vision prior to re-setting restoration actions so that adjustments are in line with the restoration goals.

Stressed red gums along Loddon River (Photo: Mal Brown)

Guiding Principles for Restoration at the Property Level

(For land managers)

1. Increase the area of native vegetation with an appropriate species mix and sufficient structural complexity to provide habitat for a range of flora and fauna.
2. Repair ecosystem processes (e.g. nutrient cycling, retention of water, soil stability, animal movement). Actions may include revegetation, strategic grazing, fire management, soil manipulation, control of invasive species and maintaining key habitat features.
3. ***Protect, Improve, Enhance and Reconstruct*** by revegetating habitat gaps or buffers, and replanting 'missing' species.
   Protect existing native vegetation by fencing or other management options.
   Improve the quality of existing native vegetation by removing or controlling threatening processes (e.g. weeds).
   Enhance and enlarge existing patches of native vegetation by revegetating habitat gaps or buffers.
   Reconstruct new patches of native vegetation by replanting or promoting natural regeneration.
4. Build diversity into landscape design in order to repair ecosystem processes. Try to avoid uniformity. Aim for variety in landscape context of restored patches. These could include riparian patches, patches adjacent to existing remnants, patches incorporating existing remnants and some new patches. Restore ridges, slopes and prioritise 'low-lying, productive parts' of the landscape.
5. Revegetate so as to simulate natural processes by using original Ecological Vegetation Classes (EVCs) and functional vegetation types (e.g. nectar, seed and fruit producing plants).
6. Promote continuity of vegetation along environmental gradients (e.g. altitudinal, topographic). Connectivity at this scale allows movement in response to changes in resource availability over time, natural catastrophes and climate change.
7. Restore landscape connectivity to counter habitat fragmentation. For example, expand area of existing remnants or amalgamate nearby patches to form a single larger patch.

"An ecosystem is a community of interdependent organisms together with the environment that they inhabit and with which they interact."

Spotted Pardalote (Photo: Adrian Martins)

Guidelines for Landscape Linkages


Regent Honeyeater (Photo: Nick Lazarus)


Brolga (Photo: David Ong)

1. Define the biological purpose of the linkage. Determine the distance of the linkage and the timeframe over which it will be used, and the ecological function (e.g. seasonal migration, access to irregular resources, natal dispersal).
2. Consider design, dimensions, vegetation type and management required to meet the biological purpose. Know the ecology and behaviour of target species.
3. Retain existing natural links where possible rather than create new habitat.
4. Connectivity is more than 'wildlife corridors'. Stepping stones, alternative land-uses and short-lived (e.g. seasonal) links may also achieve desired outcomes.
5. Ensure habitat quality and diversity in linkages is suitable for target species. Wildlife will not enter linkages if quality is poor, even if destination is pristine.
6. Structural priorities for landscape linkages:
   i. The wider the better. Aim for twice the width of edge effects (e.g. light penetration, habitat structure differences, weed invasion) to ensure there is some 'interior' habitat.
   ii. Longer linkages must be wider to provide 'habitat for the journey' (i.e. increased resources).
   iii. Build small patches (nodes) into the linkage to increase use by wildlife.
7. Location priorities for landscape linkages:
   i. Follow natural movement pathways if known – e.g. migratory routes, daily foraging patterns.
   ii. Follow natural environmental features – rivers, drainage lines, ridges and gullies. Attempt to incorporate all habitat types (multiple paths) in one or several links. These are often irregular rather than straight lines between two patches.
   iii. Include existing native vegetation.
   iv. Give highest priority to unique or irreplaceable linkages. A network of multiple connections usually functions more effectively.
   v. Locate away from sources of human disturbance (e.g. freeways).
8. Design linkages that enable passive wildlife recolonisation. Provide links from known source populations to restored sites. Habitat quality in recipient patch must also be adequate to support populations of target species.
9. Monitor success of linkage against original objectives. Effectiveness may be increased through additional management (e.g. provision of nest boxes, habitat manipulation, or increased width).

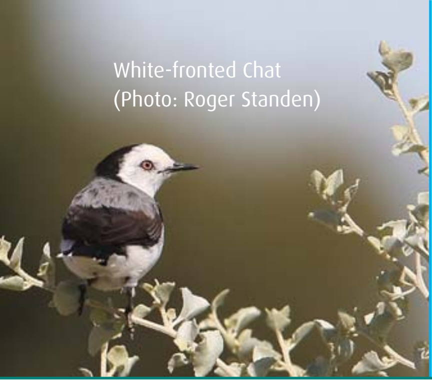

White-plumed Honeyeater (Photo: Roger Standen)

Ecosystem approaches to restoration

Natural ecosystems are self-organising and self-repairing entities expending about 30% of the energy they get from the sun just maintaining their structure and diversity. The human population has grown to its current size by harvesting much of the 30% of energy that the landscape and ecosystems need to maintain their structure and diversity. This has resulted in a simplified landscape that can no longer support its structure, its diversity and some of its processes.

Ecological restoration involves assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. ***Ecosystem processes*** are the basis for self-maintenance in an ecosystem. A common goal for restoration is to recover self-renewing ecosystem processes, or to build ecosystem resilience.

Ecosystem processes include carbon fixation by plants (photosynthesis), nutrient cycling by micro-organisms, nitrogen fixation by bacteria, decomposition of organic matter, water filtration, pollination of flowering plants by fauna and seed dispersal. Ecosystem processes that are of direct benefit to humans (e.g. carbon sequestration, water production, pest control) are called ecosystem services.



White-fronted Chat
(Photo: Roger Standen)

Species based approaches to planning restoration

Species-based approaches are often used for planning actions to restore degraded landscapes and as indicators for monitoring restoration success. In general, actions are designed based on the chosen species in the belief that this will result in wider benefits. The choice of indicators will depend on the restoration goals.

For single-species programs monitoring should include population characteristics such as survival, reproductive success, range expansion or population size. For community or ecosystem restoration, species diversity is commonly used. Plants, birds and invertebrates are often used as general indicators for other taxa.

Focal species

This approach links a particular species with threatening processes, based on quantitative data. It requires extensive field sampling and involves identifying the threatening processes in a landscape, identifying the species most sensitive to each threat and managing each threat at a level that will protect the associated focal species. Threats can include patch isolation, patch size, habitat condition, and processes such as fire.

Native vegetation

At the site or patch scale, vegetation structure (stem density, height, diameter, number of strata), plant diversity and species composition are often used to monitor restoration success. Vegetation structure and complexity is a good indicator of faunal diversity.

Keystone species

Some species have functional impacts that are much greater than their proportional abundance in the community. For example, the loss of top predators may lead to an increase in herbivores and loss of plant diversity and environmental degradation through overgrazing. Mistletoes are considered keystone species in Australian woodlands because they provide an array of resources for many other species (e.g. nectar, fruit, foliage, nest sites), and woodlands without mistletoes may have lower bird diversity.

Ecosystem engineers

Ecosystem engineers directly affect the availability of resources to other species by changing the physical state of the environment. In Victorian woodlands, termites contribute to the development of tree hollows qualifying them as both ecosystem engineers and keystone species. Managing for keystone species will help the survival of dependent species, although this will rarely be enough on its own. For example, although owls require hollows, managing for termites will not ensure owls are present.

Flagship or Icon species

Charismatic species, usually a large mammal or bird, are used to raise public awareness and galvanise support for a particular course of action. The Melbourne Commonwealth Games adopted as its mascot the Red-tailed Black Cockatoo to attract attention to its decline and the need for responsible environmental management. Flagship species are not necessarily chosen for an ecological reason, except that they are often endangered, and they need not be a good indicator species.

A common approach is to use ***indicator species*** as surrogates for other species, species richness or ecological integrity. An indicator species is one whose presence and population fluctuations reflect those of other species in the community. Focal species, keystone species, ecosystem engineers or flagship species are often used as ***indicator species***. However, use of a single indicator species may be misleading because it may not adequately capture the restoration goals or be representative of the wider community.

(Photo: Geoff Park)

Glendemar (Photo: Geoff Park)

Case Studies

Two case studies help to illustrate a range of restoration approaches and options. ***"Glendemar"*** and ***"Nil Desperandum"*** are both large sheep-growing properties in northern Victoria. Although both properties are farmed with a strong emphasis on environmental sustainability, they differ in mode, history and philosophy of management.

Glendemar: A case study in ecosystem management

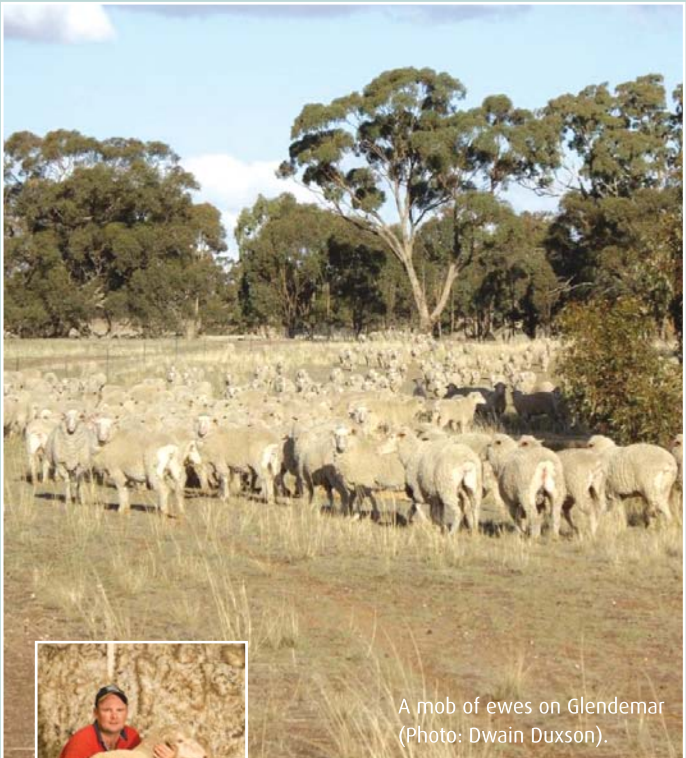
Glendemar (approximately 2400 ha) has been home to the Duxson family for over 100 years. The land has all been cropped at some stage. In 2004 Dwain Duxson turned away from high-input farming. Dwain's motivation for change was his realisation that farming was not sustainable using conventional farming practices. If he was to reverse land degradation and pass on a healthy landscape to his children, he needed to farm with the natural assets and capability of the land rather than work against it by continually adding chemicals and introducing exotic biota.

Dwain switched from a conventional mixed cropping and grazing enterprise to production based entirely on sheep farming using 'holistic grazing management' principles - intensive grazing by large mobs of sheep for short durations in relatively small paddocks.

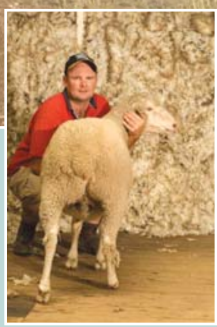
He stopped cropping entirely, removing the need for expensive fertilisers, herbicides and pesticides. He now runs sheep for meat and wool on 'improved' pasture of exotic annuals (annual rye, barley, lucerne; estimated at 70%) and native perennial grasses and forbs (~30%).

Dwain's goal is to continually increase the proportion of native perennials in his paddocks, with the ultimate goal of achieving 100% (mostly native) ground cover year-round. His grazing system based on native perennials has many advantages. Restoration of ecosystem processes is evident. These include increased ground cover; healthier, 'softer' soils due to increased water infiltration and organic matter; increased seed return to the soil; less soil loss through erosion and wind-drift; fewer weeds because the natives out-compete exotic species in the absence of fertilisers and pesticides; and fewer invertebrate pest problems. After only two years, these ecosystem services have started to deliver commercial returns as well. There is less need for supplementary feed because the native perennials are a reliable and nutritious food source all year-round. Sheep are healthier, with improved condition and no worms, making drenching unnecessary. Lambing survival is also up because the longer grass provides shelter and reduces losses from exposure.

Glendemar currently has about 5% tree cover, mostly along creeks and on the foothills. Several small remnants are fenced out and grazed intermittently. Mature paddock trees are valued for shade and shelter, and Dwain leaves fallen logs and branches on the ground to protect surface structure and recycle nutrients. A restoration plan for Glendemar aims to achieve greater biodiversity by maintaining the current level of woodland cover and increasing the quantity and diversity of native perennial grasses.



A mob of ewes on Glendemar (Photo: Dwain Duxson).



Ben Duxson with an unmulesed red tag Glendemar MPM ewe (Photo: Dwain Duxson).

The wetland constructed by the Twiggs on *Nil Desperandum* (Photo: Geoff Park)

Nil Desperandum: A case study in revegetation history

Nil Desperandum has been owned and managed by the Twigg family for 100 years. For the last 40 years, Bill and Gwen Twigg have conceived and trialed many innovative ideas to improve the landscape and increase productivity. Some worked, some didn't, some worked in unexpected ways, but ***Nil Desperandum*** is a living example of the evolution of ecological restoration for both biodiversity and production. With no sign of a farming heir, Bill concedes his focus is now continued environmental improvement with a commitment to biodiversity while maintaining the productivity and infrastructure of the farm.

Bill and Gwen Twigg inherited a stressed and treeless farm with declining productivity, and wanted to improve land condition sensing that productivity and profitability could be increased by farming in accordance with the land's capability.

The Twigg's first challenge was to return perenniality to the landscape. Bill was a pioneer of lucerne-based pastures; around 80% of the 1325 ha farm is now lucerne-based pasture, mixed with other exotic pastures such as rye and subclover, and a variety of other 'palatable weeds'. Native species (mostly Wallaby grasses *Austrodanthonia* spp.) comprise about 5% of the pasture. Bill contends this system, combined with relatively light stocking rates and rotational grazing, has proved successful, with consistently high primary productivity, reliable fodder in dry times, lower watertables, and improved ground cover and soil structure. Bill is now interested in increasing the carrying capacity of his land by increasing the native component in his pastures, particularly Kangaroo Grass *Themeda triandra*, which is slowly returning, and saltbushes *Atriplex* spp., as lucerne production falls.

Paddock trees and the remaining patches of remnant vegetation on the property were (and still are) valued for shade and shelter, and dead trees for their contribution to biodiversity, which in turn helps control invertebrate pests. Remnant patches have been fenced to protect them from grazing and in their place, Bill has established 'forage' plots of acacias and saltbushes, which provide biodiversity and land condition gains, as well as an alternative fodder source. Many early strip plantings on ***Nil Desperandum*** were too narrow to produce the anticipated biodiversity benefits from increased connectivity. However, revegetated block plantings have incorporated remnant scattered trees, further increasing their habitat value. The blocks have probably played a key role in attracting and supporting several bird species (e.g. Superb Fairy-wren, Grey Shrike-thrush, Common Bronzewing) that have returned in recent decades.

A 'third generation' revegetation strategy has been to establish wide (~100 metres) biodiverse plantings along drainage lines, resulting in long, snaking swathes of vegetation through the property. These swathes not only provide habitat and movement pathways for fauna but also capture the most productive parts of the landscape enhancing ecosystem processes. As Bill continues to experiment, watch and learn, it is inevitable he will modify his methods and approach to improving the landscape – adaptive management in action.

Bill Twigg's best practice includes 100-metre wide swathes of native vegetation along drainage lines through the property (Photo: Mal Brown).

Acknowledgements

This brochure is based on a paper titled '**Effective Landscape Restoration for Native Biodiversity in Northern Victoria**'. The paper arose from a collaborative project between the North Central CMA, Goulburn Broken CMA, North East CMA and Mallee CMA. Copies of the full paper are available at: **www.nccma.vic.gov.au/publications**

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