Restoration of the *Tasmanian* Midlands

Neil Davidson 2022

Introduction

Objective
The aim of this booklet is to present the key outcomes from an $11 million, landscape-scale environmental restoration program conducted in the Midlands of Tasmania between 2008 and 2018. The program was designed to create vegetated corridors that crossed the Midlands of Tasmania from the Eastern Tiers to the Central Plateau, which performed the dual purposes of providing shade and shelter for stock and crops, as well as habitat for native wildlife.

The Midlands
The Midlands is 803,00ha in extent, low in altitude (200-400m) and low in rainfall (400-600mm). The primary farming enterprises are livestock grazing and irrigated cropping. The region is a highly productive agricultural landscape, which is 98% privately owned but is also the site of Tasmania's only nationally recognised biodiversity hotspot. 200 years of farming has led to a more than 70% decline in natural vegetation cover, and of the remaining 30%, less than 1/3 (10% of total landscape) is in a healthy state, which is a critical threshold for rapid decline in biodiversity.

Findings
The findings presented here are based on 10 years of university research and 1800ha of plantings conducted across the Midlands in collaboration with many partners and stakeholders. The findings draw upon the results of 15 research papers published in 2021 in a Special Issue of the *Journal of Ecological Management and Restoration* 'Restoring the Midlands' (for details see Appendix 2).

Partners:
Greening Australia, Tasmanian Land Conservancy, Bush Heritage Australia, Department of Primary Industries Parks Water and the Environment, University of Tasmania, NRM North, Tasmania Farmers and Graziers Association.

Supporters:
Tasmanian State Government, Australian Federal Government, Ian Potter Foundation, Pennicott Wilderness Journeys, University of Tasmania, CSIRO, John Roberts Trust and 20 farmers.

Why restore the Midlands?

There are three main reasons to conduct restoration in the Midlands

To provide shelter for farm stock and crops to:

- Counter Rural tree decline
- Replace paddock trees removed to make way for centre pivot irrigators
- Modify farm microclimate (to mitigate effects of rising temperatures and increased drought)

To ensure survival of native vegetation remnants in a changing climate by:

- Replanting in and around declining woodlands
- Establishing hardy plants and seed sources that will survive in altered environments under a changing climate
- Re-establishing a native understory which is dense and complex

To retain and increase populations of native wildlife by:

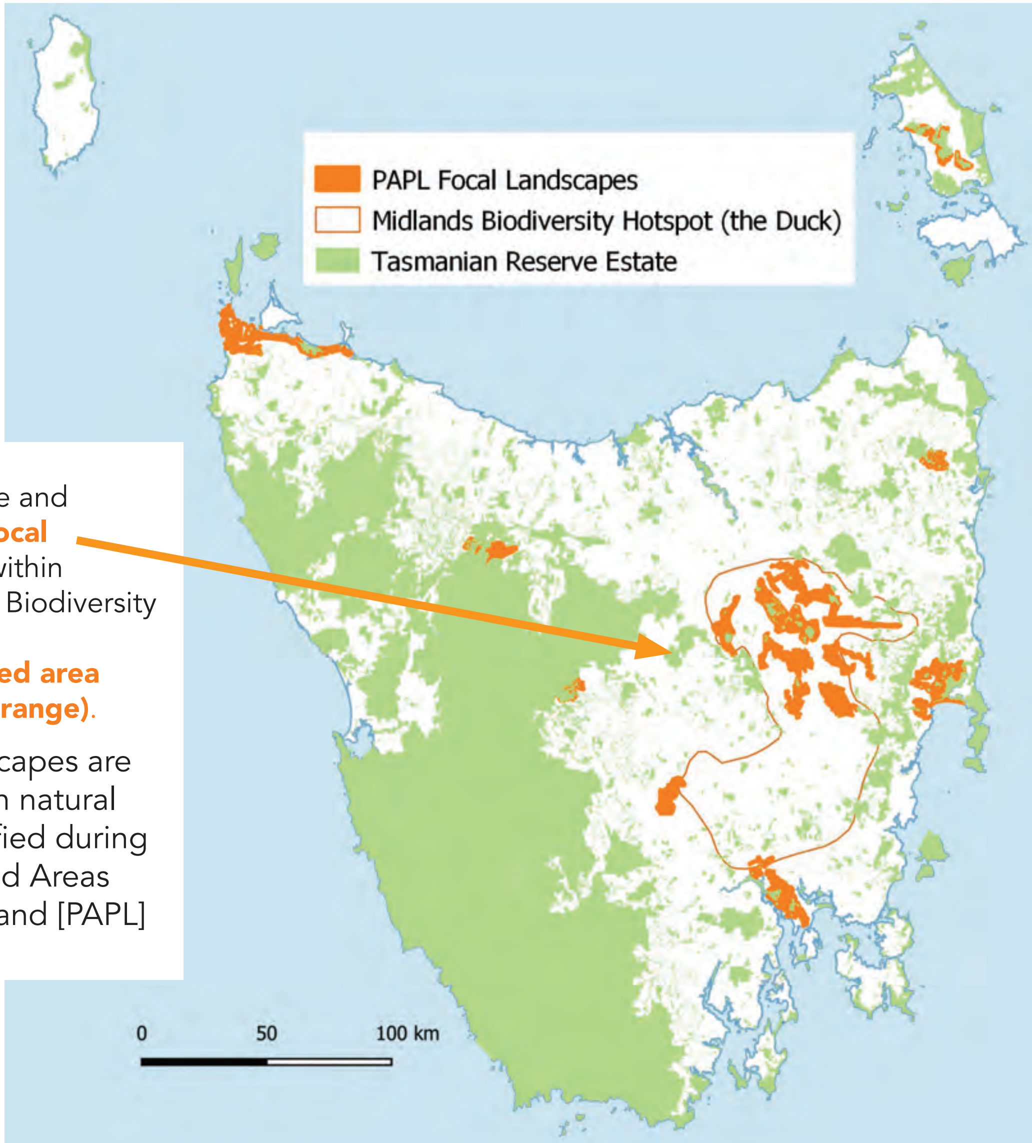
- Creating suitable animal habitat
- Making connections at landscape-scale

Because there has been a high degree of alteration to natural systems caused by 200 years of farming, in many cases there is no natural regeneration. Therefore there is need for **active restoration**. This will have multiple benefits - to farms, wildlife and the community.

Where to restore?

Restoration is needed throughout the Midlands

- Less than 10% of the remnant native vegetation in the Midlands is healthy
- Further decline in vegetation cover will have severe consequences for farm shelter and native wildlife
- Priority areas are identified below



Priority:
Restore inside and between **6 Focal landscapes** within the Midlands Biodiversity hotspot. **('Duck' shaped area outlined in orange)**.

(Focal landscapes are areas of high natural value identified during the Protected Areas on Private Land [PAPL] analysis).

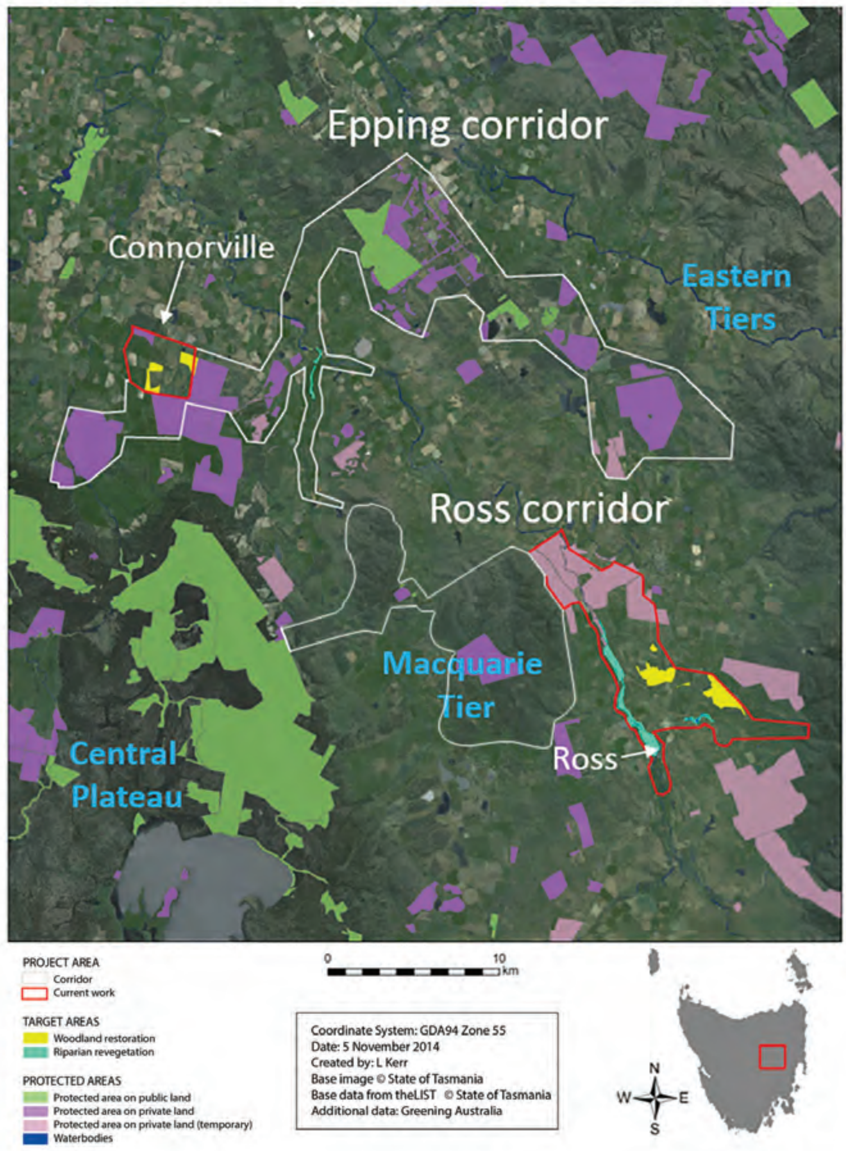
Biodiversity Hotspot
The Tasmanian Midlands contains one of the most threatened ecosystems in the world – temperate grasslands and grassy woodlands. The Midlands is home to 32 nationally threatened species and more than 180 species that are considered threatened at the state level. Connecting remnants makes it easier for species to move through the landscape to search for food, to mate and to respond to our changing climate. This helps maintain biodiversity and build species resilience.

Where to restore?

Create biodiversity corridors

Ecological modelling was conducted to identify optimal routes for biodiversity corridors. Corridors allow animals and plants to move in response to a changing climate, thus avoiding being trapped on islands in a sea of agriculture. These were designed to cross the Midlands from east to west and to capture the greatest natural values possible by including many reserves, protected areas and areas of healthy native vegetation. Two proposed corridors are shown here – the Ross corridor and the Epping corridor.

Biodiversity Corridors in the Northern Midlands



Priority: Create connections between areas of high natural value, e.g. current and proposed protected areas (shaded in **purple** and **green**). Corridors (outlined in white and **red**) are designed to maximise the benefits of restoration. Current restoration work is outlined in **red**.

The key to success

Restoration is not just growing trees

This project is one of a very few world wide to take a multidisciplinary, multi-institutional, science-based approach to environmental restoration, focused on a single geographic region, the Biodiversity Hotspot of Midlands of Tasmania.

To be successful restoration has to encompass disciplines as diverse as: climate science, plant genetics, horticulture, agriculture, animal ecology, fire ecology, finance, law, social science, education, indigenous culture, modelling and remote sensing.

Success in the Midlands owes much to the history of 4 decades of cooperation between land owners, government departments, environmental agencies and university researchers.

Restoration in the Midlands provides a model system for landscape restoration nationally and internationally.

This story is told through 15 research papers in a Special Issue of the *Journal of Ecological Management and Restoration*: 'Restoring the Midlands of Tasmania' (See details Appendix 2).

The following pages describe the key points from this publication.

Experiences of farmers

Farmer participation:

Farmer participation in long term programs stems from lived experience, observation of changes in the landscape and a thirst for knowledge.

Interactions with researchers and extension officers provides farmers with information on the natural values of their farms and how these might be improved.

Evolution of relationships

"(In) the old system it was either take it by stealth, or this is this species and you're not allowed to do this anymore. That was a really bad way to handle it with farmers"

"The best way (to approach farmers) is to say, "Come with me. . . Let's walk hand in hand. . ., let's make this work." And I think that's been more of a culture in the last decade". *Roderic O'Connor*

Success in a hostile environment

"…It was almost a relief to put some runs on the board in terms of doing something that was visible that could then be looked upon in the broader catchment as being farmers doing the right thing." *Julian von Bibra*

How to restore?

The following 10 pages outline key steps in restoration. Details can be found in the *Journal of Ecological Management and Restoration* Special Issue (see Appendix 2)

Restoration requires:

1. Choosing the right plant species and seed sources
2. Cultivating and preparing sites to maximise plant survival
3. Designing tree plantings to improve microclimates on the farm
4. Re-establishing habitat for native marsupials that minimises predation by cats
5. Improving habitat for woodland birds to reduce competition from Noisy Miner
6. Establishing fire regimes that protect assets and improve biodiversity
7. Using remote sensing to monitor growth and carbon storage
8. Maintaining long-term partnerships between farmers, natural resource managers, scientists and restoration practitioners
9. Attracting wide community involvement and support
10. Education for all ages
11. Facilitation through regulations and financial incentives

Species and seed sources to plant

It is important to use hardy seed sources that will tolerate the warmer, drier climates predicted for the future

- The choice of species, and seed source within species, will affect planting success
- Local seed source may no longer be the best for the future climate
- Feedback from previous plantings can help identify hardy seed sources
    - Keep records of species and seed sources planted
    - embed trials in restoration to test seed sources

Hardy local native species used in plantings in the Midlands between 2008 and 2018.	
Acacia dealbata	Silver wattle
Acacia melanoxylon	Black wattle
Acacia mucronata	Sallow wattle
Acacia verticillata	Prickly Moses
Allocasuarina verticillata	Drooping She-oak
Allocasuarina littoralis	Black she oak
Banksia marginata	Banksia
Cassinia aculiata	Dolly bush
Dodonaea viscosa	Hop bush
Eucalyptus amygdalina	Black peppermint
Eucalyptus ovata	Black gum
Eucalyptus pauciflora	Cabbage gum
Eucalyptus rodwayi	Swamp gum
Eucalyptus viminalis	White gum
Hakea microcarpa	Small-fruit Hakea
Leptospermum lanigerum	Woolly Tea-tree
Melaleuca gibbose	Honey myrtle
Melaleuca pallida	Lemon Bottlebrush

Seed source trial for *Eucalyptus ovata* and *E. pauciflora* planted in restoration at Connorville, Cressy.

Planting trees

Robust and reliable methods (detailed in Appendix 1) are available for establishing and growing native plants (trees, shrubs and grasses) in the Midlands of Tasmania.

Success is dependent on using the right techniques (Wilco spot cultivation or rip/mounding), rigorous weed control, and fencing and caging against browsing animals.


Dense plantings


Scattered trees


Wilco spot cultivator


Rip/mound


Cage 60cm diameter

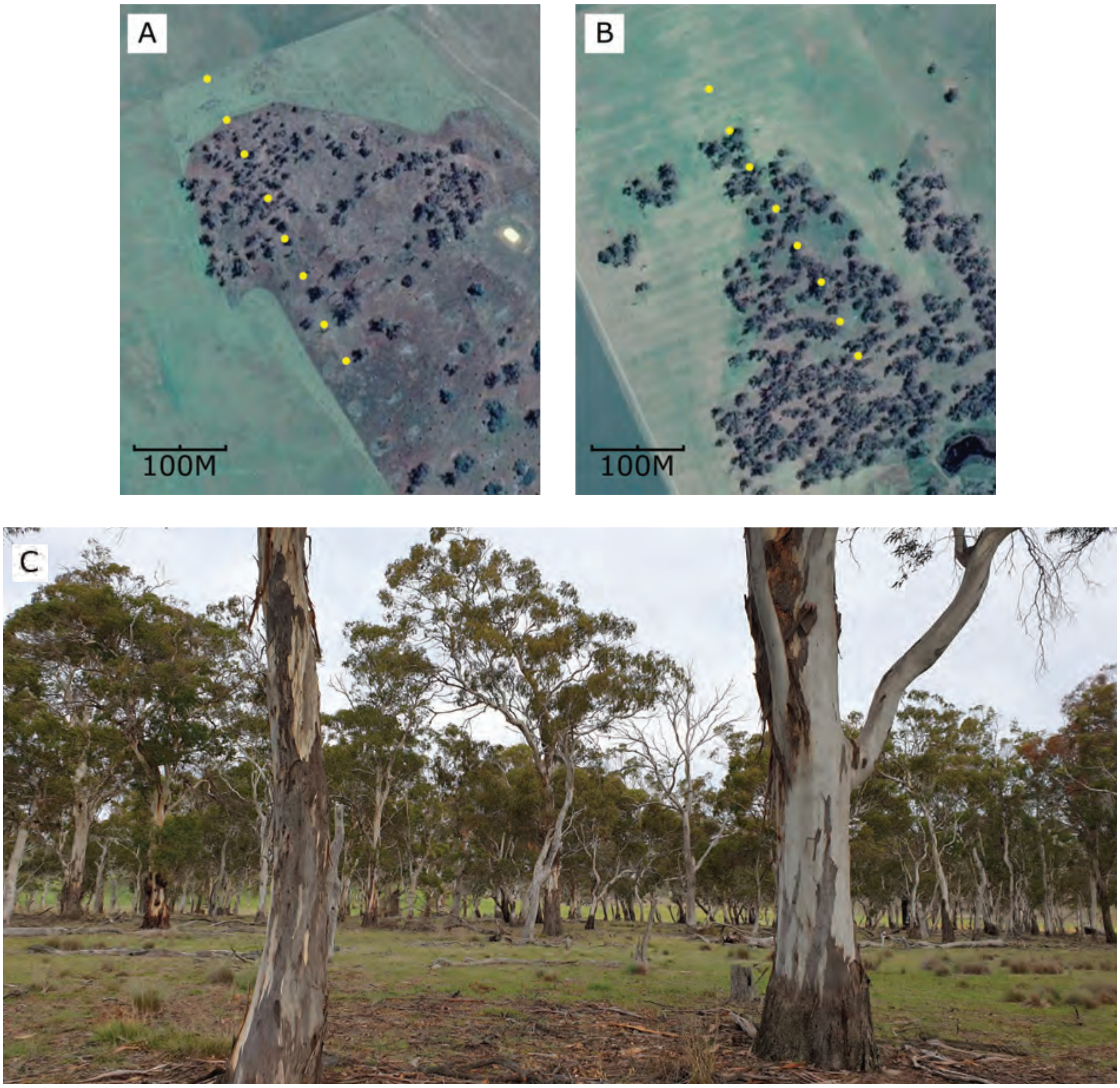

2mx2m fence

Improving the microclimate

Patches of native trees (planted or remnants) can have a major impact on the micro-climate. As little as 20 to 40 scattered trees, upwind:

- Halves the wind velocity
- Raises the minimum temperature by 0.5ºC
- Under extreme conditions reduces wind chill by up to 5ºC

Wide-spaced tree plantings can be used to modify microclimate (reduce wind velocity and moderate high and low temperatures) within grazed paddocks.



(A) & (B) show the position of weather stations (marked as yellow dots) within native vegetation remnants used to study microclimate. (C) is a typical native vegetation remnant shown to modify farm microclimate by halving wind velocity and raising minimum temperature by 0.5ºC.

Habitat for native animals

Many native marsupials, once common in the Midlands, are now rare. However, this can be reversed by providing suitable habitat.

Small to medium sized native marsupials (e.g. bandicoots, potoroos, eastern quoll) are at risk from feral cats, which are present in large numbers in the Midlands.

Cats are efficient hunters in open country but their success is greatly reduced in dense vegetation.

To improve marsupial habitat:

- Create a dense ground cover - native grasses [Poa], Sag [Lomandra], bracken and low shrubs are best
- Use plantings to improve the size of native vegetation remnants and links between them. Wide linkages are best, as cats prowl edges
- Retain small patches of native vegetation and any isolated trees, rock piles and logs that provide 'stepping stones' for animals to use when crossing open spaces

Bettong

Tasmanian Devil

Eastern Quoll

Habitat for woodland birds

There has been a steep decline in native bird numbers in the Midlands

The main causes are:

- Habitat loss
- Predation by feral cats and introduced rodents
- Reduced biodiversity - driven by the invasive Noisy Miner. Noisy Miner is a highly aggressive native honeyeater species, which moves into small patches of woodland with a simplified understory. Miners outcompete and exclude smaller birds from otherwise suitable habitat.

The solution is to provide birds with suitable habitat:

- Plant dense ground covers of grasses, sag (Lomandra), bracken and shrubs. These will provide protection from predators and miner birds and offer nesting sites.
- Retain and expand small native vegetation remnants
- Retain old paddock trees with nesting hollows, which also provide 'stepping stones' for birds to cross open areas
- Retain fallen logs and rock piles to provide hiding places and increase abundance of insect prey

Poa understorey

Noisy Miner

Superb Fairy-wren

The use of fire

Fire behaviour is changing

As the climate changes, dangerous fire conditions will occur more frequently and fires will be more intense. Aboriginal fire regimes can be used to reduce the risk fire poses to assets, and to improve the health and biodiversity of native vegetation, as follows:

Aboriginal fire, applied under the right conditions, trickles through the landscape.

This approach can:

- Reduce fuel load and the intensity of subsequent fires
- Encourage native grasses and increases species diversity
- Reduce the dominance of highly flammable mid-storey shrubs (e.g. wattle & she-oak)
- Encourage the regeneration of trees (eucalypts)
- Encourage development of marsupial lawns which are fire retarding. These lawns are created by intense grazing by native marsupials and improved by the dung they import.

Note: it is important to include careful grazing management after fire so tree regeneration is not removed through browsing, e.g. by stock, feral deer and hare.

Grassy woodland

Patchy burn

Burnt area

Monitoring (by remote sensing)

Remote sensing is the monitoring tool of the future

Remote sensing will provide monitoring and management tools for the future, to:

- Determine the shape and size of trees and shrubs as they grow
- Calculate tree biomass, carbon stored, and shade and shelter produced
- Identify the species planted and even the seed sources used
- Monitor animal movement patterns and preferences for habitat types

This capability comes with the use of drones that carry detectors which can assess shape and size of plants (Lidar or photogrammetry) or colour and reflectance (hyperspectral imagery) of their foliage.

- In the future it will be possible to measure most attributes of woodlands remotely
- Currently, the cost of this technology is high but with miniturisation and mass production, costs are falling

Aerial view of environmental plantings near the Ross township.

Partnerships and Collaboration

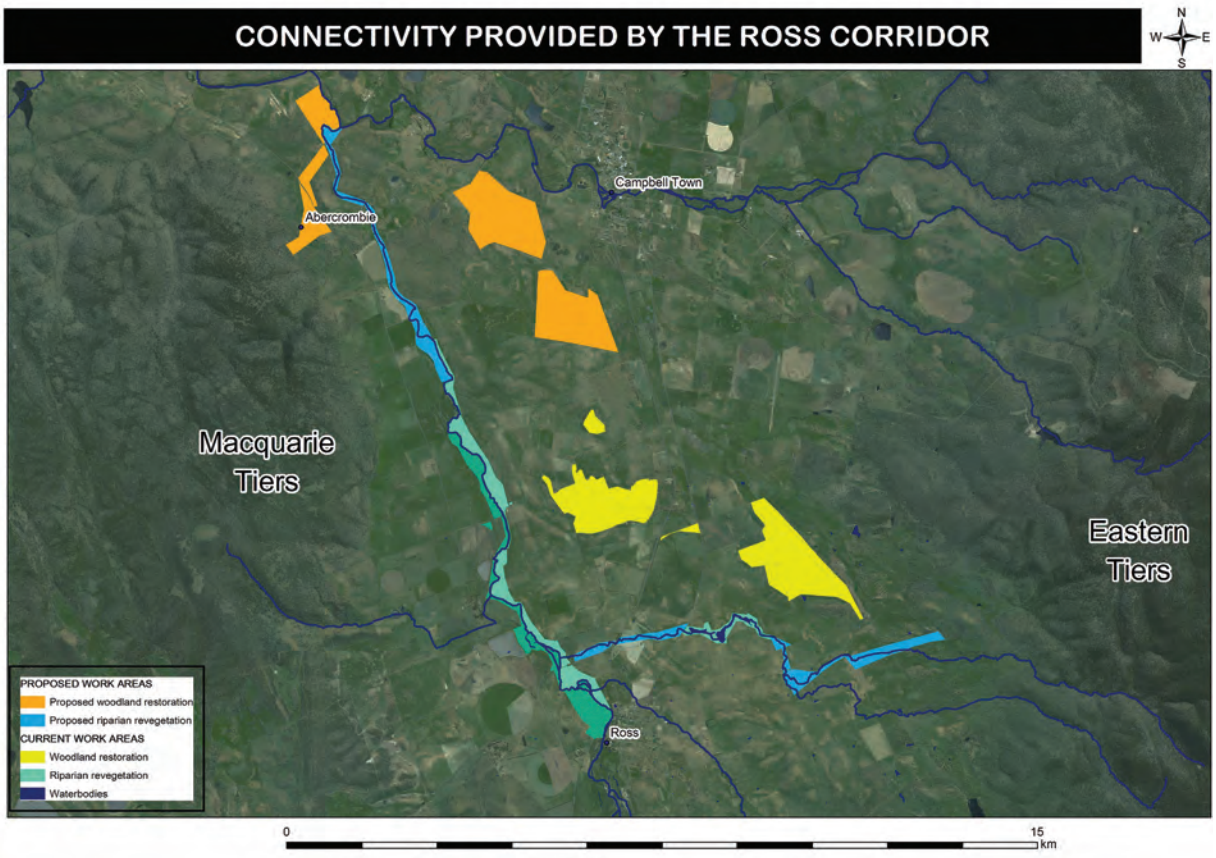
Partnerships and collaboration are vital

The wide range of partners and stakeholders that have been involved in conservation and restoration has been a huge benefit in achieving goals in the Midlands.

40 years of collaboration and connection in the Midlands

Over 40 years there has been an increase in the sophistication of approach to reservation and restoration in an area of great conservation significance – and 98% privately owned.

- There has been an evolution in approaches to biodiversity protection from covenants to management agreements
- There has been a shift from site to landscape scale restoration
- There is now a focus on climate ready restoration and improving habitat quality and connection for wildlife, which also benefits the farm



Restoration to create; Riparian corridors along the Macquarie River (blue) and enhance islands of healthy native woodland (yellow), to provide connections for wildlife between Macquarie Tier and the Eastern Tiers – as well as shade and shelter for stock and crops.

Community involvement

Community support is fundamental to a restoration program

Including the environment in farm management decisions benefits the whole community:

- Developing community ownership and pride in the nationally recognised 'Midlands Biodoversity Hot Spot'
- Improving the image of farmers and the farming community - as seen by city dwellers
- Providing a focus for visitors to the Midlands – by using the methods and outcomes of environmental rehabilitation as draw card for tourists, e.g.:
    - The sculpture trail (depicting 'Species hotels') on the Macquarie River
    - Descriptions of design and methods used in restoration at Ross
- Involving the Aboriginal community and adopting Aboriginal fire management practices in restoring native grasslands

'Species Hotels' at Ross created by architecture and design students, (UTAS)

Midlands rock shelter visited during an 'Aboriginal emersion' day

Education

Education for all ages

For the last 10 years, children in kinder to grade 12, have been learning about the natural environment of the Midlands and the value to us all associated with looking after the plants and animals in our landscape. Inevitably this is transferred to parents and the broader community.

Activities include:

- Understanding the power of environmental processes
- Researchers visiting schools to describe the lives of our native animals and birds, and how they are being studied
- Night walks to see nocturnal animals, hosted by farmers
- Planting trees as part of restoration
- Aboriginal emersion days

Governance and financing

- A mixed funding model (Government, philanthropic, business and research) was very successful in delivering the Tasmania Island Ark Project
- The cost of restoration was very site-specific, depending on landscape position, history of land use, weed loads and browsing pressure
- Forest Practices Plans (a legal requirement in Tasmania) provided a useful framework for environmental restoration

Improvements are needed

- Australia has weak financial and legal arrangements for ecological restoration
- Government funding is inadequate for funding most restoration projects, which necessitates funding from a mix of philanthropic and commercial sources
- Legal frameworks are inadequate. There is a lack of statutory obligations to undertake restoration and lack of restoration standards
- The costs of restoring a full ecosystem to support native biodiversity are high - so policy favours mass tree plantings for carbon
- Carbon offset can be used to fund ecological restoration but current value of carbon is low
- Cost of restoration is high but the cost of inaction will be much higher in the longer term

Advice and further information

General advice on environmental restoration is available through Greening Australia's 'Tasmania Island Ark' website:
https://www.greeningaustralia.org.au/programs/tasmania-island-ark/

Advice can also be obtained from NRM North, Tasmanian Land Conservancy, Bush Heritage Australia and the State Department of Primary Industries Parks Water and Environment.

Detailed accounts of the Midlands restoration work were published as a book in December 2021:

'Restoring the Midlands of Tasmania' Special Issue No 22, *Journal of Ecological Management and Restoration*

which is freely available on line at:

https://onlinelibrary.wiley.com/toc/14428903/2021/22/S2
or through QR Code:

Impacts of Climate Change

By 2100, the climate of the Midlands is predicted to change:

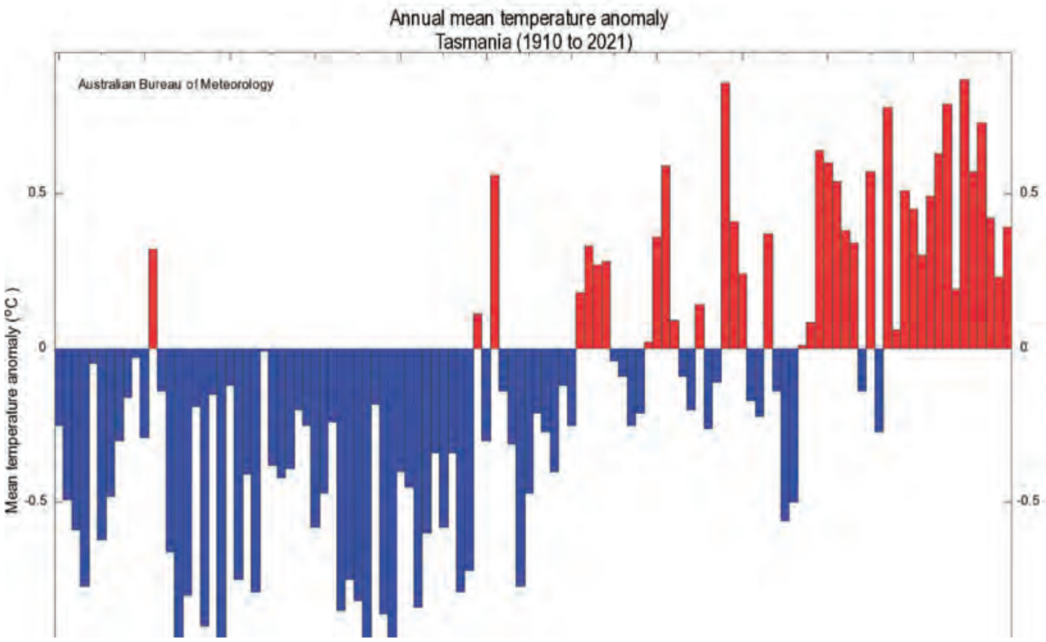
- 3°C rise in average annual temperature
- the same rainfall but greater rates of evaporation (aridity) because of higher temperatures
- More extremes – heatwaves, extended droughts, heavy rainfall events and cold snaps.

The Midlands will become hotter and drier.

In 2100, the current climate of the Midlands will be experienced on the eastern edge of the Central Plateau, i.e. at higher altitude.

Annual mean temperature anomaly for Tasmania from 1910 to 2020

Warmer (red) or cooler (blue) than the average



Over 110 years, mean annual temperatures for Tasmania were generally cooler (**blue**) than the 100-year mean at the start of the graph and warmer (**red**) than the 100 year mean at the end of the graph, showing a progressive warming of the climate of Tasmania.

The Future

The future is in our hands

- Because of the scale of land clearing and habitat loss globally, and the associated degradation of the life support systems humans require on this planet, restoration is becoming a major plank in the plan for the future of humanity.
- Internationally, there has been an ongoing search for effective methods for restoring degraded landscapes. Methods developed and lessons learned in the Midlands are an important contribution and can be applied nationally and internationally in matching dry agricultural landscapes.
- Effective restoration is costly. However, with improvements in the design of machinery (for delivering restoration) and economies of scale, this price will come down.
- With increases in the 'value of carbon' which must come as the world moves towards "net zero carbon emissions", the carbon stored in the restoration plantings and remnant woodland (and biodiversity benefits created) will become a major asset for farmers – and hopefully tradable commodities.
- Because of the changes we are all going to face in the transition to farming in an altered climate, education and community engagement must remain an important focus of a continuing restoration program.
- Because of the uncertainties of the impact of a changing climate and the responses of plants and animals to these changes, it is vital that research (across a range of disciplines) remains an integral component of restoration, so we are able to deliver on the opportunities outlined in this booklet.
- The cooperation and collaboration between farmers, resource managers and researchers developed in the Midlands over the last 40 years has been a huge benefit to restoring the Midlands and in achieving a sustainable future.

Appendix 1: Restoration methods

Two planting strategies were used

1. Dense plantings (830 plants/ha, i.e. 3 m x 4 m spacings) were used along river systems and beside woodland remnants. These were fenced to exclude livestock or completely enclosed in 2 m tall deer proof fence to minimise browsing damage.
2. Wide-spaced plantings (200 stems/ha, i.e. 60 group plantings/ha at 13mx13m spacings) were used to provide shade and shelter within existing paddocks. Paddocks could be grazed immediately after planting.

   In wide-spaced plantings, trees and shrubs were established at low density using two approaches:

   - Scattered trees – two eucalypts seedlings were planted together within a cylindrical steel mesh guard. This was done at 50 placements/ha to re-establish paddock trees.
   - Vegetation islets – two trees and eight shrubs enclosed in 2x2 m fenced plots. This was done at 10 placements/ha to create thickets to provide stock shelter and habitat for native animals.

Preparation and planting

- Two mechanical cultivation techniques were used to fracture soil to depth and provide a pathway for plant roots to reach a permanent water supply:
  - Wilco spot cultivation on vulnerable land (river banks and erodible soils) and in wide spaced plantings,
  - Rip-mounding was used for most dense plantingsA fallow period of 6 months after cultivation was used to store soil moisture
- Control of grassy weeds: Initial knock down herbicide application in spring before cultivation by Rip-mound, or immediately after cultivation by Wilco. A second application of knock down and residual herbicide (not near rivers) in autumn prior to planting.
- Control of woody weeds: Cut and paste with neat glyphosate for Willow, Briar Rose and Hawthorn; Gorse was pushed with a bulldozer blade; all residues were burnt immediately.
- Seedlings were grown from local native seed provenances and the mix was enhanced with climate tolerant seed sources.
- Seedlings were raised in nursery for 6-9 months and hardened by nutrient starving and cold treatment before planting.
- Planting in late winter/early spring allowed plant roots to penetrate deeply before surface soils dried. This timing also minimised damage from winter frost.
- Seedlings were planted deeply (root ball 2 cm below the soil surface) with a Pottiputki tree planter and firmed down with the heal of a boot.
- Site preparation and plantings were conducted in accordance with the Forest Practices Code of Tasmania.

Appendix 1: Restoration methods (continued)

Constraints on restoration

- Restoration is much easier to conduct in areas less altered by farm activities. This is because in these sites natural soil processes are still intact. Soils beneath healthy native vegetation are high in carbon, low in nitrogen and phosphorus, high in fungi and low in bacteria. Where there has been a long history of cultivation and fertilisation soils are low in carbon, high in nitrogen and phosphorus, high in bacteria (*Rhizobium* for clover) and low in fungi (essential for mycorrhizal associations with the roots of native plants). Nutrient rich sites, high in nitrogen and phosphorus, support a wide variety of grassy, herbaceous and woody weeds which compete strongly with native plants for water and nutrients.
- Restoration is problematic in deep sands because these soils hold little moisture after rain and soon become droughted once rain stops.
- To successfully grow a tree it is essential to effectively control weeds (grassy, herbaceous and woody weeds) within 1m of the base of the tree for at least one year and to prevent browsing by native and feral animals and stock for at least 2 years and up to 10 years.
- To successfully establish understorey cover (grasses and low shrubs) suitable for native wildlife, generally it is necessary to permanently exclude stock. Carefully managed seasonal light grazing (e.g. during lambing or after shearing) can be employed in some situations.

Appendix 2: Further reading

Publication:

'Restoring the Midlands of Tasmania' *Ecological Management & Restoration* Special Issue, Volume 22, Supplement 2, published December 2021 Eds Neil Davidson, David Freudenberger, Julianne O'Reilly-Wapstra, Ted Lefroy (available as free access on line) https://onlinelibrary.wiley.com/toc/14428903/2021/22/S2

Individual papers:

Davidson et al. (2021) Restoring the Midlands of Tasmania: An introduction, pp3-10.

Gilfedder et al. (2021) Tasmanian Midlands: A case study of increasing sophistication in conservation planning and action over four decades, pp11-23.

Bridle et al. (2021) Landholder reflections of their engagement in landscape conservation and restoration projects in the Northern Midlands of Tasmania, pp24-35.

Richardson and Davidson (2021) Financing and governing ecological restoration projects: The Tasmanian Island Ark, pp36-46.

Davidson et al. (2021) New approaches for revegetating agricultural landscapes to provide connectivity for wildlife: The example of the Tasmanian Midlands, Australia, pp47-60.

Davidson et al. (2021) Dry biomass and carbon sequestration in environmental plantings in the Midlands of Tasmania, pp61-64.

Jones et al. (2021) Research supporting restoration aiming to make a fragmented landscape 'functional' for native wildlife, pp65-74

Harrison (2021) Climate change and the suitability of local and non-local species for ecosystem restoration, pp75-91.

Bailey et al. (2021) Embedding genetics experiments in restoration to guide plant choice for a degraded landscape with a changing climate, pp92-105.

Bailey et al. (2021) Investigating constraints on direct seeding for native revegetation in the Tasmanian Midlands, pp106-117

Baker et al. (2021) The role of open woodland in mitigating microclimatic extremes in agricultural landscapes, pp118-126.

Harrison et al. (2021) From communities to individuals: Using remote sensing to inform and monitor woodland restoration, pp127-139

Bowman et al. (2021) Fire, herbivores and the management of temperate Eucalyptus savanna in Tasmania: Introducing the Beaufront fire – mammalian herbivore field experiment, pp140-151.

Wallis et al. (2021) From little things, big things grow: Building connections through place-based education in the Tasmanian Midlands biodiversity hotspot, pp152-163

Harrison et al. (2021) A decade of restoring a temperate woodland: Lessons learned and future directions, pp164-174.

Partners and stakeholders

TASMANIAN LAND CONSERVANCY

Australian Government
Australian Research Council

The Ian Potter Foundation

PENNICOTT WILDERNESS JOURNEYS

NRM North

BUSH HERITAGE AUSTRALIA

Australian Government

UNIVERSITY of TASMANIA

JM Roberts Charitable Trust

Tasmanian Farmers and Graziers Association TFGA

Tasmanian Government

Greening Australia

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