Threatened Species and Farming

Victoria
The Place To Be

Department of Sustainability and Environment
Department of Primary Industries

Threatened Species and Farming

Victoria
The Place To Be

Published by the Victorian Government Departments of Primary Industries and Sustainability and Environment Melbourne, June 2006

ISBN

For more information about this publication contact
Annette Muir
Biodiversity Planner
Department of Sustainability and Environment
2/8 Nicholson Street
East Melbourne 3002
Phone. (03) 9637 9850
Email: annette.muir@dse.vic.gov.au

www.dpi.vic.gov.au/vro/biodiversity
Go to the Victorian Resources Online (VRO) website's Biodiversity section:
click onto Biodiversity in Agriculture, then Threatened Species and Farming.

www.dse.vic.gov.au (Go to: Plants & Animals, Native Plants & Animals, Threatened Species & Communities)

Acknowledgements
This research was undertaken as part of the Ecologically Sustainable Agriculture Initiative (project 05118). It was funded by the Victorian Department of Primary Industries, with in-kind funding from the Victorian Department of Sustainability & Environment, and additional funding from the Commonwealth Natural Heritage Trust.

Many people provided invaluable assistance, and without whom the project could not have proceeded. These people included farmers, who allowed research to be carried out on their properties and who were interviewed, and staff from DPI, DSE and Catchment Management Authorities, who assisted with the case studies and field days. For a full list of names, see Acknowledgements section.

Project Team
Project Leader: Annette Muir, Biodiversity & Natural Resources, DSE, East Melbourne
Tamara Lavis, Research Scientist, Primary Industries Research Vic, DPI, Rutherglen
Adrian Moorrees, Manager Threatened Species & Communities, Biodiversity & Natural Resources, DSE, East Melbourne
Jeff Hirth, Research Scientist, Primary Industries Research Vic, DPI, Rutherglen
Alan Crouch, Policy Analyst, Biodiversity & Natural Resources, DSE, East Melbourne
Nicholas Bate, Cropping Team Leader, Catchment and Agriculture Services, DPI, Bendigo
Paul Strickland, Project Officer, Primary Industries Research Vic, DPI, Ellinbank
Donna Gibson, Technical Officer, Primary Industries Research Vic, DPI, Ellinbank
Peter Menkhorst, Wildlife Policy Officer, Biodiversity & Natural Resources, DSE, East Melbourne

Research Consultants
Matthew Herring, c/o Arthur Rylah Institute, DSE, Heidelberg
Martine Maron, c/o Arthur Rylah Institute, DSE, Heidelberg
Richard Loyn, Arthur Rylah Institute, DSE, Heidelberg
Beverley Van Praagh, c/o Knoxfield Research Institute, DPI
Alan Yen, Knoxfield Research Institute, DPI
Neville Rosengren, LaTrobe University, Bendigo
Claire Moxham, Arthur Rylah Institute, DSE, Heidelberg
Josh Dorrough, Arthur Rylah Institute, DSE, Heidelberg
Garry Peterson, South West Region, DSE, Warrnambool
Paul Foreman, c/o Australian Bush Heritage, Melbourne
Ruth Nettle, Ruth Nettle Consulting, Melbourne
Pam Watson, Down to Earth Research, Frankston South

Contents

INTRODUCTION

1.1 Background

Approximately 950 species of native plants and animals are threatened with decline and extinction in Victoria (www.dse.vic.gov.au, then search for 'Advisory Lists'). About two-thirds of Victoria is private land, largely cleared of native vegetation and primarily used for agriculture. Many threatened native plants and animals occur in these landscapes and are affected by agricultural practices. Threatened vegetation types, which often provide habitat for these species, comprise about 60% of the area of native vegetation remaining on private land (NRE 2000).

Agricultural land now provides the last refuge for some species, and its management is therefore crucial to their long-term survival. Many farmers already actively manage threatened species as part of a broader aim of native habitat conservation on their farms.

The Ecologically Sustainable Agriculture Initiative (ESAI) investigated new ways of protecting the natural environment while maintaining the economic viability of farm enterprises (NRE 2002). Many farmers are aware of the environmental impacts of agriculture but require additional resources and knowledge to implement effective management of these impacts.

ESAI developed as a result of collaboration between Department of Primary Industries (DPI) and Department of Sustainability and Environment (DSE), previously NRE, as part of the Victorian Government's commitment to managing environmental assets in a way that is ecologically and socially sustainable.

This project, Threatened Species and Farming, contributes to ESAI by examining some of the underlying conservation issues and illustrating practical management options through case studies of threatened species of flora and fauna that are managed on farmland.

1.2 Objectives

The objectives of the project were:

- To document management techniques that could potentially integrate protection of threatened species with sustainable agricultural production, in a range of farming systems across Victoria.
- To improve understanding of the conservation of threatened species on farmland among stakeholders in the agricultural community, including farmers, and employees of DPI, DSE and Catchment Management Authorities.

1.3 Structure of this report

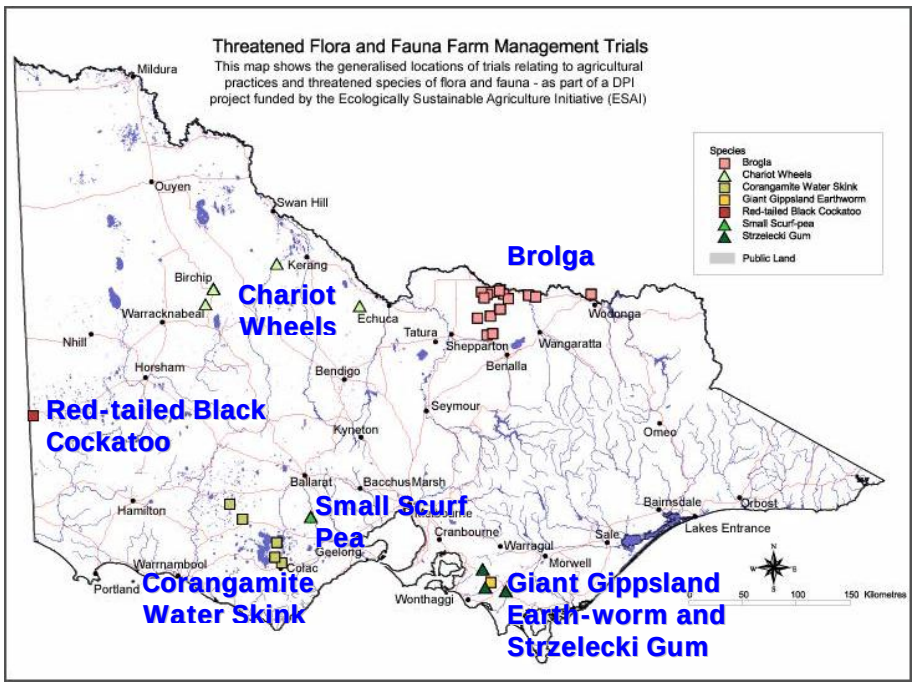
The report is organised in four sections. Section 2 presents six case studies, each of which includes a summary of flora and fauna research results, and implications for managing threatened species for conservation and agricultural production. This component of the project aimed to provide detailed insights into best management practice for selected threatened species, relevant to geographic areas and industry sectors.

The criteria for selection of threatened species case studies were:

- a mix of flora and fauna species, facing different threats
- a variety of habitats across a range of regions in farming landscapes
- a number of agricultural system sectors represented
- the selected species are reliant on habitat in farming areas, and are potentially affected by agricultural practices.

The following table and map show the selected case study species, the farming systems where research was undertaken, and the distribution of sites across Victoria.

Threatened species	Enterprises	Region
Brolga	Dairy, Cropping, Meat	Victorian Riverina
Chariot Wheels	Sheepmeat, Cropping	Victorian Riverina
Red-tailed Black Cockatoo	Bull beef, Wool	Wimmera
Giant Gippsland Earthworm	Dairy	Gippsland Plain
Strzelecki Gum	Dairy, Beef	Gippsland Plain
Small Scurf Pea	Wool	Victorian Volcanic Plain
Corangamite Water Skink	Wool, Cropping, Dairy, Beef	Victorian Volcanic Plain



Results from the case studies varied due to factors such as the short time frame of the project and by dry seasonal conditions. The application of research results to farm practices was more readily demonstrated by case studies involving threatened fauna, such as Brolga and Corangamite Water Skink. The responses of threatened plant species to changed management regimes were less conclusive, and will require longer monitoring periods. The Chariot Wheels research project will require further monitoring to obtain meaningful results, and so it is not included in this report.

Section 3 presents the findings of interviews conducted with some case study farmers. The purpose of these interviews was to investigate the level of farmers' understanding of threatened species on their farms and their experience in integrating conservation techniques with farming practices. The findings from this section are not meant to be indicative of other farmers' opinions or experiences. The barriers and opportunities identified in managing threatened species on farms indicate future directions for the outcomes of this project.

The following summaries in sections 2 and 3 are derived from research reports, the full versions of which can be found on the project website: www.dpi.vic.gov.au/vro/biodiversity

Section 4 discusses the findings of the case study research, and options for the future use of the outcomes for this project are outlined. This has also been informed by feedback from a series of field workshops.

2. FLORA AND FAUNA CASE STUDIES

2.1 Victorian Riverina Bioregion

Brolga (*Grus rubicunda)*

Management of breeding wetlands in Goulburn-Broken catchment and North-east Victoria

What are the problems

- Brolgas require vegetated wetlands to breed, and most of these are on farms.
- Practical guidelines are needed to manage these wetlands for breeding success.

What are the solutions

- Ephemeral shallows (up to 50 cm) that are flooded for 2 to 6 months are needed.
- Wetlands should have about 25% vegetation cover, 75% water cover.
- These wetlands can be incorporated into farm water storages.
- Cropping around wetlands can provide food sources for Brolgas.

MANAGEMENT RESEARCH (from Herring 2005)

Species description and threats

The Brolga is a large wetland crane, listed as vulnerable to extinction in Victoria. There are fewer than 1000 Brolgas remaining in south-eastern Australia. Their survival ultimately depends on the management of wetlands on farms, which are their primary breeding habitat.

(Photo – Matt Herring)

Research aims and methods

The aims were to identify the effects of and relationships between different wetland management regimes and Brolga breeding habitat availability, and to determine practical management guidelines for maintaining, enhancing and creating Brolga breeding habitat.

Eleven wetlands where Brolgas breed and five wetlands where no breeding has been recorded ('control' sites) were monitored over three years to study the effects of different wetland management regimes on Brolga breeding habitat.

The research focused on a distinct breeding sub-population in the Rutherglen – Yarrawonga – Katamatite – Tungamah – Dookie region, which consists of about 11 breeding pairs that use artificial and highly modified wetlands associated with irrigation. Data was collected on vegetation composition, water regimes and grazing levels, and was compared to breeding records. Additional research (e.g. recruitment at flocking sites, breeding success) at several sites incorporated a broader study area in the Victorian and New South Wales Riverina.

Results

Brolgas were recorded nesting between June and January, but mainly in September and October. Breeding occurred almost exclusively in ephemeral wetlands (most of the area continuously flooded for 2–6 months, up to 50 cm deep). The only other breeding records were in semipermanent wetlands (most of the area continuously flooded for 6–12 months) with a smaller ephemeral area. Brolgas were never recorded breeding in permanent wetlands, which are typical of many created wetlands on farms. The ephemeral wetlands typically had larger, healthier stands of water plants, particularly *Elaeocharis* (Spike-rush) species, whose tubers provide Brolgas with an important food source.

All Brolga breeding sites supported at least some grazing by sheep or cattle, although they tended to be ungrazed (or only very lightly grazed — below 4 DSE/ha) when wet and not subject to set stocking rates. More or less continuous intensive grazing (above 10 DSE/ha) around most of the control sites, coupled with a lack of shallow, ephemeral areas, resulted in these sites being devoid of wetland vegetation and of little value to Brolgas.

As the simplest, most effective way to monitor the health of the Brolga population is to measure annual recruitment, large, non-breeding flocking sites further abroad were studied. No recruitment was recorded after the drought in 2003 (0/123), while in 2004 recruitment was 5.1%.

Management implications

Encouraging landholders responsible for managing wetlands to maintain ephemeral shallows (up to 50 cm) that are continuously flooded for 2–6 months will benefit Brolgas and other wetland birds. Wetlands can be modified or created on farms to make them more productive for threatened species and biodiversity generally. However, consideration of the construction of additional wetlands needs to firstly identify and protect any existing ephemeral wetlands.

Ideally, such wetlands would have deep (50–140 cm), permanent areas of open water, as well as other deep areas that support stands of dense vegetation such as *Typha* species, together with the ephemeral shallows (less than 50 cm) and mudflats. Brolga breeding sites typically have emergent vegetation, particularly *Eleaocharis* species, around 90 cm high, with an aerial cover of about 25% to provide adequate cover and food resources. In the broader study region, a few study sites and other created or highly modified wetlands that supported breeding Brolgas had such diversity.

There is great potential for successful Brolga breeding from small wetlands (< 5 ha) on farms that use relatively small amounts of water, in many cases less than 10 ML per site per wetting-drying cycle. Stock can still utilise the water by restricting access points or water can be pumped out to a trough.

(Photo – Jeff Hirth, DPI)

2.2 Wimmera Bioregion

Red-tailed Black Cockatoo *(Calyptorhynchus banksii graptogyne)*
Management of Buloke feeding habitat in the Southern Wimmera

What are the problems
- Seeds of mature Buloke trees are a major food source
- Mature Bulokes mostly occur on farmland.
- Losses of these trees continue, and recruitment of new Bulokes is largely prevented.
- Existing Bulokes need to be protected to prolong their survival.
- New Bulokes need to be established.

What are the solutions
- Electric fencing of individual trees or small groups is likely to prolong tree life.
- Stocking with sheep or steers rather than bulls may reduce damage to trees.
- Protection of trees from stubble fires and cultivation will reduce Buloke loss.

MANAGEMENT RESEARCH (from Maron 2005)

(Photo – Rob Drummond)

Species description and threats

The Red-tailed Black Cockatoo (RtBC) occurs only in south-western Victoria and adjoining far south-eastern South Australia. It is a specialised feeder and consumes only the seeds of three tree species. The south-eastern RtBC population is considered to consist of about 1200 individuals, and is listed as nationally endangered with extinction.

The population is thought to be limited by food availability, and the most depleted of its food sources is the seeds of the Buloke tree. Almost all remaining mature Buloke trees within the range of the RtBC occur on private agricultural land, and conservation of these is essential to the future of the RtBC population. However, losses of these trees continue, and recruitment of new Bulokes is largely prevented by the major land uses in the area.

Research aims and methods

The aim of the research was to investigate ways of both prolonging the life of existing Bulokes and contributing to the establishment of new Bulokes, as well as documenting the decline in Buloke populations.

The first component involved an experimental trial of stock-proof fencing around paddock trees over two seasons. The aims were to a) identify the degree to which bark damage and canopy dieback could be reduced by the use of stock-proof fencing, and b) determine whether fruit production and/or quality were affected as a result of protection from livestock. Thirty-five female Bulokes were fenced and paired with control trees.

The second component of the study involved an aerial photograph analysis to assess the rate of loss of paddock Buloke trees within the RtBC's range. The aims were to a) determine the rate at which Buloke trees are being lost from within the cockatoo's range, b) assess the amount of Buloke revegetation occurring in the area, and c) provide advice relating to revegetation and protection of existing Buloke trees in order to minimise the impact of current and future food limitation on the cockatoo population.

The final component of the study focused on a one year trial of soil disturbance by ripping at different distances from mature Buloke trees. Promotion of suckering may be a useful method of Buloke regeneration as it produces stronger, faster growing plants, is low cost, and requires lower levels of maintenance than planting seedlings. However, identification of the distance from parent plants at which sucker production can be initiated is required to determine the usefulness of this method.

Results

Stock damage to the bark of unfenced control trees was found to be severe compared to fenced trees. There was an increase in mean bark damage scores of control trees of 53%, compared with a decrease of 25% for fenced experimental trees (due to previous damage becoming less evident). Damage due to cattle, particularly bulls, was more severe than that caused by sheep. Despite this difference in the degree of bark damage, there was no significant difference in canopy health, cone density, seed weight per cone, or ratio of seed to cone mass between fenced and unfenced trees. However, a slight trend towards lower ratios of seed to cone mass (less profitable foraging trees) in more damaged trees suggests that further monitoring to identify longer-term influences of fencing would be desirable.

Analysis of aerial photographs revealed an average 25% loss of Buloke trees over a period of just 15 years. Losses in three of the five areas studied were above 33%, with trees in one area being reduced by nearly 39%. These losses are likely to be attributable largely to deliberate and accidental tree removal rather than natural tree decline, as losses in one area were just 4.4% over the 15-year period. Regeneration of Buloke was only evident on roadsides in the focal areas. Discussions with local residents identified that the major barriers to Buloke revegetation included the cost of and time and effort required for successful establishment.

Only one sucker was identified during the course of this study, at a distance of seven metres from the parent tree. Personal observations from the study area suggest that suckering is common within 12 m from a parent Buloke.

Management implications

Fencing of even individual trees or small groups appears to be a successful strategy to minimize bark damage and is likely to prolong tree life. The use of temporary electric fencing of small numbers of trees, where rotational grazing regimes are used, could be considered as a simple inexpensive option to protect Bulokes. In situations where such fencing is not feasible due to large numbers of Bulokes in a particular paddock, stocking with sheep or steers rather than bulls may reduce the damage to trees.

In order to minimise the impact of Buloke tree losses on the RtBC, efforts should be made to protect existing mature trees, manage areas of regeneration appropriately and encourage revegetation of Buloke. These management options, relating to management of existing Buloke feeding habitat as well as creation of future habitat, will need to be further developed with various stakeholders. The protection of trees from stubble fires and cultivation is one such option that should substantially reduce the rate of tree loss.

Longer-term monitoring of the suckering trials would be valuable in identifying the maximum distance of reliable sucker production.

(Photo – Dean Robertson, Wimmera CMA)

2.3 Gippsland Plain Bioregion

Giant Gippsland Earthworm (*Megascolides australis)*
Management of farm habitats in South Gippsland

What are the problems
- The species is largely confined to private farmland and can survive under pasture.
- To prevent farm impacts on GGE sites, small-scale topographical and hydrological factors in its distribution need to be identified.

What are the solutions
- Small, localised distribution often associated with streams makes exclusion of threats feasible, with little loss of productive land.
- Prevent cultivation, heavy cattle grazing and effluent run-off at these sites.
- Avoid very dense tree planting on earthworm sites, to maintain existing water regimes.

MANAGEMENT RESEARCH (from Van Praagh *et al.* 2004, 2005)

(Photo – Alan Yen, DPI)

Species description and threats

The Giant Gippsland Earthworm (GGE) is considered one of the largest species of earthworm in the world, reaching lengths of over 1 m. The distribution of the GGE is confined to approximately 40,000 ha in south and west Gippsland, almost entirely on privately-owned agricultural land. It is listed as nationally vulnerable to extinction. The GGE has co-existed with agricultural land use since European settlement of South Gippsland in the 1870s, but the overall effects of these habitat changes on GGE populations and their distribution are not known. Therefore, identifying the effects of agricultural and land management practices on GGE remains crucial to its conservation management.

Research aims and methods

Two farms were selected to examine the main topographical and hydrological soil factors influencing the distribution of the GGE within the landscape of an individual farm, and to identify the effects of land management on these factors.

The first study was conducted on a dairy farm at Jumbunna, south of Korumburra, situated on the alluvial and colluvial grey clay soils in the south of the species range. The second study occurred at the Department of Primary Industries Research Farm at Ellinbank, situated in the north of the species range, in soils developed on Tertiary Volcanic basalts.

Results

At Jumbunna, GGEs were found in four distinct habitat types within the farm study area. These included; minor creek and drainage lines, flat to gentle sloping alluvial terraces above present flood levels, steep south facing hillslopes with terracettes (narrow terraces), and colluvial footslopes without terracettes. Various landscape features may play a role in influencing GGE distribution, including the nature and depth of soil, slope, micro-topography and aspect of steep hillslopes, in addition to site soil and surface hydrology.

When management on the farm site over the last 50 years was considered, there is only one known GGE population which has become extinct, as a result of the concentrated movement of cattle at one crossing point over a stream. This property has been subject to fairly low level stocking rates and very low levels of cultivation.

At the Ellinbank Research Farm GGE distribution occurred in one main habitat type; the lower slopes and colluvial and alluvial terrain adjacent to the stream channels, just above the level reached by moderate flooding. GGE at Ellinbank were restricted to riparian zones, which have largely been fenced off and protected from most agricultural impacts at the site. Therefore it was not possible to make any assessment of farm management practices in the study area on

GGE. It is likely that most recent agricultural practices in the study area have not impacted upon GGE populations. One possible exception to this is pugging when soils are wet and compaction by stock.

The major management issue identified that is relevant to the riparian zones is the actual and potential impact on GGE habitat of the dense revegetation of these riparian zones. Over the past four years, there has been extensive replanting and fencing of riparian zones with approximately 40,000 seedlings planted. Whilst the broader benefits of revegetation of riparian zones is acknowledged, the effects of dense replanting of areas occupied by GGEs requires investigation. Increased transpiration rates will lower water tables leading to drying of soils at depths of potential worm habitat on the lower slopes, colluvial slopes and floodplains. Due to timing and access limitations, only one heavily replanted riparian zone was surveyed and GGE were found to only occur on the opposite stream bank where there was very little vegetation with predominantly open pasture. This is similar to other anecdotal evidence obtained for replanted sites.

Management implications

Conservation of GGE on individual farms may need to consider the different habitat types in which the worms are found, such as minor creek banks and steep slopes. Each habitat type may require different types of management. The main processes identified that may require mitigation for GGE conservation include soil erosion and changes in soil and surface hydrology. Agricultural activities that may contribute to these processes include; cultivation, stocking rates (pugging), infrastructure development, water run-off, and effluent production and treatment.

GGE are often very localised in their distribution; hence managing and protecting populations by abatement or exclusion of threats can be feasible and effective. However, broader landscape factors, such as soil hydrology dynamics upslope of a GGE site, could have major local impacts on GGE populations.

Despite the preliminary nature of these and previous findings, the very dense planting of riparian GGE habitat may represent one of the most important agricultural management practices that has the potential to impact on GGE populations. It is recommended that extensive long-term monitoring programs be developed in order to examine impacts of revegetation on factors such as soil moisture, hydrological patterns, and water table levels and how these might impact on GGE populations. Factors such as density, structure and composition as well as age of plantings should be considered. Once such information is available, informed recommendations regarding management of GGE streamside habitat by farmers can be formulated.

(Photo – John Bowman, DPI)

Strzelecki Gum *(Eucalyptus strzeleckii)*

Natural regeneration on farms in South Gippsland

What are the problems

- Little seed regeneration has been observed under old trees on farms.
- Cattle grazing and weed competition are thought to restrict regeneration.
- Seed supply and adult tree health may also contribute to lack of regeneration.

What are the solutions

- Removal of weed competition and access to bare earth to enable seedlings to establish.
- Regeneration of seedlings occurs at or away from the parent plant canopy.
- Restrict cattle grazing until seedlings high enough so as not to be damaged by stock.
- Fence old trees from stock to enhance health and seed production.

MANAGEMENT RESEARCH (from Moxham and Dorrough 2005)

(Photo – Viridans Biological Databases)

Species description and threats

Strzelecki Gum is endemic to the high rainfall, primarily diary production region of the Gippsland Plain Bioregion. Strzelecki Gums often persist as isolated trees in varying stages of dieback. Little natural recruitment has been observed for this species and removal of livestock is often not sufficient to promote regeneration. It is listed as nationally vulnerable to extinction.

Research aims and methods

The aim of this study was to determine those factors limiting recruitment of Strzelecki Gum in the agricultural landscape. Possible reasons include grazing of seedlings by stock, absence of microhabitats for germination and weed competition. At each of three properties an isolated adult tree was fenced off from stock and a replicated field trial established. Factors investigated included soil compaction, pasture competition and seed supply. To investigate parent plant competition the trial was applied at three distances from the parent tree canopy. Data was collected over two seasons.

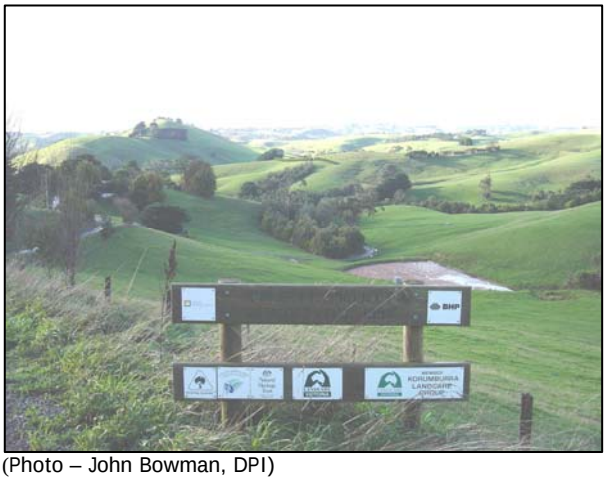
Results

Successful seedling establishment is strongly dependent on seed production of mature trees, and seed supply during this study was found to be limiting. However, when seed supply was not limiting, access to bare ground was essential for germination and establishment. This research also supports observations elsewhere that intense competition with the parent tree limit recruitment to or beyond the canopy drip-line.

During the first year of establishment, competition from exotic pasture and declining soil moisture limited seedling establishment. It appears that a one-off removal of competition just prior to germination may be sufficient to enable some seedlings to successfully establish to the end of their first year, by which time many seedlings may have grown over the top of the surrounding pasture. Adequate soil moisture in the early stages of establishment is also clearly important. Further monitoring of the experimental sites will be required to determine whether seedlings established after one disturbance event are able to persist in the long-term.

Management implications

Predation of seedlings by stock is regarded as the main factor limiting regeneration of trees on farms, by grazing, trampling and dunging. However, the removal of grazing may increase weed competition and remove disturbance events that provide niches for seedling establishment. Further experimentation with cattle reintroduction and monitoring over a longer time frame is required to determine the optimal grazing regime for successful regeneration of the species.



(Photo – John Bowman, DPI)

2.4 Victorian Volcanic Plain Bioregion

Corangamite Water Skink *(Eulamprus tympanum marnieae)*
Monitoring of grazing exclusion

What are the problems
- The Corangamite Water Skink is found amongst basalt rocks next to wetlands on farms.
- Grazing threatens the skink through direct trampling and degradation of vegetation.

What are the solutions
- Avoid stock grazing on skink habitat.
- Narrow wetland habitat is easy to fence, with little loss in agricultural productivity.
- Improved wetland management likely to have benefits for stock.
- Periodic or pulse grazing of fenced areas may be desirable to control weeds.

MANAGEMENT RESEARCH (from Peterson 2005)

(Photo – Peter Robertson)

Species description and threats
The Corangamite Water Skink is endemic to the Victorian Volcanic Plain, and is currently known from only about 30 small sites, primarily on private land. It is nationally endangered with extinction. All populations are found associated with deeply fissured basalt rock piles, grassy shrubland and permanent or ephemeral wetlands.

The skink's habitat has been reduced and fragmented through vegetation clearance, rock removal and draining of wetlands. Remaining areas of habitat have been degraded by heavy grazing regimes, weed invasion, rock removal, changed hydrology and/or water quality and impacts of introduced animals.

Research aims and methods
The aim was to assess experimentally the implementation of management actions to alleviate the threat of agricultural practices on Corangamite Water Skink and its habitat. Grazing exclusion plots were monitored to assess changes to skink populations and vegetation habitat.

Five sites representing different land use practices (wool production, dairy and beef farming) were used. At each site a grazing exclusion plot was established, consisting of a 100m x 15m section of a pre-established 200m Corangamite Water Skink population monitoring transect.

Population monitoring was undertaken along these transects, five times per field season during optimal weather for skink activity, over a three year period.

The effect grazing exclusion had on the vegetation density, cover, and diversity was assessed. Data collection was conducted in Spring and Autumn 2003/04 and 2004/05, using a point intercept method.

Data analysis was used to assess the response of the Corangamite Water Skink populations to grazing exclusion, the habitat response to grazing exclusion, and the relationship between population density and spatial distribution of Corangamite Water Skink and the habitat, and changes in habitat along the transect.

Results

Any significant change in adult skink abundances in response to grazing exclusion could take numerous years to detect. However, recovery may be quicker depending on the degree of previous disturbance. Adult Corangamite Water Skinks increased at one site where stock were excluded, following heavy grazing pressure. The recovery rate may be linked to the rate of change of vegetation.

Little change in the skink's habitat was detected in the 12 months following grazing exclusion, with an increase in perennial grass cover the only significant response. Other vegetation life forms are expected to take longer to recover. Some regeneration of native plants, including those that have been identified as beneficial to the Corangamite Water Skink, was evident at some sites. Weed cover has increased at some sites.

Monitoring is anticipated to continue until at least 2008.

Management implications

To enable its long-term survival, efforts need to be made to minimise any adverse impacts on the skink and its habitat. Grazing should be excluded from the Corangamite Water Skink habitat where possible, and the wetland communities associated with skink populations should be conserved.

The skink's wetland habitat makes it relatively easy to implement management in the form of fencing, with little or no net loss in agricultural productivity. This may even have benefits for stock management. Periodic or pulse grazing of fenced areas may be desirable to control weeds and reduce biomass. Watering troughs can be provided if stock are completely excluded from a water body.

Approximately 22km of fencing has already been implemented. Careful monitoring to assess the effect of the fencing must be undertaken, to ensure that weed invasion does not become a problem. Supplementary planting at some sites may be needed to help restore original vegetation composition. Monitoring and feedback will be required so that management is continually refined.

(Photo – Rachel Chynoweth, Swinburne University)

Small Scurf-pea (*Cullen parvum*)
Grazing season and strategy on the Western Plains

What are the problems
- The species is highly palatable and has declined in native pastures due to factors such as stock grazing.
- The best grazing regime to promote growth, seed production and survival is unknown.

What are the solutions
- Restrict stock grazing early in the growing season, from late spring to late summer.
- Grazing regimes depend on species composition of the pasture and seasonal conditions, and management needs to be adjusted yearly.

MANAGEMENT RESEARCH (from Moxham and Dorrough 2005)

Photo - John Eichler

Species description and threats
Small Scurf-pea is a perennial herbaceous legume, re-sprouting in spring from a thick, woody rootstock. It occurs in the threatened Western (Basalt) Plains Grassland community. It is likely that grazing by livestock has led to declines in the abundance and distribution of this species, and it is now nationally endangered with extinction. Legumes are valued in grazing ecosystems because of the role they play in nitrogen fixation.

Research aims and methods
Grazing intensity, selection and season of grazing influence the composition of grazed grasslands. In native pastures inter-tussock forbs are often highly palatable and can be susceptible to intensive herbivory. It is argued that under set-stock grazing systems, grazing animals are able to selectively forage, leading to alterations in the competitive hierarchy between plant species and particularly to a decline and eventual loss of palatable species. Alternative grazing systems using high densities of animals for short durations are thought to reduce selective grazing, favouring persistence of palatable species.

By using the grazing analogue treatment of clipping and trampling, the responses of the native legume, Small Scurf-pea to selective, non-selective and season of grazing was investigated. Two sites (12m x 12m) were fenced, at which three replicates of twelve “grazing” treatments were established. Data was collected over two seasons. The forage quality (digestibility and crude protein) of the species was also measured.

Results
Results suggest that Small Scurf-pea will probably be favoured by simple deferred grazing strategies that minimise grazing damage through the growing season and maintain surrounding vegetation biomass. Results also suggest that grazing early in the growing season (resting from late spring to late summer) may be preferable to late summer or multiple grazing events throughout the growing season. However, the long-term persistence of this species under any grazing regime is unknown, with results from this study indicating that ungrazed plants have greater growth and inflorescence production than grazed plants.

Averaged across the growing season, crude protein, metabolisable energy and digestibility tend to be higher and neutral detergent fibre lower in Small Scurf-pea than in adjacent pasture samples lacking this species. These results suggest that relative to adjacent pasture, the species could on average provide higher forage quality.

Management implications
While further field studies using livestock are required to confirm the results presented here, it is recommended that in sites managed for the persistence of this species, livestock access should be minimised through the growing season, particularly in summer months.

(Photo – Rachel Chynoweth, Swinburne University)

3. FARMER CASE STUDIES

The following are edited exerpts from interviews conducted by Pam Watson of Down to Earth Research. These interviews are with some of the case study farmers whose properties were the subject of research into the threatened species, as documented in the previous section of this report.

3.1 Victorian Riverina Bioregion

Brolga

Background

A Yarrawonga wetland serves as an important farm management tool as well as providing habitat for a variety of native bird species including Brolgas. The wetland is found on a property belonging to Rod and Carmel O'Kane who, along with their children, have watched several Brolga chicks hatch there, although some have fallen prey to predators.

The O'Kanes own 400 hectares of land which is used for cropping and grazing. The wetland area covers approximately three hectares of low lying swamp land and was originally created as a management tool for irrigation water, but has since been adopted by many birds.

Scientist, Matt Herring has been monitoring the wetland for a number of years after being granted access to the O'Kane property to conduct Brolga research.

Conservation activities undertaken

Although the wetland on the O'Kane's property was primarily designed as an irrigation water management tool, the family has undertaken some planting around the site, resulting in a habitat which suits a number of different species.

Perceived success of activities undertaken

The wetland on the O'Kane property has been described by Matt Herring as a model site and Rod believes it is very successful:

> *"We can guarantee a Brolga chick every year. They nest and they produce a chick every year and some years they produce more than one if they lose the first one."*

However, Rod also suggests the success rate of Brolga chicks reaching fledgling stage would be improved if funding for suitable fox fencing was provided.

Perceived impact of activities on financial or production costs

As a useful farm and irrigation water management tool, the wetland has a positive effect on the farm's profitability and productivity.

Secure access to an environmental water flow to maintain acceptable levels in the recycle dam when required by the Brolgas is an area where Rod believes support could be given in future.

> *"There's two things I need. One is an environmental water flow to keep water in that dam in the spring time and the other is a fox proof fence around what is their habitat area."*

3.2 Wimmera Bioregion

Red-tailed Black Cockatoo

Background
Red-tailed Black Cockatoos frequent the widespread stands of Bulokes on a farm in West Wimmera. The owner of the property, Bill Wallace, believes it is important to provide a balanced approach to land management, including protecting habitat for indigenous species.

Bill owns a 630 hectare property in Apsley, where sheep were traditionally grazed, but is now used to grow 800 bull beef. The farm is grazed using a New Zealand method termed *techno grazing*, which involves short and intense grazing periods where the cattle are encouraged to eat all the available pasture, following by quite long periods where the country is rested.

In recent years, scientist Martine Maron has been granted access to the Wallace farm to undertake studies and trials relating to the Red-tailed Black Cockatoo and its habitat requirements.

Conservation activities undertaken
In the past, when Bill ran sheep in paddocks with stands of Buloke, the impact was negligible. Cattle, however, tend to rub against the trees and this has proven a difficult issue to remedy:

> *"The biggest issue for me is the cattle and their impact on Buloke, which is not good. They rub a lot – they ringbark them in fact and I'm yet to work out how to handle that. It's not feasible to fence off every tree – there's probably 1500 trees on this farm. I've tried barbed wire around the tree itself – that doesn't work. I think in the end it will be… maybe wire netting – that seemed to work the best. So I might go ahead with that this summer and see if I can do a few because they seem to pick on particular trees for some reason."*

Perceived success of activities undertaken
The grazing regime Bill has implemented appears to have been relatively successful for both cattle and indigenous species, although the damage caused by bulls rubbing themselves on the bark of some Buloke trees continues to be a problem. In Bill's experience, the success of the techno grazing regime is evident in the number of native grasses, forbs and herbs persisting:

> *"The interesting thing* (about techno grazing) *is that some of the natives that are there actually do better in that system. I have native grasses in some places … and when Martine was here, she was … finding little things like chocolate lilies … growing in those areas despite being part of an intensive grazing system. I think the key to it is that they get rested for so long."*

Perceived impact of activities on financial or production costs
Bill aims to set aside 10% of his land for environmental purposes as a medium to long term plan. While there is clearly some effect on production when land is set aside, Bill acknowledges that it is probably less than it first appears due to the low production value of much of this land:

> *"It does affect production, but it's all about balance. There are areas here that were natural set asides anyway and all I've done is fence them off. Then there are other areas that were always grazed, but you think, well, that's got to be looked after. There's quite a bit of swamp land on this farm … that is not too painful from a production point of view to set aside. A lot of the stuff you're fencing off is not terribly productive anyway. To be honest, if you fence off 10% on this particular farm, I doubt if you would lose more than 5% of your productivity and at a guess I'd say it's more like 1 or 2%."*

Bill also points out the benefit to production by providing shelter to stock through the creation of shelter belts:

> *"There's plenty of studies to show that we could probably do with a lot more shelter in this country for stock health and stress in the winter."*

3.3 Gippsland Plain Bioregion

Giant Gippsland Earthworm

Background
Six active colonies of Giant Gippsland Earthworm have been identified on one of the many dairy farms located in the Korumburra region. The owners of the property, Brian and Cheryl Enbom, have known of the existence of the colonies for many decades and have graciously allowed researchers, students and other interested people full access to their property to study the earthworm colonies. They express substantial pride in the fact these colonies have persisted on their farm, mainly due to their care and interest.

Brian and Cheryl own a 148 hectare dairy farm in Jumbunna, South Gippsland. Stocking rates are moderate, with only 215 dairy cows grazed on the property (1.45 cows per ha). Brian has lived in the local area all his life and has always known that Giant Gippsland Earthworms existed both on the home farm and neighbouring properties. Brian is a member of Landcare.

In recent years, DSE scientist Bev van Praagh has formally identified six colonies of earthworms on Brian and Cheryl's property. The earthworm colonies tend to occur along minor stream banks and drainage channels, alluvial terraces and colluvial footslopes in areas not typically prone to heavy cattle traffic. Consequently, it has been fairly easy to ensure the colonies are relatively undisturbed.

Conservation activities undertaken
The farming system implemented by Brian and Cheryl is generally harmonious with the needs of the Giant Gippsland Earthworm. Stocking rates are medium and the sites of earthworm colonies are grazed lightly, mostly by young stock. This regime is unlikely to change dramatically while the farm remains under the Enbom's ownership due to their interest in protecting the endangered earthworms.

Brian and Cheryl have undertaken substantial replanting of riparian zones along the banks of Foster Creek and tributaries which run through their property, which have no obvious colonies of earthworms. These revegetation activities have been driven by a desire to improve the water quality of Foster Creek, which has been seen to be deteriorating over the years, as well as attract birds.

While further streamside revegetation is not being planned at this point in time due to the substantial labour input required, Brian admits that current lack of knowledge on the effects of dense vegetation on earthworm colonies has resulted in a degree of uncertainty on the best way forward. He also flagged this as an issue for others in the region:

> *"One fellow was horrified to hear* (at the Jumbunna Field Day) *of the possible effects of tree roots. He's planted out all of his worm areas. He doesn't know what to do now – nor do we."*

Perceived success of activities undertaken
The fact that the earthworm colonies have persisted is proof to Brian and Cheryl that their efforts have been successful. Brian did however mention the difficulty in monitoring earthworm numbers to determine the impact of activities undertaken:

> *"We can't see them, so we don't know if there was 10* (earthworms) *in that particular spot 20 years ago and we don't know if there's 10 in there now or 20 or none. We just don't know."*

Perceived impact of activities on financial or production costs
Due in part to the compatibility of the current farming system and the location of sites with the needs of the earthworms, Brian and Cheryl believe that conserving the sites has resulted in little if any impact on either the productivity or profitability of the farm. They suggest that even if there was a slightly negative impact, they would be prepared to accept this:

> *"We feel obliged to look after them unless it's going to impact drastically on what we do. Even if it took 5% or 10% of your property out of action, I think you'd still look after them."*

Strzelecki Gum

Background

Several specimens of Strzelecki Gum can be found on a Koonwarra property in Gippsland. The property is owned by Kevin and Coral Hughes but has recently been leased to their son and daughter-in-law, Chris and Sharon. The Hughes family is very focussed on environmental farming and have witnessed the benefits of their system.

Currently, Chris and Sharon run approximately 180 milking cows, 40 dairy heifers and 60 head of adult and young beef cattle on their 160 hectare property. A cell grazing regime is in place. Chris and Sharon are members of Landcare and the property is registered with the Land for Wildlife scheme.

Claire Moxham (DSE) has been granted permission to undertake Strzelecki gum seedling trials and studies on the Hughes property and consequently has had some interaction with the family.

Conservation activities undertaken

When Kevin and Coral first took over the property, it was a *"fairly bleak farm"* with some Cypress trees around the house and a few pockets of remnant vegetation in the gullies. Being keen to provide an environment they believed would increase productivity, Kevin and Coral embarked on a tree and shrub planting project to provide shelter to both stock and pastures.

Seeds from the Strzelecki Gum have been collected and propagated (long before it was recognised as a separate species) and these trees have been included in shelterbelts, plantations and revegetated riparian zones. Coral points out that provision of wildlife corridors was also an aim of planting shelterbelts.

Perceived success of activities undertaken

The success of conservation activities undertaken by the Hughes family is self evident. Revegetated areas have assisted with erosion control, provided shelter for pastures and stock now enjoy greater comfort:

> *"...On the hill ... when we first bought that, nine times out of ten you would put the cows out there and it would turn lousy overnight and they'd all be hunched up on the fence. And now ... when the weather is howling up across here we can see that they're still out grazing."*

Revegetated areas have also assisted in improving biodiversity and consequently soil biology and the result has been a generally more sustainable farming system.

One of the Hughes' objectives for the farm was to increase its asset value. In Kevin's and Coral's view, the revegetated areas have successfully improved working conditions on the farm – both in terms of personal comfort and visually.

Perceived impact of activities on financial or production costs

In general, the Hughes family believes the conservation activities they have undertaken have provided a positive net gain to productivity and profitability. Chris pointed out that some of the land that has been taken out of production to revegetate was relatively unproductive as a pasture source anyway:

> *"Most of the gullies that we've pulled out have either been really wet, boggy spots or steep, dry areas that grew very little pastures anyway, so as well as protecting the gullies, so to speak, it's not been super productive. They've been more productive as a shelterbelt than as a little bit of pasture."*

Fencing of shelterbelts, gullies and riparian zones has occurred as Kevin and Coral replaced the old fences or created new paddocks – thus incorporating the cost and labour of conservation activities with farm activities.

2.4 Victorian Volcanic Plain Bioregion

Corangamite Water Skink

Background

The Corangamite Water Skink has been found on the banks of Deep Lake, which is part of a series of six lakes that form the Nerrin Nerrin wetlands, west of Ballarat. Deep Lake is situated on a property currently owned by Stuart Wills, who is aware of the Skinks' presence and has allowed Garry Peterson (DSE) unrestricted access to the lake since 1998 to conduct trials to track population changes in the species.

Stuart owns approximately 360 hectares of land which was originally part of his parents' farm. He was raised on the property and consequently has substantial historic knowledge of the land and Deep Lake. The majority of his land is used for wheat, barley and canola cropping programs, but Stuart also runs approximately 2,500 fine wool merinos on pasture paddocks at a reasonably high stocking rate. Stuart is a member of the Southern Farming Systems group.

Conservation activities undertaken

Prior to Garry Peterson's study, Deep Lake was ringed by an old fence in need of repair. The fence had originally been erected to exclude stock from the muddy outer regions of the lake. Approximately three years ago, Stuart replaced much of the old fence with new conventional fencing, while Garry Peterson provided about 100 metres of electric fencing. The sheep therefore do not graze the lake boundaries and are completely excluded from the Skink habitat:

> *"Garry told me that the idea of fencing off the lake area to keep the sheep from grazing it was to provide a bit of grass as shelter for the Skinks so they can hide from the birds that come down and eat them."*

Stuart has also planted some trees on one bank of the lake and hopes to plant more to create additional wildlife habitat. While the initial trees planted created too much shade in areas inhabited by the Skinks, future plantings will be along outer boundaries:

> *"I'm going to turn the area into a little bit of a wildlife sanctuary. I'll just be careful that I don't plant the trees where they'll create too much shade for the Skinks."*

Perceived success of activities undertaken

With the main aim of erecting an electric fence being to provide grass as shelter for the Skinks, Stuart is not completely convinced of the success of the project due to the high number of weeds emerging:

> *"I don't know if the fencing has been really successful, because I don't know if they're really native a lot of those grasses that are growing down there... The weeds seem to have taken over. I don't know if that's impacted on the Water Skinks though – you'd have to ask Garry."*

Perceived impact of activities on financial or production costs

The Skinks on Stuart's property are located in an area which is not conducive to cropping due to the slope and rockiness of the terrain. While fencing the area around Deep Lake means there is a little less feed for sheep, it also saves them from becoming stuck in the mud at the lake edge. Consequently, there is little impact overall on the profitability or productivity of Stuart's farming enterprise:

> *"They just don't impact because of where they are ... I don't think you can do much with the land around the lake. It's too rocky to crop and you probably don't want stock in there too often because with the decreased depth of the lake, there's a lot of mud around it and the stock will get stuck in the mud."*

Small Scurf-pea

Background

A colony of Small Scurf-pea has been found in native grasslands on a property in the Basalt Plains region. The property is owned by Roger and Jeanette Bellchambers, who place great value on their *"little grassland community"* and believe it is an important area to protect.

Roger and Jeanette were both brought up in the city and purchased their farm only after the birth of their first child. Today, the Bellchamber's wool producing enterprise consists of approximately 450 hectares, with 3,500 sheep, grazed on a rotation system. Jeanette takes care of the day to day running of the farm and Roger has a full time position away from the property.

A few years ago Roger and Jeanette purchased a neighbouring property on which they discovered a grassland area *"with Kangaroo Grasses and Danthonia and herbs and forbs which are there during the spring, but which looks very ordinary at other times of the year"*. It was only after exposure to a significant roadside location containing indigenous plant species that the Bellchambers realised its uniqueness.

Scientists Claire Moxham and Josh Dorrough have been granted access to the grasslands to conduct a three year project to explore the compatibility of grazing regimes.

Conservation activities undertaken

The Bellchambers are keen conservationists and consequently they aim to have a balanced farming system which results in an acceptable level of production as well as conserving the grasslands on their property. A rotational grazing system, which involves resting native grassland paddocks during spring is implemented to ensure these areas continue to flourish.

For ease of management, the Bellchambers incorporate the grassland areas on their farm into the larger paddock structure:

> *"We actually incorporate it as part of the paddock structure for management, so ultimately we didn't believe it a good idea just to fence around that 25 acres or whatever … right through the paddock area, there are the same endangered or whatever species."*

Roger and Jeanette are about to trial a changed grazing regime however, in an attempt to combat specific annual weeds which have become a problem in the grassland paddocks at the resting time. In line with their reluctance to use chemical applications, the Bellchambers plan to undertake a crash grazing regime early in the season and hope this will have the desired effect.

The Bellchambers have been keen observers of the Potter farms and believe that up to between 15% and 20% of their land can be covered by tree and understorey vegetation without negatively impacting farm productivity.

Perceived success of activities undertaken

The grazing regime implemented by Roger and Jeanette has successfully conserved and actually improved their native grasslands:

> *"On some of our grassland blocks as early as 8 years ago, we began to take off our stock in spring because we had feed elsewhere and we rested the grasslands and then really scarce and vulnerable plants became far more prolific on our property … the legumes, the Cullen parvum and others … and purely that resting mechanism allows plants to flourish."*

Perceived impact of activities on financial or production costs

Apart from the satisfaction of seeing the native grasslands on the property continue to flourish and enjoying the aesthetics of a well vegetated farm, Roger and Jeanette have noticed other benefits of retaining native grasslands to stock health and wellbeing:

"We have other benefits that come with that too. We used to lamb in the autumn and we could put pregnant ewes down in the grassland around that time and we had the benefit of clean pasture for them – worms can be such a big problem for the sheep industry."

The Bellchambers prefer not to consider whether their conservation activities are impacting on profitability, believing that implementing a farming system which suits their principles is equally as important:

"Profitability is one thing, doing what we want and being satisfied is another. As long as we're happy and we've got enough money to live, the profitability of it doesn't mean a huge amount to us. I don't believe that at this stage it costs a huge amount of money."

4. CONCLUSIONS

4.1 Discussion

The ESAI "Threatened Species and Farming" project has made some preliminary findings on practical methods of managing threatened species on farms. A selection of species was investigated with applications to dairy, meat, wool and cropping enterprises. These species are at risk of local extinction because of degradation or loss of their habitats. Conservation of their habitats is often compatible with farm production, especially when they occupy small areas of the farm that are difficult to utilise.

In the cases of Brolga, Giant Gippsland Earthworm, Strzelecki Gum and Corangamite Water Skink, habitat requirements coincide with wetter areas of the farms, which contribute little to production. Active management input is required for Brolga in the creation of suitable wetland conditions and for Strzelecki Gum in the control of weeds to enable establishment.

However, for Red-tailed Black Cockatoo and Small Scurf-pea, habitat is scattered throughout production areas of farms and some adjustments to farming regimes are required if they are to persist. Protection of paddock trees, particularly Buloke, is a key requirement. Further trials are needed to determine optimum grazing regimes for Small Scurf-pea and Chariot Wheels in native grasslands.

A selection of case study farmers provided insights into the management of threatened species and the impacts on farm productivity (Watson 2005). Some farmers are actively managing for the threatened species, but others have found that little alteration is needed to their farming practices.

For most case study participants, managing their property in a way that protects threatened species has not impacted on productivity or profitability. Some suggest productivity gains have resulted from wetlands acting as important water management tools, remnant vegetation areas and shelterbelts providing shelter for stock and crops, and fewer stock losses due to fencing off hazardous areas. In some situations, only the less productive areas of the farm have been conserved, such as swampy areas, steep sections of the farm or corners of paddocks where crops cannot be sown or harvested easily. Other case study participants however, believe taking areas out of production and conserving remnant vegetation can have a significant impact on a farm's potential profitability.

Farmers interviewed for this project identified assistance needed for them to better manage threatened species on their farms. This included more frequent personal contact with knowledgeable government staff and simplified applications for and promotion of funding and labour support.

4.2 Future Directions

The outcomes of this project are a result of a four-year collaboration between DSE and DPI. Further development of these outcomes is needed to produce tangible contributions to the long-term goal of ecologically sustainable agriculture.

Based on the findings of the case study research, interviews with farmers and DPI extension staff and feedback from field days, this should include:

- Developing training packages for DPI extension, research and natural resource management programs.
- Producing and distributing threatened species information resources.
- Implementing further management trials for particular species to identify practical farm management solutions.
- Reviewing fine-tuning and promoting incentives for management of threatened species on farms.
- Establishing and building on local partnerships to improve information exchange between DSE, DPI, CMAs, local government and community organisations (including Landcare, conservation and farming groups).

ACKNOWLEDGEMENTS

We gratefully acknowledge the following people for their generous assistance with the project:

Farmers – management trials and interviews
Jeanette and Roger Bellchambers
Stuart Wills
Greg Wisbey and Paula Dare
Garry Mason
Neville Guthridge
Tony and Kathy Mahoney
Ross and Jodie Olden
Chris, Sharon, Kevin and Coral Hughes
Paul Knox
Brian and Cheryl Enbom
Wendy and Peter Wallace
Mary Fielding
Neil Slocumbe
Jon and Pat Collins
Bill Wallace
Barry and Maureen Reader
John and Susie Cormack
Rod and Carmel O'Kane
Keith and Rhonda Buckingham
Warren and Judy Miles

DSE – support with case studies
Richard Loyn
Vivienne Turner
Susan Taylor
Sue Berwick
Deanna Marshall
Jim McGuire
Yvonne Ingeme
Andrew Pritchard

DSE – project planning
Di Marshall
Steve Platt
Andrew Straker

DPI – assistance with case studies and field days
John Bowman
Greg O'Brien
Nathan McDonald
Bernard Noonan
Howard Pascoe
James Whatley
Sophie Wadley

DPI – assistance with project communication
David Beckingsale
Eloise Seymour

CMAs – assistance with case studies and field days
Geoff Trease – West Gippsland
Kate Walsh – West Gippsland
Bronwyn Teasdale – West Gippsland
Peter McRostie – North Central
Luke Bayley – North East
Andrea Montgomery – Goulburn Broken
Dean Robertson – Wimmera

REFERENCES

Department of Natural Resources and Environment (2000) *Victoria's Draft Native Vegetation Management Framework*. NRE, Victoria.

Department of Natural Resources and Environment (2002) *New approaches, better future. Ecologically Sustainable Agriculture Initiative.* NRE, Victoria.

Department of Primary Industries (undated) *Beginners Guide to Environmental Management Systems in Agriculture.* DPI, Victoria.

Department of Sustainability and Environment (2004) *Environmental Management in Agriculture. Native Biodiversity Resource Kit*. DSE, Victoria.

Foreman, P (2005, unpubl.) *Threatened Species and Farming. Chariot Wheels case study*. Commissioned by ESAI.

Herring, M (2005, unpubl.) *Threatened Species and Farming. Brolga case study*. Commissioned by ESAI and NHT.

Maron, M (2005, unpubl.) *Threatened Species and Farming. South-eastern Red-tailed Black Cockatoo case study*. Commissioned by ESAI.

Moxham, C and Dorrough, J (2005, unpubl.) *Threatened Species and Farming. Strzelecki Gum case study*. Arthur Rylah Institute for Environmental Research. Commissioned by ESAI and NHT.

Moxham, C and Dorrough, J (2005, unpubl.) *Threatened Species and Farming. Small Scurf-pea case study*. Arthur Rylah Institute for Environmental Research. Commissioned by ESAI and NHT.

Peterson, G (2005, unpubl.) *Threatened Species and Farming. Corangamite Water Skink case study*. Commissioned by ESAI and NHT.

Van Praagh, B, Yen, A, Rosengren, N (2004, unpubl.) *Threatened Species and Farming. Giant Gippsland Earthworm case study 1*. Commissioned by ESAI.

Van Praagh, B, Yen, A, Rosengren, N (2005, unpubl.) *Threatened Species and Farming. Giant Gippsland Earthworm case study 2*. Commissioned by ESAI and NHT.

Victorian Government (2005) *Our Environment Our Future - Victoria's Environmental Sustainability Framework*. Victorian Government.

Watson, P (2005, unpubl.) *Threatened Species and Farming – Farmer Case Studies*. Report by Down to Earth Research. Commissioned by ESAI.