WETLAND REVIVAL TRUST

BLUEPRINT FOR ACTION

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OCTOBER 2021

A BLUEPRINT FOR RESTORATION ACTIVITIES IN A RANGE OF SIGNIFICANT WETLANDS IN NORTH CENTRAL VICTORIA

▲ Three generations of Barapa Barapa and Wemba Wemba Traditional Owners with plants for wetland restoration at Johnson Swamp

◀ Cover image: The nationally vulnerable Growling Grass Frog *(Litoria raniformis)* and Wavy Marshwort *(Nymphoides crenata)* at Wirra-lo Wetlands

ACKNOWLEDGEMENTS

Thanks to Beth Mellick of the Wettenhall Environment Trust for her support with this project and to Gib Wettenhall for editing this blueprint.

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SUMMARY

River catchments in North Central Victoria support a large concentration of important wetlands. These catchments include the Avon-Richardson, Avoca, Loddon, Campaspe, Goulburn and Murray River. There is a high diversity of wetland types which range from fresh to saline and permanent to temporary, each dominated by different vegetation types and supporting a unique variety of plants and animals. Twenty-nine wetland systems in this region are regarded as nationally significant and two, Gunbower Forest and Kerang Wetlands, are recognised as internationally significant.

North Central Victoria's wetlands support important economic, cultural and ecological values. These values include:

- Sites of importance to Traditional Owners such as scar trees and burial grounds;
- Habitat for endangered vegetation types and over 200 threatened plant and animal species.
- Protection from floods;
- Ecological services such as the control of agricultural insect pests by wetland birds;
- A thriving tourism industry.

Over the past 200 years, half of the original area of freshwater wetlands in North Central Victoria have been destroyed and many of those that remain are degraded. 20% of plant species and 30% of animal species in the region's wetlands are threatened with extinction. In a broader context, across the entire Murray-Darling Basin, wetland bird populations have declined by 70 to 90% over the past 30 years.

The Wetland Revival Trust (WRT) is a new not-for-profit organisation that will work with Traditional Owners, other local community members, government agencies, not-for-profit organisations and universities within North Central Victoria. WRT aims to protect and restore high value wetlands and waterways on both private and public lands, ensuring restoration is based on sound science and practical knowledge. This will assist the survival of endangered plants and animals, halt the decline of wetland bird populations, increase wetland resilience against threats such as climate change, tackle salinity and other forms of land degradation and support the health of surrounding agricultural systems.

This blueprint describes the processes that have degraded wetlands in North Central Victoria, details the ecological significance of several important wetland clusters and outlines projects that will improve knowledge, restore wetland vegetation condition, establish additional populations of endangered plant species and improve the quality and quantity of fauna habitat, particularly for threatened species.

Over the next five years WRT aims to build knowledge about 10,000 hectares of wetland, improve vegetation condition through revegetation at 2,740 hectares of wetland, assist with monitoring and adaptive management at 795 hectares of wetland, restore hydrology at 241 hectares of wetland and control weeds at 170 hectares of wetland. The projects will be designed to have multiple benefits and can be grouped according to targeted outcomes. For example, projects designed to improve habitat quality for Australasian Bittern cover 2,339 hectares, and projects to improve the management and condition of threatened EVCs cover 13,751 hectares.

▲ Ancient Black Box *(Eucalyptus largiflorens)*, Wirra-lo Wetlands

1. INTRODUCTION

1.1. CONTEXT

Two hundred and fifty years ago the riverine plains of North Central Victoria were a vast mosaic of interconnected natural ecosystems, supporting a spectacular diversity of native plants and animals and thriving Aboriginal communities. Pulsing through this landscape with the ebb and flow of the seasons and longer-term climatic cycles, a network of rivers, creeks, floodplains and wetlands provided life-sustaining water to its plants, animals and people.

Over the last two hundred years, European occupation has wrought vast changes across these plains. Over 80% of the native vegetation has been cleared and converted to dryland or irrigated pasture and cropland (VEAC, 2010); the rivers have been dammed and regulated to supply water for irrigated agriculture; the land surface criss-crossed by irrigation channels, levees, roads and other infrastructure. This has changed the way water moves through the landscape and salt that was once distributed through the soil has been concentrated close to the surface in low-lying areas. These changes have resulted in the elimination and degradation of hundreds of wetlands. In the North Central Catchment Management Authority (NCCMA) area, over 47,000 ha (close to half of the original area) of freshwater wetlands have been destroyed (NCCMA, 2011).

Despite these changes, the riverine plains still support a diverse array of wetlands on both public and private land ranging from large freshwater and saline lakes to River Red Gum, Black Box and Tangled Lignum dominated swamps and floodplains and to shallow freshwater marshes and meadows dominated by grasses, sedges and wildflowers. Many of these wetlands have high conservation significance as they support rare examples of ecologically intact vegetation communities and populations of highly threatened plant and animal species.

Internationally and nationally significant wetlands recognised on the riverine plains of North Central Victoria are shown in Table 1. The Convention on Wetlands of International Importance, known as the Ramsar Convention, is an intergovernmental treaty for the conservation and wise use of wetlands and their resources (Gardner, 2015). Nationally significant wetlands are identified in the Directory of Important Wetlands in Australia (ANCA , 1993).

WHY DOES WETLAND RESTORATION MATTER?

Wetlands are among the world's most productive environments and are vital for human survival. They deliver a wide range of ecosystem services including fish and fibre, water supply, water purification, climate regulation, flood regulation, protection from erosion, control of agricultural insect pests by wetland birds, recreational opportunities and tourism (Millennium Ecosystem Assessment, 2005).

Wetlands are estimated to have declined globally between 64-71% in the 20th century, with losses and degradation continuing worldwide. Their degradation has led to an economic loss of more than US$20 trillion in ecosystem services annually. (Gardner, 2015).

More than 50% of the area of wetlands have been lost during the 20th century in parts of Australia and New Zealand (Millennium Ecosystem Assessment, 2005). Since European occupation, two-thirds of Victoria's wetlands or almost 4,000 natural wetlands (191,000 hectares) have been destroyed, primarily by drainage for agricultural purposes (VEAC, 2010).

'POLICYMAKERS HAVE SUFFICIENT SCIENTIFIC INFORMATION TO UNDERSTAND THE URGENT NEED TO TAKE APPROPRIATE ACTIONS TO CONSERVE WETLANDS AND THEIR SERVICES TO PEOPLE.'

(Gardner, 2015)

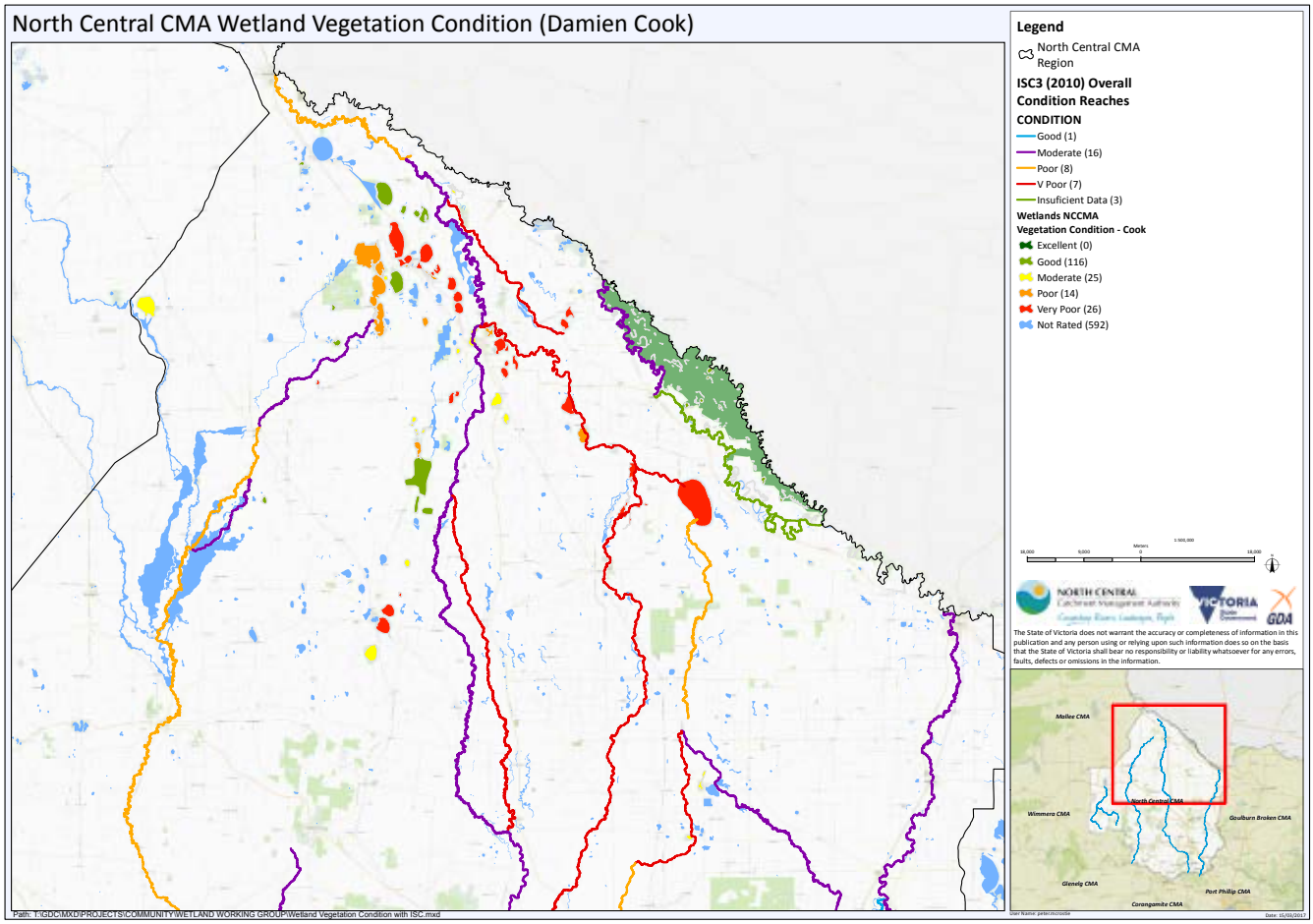
'The benefits of large-scale landscape regeneration, reforestation and revegetation, include: preserving biodiversity; reducing soil and water loss and degradation; providing shelter, shade and fodder; a cooler regional climate; carbon sequestration; increasing soil fertility and productivity; more sustainable agriculture; more timber and other tree products; better pollination; production of biofuels; enhanced food, water and energy security; benefits to tourism; supporting rural communities; creating employment; bridging the cultural divide between city and country; promoting national reconciliation; improving people's wellbeing; and higher civic morale' (Eckersley, 2013).

Table 1 Wetlands of international and national significance on the riverine plains of North Central Victoria

RAMSAR-LISTED SITES OF INTERNATIONAL SIGNIFICANCE FOR WETLAND CONSERVATION	KERANG WETLANDS	GUNBOWER FOREST
Sites of national significance for wetland conservation listed in the Directory of Important Wetlands in Australia (ANCA 1993)	Lake Bael Bael First Marsh Second Marsh Third Marsh Third, Middle and Reedy Lakes Little Lake Charm, Kangaroo Lake and Racecourse Lake Lake Charm Johnson Swamp Hird Swamp Town Swamp Cemetery Swamp Lake Cullen Fosters Swamp	Lake Kelly Stevensons Swamp Lake William Kow Swamp Woolshed Swamp Tragowel Swamp Tang Tang Swamp Two Tree Swamp Mansfield Swamp Wallenjoe Swamp Bunguluke Wetlands, Tyrrell Creek and Lalbert Creek Creswick Swamp

Wetlands on the riverine plains of North Central Victoria vary in condition from good (with healthy trees, few weeds and a high diversity of indigenous plants, often including many threatened species) to very degraded (where trees are either unhealthy or dead; there is a high cover of weeds and plant diversity has been simplified by the dominance of a few competitive or salt tolerant species); see Photograph 1.

Photograph 1 Wetlands in good and very degraded condition, North Central Victoria



Map 1 Wetland vegetation condition in North Central Victoria

Map 1 shows the distribution and condition of wetlands, rivers and creeks in the NCCMA region. Note that few wetlands are in good or excellent condition and that there are areas where almost all wetlands are in very poor condition.

Photograph 2 Lake Bael Bael in March 2018. Wetlands in the Kerang region can be exceptionally productive for water birds

A diverse range of animal species utilise the wetland systems of the riverine plains, either as residents or nomadic populations that arrive when conditions are suitable. At maximum productivity the wetlands support an astounding diversity and abundance of wetland birds (see Photograph 2). During surveys of the Kerang Wetlands Ramsar site in March 2018, over 75,000 individuals of 70 wetland bird species were observed (Cook 2018), including significant populations of the nationally endangered Australasian Bittern.

Over the past few decades, state and national government agencies and other organisations have recognised the imperilled situation of wetlands and have initiated a wide variety of actions to protect and restore them, ranging from purchasing wetlands to include them in the conservation estate, tree planting and other ecological restoration works, controlling weeds and feral animals, and in some cases restoring more natural flooding and drying cycles by delivering environmental water.

Wetlands are extremely dynamic ecosystems that can respond rapidly to environmental changes. When an understanding of the factors that drive ecosystem processes is carefully applied to managing and restoring wetlands, significant improvements in ecological condition can occur relatively quickly.

1.2. WETLAND REVIVAL TRUST

1.2.1. Origin

The idea for the Wetland Revival Trust began with projects that were developed to improve the condition of Hird, Johnson and McDonalds Swamps near Kerang in northern Victoria. These wetlands support a high abundance and diversity of wetland birds and breeding habitat for several threatened species, including the Australasian Bittern. However, the vegetation within these wetlands was in very poor condition because of past land and water management practices.

These wetlands receive what is known as environmental water, which is water that is used to fill wetlands that no longer receive enough natural flooding because of river regulation and water diversion. Currently environmental water is limited to less than 5% of the Murray River's flow and is only delivered to a small percentage of wetlands (<1%).

Past water management at Hird, Johnson and McDonalds Swamps had caused frequent and prolonged flooding which drowned all the mature trees and allowed tall, dense Common Reed and Cumbungi to become over-dominant. In 2014, the NCCMA reviewed the way water was delivered to the wetlands with the aims of controlling the spread of invasive Common Reed and Cumbungi and improving the condition of wetland vegetation and bird habitat.

To assist with the review, the NCCMA engaged wetland ecologists Damien Cook and Elaine Bayes to assess the condition of vegetation, map the extent of invasive species, and make recommendations on how they could be controlled. Watering plans (known as Environmental Water Management Plans or EWMPS) for the wetlands had recommended that the wetlands be filled in spring, and that when filled they be kept full for one or two summers. Common Reed and Cumbungi grow and spread rapidly when inundated during warm conditions, but their growth is slowed, and Cumbungi can even be killed, if the plants are kept dry for long enough.

As a result of the review, recommendations were made to adjust the way water was delivered so that Common Reed and Cumbungi would have less access to water during their growing season. Using a detailed knowledge of the ecology of wetland plants and how they respond to natural wetting and drying cycles (including depth, season and duration of flooding), it was also realised that environmental water delivery could be used to initiate the re-establishment of a living tree canopy and more diverse understorey. This could be done by stimulating the germination of the seed of any native wetland plant species that may have survived in the soil and by strategically planting and direct seeding at critical times as the wetland was filling and drying. Thus, by carefully planning restoration activities in conjunction with the delivery of water, not only would invasive species be controlled, but the condition of wetland vegetation and the quality of fauna habitat would also be improved.

Water was delivered to Johnson Swamp in autumn 2015 trialling the water delivery recommendations. Other restoration actions were planned by wetland ecologist Damien Cook to coincide with the filling and drying of the wetland. Members of the Barapa Barapa community were engaged by the NCCMA to plant wetland species as the wetland filled, then River Red Gum, Eumong and Black Box were planted as the wetland dried (see Photograph 3).

Monitoring has shown that these activities have set the wetland on a trajectory of improved vegetation condition and habitat diversity (Cook, 2018). The success of this project consolidated the idea that the delivery of environmental water could act as a catalyst to restore degraded wetland vegetation; and that this restoration work would provide Traditional Owners with employment, training and opportunities to spend time together on country.

These projects inspired Damien Cook and Elaine Bayes to establish the Wetland Revival Trust. Discussion with peers indicated that it would be confusing if Damien was both a for-profit consultant and director of a not-for-profit trust, and that operating as a trust would be a way to attract funding to projects that may otherwise be difficult to resource. After working as a successful ecological consultant for over 30 years, most recently as the owner and co-director of Rakali Consulting, Damien has decided to leave Rakali and direct his energy into a not-for-profit trust as a way of achieving the best ecological and social outcomes for wetlands and the plants and animals that depend on them. Income generated from Damien's consulting work will now be directed into wetland restoration projects via the trust. In the professional opinion of Matthew Shaddock, registered accountant of Rakali Consulting, the business has been producing a consistent profit after wages in excess of $100,000 per year (Shaddock & Co. 2021). This will now be available for use by the trust.

Photograph 3 Barapa Barapa Traditional Owner Uncle Duck Charles tree planting at Johnson Swamp, September 2016

1.2.2. The Wetland Revival Trust Structure

The Wetland Revival Trust has been developed following consultation with Traditional Owners, Catchment Management Authorities and other wetland stakeholders. It is a registered not-for-profit organisation governed by a board that ensures its legal functioning. A committee of wetland stakeholders, ecologists and academics will set the strategic direction of the Trust. Individual restoration projects will be governed by a steering committee composed of relevant stakeholders including:

- Members of the Dja Dja Wurrung, Wemba Wemba, Barapa Barapa, Taungurung and Yorta Yorta communities;
- The Wettenhall Environment Trust;
- North Central Catchment Management Authority (NCCMA);
- Goulburn Broken Catchment Management Authority (GBCMA);
- Goulburn-Murray Water (GMW);
- Victorian Environmental Water Holder (VEWH);
- Commonwealth Environmental Water Holder (CEWH);
- Murray-Darling Wetland Working Group;
- Parks Victoria;
- Department of Environment, Land, Water and Planning;
- Deakin University Blue Carbon Lab;
- Other universities and relevant academics.

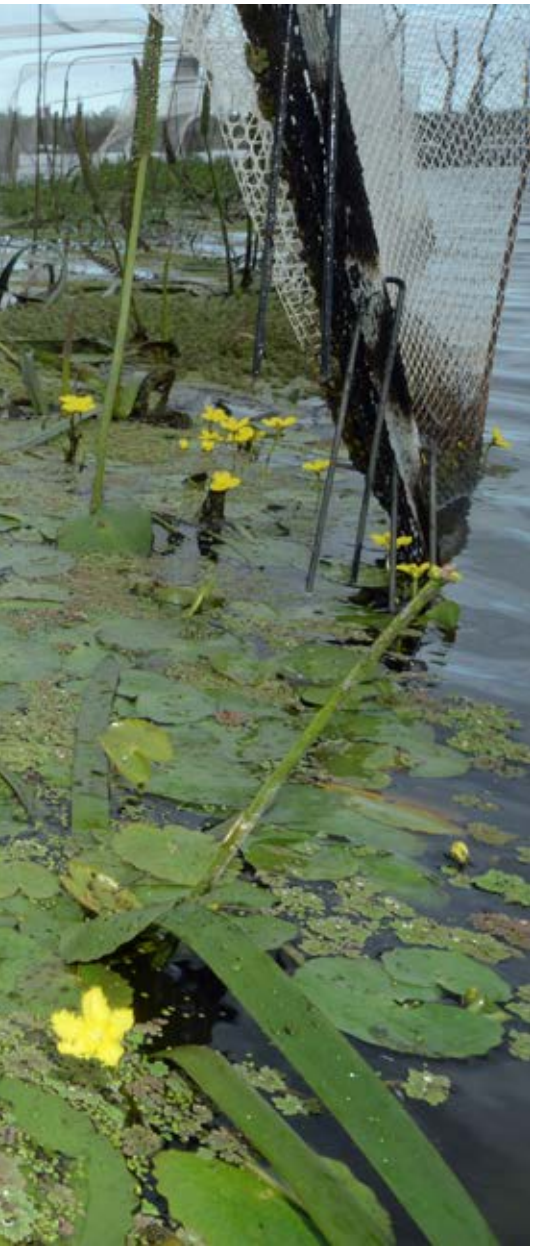
WRT will be designed to be administratively efficient so that funds are spent on achieving project outcomes. Being a not-for-profit will provide a diverse range of opportunities to source funding for restoration projects and potentially encourage the engagement of landholders with wetlands on private land.

1.2.3. Working together for ecological restoration

Since the initial work at Johnson Swamp began in 2015, another 11 wetland restoration projects have been initiated in North Central Victoria. Designed by wetland ecologist Damien Cook, these projects have involved collaboration between Traditional Owners, NCCMA, Murray Darling Wetlands Working Group (MDWWG), private wetland owners Ken and Jill Hooper and the Victorian Department of Land Water and Planning (DELWP). Collaboration has fostered the development of strong relationships between partner organisations and individuals.

Projects completed have achieved excellent establishment rates (>90%), with over 38,000 plants established across 1,600 hectares of 12 wetlands (see Table 2). The planning and implementation of these projects has been informed by indigenous perspectives of local ecosystems and by an understanding of ecosystem processes and restoration principles.

The projects have trialled new methods of re-establishing tree, shrub and ground-layer species within degraded wetlands using a combination of planting and direct-seeding techniques (see Photograph 4 and Photograph 5). The Wetland Revival Trust will build on these projects and continue to bring organisations, agencies and individuals together to achieve excellence in wetland restoration.



Photograph 4 Aquatic plant species planted by Barapa Barapa at McDonalds Swamp in October 2018, including culturally significant Water Ribbons *(Cycnogeton procerum)*

Photograph 5 Aquatic vegetation established by direct-seeding at Brolga Swamp at Wirra-lo Wetlands, including the nationally vulnerable Ridged Water-milfoil *(Myriophyllum porcatum)*, which is the emergent green plant on the right of the picture

Table 2 Wetland restoration projects involving Traditional Owners in North Central Victoria from 2015-2019

TRADITIONAL OWNER GROUP	WETLAND	TOTAL WETLAND AREA (HA)	AREA PLANTED (HA)	PROJECT PARTNERS	SPECIES USED FOR REVEGETATION	QUANTITY PLANTED	WHEN PLANTED
Barapa Barapa	McDonalds Swamp	164	40	MDWWG NCCMA Parks Victoria DELWP Landcare	River Red Gum	2000	River Red Gum October 2016 to January 2017
					diverse mix of understorey plants	6000	2000 understorey plants September 2016
							4000 understorey plants May 2018
	Hird Swamp	345	150	NCCMA Parks Victoria	Black Box	1020	October 2017 to November 2018
					River Red Gum	580	
					Eumong	400	
					diverse mix of understorey plants	3000	
	Johnson Swamp	340	150	NCCMA Parks Victoria Landcare	River Red Gum	1600	River Red Gum December 2015 to March 2016
					Black Box	160	Black Box, Eumong and understorey plants September 2015 to September 2016
					Eumong	560	
					diverse mix of understorey plants	3000	
	Wirra-Lo Wetlands-Brolga Swamp	9	9	Ken and Jill Hooper NCCMA Landcare	diverse mix of understorey plants	2000	April 2016 and October 2017
	Yando Swamp	40	4	NCCMA Parks Victoria DELWP	diverse mix of understorey plants	630	October to November 2017

TRADITIONAL OWNER GROUP	WETLAND	TOTAL WETLAND AREA (HA)	AREA PLANTED (HA)	PROJECT PARTNERS	SPECIES USED FOR REVEGETATION	QUANTITY PLANTED	WHEN PLANTED
Barapa Barapa *(continued)*	Lake Leaghur	63	50	NCCMA Parks Victoria DELWP	River Red Gum	800	February 2018 to March 2018
					Eumong	200	
					diverse mix of understorey plants	660	
	Lake Murphy	168	80	MDWWG NCCMA Parks Victoria	Black Box	160	September to October 2016
					River Red Gum	1200	
					Eumong	360	
	Tragowel Swamp	125	20	NCCMA Parks Victoria	River Red Gum	280	March 2017 to December 2017
					Eumong	120	
Wemba Wamba-Barapa Barapa	First Marsh	778	600	NCCMA Parks Victoria	River Red Gum	5000	January 2018 to May 2018
					Eumong	1000	
	Second Marsh	237.5	220	NCCMA Parks Victoria	River Red Gum	3200	April 2017 to November 2017
					Eumong	800	
	Third Marsh	1233	40	NCCMA Parks Victoria	River Red Gum	600	December 2016 to January 2017
					Eumong	200	
Dja Dja Wurrung	Lake Boort	404	250	Paul Haw Parks Victoria	River Red Gum	2300	February to April 2018
					Eumong	200	
Totals		**3906.5**	**1613**			**38,030**	

WETLAND REVIVAL TRUST VISION:

- **Utilising rigorous science and community collaboration to restore healthy wetlands that are connected across the landscape and that provide diverse and productive habitats for flora and fauna;**
- **Allowing for the movement of species and genetic flow to increase ecosystem resilience to threats such as climate change; and**
- **Providing ecosystems services to the agriculturally productive communities that live around them.**

AIMS AND OBJECTIVES OF THE WETLAND REVIVAL TRUST:

1. **Protect** and ensure the best possible management of high value wetlands and waterways at the landscape scale on both private and public lands.
2. **Restore** degraded wetlands in northern Victoria that are of high cultural and ecological significance.
3. Ensure restoration is based on **sound science and practical knowledge:**
    - Using Society for Ecological Restoration Australia guidelines (SERA 2017);
    - Base restoration on appropriate local indigenous reference ecosystems;
    - Establish a technical steering committee utilising state and local experts;
    - Improve knowledge of ecological restoration by trialling innovative restoration techniques and sharing/collaborating with the broader restoration community.
4. Ensure projects are **strategic** and align with state and local strategies and plans (collaborative governance).
5. Consult and **develop relationships with local Indigenous groups**:
    - Train, employ and assist local Aboriginal people in ecological restoration, management and monitoring.
6. **Work with communities** and raise awareness of the significance of wetlands and the need to protect and restore them.
7. Undertake **effective planning and monitoring**: Restoration will be based on clear targets, goals and objectives:
    - Develop strategic management plans for each wetland;
    - Establish long term monitoring and relationships with universities and other groups;
    - Establish ecosystem baseline inventory for individual wetland projects;
    - Improve the condition of endangered ecological communities and the quantity and quality of habitat available for threatened species.

The Wetland Revival Trust will work towards achieving its vision and objectives through actively seeking government and non-government investment for wetland restoration projects; providing expertise in wetland restoration; and working closely with Aboriginal groups, landholders, government agencies and local communities.

Specific activities will include;

1. Documenting ecological restoration works that are required in ecological restoration and management plans;
2. Collection of indigenous plant seed;
3. Planting and establishing indigenous tree, shrub and ground-layer species to restore vegetation diversity and structure to enhance fauna habitat;
4. Weed and feral animal control;
5. Monitoring the outcomes of ecological restoration projects and the general condition of wetlands and surrounding ecosystems;
6. Engaging with the broader community and conducting events to promote the importance of wetlands and the need to protect and restore them;
7. Purchasing land with high conservation values to protect and conserve wetlands and surrounding ecosystems;
8. Assisting farmers and other landholders to protect and restore wetlands on their properties;
9. Managing land to protect and restore its ecological condition and significance;
10. Training Traditional Owners to take a leading role in all the above activities.

To ensure that Wetland Revival Trust ecological restoration projects are carried out using sound stewardship and the best possible science, the underpinning principles of the 'National Standards for the Practice of Ecological Restoration in Australia' (SERA, 2017) will be adopted. These principles are:

1. Ecological restoration practice is based on an appropriate local indigenous reference ecosystem;
2. Restoration inputs will be dictated by the level of resilience and degradation;
3. Recovery of ecosystem attributes is facilitated by identifying clear targets, goals and objectives;
4. The goal of ecological restoration is for full recovery, insofar as possible, even if outcomes take long timeframes or involve high inputs;
5. Restoration science and practice are synergistic;
6. Social aspects are critical to successful ecological restoration.

'Substantial background knowledge of both restoration practice and underpinning ecology is needed for professional ecological restoration planning, implementation and monitoring, requiring the planner and practitioner to draw as fully as possible from all learnings to date. The practice of ecological restoration and rehabilitation seeks to transform humanity's role from one where we are the agents of degradation to one where we act as conservators and healers of indigenous ecosystems' (SERA, 2017).

1.3. THE CENTRAL ROLE OF TRADITIONAL OWNERS

Wetland Revival Trust projects are focused in North Central Victoria, bounded by the Mallee region to the west, the Murray River to the north, the Goulburn River to the east and Bendigo to the south.

This area takes in parts of the traditional lands of the Dja Dja Wurrung, Wemba Wemba, Barapa Barapa, Taungurung and Yorta Yorta Aboriginal peoples. These communities have cared for their country for many thousands of years and wetlands have always played a central role in their cultural, spiritual and economic life.

Aboriginal connection to wetlands is evident in the many cultural sites that are found within and around them, including scar trees, middens, camp sites and oven mounds and ceremonial grounds.

Being actively involved in on-ground works and ecological monitoring provides Traditional Owners with opportunities for training and employment in regional areas and facilitates spending time together out on country to pass on cultural knowledge from one generation to the next (see Photograph 6). Traditional Owners will be centrally involved in planning, implementing and monitoring the projects described in this blueprint.

Photograph 6 Traditional Owners planting River Red Gum and Eumong at Second Marsh in the Koorangie State game Reserve, October 2017. From left to right, Richie Murray, Darren Kirby, Budge Wilson, Noelene Murphy, Laura Kirby, Shani Hamilton and Uncle Duck Charles

"I like the satisfaction of working on country, being connected to the environment and feeling part of it. It's a good feeling eradicating weeds and working to get the native plants and animals back, to return the country to better health."

– Uncle Duck Charles, Barapa Barapa elder

"Getting out and planting more trees and other native plants is good for country. When we do that work, we are strengthening our connection with family and country. It's about doing the right thing for the earth."

– Rochelle Patten, Barapa Barapa-Yorta Yorta Woman

◀ *Photograph 7* Uncle Dixie Patten with a River Red Gum planted at First Marsh in March 2019. This tree was planted less than 12 months before the photograph was taken

▲ *Photograph 8* Wemba Wemba Traditional Owner Wayne Walsh with a 21 month-old River Red Gum at First Marsh in December 2019. This tree should now be large enough to survive a substantial flood

1.4. WETLAND REVIVAL ENVIRONMENTAL POLICY AND OPERATING PRINCIPLES

Environmental Policy

WRT is committed to minimising its operational activities impact on the earth.

The WRT Office is:

- Run by 100% solar power;
- All wastewater is contained on site and treated through a greywater treatment system (using indigenous wetland plant species);
- All office paper is 100% post-consumer waste;
- Purchases are as local as possible;
- All biodegradable wastes are composted.

WRT field work:

- Is carried out with weed and pest hygiene procedures for example to prevent the transfer of Chytrid fungus and other pathogens between sites;
- With rigorous occupational health and safety procedures to ensure all staff are kept safe and supported.

Operating Principles for WRT projects

1. Consult with stakeholders and establish a technical steering committee of community members and practitioners.
2. Projects must be strategic and align with state and local strategies and plans.
3. Restoration is based on sound science and practical knowledge using the Society for Ecological Restoration Australia guidelines.
4. Projects should improve knowledge of ecological restoration by trialling innovative techniques.
5. Projects will provide training and employment and assist local Aboriginal people in ecological restoration, management and monitoring.
6. A comprehensive plan will be developed to guide each project.
7. Project planning and monitoring will be based on clear targets and objectives.
8. Establish long term monitoring and relationships with universities and other groups.
9. Improve the condition of endangered ecological communities and the quality and quantity of habitat for threatened species.

2. SHORT TO MEDIUM TERM GOALS

2.1. PROTECTING AND ENHANCING WETLAND VALUES

Ecosystem restoration requires an understanding of current ecosystem conditions, why and how degrading processes have occurred, factors that are impairing ecosystem recovery, how to remove those impairments and how to determine and measure restoration success (SER, 2004).

The following sections of this blueprint provide an analysis of how the wetlands of North Central Victoria have been degraded by past land and water management practices and details the ecological and cultural values that have survived these degrading processes. These threats and values are summarised in Table 3.

Table 3 Summary of values and threats in North Central Victorian wetlands

VALUES	THREATS
Threatened animal species including: • Australasian Bittern; • Australian Painted Snipe; • Migratory waders including Curlew, Wood and Marsh Sandpipers; • Growling Grass Frog; • Carpet Python; • Brolga; • Freckled Duck; • Magpie Goose; • Grey-crowned Babbler.	Altered hydrology
	Loss of living canopy trees
	Loss of habitat and plant species diversity caused by invasive species
	Feral animals
	Clearing of native vegetation
	Habitat fragmentation
	Salinisation
	Climate change
	Insufficient knowledge and baseline data
Colonial nesting water bird rookeries	Altered hydrology
	Loss of living canopy trees
	Salinisation
	Climate change
	Insufficient knowledge and baseline data
Threatened plant species and ecological communities including: • Stiff Groundsel; • Ridged Milfoil; • Seasonal Herbaceous Wetlands; • Intermittent Swampy Woodland; • Lignum Swampy Woodland.	Altered hydrology
	Loss of living canopy trees (some communities)
	Loss of habitat and plant species diversity caused by invasive species
	Feral animals
	Clearing of native vegetation
	Habitat fragmentation
	Eutrophication
	Salinisation
	Climate change
	Insufficient knowledge and baseline data

An analysis of threats and values was used as the basis for developing a set of short to medium term goals and range of potential projects. These projects and goals will be further refined through discussion with wetland stakeholders.

Table 4 summarises potential projects and the threatened species and other values they are designed to protect and enhance.

Note that the projects are categorised on their major emphasis and most projects incorporate aspects of several categories; for example, an integral part of revegetation projects is monitoring and adaptive management. More detail about the potential projects is provided in Section 5.

Over the next five years WRT aims to build knowledge about 10,000 hectares of wetland, improve vegetation condition through revegetation at 2,740 hectares of wetland, assist with monitoring and adaptive management at 795 hectares of wetland, restore hydrology at 241 hectares of wetland and control weeds at 170 hectares of wetland. The projects will be designed to have multiple benefits and can be grouped according to targeted outcomes; for example, projects designed to improve habitat quality for Australasian Bittern cover 2,339 hectares as well as projects to improve the management and condition of threatened EVCs cover 13,751 hectares.

Table 4 Summary of potential projects

Colour coded into project categories; **green** for revegetation, **blue** for restoring hydrology, **yellow** for knowledge building, **brown** for weed control and **orange** for monitoring and adaptive management.

WETLAND COMPLEX	PROJECT	PROJECT AREA (HA)	PROJECT TYPE	TIMING CONSTRAINTS	THREATENED SPECIES AND OTHER VALUES PROTECTED OR ENHANCED
Avoca River floodplain wetlands	Improving knowledge of the Bungaluke Wetlands	9,946	Knowledge building	None	Freckled Duck, Hardhead, Australasian Shoveler, Growling Grass Frog, Carpet Python, intact endangered Ecological Vegetation Classes (EVCs)
Kamarooka Wetlands	Restoring the natural hydrology of Kamarooka Wetlands that have been drained	100	Restoration of wetland hydrology	Greatest impact would occur if project was completed before the next natural flood event	Australasian Bittern, migratory waders, Ridged Water-milfoil, intact endangered EVCs
Corop Wetlands	Restoring the tree canopy of Gaynor Swamp	200	Revegetation	Revegetation should coincide with environmental water delivery or the recession of next natural flood	Colonial nesting waterbirds, restoration of threatened EVCs

WETLAND COMPLEX	PROJECT	PROJECT AREA (HA)	PROJECT TYPE	TIMING CONSTRAINTS	THREATENED SPECIES AND OTHER VALUES PROTECTED OR ENHANCED
Corop Wetlands	Monitoring and adaptively managing the transition of Greens Lake from a water storage back to a wetland reliant on natural catchment	795	Monitoring and adaptive management	Monitoring must begin as soon as possible to document changes as the water regime is altered	Brolga, Australasian Bittern, Australian Painted-snipe and migratory waders including the Curlew Sandpiper and Marsh Sandpiper, restoration of threatened EVCs
	Woody weed control at Greens Lake	170	Weed control	None	Endangered grassy woodlands and seasonal herbaceous wetlands
Kerang Wetlands	Continuing to improve vegetation diversity and tree canopy cover at Johnson Swamp	340	Revegetation and control of Common Reed and Cumbungi	Revegetation should coincide with environmental water delivery	Brolga, Australasian Bittern, Australian Painted-snipe, Freckled Duck, Magpie Goose and migratory waders, restoration of threatened EVCs
	Continuing to improve vegetation diversity and tree canopy cover at Hird Swamp	345	Revegetation and control of Common Reed and Cumbungi	Revegetation should coincide with environmental water delivery	Brolga, Australian Little Bittern, Australasian Bittern, Australian Painted-snipe, Freckled Duck, Magpie Goose and migratory waders, restoration of threatened EVCs
	Continuing to improve vegetation diversity and tree canopy cover at McDonald Swamp	164	Revegetation and control of Common Reed and Cumbungi	Revegetation should coincide with environmental water delivery	Brolga, Australasian Bittern and migratory waders, restoration of threatened EVCs
	Restoring hydrology, vegetation diversity and tree canopy cover at Red Gum Swamp	141	Restoration of wetland hydrology, revegetation	Revegetation should coincide with environmental water delivery	Brolga, Australasian Bittern and migratory waders, restoration of threatened EVCs
	Barapa Barapa Seed Bank	Not applicable	Required to enable other projects, capacity building	None, although summer is the optimal time for seed collection	

WETLAND COMPLEX	PROJECT	PROJECT AREA (HA)	PROJECT TYPE	TIMING CONSTRAINTS	THREATENED SPECIES AND OTHER VALUES PROTECTED OR ENHANCED
Kerang Wetlands *(continued)*	Restoration of Semi-arid Woodland on the lunette of Second Marsh, Koorangie State Game Reserve	20	Revegetation	Terrestrial revegetation should be planned for a period of above average rainfall associated with La Nina or negative Indian Ocean dipole climate patterns	Nationally endangered Buloke woodlands of the Riverina region
	Restoration of tree canopy at Third Marsh, Koorangie State Game Reserve	363	Revegetation	Revegetation should coincide with the recession of the next natural flood	Colonial nesting waterbirds, Freckled Duck, restoration of threatened EVCs
	Raising awareness of the significance of the Kerang Ramsar Wetlands site in the local community	9,419	Community engagement and education	None	
	Vegetation restoration at Third Reedy Lake	234	Revegetation	Revegetation should follow initial drying of the wetland in summer/autumn 2020	Australasian Bittern, Australian Painted Snipe, restoration of threatened EVCs
Lower Loddon Floodplain Wetlands	Wirra-Lo Wetlands Management Plan and Operating Manual	60	Knowledge building	None	Growling Grass Frog, Australasian Bittern, Brolga
	Continued restoration and management of Wirra-Lo Wetlands	60	Revegetation	Revegetation should coincide with environmental water delivery	Growling Grass Frog, Stiff Groundsel, Ridged Water-milfoil, restoration of threatened EVCs
	Restoration of tree canopy at Lake Murphy and improvement of habitat condition for Brolga and Australasian Bittern	168	Revegetation	Revegetation should coincide with environmental water delivery	Brolga, Australasian Bittern, Freckled Duck

WETLAND COMPLEX	PROJECT	PROJECT AREA (HA)	PROJECT TYPE	TIMING CONSTRAINTS	THREATENED SPECIES AND OTHER VALUES PROTECTED OR ENHANCED
Lower Loddon Floodplain Wetlands *(continued)*	Restoration of tree canopy cover and understorey diversity at Lake Boort	400	Revegetation	Revegetation should coincide with environmental water delivery or the recession of next natural flood	Colonial nesting waterbirds, Freckled Duck
	Vegetation restoration at Lake Lyndger	180	Revegetation	Revegetation should coincide with environmental water delivery or the recession of next natural flood	Colonial nesting waterbirds, Freckled Duck
	Vegetation restoration at Tragowel Swamp	125	Revegetation	Revegetation should coincide with the recession of the next natural flood	Colonial nesting waterbirds, Freckled Duck

2.2. PROVIDING ECOLOGICAL CONSULTING SERVICES

To further the aims of protecting and improving the management of wetlands, WRT will provide expert consulting services for ecological surveys, wetland condition assessments and monitoring, advice on ecological restoration and produce restoration management plans. It will also provide training in relevant disciplines including plant identification and ecological restoration techniques. Funds raised through provision of these services will be used by the trust to fund wetland purchase, restoration and management.

2.3. PURCHASING WETLANDS AT RISK

In Victoria, 98% of the wetlands that have been destroyed occurred on private land. Conservation of wetlands on private land is critical as this is where over 80% of remaining wetlands occur (DSE, 2012). WRT will seek to actively engage with landholders who own high value wetlands to improve their protection and management. When appropriate, WRT will seek funding and public donations to purchase high value wetlands to add them to the conservation estate.

2.4. INCREASING THE CARBON STORAGE CAPACITY OF WETLANDS

A key outcome of WRT projects will involve the restoration of large areas of tree canopy in wetlands where past land and water management has killed River Red Gum and Black Box trees.

In a study of the biodiversity and ecosystem services associated with remnant native vegetation in an agricultural floodplain landscape, carbon storage was measured or estimated for soils, woody vegetation, dead standing vegetation, coarse woody debris, herbaceous vegetation, litter and roots (Smith, 2010). River red gum sites were the most valuable vegetation type for carbon storage, having up to 4.5% carbon content in the surface 0–5 cm of the soil profile, with total site carbon storage averaging 216 t C ha^{-1}. Restoring River Red Gum cover in degraded wetlands has the potential to help absorb significant quantities of carbon pollution from the atmosphere. For example, the restoration of living Red Gums over 160 hectares at McDonalds Swamp near Koondrook could potentially absorb up to 35,000 tons of atmospheric carbon.

Goals of the WRT will include partnering with research institutions, such as the Deakin University Blue Carbon lab, to research how restoring wetlands may increase their carbon storage potential, plus exploring carbon sequestration as a potential source of funding for wetland restoration projects.

3. THREATS TO WETLANDS IN NORTH CENTRAL VICTORIA

3.1. ALTERED HYDROLOGY

Wetland hydrology has several components including the frequency with which a wetland floods, the depth to which it is inundated, the length of time the inundation lasts and the season when the inundation occurs. A change to any one of these components will have significant ecological consequences and altered hydrology is a major cause of decline in the condition of many wetlands.

Wetland hydrology can be altered by either decreasing or increasing the amount of water a wetland receives and can hold. Processes such as river regulation that prevent small to medium sized floods from reaching wetlands, the construction of levees that contain the spread of floodwaters and the digging of drains can all reduce the frequency, depth and length of time wetlands are inundated. The drier regime produced by these processes favours some species of terrestrial native plants and weeds, which invade wetlands.

These changes have negative impacts on wetland plants and animals, including reducing the frequency and amount of time they can grow and reproduce. This can ultimately lead to the local extinction of wetland species.

Processes such as the construction of weirs and channels and the movement of water for irrigated agriculture can increase the frequency, depth and duration of flooding in wetlands. They can change the seasonality of when they are wet, often causing more inundation in summer than would naturally occur. These changes can favour the growth of serious weeds, drown canopy trees and alter the composition of understory vegetation, including allowing the overabundance of dominating native plant species. These issues are discussed in more detail below.

3.2. LOSS OF LIVING CANOPY TREES

Many wetlands in North Central Victoria occur in areas where the landscape has been highly modified to support irrigated agriculture. In the past, wetlands in these areas were often used as basins to receive excess irrigation water, including what is known as rain rejection flows, or as part of irrigation infrastructure to move and store water. Consequently, these wetlands held water for extended periods of time, which drowned the canopy trees and changed the composition and structure of understorey vegetation (see Photograph 9).

▲ *Photograph 9* Example of a drowned River Red Gum dominated wetland, Third Reedy Lake near Kerang. The centre of this wetland has no live canopy trees and supports no submerged, floating or emergent aquatic plant species

Loss of canopy and understorey diversity has negative impacts on native fauna, as habitat structure is significantly altered, and patterns of nutrient cycling and productivity are disrupted.

Living River Red Gum, Black Box and Eumong trees play several critical ecological roles in the wetland habitats in which they occur. Hollows in these trees provide nesting sites for large numbers of ducks and parrots, and shelter for possums, bats and reptiles; in south-eastern Australia 17% of bird species, 42% of mammals and 28% of reptiles are hollow-dependent (Gibbons, 1997).

While some wetland birds will nest in dead trees, live trees are much more attractive to many species of birds for nesting. As well as providing platforms to build nests on, they afford shade for nestlings and support a diverse insect fauna, which can contribute to the diet of young birds (Rogers, 2011). Living River Red Gum, Black Box and Eumong trees also offer other important resources for fauna such as nectar, pollen and seeds. As they drop leaves, twigs and branches, these trees create leaf litter and logs, which are crucial for ground-dwelling fauna and provide carbon and other nutrients for the rest of the wetland.

While dead trees in wetlands can act as a very important habitat resource for roosting and nesting birds (see Photograph 11), they eventually rot and fall over so it is important to facilitate the recruitment of living trees that will ultimately take their place.

Loss of living canopy trees is a widespread issue in North Central Victoria. It is estimated that over 13,000 ha of wetland vegetation have been affected by the death of trees in this region. Projects have been initiated at the Avoca Marshes, Hird Swamp, Johnson Swamp, McDonalds Swamp, Tragowal Swamp, Lake Murphy, Lake Leaghur and Lake Boort to restore a living tree canopy to areas of these wetlands. As well as improving wildlife habitat structure and restoring ecosystem functions, such as nutrient cycling, the restoration of the tree canopies at these wetlands has enormous potential to sequester atmospheric carbon.

◀ *Photograph 10* Colonial nesting wetland birds, such as these Little Pied Cormorants, build their rookeries in live River Red Gums overhanging water

◀ *Photograph 11* Birds roosting in dead trees on dusk at Hird Swamp near Kerang

3.3. LOSS OF HABITAT AND PLANT SPECIES DIVERSITY CAUSED BY OVERABUNDANCE OF COMMON REED *(PHRAGMITES AUSTRALIS)*, CUMBUNGI *(TYPHA ORIENTALIS* AND *T. DOMINGENSIS)* AND TANGLED LIGNUM *(DUMA FLORULENTA)*

Common Reed, Cumbungi and Tangled Lignum are all indigenous wetland species that can be structurally important within wetland vegetation and provide habitat in the form of cover and nest sites and materials for wetland fauna, particularly birds. Threatened species such as Australasian Bittern and Australian Little Bittern nest in dense reed and rush beds, although these species also require open areas along the edges of reed beds as foraging habitat. Changes to environmental conditions such as the wetting and drying regime of wetlands has resulted in Common Reed, Cumbungi and Tangled Lignum becoming overabundant and forming dense, extensive thickets, which shade out other wetland vegetation types and reduce habitat quality and plant diversity.

For example, Common Reed and Cumbungi cover extensive areas of shallow wetlands (including Hird, Johnson and McDonald Swamps) that have historically been managed to be wetter than would have naturally occurred, particularly as inundation of the wetlands has taken place throughout the warmer months of the year. While the area of reed and rush beds in these wetlands has expanded, the area occupied by open water habitat or other structurally important plant species such as Swamp Wallaby-grass *(Amphibromus nervosus)*, Southern Cane Grass *(Eragrostis infecunda)*, Common Spike-sedge *(Eleocharis acuta)* and Water Ribbons (*Cycnogeton* species) has been reduced. This has limited the availability of nesting materials and food for threatened species including Brolga and Magpie Geese.

Managing wetting and drying cycles through the timing of the delivery of environmental water is one way to regulate and potentially control the growth of Common Reed, Cumbungi and Tangled Lignum as well as encourage the regeneration and growth of a diversity of other structurally important plant species. Other options for control may include slashing or burning the aerial parts of the plants just prior to inundating them with environmental water.

Barapa Barapa Traditional Owners have expressed an interest in trialling burning to reduce the overall cover of Common Reed and Cumbungi, thereby assisting in re-instating a mosaic of open areas amongst dense areas of reed and rush beds. This technique has been successfully used for managing Australasian Bittern habitat in south western Victoria (Birdlife, 2019).

3.4. ENVIRONMENTAL WEEDS

Environmental weeds have a devastating impact on native vegetation by outcompeting native plant species and altering the habitat structure of indigenous fauna. High threat terrestrial weeds that occur around many northern Victorian wetlands include African Boxthorn *(*Lycium ferocissimum)*, Peppercorn *(*Schinus molle)*, Desert Ash *(*Fraxinus angustifolia subsp. angustifolia)* and Horehound *(*Marrubium vulgare)*. These species can only be kept under control by ongoing management programs that include diligent monitoring, as they are so abundant and widespread on surrounding private land and roadsides that a constant source of seed allows re-infestation.

Wetland vegetation can be protected from weed invasion to some extent if natural wetting and drying cycles are maintained. While favouring the survival of indigenous wetland plants, alternating flooding and drying prevents many weed species from establishing or reduces their vigour. However, eutrophication (an increase in nutrient levels) can favour the establishment of certain high threat weed species including Pale Yellow Waterlily *(*Nymphaea mexicana)*, Parrot's Feather *(*Myriophyllum aquaticum)* and Water Couch *(*Paspalum distichum)*. These species are assisted by altered water regimes, which shorten or completely exclude drying cycles.

Wetland restoration planning requires a thorough understanding of the environmental weeds present at a site and surrounding areas; and of strategies to limit the growth of these weeds, while encouraging the recruitment and growth of indigenous species.

3.5. FERAL AND INTRODUCED GRAZING ANIMALS AND PREDATORS

Feral animals that impact the condition of North Central Victoria's wetlands include:

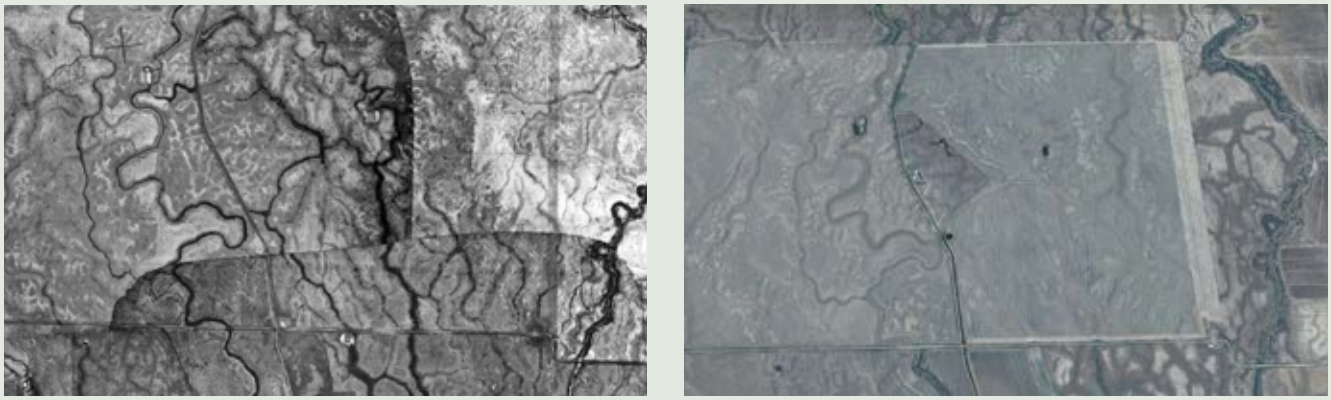
- European Carp, which increase turbidity and retard the growth of aquatic vegetation because of their soil-disturbing feeding method;
- Gambusia, which prey on tadpoles and compete with native fish;
- Feral pigs, which wallow and root around in the soft mud of wetlands causing significant soil disturbance;
- European Rabbits and Hares, which change the composition and structure of vegetation by selectively eating palatable herbaceous species and preventing the recruitment of trees and shrubs. These impacts along with severe soil disturbance can also occur when introduced grazing animals, including cattle, sheep and deer, have access to wetlands;
- Foxes and cats prey on a wide range of native fauna and have a significant impact on their populations. Predation by foxes is a significant cause of mortality of the young of many threatened species including Brolga (White, 1987) and Eastern Long-necked and Murray River Turtles (NSW NPWS, 2001).

Wetland restoration is reliant upon controlling the impacts of feral and introduced grazing animals. Successful methods of control include carp screens to prevent mature carp from entering wetlands when environmental water is being delivered; the use of guards or fenced plots to protect establishing plants from grazing pressure; baiting and ripping of warrens to control rabbits; baiting of foxes; and protecting individual turtle nests with mesh guards.

When conducting restoration works it is important to ensure the boundary fences around the wetland are stock-proof and neighbouring farmers are informed, so they can monitor their stock to ensure that they do not access the areas being restored.

Each wetland restoration project will have its own challenges when it comes to controlling the impacts of pest plants and animals. Restoration project managers must commit adequate resources to pest management, and ensure they record and report on what works, as well as attempt to develop innovative and cost-effective methods of control.

Photograph 12 The Red Fox *(Vulpes vuples)* is a significant predator of a wide range of threatened wetland species



Photograph 13 Area of the Loddon River floodplain between Serpentine Creek and Twelve Mile Creek that has been cleared of native vegetation over the last few decades. Note in the historic image on the left, floodways are prominent and extensive areas of Tangled Lignum are evident. In the contemporary image on the right, the vegetation has been cleared, the floodways are less obvious and cropping lines are evident

3.6. CLEARING OF NATIVE VEGETATION

Native vegetation clearing continues throughout Victoria despite the policies, legislation and incentives that exist to prevent this from happening. Clearing and cropping of native wetland vegetation has been particularly prevalent during recent dry periods, including the Millennium drought (see Photograph 13).

Many endangered wetland Ecological Vegetation Classes are poorly represented in the conservation reserve system, with some of the largest and most intact remaining examples existing on private land. To ensure the survival of these ecosystem types and the threatened fauna species they support, it is imperative that methods are found to protect them on private land.

3.7. FRAGMENTATION AND THE ASSOCIATED LOSS OF LANDSCAPE CONNECTIVITY

Many wetlands on the riverine plains occur, or formerly occurred, as chains or clusters across the landscape. The proximity of wetlands to one another, and their physical connection during times of flood, facilitates movement of animal and plant propagules (seed, spores, eggs) and nutrients, such as organic carbon, and provides the opportunity for animals to move as resources ebb and flow.

Isolating wetlands from each other and removing their interconnecting watercourses and floodplains limits the opportunity for exchange. They become less resilient with the species they support being vulnerable to genetic inbreeding and unable, or less likely, to recolonise if drought or other impacts makes them locally extinct.

Restoration activities should aim to increase the connectivity of wetlands, watercourses and floodplains across the landscape.

3.8. EUTROPHICATION

Eutrophication is an excessive richness of nutrients, such as nitrogen and phosphorus, in a body of water, frequently due to run-off from the land, which causes a dense growth of plant life, including algae and cyano-bacteria that may result in oxygen depletion.

The dense growth of floating aquatic plants such as *Azolla* and *Lemna* and some algal blooms that have occurred during environmental watering events are likely to have been caused by eutrophication. Wetlands affected by eutrophication are also likely to suffer from vigorous growth of terrestrial weeds as they dry out.

A potential source of eutrophication in wetlands that receive environmental water are dairies, piggeries and other forms of intensive animal production. They act as point sources of nutrients if untreated run-off from them enters the channel system from which environmental water is delivered.

As agricultural lands surround almost all the North Central Victorian wetlands, they are prone to receiving nutrient-rich agricultural run-off. Maintaining or establishing buffers of terrestrial native vegetation around wetlands provides a means of intercepting nutrient-rich run-off.

3.9. SALINISATION

An increase in the concentration of salts in the surface layers of soil has occurred around many wetlands in North Central Victoria. Salt is transported to the surface layers of soil from deeper in the soil profile by an increase in the height of the groundwater table in a process known as salinisation, with wetlands being significantly affected as they generally occur in the lower parts of the landscape where the groundwater table is closest to the surface. Increasing the salinity of a wetland has significant effects on wetland plants and animals; if salinity levels become too high it will kill freshwater species and they may be replaced by more salt tolerant species (ANZECC, 2001).

Sources of water that increase the height of the groundwater table can be either local or from many kilometres away. Application of excessive amounts of irrigation water to surrounding farmland (termed irrigation salinity) is a local example. Clearing of native vegetation from catchments can have a wide impact, reducing evapotranspiration rates and increasing the amount of water that enters the shallow groundwater aquifer, which then discharges at the ground surface further down the catchment (termed dryland salinity).

With the development of more efficient irrigation practices, the effects of irrigation salinity have been substantially reduced. Moreover, successive recent periods of low rainfall, including the Millennium drought, have led to a decrease in both irrigation and dryland salinity. Revegetation of recharge areas in upper catchments is important for reducing the risk of dryland salinity from impacting on wetlands during future prolonged periods of above average rainfall.

3.10. CLIMATE CHANGE

Wetlands are the most vulnerable ecosystems to climate change in Victoria (Jin, 2009). Predicted changes to temperature, rainfall and the severity and frequency of extreme weather events, such as prolonged droughts, will have catastrophic impacts on wetland ecosystems. Climate change will exacerbate many of the threats listed above, including loss of habitat, altered hydrological regimes and invasive species.

Wetland restoration activities, including the delivery of environmental water, have the potential to reduce the severity of some of the impacts of climate change and make wetlands more resilient. Careful planning and excellent communication across the whole community is essential for maximising the impact of environmental watering and other restoration activities. It will ensure the community understands and supports these actions.

3.11. INSUFFICIENT KNOWLEDGE AND BASELINE DATA

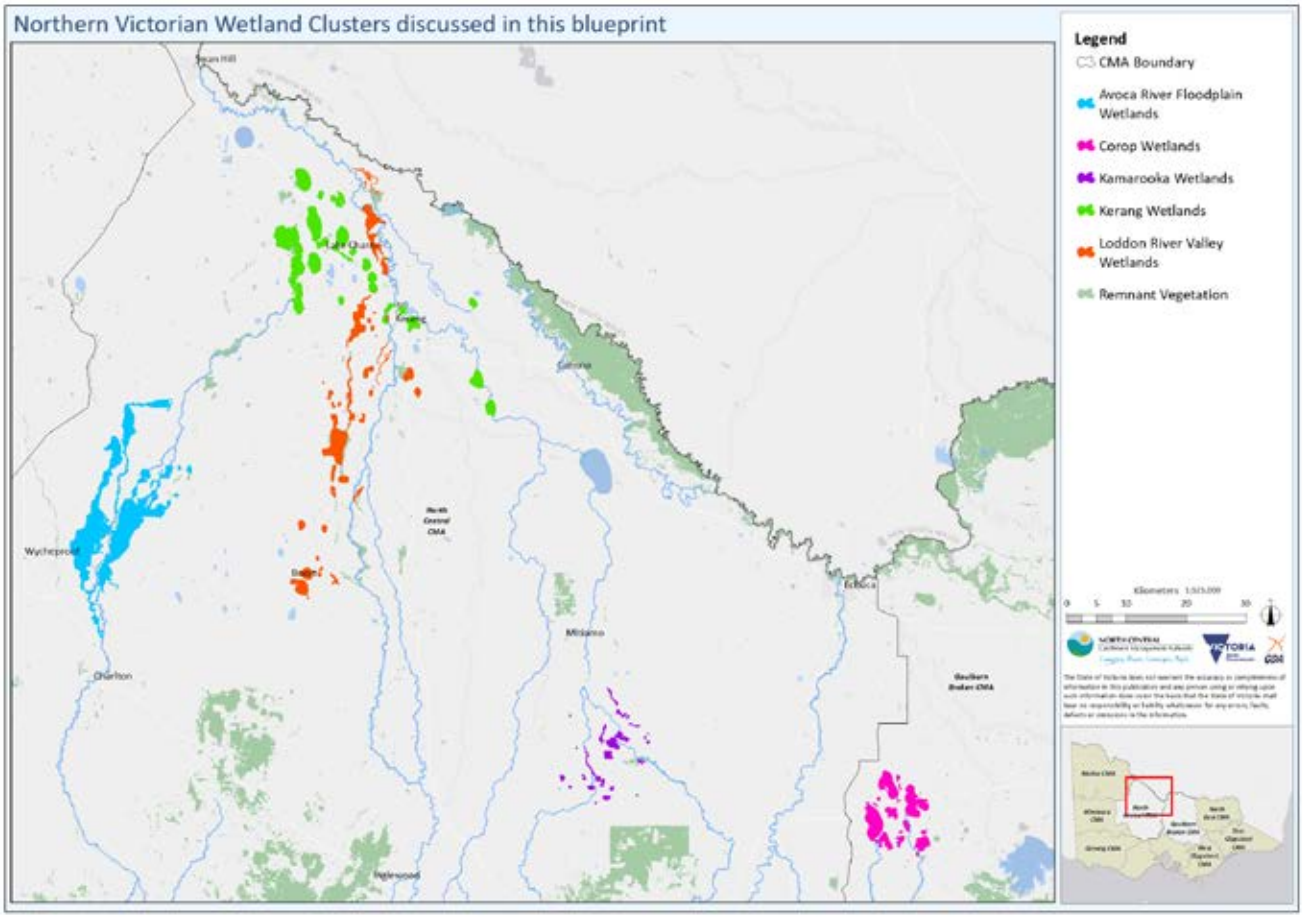
Knowledge of the distribution of wetland values, such as threatened species and communities and baseline data of their condition, are critical to inform restoration and management actions. Without this knowledge and baseline data, it is not possible to know where to direct resources or whether the condition of values is improving or declining.

Wetland values that are poorly known in North Central Victoria include the distribution and condition of the nationally endangered Seasonal Herbaceous Wetland community (see Photograph 14), the composition and condition of the Bunguluke Wetlands and the distribution and size of populations of threatened species including the Carpet Python and Growling Grass Frog.

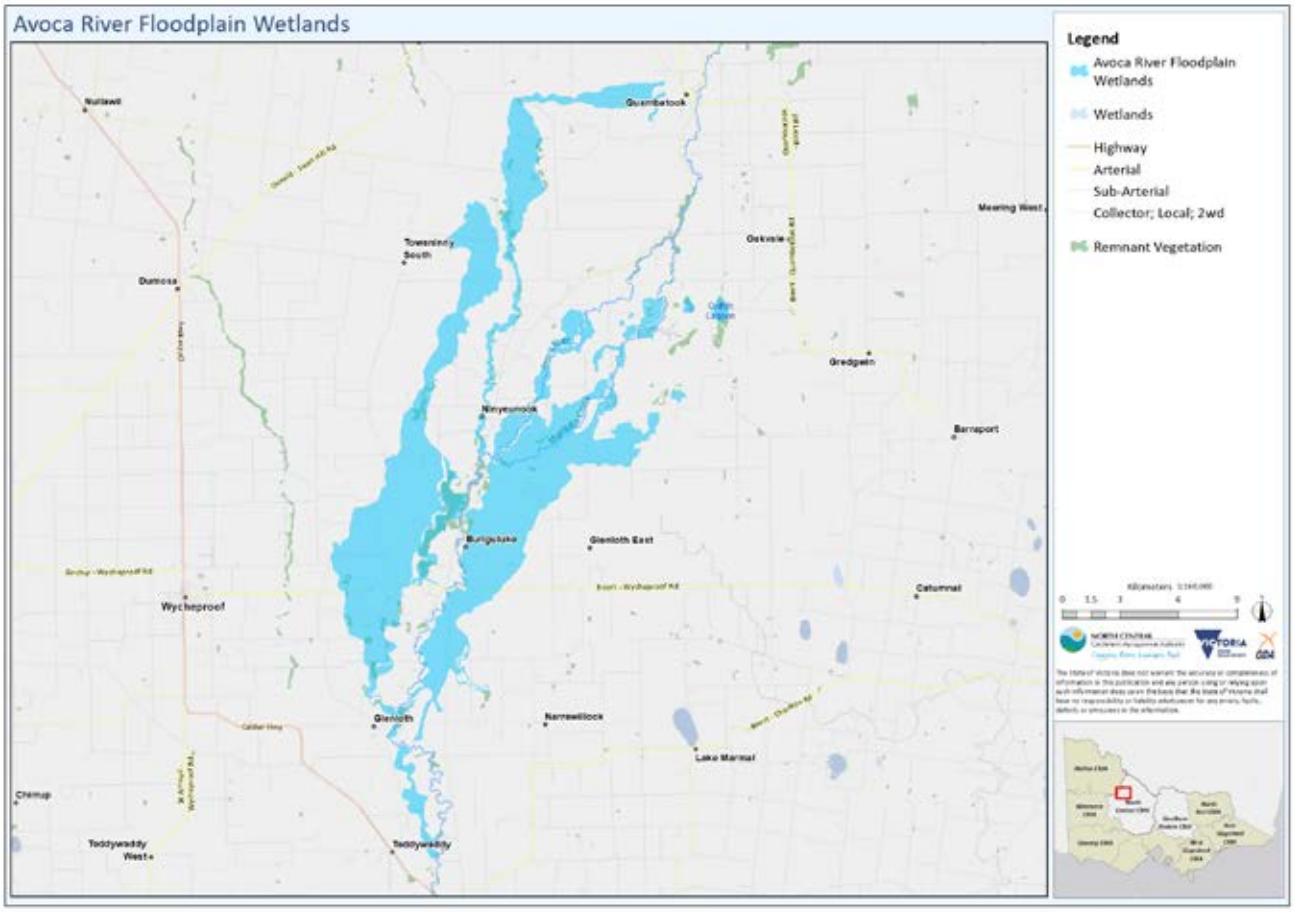
Photograph 14 Knowledge of the distribution and condition of Seasonal Herbaceous Wetlands on the riverine plains of North Central Victoria is very poor

4. ECOLOGICAL AND CULTURAL VALUES OF SELECTED WETLAND CLUSTERS

Clusters of significant wetlands in North Central Victoria that will be the initial focus of the Wetland Revival Trust's projects, include the Avoca River floodplain wetlands from Glenloth to Griffith Lagoon (including Bunguluke Wetlands), the Kerang Wetlands, wetlands along the Loddon River valley from Lake Boort in the south to Benjeroop in the north, the Kamarooka Wetlands and the Corop Wetlands (see Map 2). The ecological & cultural characteristics and values of these wetland clusters are discussed below.



Map 2 Location of wetland clusters



Map 3 Location of Avoca floodplain wetlands

4.1. AVOCA RIVER FLOODPLAIN WETLANDS FROM GLENLOTH TO GRIFFITH LAGOON (INCLUDING BUNGULUKE WETLANDS)

The Avoca River floodplain wetlands occur in a landscape where the surrounding land use is predominantly dryland farming. The tree canopy of most of these wetlands supports many very large, old healthy trees (see Photograph 15). This is in stark contrast to many of the wetlands that occur further to the east that are surrounded by irrigated agriculture, where trees have been killed over large areas by prolonged inundation or waterlogging and salinisation.

The Bunguluke Wetlands cover an area of about 9,946 hectares on private land approximately 10 km east of Wycheproof, on the traditional lands of the Barapa Barapa people. These wetlands are a complex of River Red Gum, Black Box and Tangled Lignum dominated swamps and treeless freshwater meadows.

▲
Photograph 15 Heathy veteran River Red Gums *(Eucalyptus camaldulensis)* in the Bunguluke Wetlands

The Bunguluke Wetlands are listed in the Directory of Important Wetlands in Australia (ANCA 1993). They have been known to support breeding Freckled Duck *(Stictonetta naevosa)*, a species for which there are very few breeding records in Victoria. Following the 2016 floods, colonial nesting birds including Little Pied Cormorants *(Microcarbo melanoleucos)* and White-necked Herons *(Ardea pacifica)* were observed breeding there (Cook, 2017).

Griffith Lagoon is another very significant wetland that forms part of this complex. Apart from areas of river frontage along the Avoca River and Mosquito Creek, it is the only significant area of public land in the complex. Being a Nature Conservation Reserve, it is one of very few wetlands in northern Victoria where duck hunting is not permitted. When inundated, it provides breeding habitat for a diverse range of wetland birds including White-necked Heron, Dusky Moorhen, Hardhead, Pink-eared Duck, Grey Teal, Australasian Shoveler, Eurasian Coot, Australasian Grebe and Hoary-headed Grebe.

▲ *Photograph 16* Griffith Lagoon supports many large old Black Box *(Eucalyptus largiflorens)* and is an important water bird breeding habitat

▶ *Photograph 17* White-necked Heron nestlings at Griffiths Lagoon following the 2016 floods

These areas have not been thoroughly surveyed for flora and fauna or cultural sites, and no detailed vegetation mapping or wetland condition assessments have been conducted. Threatened fauna for which this area is likely to be important include Carpet Python, Growling Grass Frog and Freckled Duck (see Table 5).

Preliminary investigations indicate that the wetlands in this region support intact examples of threatened Ecological Vegetation Classes (EVCs) including Lake Bed Herbland, Black Box Wetland and Lignum Swampy Woodland (see Table 6); and they contain many sites of cultural significance including Aboriginal oven mounds, scar trees and artefact scatters (see Photograph 18).

This area may also support examples of the nationally endangered, EPBC Act listed "Seasonal Herbaceous Wetland" community in this region, although field surveys following a wet period are required to confirm this.

Photograph 18 Aboriginal scar tree at Griffith Lagoon

Table 5 Threatened fauna recorded in the mid-Avoca floodplain wetlands (note that definitions of conservation status codes are found in Appendix 1)

COMMON NAME	SPECIES	EPBCA	FFG	DELWP
Australasian Shoveler	*Spatula rhynchotis*			vu
Brown Treecreeper	*Climacteris picumnus*			nt
Bush Stone-curlew	*Burhinus grallarius*		L	en
Carpet Python	*Morelia spilota metcalfei*		L	en
Diamond Dove	*Geopelia cuneata*		L	nt
Great Egret	*Ardea alba*		L	vu
Freckled Duck	*Stictonetta naevosa*		L	en
Grey-crowned Babbler	*Pomatostomus temporalis*		L	en
Ground Cuckoo-shrike	*Coracina maxima*			vu
Growling Grass Frog	*Litoria raniformis*	VU	L	en
Hardhead	*Aythya australis*			vu
Latham's Snipe	*Gallinago hardwickii*			nt
Nankeen Night Heron	*Nycticorax caledonicus*			nt
Royal Spoonbill	*Platalea regia*			nt
Spotted Harrier	*Circus assimilis*			nt
White-bellied Sea Eagle	*Haliaeetus leucogaster*		L	vu

Table 6 Bioregional Conservation Status of EVCS in the mid-Avoca floodplain wetlands

ECOLOGICAL VEGETATION CLASS	EVC#	BIOREGIONAL CONSERVATION STATUS
Aquatic Herbland	653	Endangered
Black Box Wetland	369	Endangered
Grassy Riverine Forest/Riverine Swamp Forest Complex	812	Depleted
Intermittent Swampy Woodland	813	Endangered
Lake Bed Herbland	107	Depleted
Lignum Swamp	104	Vulnerable
Lignum Swampy Woodland	823	Vulnerable
Riverine Swampy Woodland	815	Vulnerable

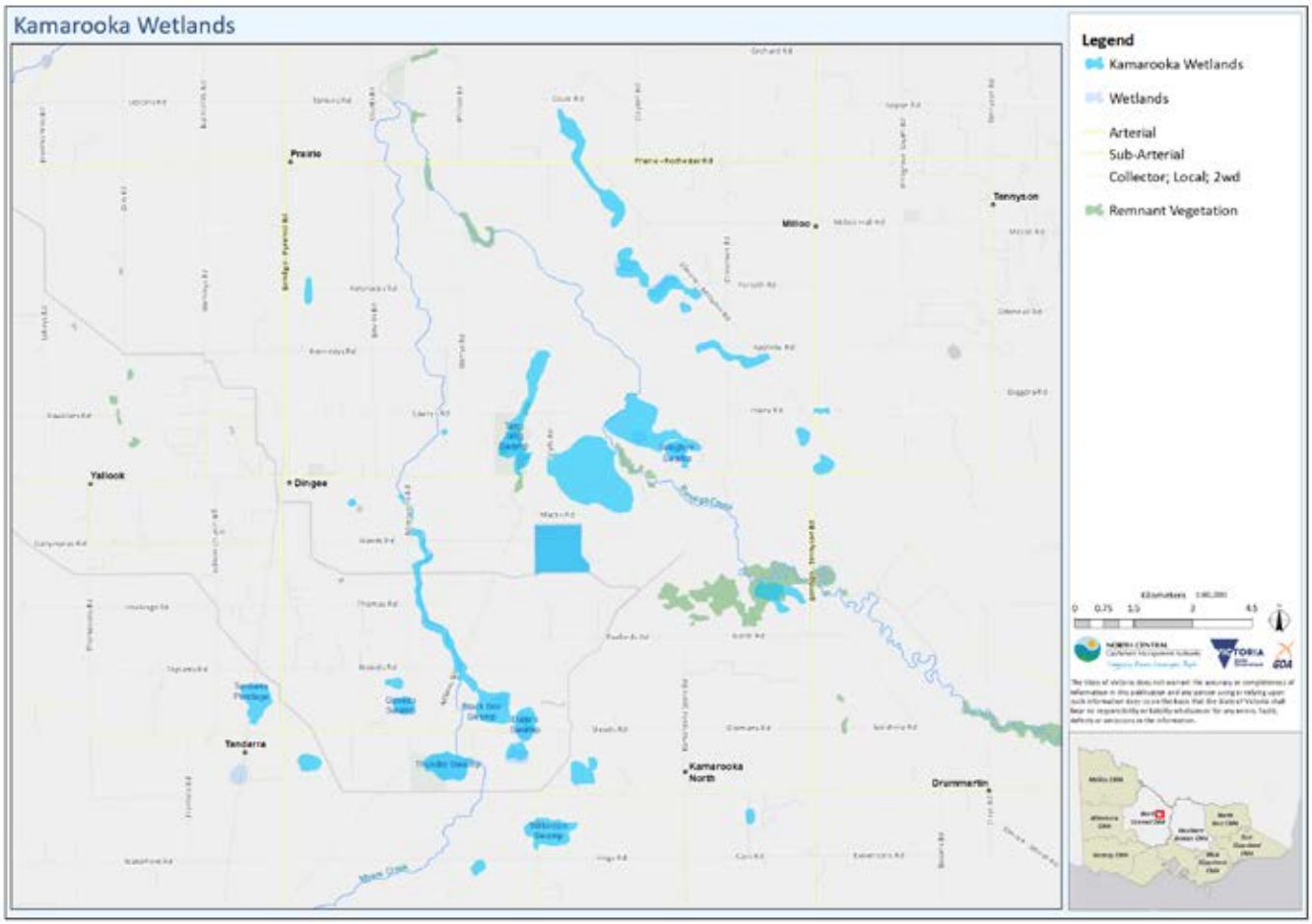
4.2. KAMAROOKA WETLANDS

The Kamarooka Wetlands are a complex of River Red Gum and Black Box dominated swamps and seasonal grassy wetlands located on both public and private land. The occurrence of Black Box *(Eucalyptus largiflorens)* in these wetlands is biogeographically significant as these populations are at the south-eastern limit of the distribution of this species. Black Box dominated vegetation in this wetland cluster is mostly restricted to remnants on private land.

The grassy wetlands that form part of this complex are examples of the nationally endangered EPBC Act listed "Seasonal Herbaceous Wetland" community. All the EVCs occurring in this wetland complex are either vulnerable or endangered (see Table 8).

The largest wetlands on public land in this cluster occur in Tang Tang Swamp and Thunder Swamp Wildlife Reserves. Tang Tang Swamp supports a diversity of vegetation types including treeless areas dominated by Swamp Wallaby-grass (see Photograph 19) and Southern Cane Grass, and Red Gum Swamp dominated by very large old trees. Many of the trees within the wetland are in good health, however some are in poor condition, with some dead trees present indicating changes in hydrology are impacting the area as a result of increased run-off from the upstream catchment.

Map 4 Location of Kamarooka Wetlands



▲ *Photograph 19* Deepest treeless area of Tang Tang Swamp

Thunder Swamp is a large seasonal herbaceous wetland. The western half of this wetland occurs within a Wildlife Reserve, while the eastern half is on private land. Vegetation in the Wildlife Reserve supports relatively intact examples of endangered EVCs with high floristic diversity including threatened plant species such as Western Bitter-cress *(Cardamine lineariloba)*. Brolga have been recorded breeding at both Tang Tang and Thunder Swamps and the entire Kamarooka wetland complex provides important habitat for this species. The complex is also known to support a diversity of other threatened wetland birds including Australasian Bittern, Musk Duck and several migratory waders (see Table 7).

Table 7 **Threatened fauna recorded in the Kamarooka wetlands**

COMMON NAME	SPECIES	EPBCA	FFG	DELWP
Australasian Bittern	*Botaurus poiciloptilus*	EN	L	en
Australasian Shoveler	*Spatula rhynchotis*			vu
Baillon's Crake	*Porzana pusilla*		L	vu
Black Falcon	*Falco subniger*			vu
Brolga	*Grus rubicunda*		L	vu
Brown Treecreeper	*Climacteris picumnus*			nt
Caspian Tern	*Hydroprogne caspia*		L	nt
Common Greenshank	*Tringa nebularia*			vu
Diamond Firetail	*Stagonopleura guttata*		L	nt
Fat-tailed Dunnart	*Sminthopsis crassicaudata*			nt
Freckled Duck	*Stictonetta naevosa*		L	en
Glossy Ibis	*Plegadis falcinellus*			nt
Great Egret	*Ardea alba*		L	vu
Grey-crowned Babbler	*Pomatostomus temporalis*		L	en
Hardhead	*Aythya australis*			vu
Latham's Snipe	*Gallinago hardwickii*			nt
Little Button-quail	*Turnix velox*			nt
Musk Duck	*Biziura lobata*			vu
Nankeen Night Heron	*Nycticorax caledonicus*			nt
Pied Cormorant	*Phalacrocorax varius*			nt
Plumed Egret	*Ardea plumifera*		L	en
Royal Spoonbill	*Platalea regia*			nt
Striped Legless Lizard	*Delma impar*	VU	L	en
Swift Parrot	*Lathamus discolor*	CR	L	en
Whiskered Tern	*Chlidonias hybridus*			nt
Wood Sandpiper	*Tringa glareola*			vu

Threatened EVCs that occur on private land in the Kamarooka Wetland complex include Plains Grassy Wetland, Black Box Wetland and Riverine Swampy Woodland (see Table 8). Some of these EVCs are relatively intact and support threatened plant species including the nationally vulnerable Ridged Water-milfoil *(Myriophyllum porcatum)*. Sites of cultural significance observed on private land in the complex include Aboriginal oven mounds and scar trees.

Photograph 20 Brolga at Tang Tang Swamp

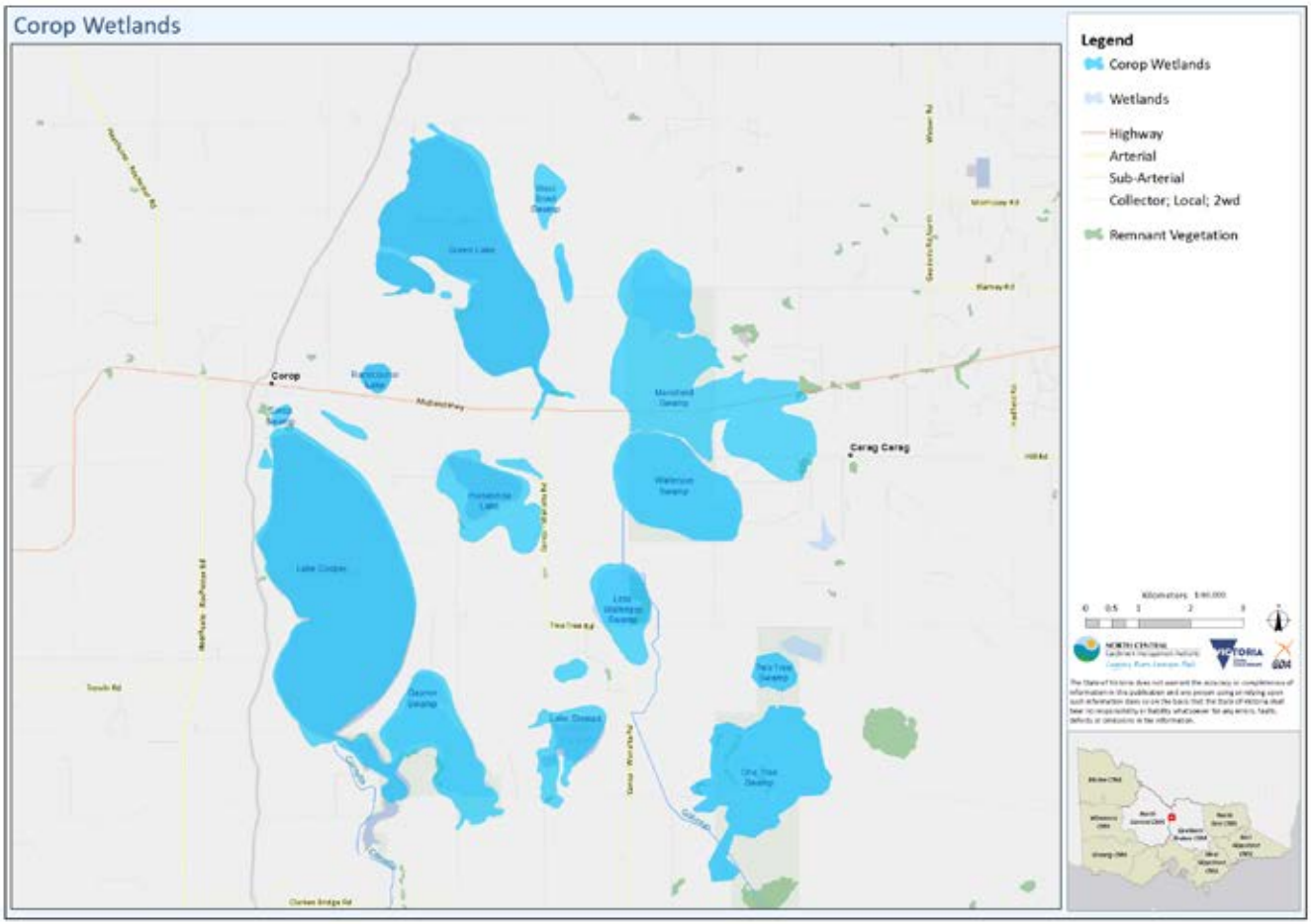
Table 8 Bioregional Conservation Status of EVCS in the Kamarooka wetlands

ECOLOGICAL VEGETATION CLASS	EVC#	BIOREGIONAL CONSERVATION STATUS
Aquatic Herbland	653	Endangered
Black Box Wetland	369	Endangered
Cane Grass Wetland	291	Vulnerable
Plains Grassy Wetland	125	Endangered
Plains Grassy Wetland / Lignum Swamp Complex	A101	Endangered
Red Gum Swamp	292	Vulnerable
Red Gum Swamp/Cane Grass Wetland Complex	A114	Endangered
Riverine Swampy Woodland	815	Vulnerable
Spike-sedge Wetland	819	Endangered

4.3. COROP WETLANDS

The Corop Wetlands are a diverse complex including Lake Cooper, which is a large episodically flooded brackish lake; Greens Lake, which is a large freshwater lake that has been used in the past as an irrigation storage but is being returned to a wetland reliant on catchment inflows; Gaynor, Wallenjoe and Mansfield Swamps, which are large River Red Gum Swamps; One and Two Tree Swamps, which are large grassy wetlands; Horsehoe Swamp, which is an episodic fresh water lake; and many other smaller wetlands that range from fresh to saline. Vegetation condition within this complex is not well documented, although areas of Greens Lake and One and Two Tree Swamps have been assessed as being in good to excellent condition.

Map 5 Location of Corop Wetlands



A very high diversity of fauna has been recorded at the Corop Wetlands, including 38 threatened species (see Table 9). Brolga have been frequently recorded breeding in this wetland complex, with recent breeding events occurring at Greens Lake and One Tree Swamp. Several of the Corop Wetlands, including Greens Lake, Gaynor Swamp and a wetland on private land north of Two Tree Swamp, are important Brolga flocking sites where the species congregates in autumn, with the largest group of 35 birds being recorded in March 2019 (see Photograph 22).

The complex also provides important habitat for the Australasian Bittern. Historically, Australasian Bitterns were "an exceptionally common bird on the open tussocky swamps around Corop. Scores of these can be seen and heard on the One-Tree swamp, where there is ample cover to allow them to breed freely" (Bright, 1932).

There are collections of the eggs of Australasian Bittern in the Museum of Victoria from Lake Cooper in 1940 and Gaynor Swamp in 1975 (Atlas of Living Australia, 2018). The most recent record of breeding behaviour of Australasian Bitterns in the Corop area was at One and Two Tree Swamps in the year 2000 (Matt Herring, Murray Wildlife, pers. comm. 2018).

The nationally endangered Australian Painted Snipe has been regularly observed in the Corop Wetlands, with breeding recorded at Two Tree Swamp in 2011 and an individual observed there in early 2018. Mud flats develop at the larger wetlands as they dry out, attracting a diversity of endangered migratory waders including the Curlew Sandpiper, Marsh Sandpiper and Common Greenshank.

Photograph 21 Cane Grass Wetland/ Aquatic Herbland Complex at Greens Lake

Photograph 22 Part of a large flock of Brolga observed at Greens Lake, March 2019

Table 9 **Threatened fauna recorded in the Corop wetlands**

COMMON NAME	SPECIES	EPBCA	FFG	DELWP
Australasian Bittern	*Botaurus poiciloptilus*	EN	L	en
Australasian Shoveler	*Spatula rhynchotis*			vu
Australian Little Bittern	*Ixobrychus dubius*		L	en
Australian Painted Snipe	*Rostratula australis*	EN	L	cr
Australian Pratincole	*Stiltia isabella*			nt
Azure Kingfisher	*Alcedo azurea*			nt
Baillon's Crake	*Porzana pusilla*		L	vu
Black Falcon	*Falco subniger*			vu
Blue-billed Duck	*Oxyura australis*		L	en
Brolga	*Grus rubicunda*		L	vu
Brown Treecreeper	*Climacteris picumnus*			nt
Bush Stone-curlew	*Burhinus grallarius*		L	en
Caspian Tern	*Hydroprogne caspia*		L	nt
Common Greenshank	*Tringa nebularia*			vu
Common Sandpiper	*Actitis hypoleucos*			vu
Curlew Sandpiper	*Calidris ferruginea*	CR		en
Diamond Firetail	*Stagonopleura guttata*		L	nt
Flat-headed Galaxias	*Galaxias rostratus*	CR	X	vu
Freckled Duck	*Stictonetta naevosa*		L	en
Glossy Ibis	*Plegadis falcinellus*			nt
Great Egret	*Ardea alba*		L	vu
Grey-crowned Babbler	*Pomatostomus temporalis*		L	en
Growling Grass Frog	*Litoria raniformis*	VU	L	en
Gull-billed Tern	*Gelochelidon nilotica macrotarsa*		L	en
Hardhead	*Aythya australis*			vu
Latham's Snipe	*Gallinago hardwickii*			nt
Little Egret	*Egretta garzetta*		L	en
Marsh Sandpiper	*Tringa stagnatilis*			vu
Musk Duck	*Biziura lobata*			vu
Nankeen Night Heron	*Nycticorax caledonicus*			nt
Pectoral Sandpiper	*Calidris melanotos*			nt
Pied Cormorant	*Phalacrocorax varius*			nt
Plumed Egret	*Ardea plumifera*		L	en
Royal Spoonbill	*Platalea regia*			nt
Spotted Harrier	*Circus assimilis*			nt
Whiskered Tern	*Chlidonias hybridus*			nt
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		L	vu
Woodland Blind Snake	*Anilios proximus*			nt

The variation of wetland types around Corop, including from large and deep to small and shallow, and with salinities ranging from fresh to saline, supports a high diversity of wetland EVCs, many of which are endangered or vulnerable (see Table 10). Three of the wetlands in the Corop complex support the largest of the few surviving populations of the nationally endangered Stiff Groundsel *(Senecio behrianus)*.

Table 10 Bioregional Conservation Status of EVCS in the Corop wetlands

ECOLOGICAL VEGETATION CLASS	EVC#	BIOREGIONAL CONSERVATION STATUS
Alluvial Plains Semi-arid Grassland	806	Endangered
Aquatic Herbland	653	Endangered
Brackish Aquatic Herbland	537	Vulnerable
Brackish Lake Bed Herbland	539	Vulnerable
Cane Grass Wetland	291	Vulnerable
Cane Grass Wetland/Aquatic Herbland Complex	602	Vulnerable
Intermittent Swampy Woodland	813	Endangered
Plains Grassy Wetland	125	Endangered
Plains Grassy Wetland / Lignum Swamp Complex	A101	Endangered
Red Gum Swamp	292	Vulnerable
Red Gum Swamp/Cane Grass Wetland Complex	A114	Endangered
Saline Aquatic Meadow	842	Rare
Samphire Shrubland	101	Depleted
Spike-sedge Wetland	819	Endangered
Tall Marsh	821	Depleted

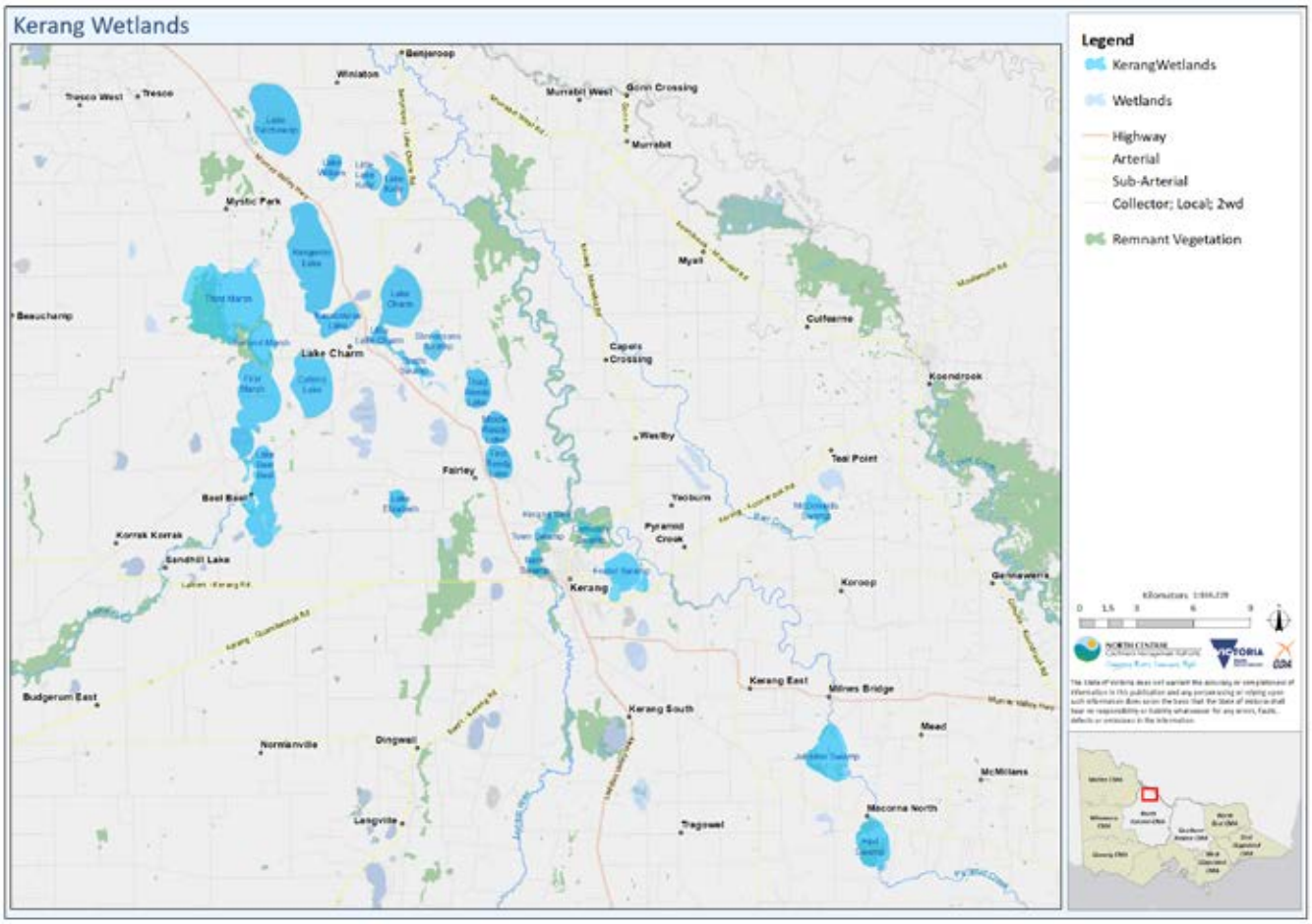
4.4. KERANG WETLANDS, INCLUDING THE RAMSAR SITE, MCDONALDS SWAMP AND OTHER HIGH VALUE WETLANDS

This wetland complex includes the 23 wetlands that make up the Kerang Wetlands Ramsar Site (recognised as internationally significant for conservation of wetland birds) and other ecologically important wetlands within a 25-kilometre radius of the township of Kerang, including Lake Elizabeth and McDonalds Swamp. These wetlands support a diverse range of habitats, from fresh, brackish and saline lakes that support submerged aquatic vegetation to swamps dominated by River Red Gum, Black Box and Lignum, as well as shallow meadows dominated by sedges, grasses and other herbs.

These wetlands occur within a heavily cleared landscape that is mostly utilised for broad-acre cropping, grazing and irrigated agriculture. They can be grouped according to how to their hydrology has been affected by water management practices, with categories including regulated freshwater permanent wetlands, regulated intermittent wetlands, salt/sewage disposal and drainage wetlands, and unregulated freshwater intermittent wetlands.

Wetlands, such as Kangaroo Lake and the Reedy Lakes system, are used as storages and conduits for irrigation water and as a result they are artificially, permanently full. The extent to which irrigation has altered the hydrology from its natural state has led to the vegetation within these wetlands being mostly in very poor condition.

Map 6 Location of Kerang Wetlands



The hydrology of regulated intermittent wetlands, which includes Lake Cullen and Hird, Johnson and McDonalds Swamps, is determined by the delivery of environmental water. Water delivery to these wetlands is now designed to mimic the natural wetting and drying cycles that support highly productive wetland systems. However, the legacy of past altered hydrology has meant the vegetation at Hird, Johnson and McDonalds Swamps is in very poor condition because of the loss of canopy trees and alteration of vegetation structure and composition. With a more natural hydrological regime now in place, conditions are suitable for ecological restoration activities complementary to the delivery of environmental water, such as restoring tree cover and vegetation diversity.

Wetlands such as Lake Tutchewop and Lake Kelly are used as basins for the disposal of saline water. While not kept permanently full, their hydrology is still dominated by artificial inputs and their condition varies from good to poor depending on whether they were naturally saline prior to being used for salt disposal.

The last group of wetlands within this complex are intermittent and unregulated and includes the Koorangie Marshes and Cemetery and Stevensons Swamps. The vegetation quality within this group ranges from very poor to good depending on how severely they were affected by salinisation and other effects of historic water and land mismanagement.

Cycles of wetting and drying can prove exceptionally productive for wetland birds within the Kerang complex wetlands, including the unregulated wetlands, those receiving environmental water and those used for salt disposal. For example, after the 2016 floods Lake Bael Bael supported nearly 40,000 wetland birds with 38 species being observed during a single count, including over 1,500 individuals of the threatened Freckled Duck *(Stictonetta naevosa)* – see Photograph 23.

Large numbers of wetland birds bred at Lake Bael Bael and the Koorangie Marshes following the 2016 floods including Australasian Darter, Little Pied Cormorant, Black Swan, Pacific Black Duck, Grey Teal and White-bellied Sea Eagle. Historically, the productivity of the Koorangie Marshes supported large gatherings

Photograph 23 The Kerang Wetlands complex provides important habitat for the threatened Freckled Duck *(Stictonetta naevosa)*

Photograph 24 Australasian Bittern, Lake Cullen

of Aboriginal people, and there is at these wetlands a very high density of culturally important sites, such as scar trees, oven mounds and artefact scatters.

After receiving deliveries of environmental water in 2017 with top ups in 2018, Lake Cullen has regularly supported over 20,000 wetland birds, with 51 species being observed during a single count. Reed beds at the northern end of Lake Cullen provide important habitat for the Australasian Bittern, which have gathered there in significant numbers over the past few years in autumn. The shallows of the lake are important feeding habitat for Brolga.

Other significant sites for Brolga where breeding has recently been recorded within the Kerang wetland complex include Hird and Johnson Swamps and Lake Murphy. Hird, Johnson and McDonalds Swamps are all Brolga flocking sites, where gatherings of up to 13 birds have been observed in autumn. Hird and Johnson Swamps are also important sites for Australasian Bittern and Australian Little Bittern, where both species have been observed breeding. Significant numbers of waterfowl breed when conditions are suitable at Hird, Johnson and McDonalds Swamps, including Black Swan, Australian Shelduck, Grey Teal, Pacific Black Duck and Pink-eared Duck. The vulnerable White-bellied Sea Eagle has also been observed breeding at Hird Swamp.

Species of fauna regarded as culturally significant by Barapa Barapa people in this region include the White-bellied Sea Eagle, Brolga, Magpie Goose and Eastern Long-necked Turtle.

While the regulated freshwater permanent wetlands that form part of the Kerang Ramsar site are generally not as productive as the other wetland types in this complex, they do provide a drought refuge function. Their permanence also ensures important habitat for Rakali, some species of turtles and native fish. The availability of fish from the deep-water habitat means these wetlands provide important feeding grounds for fish-eating birds, such as the Australasian Darter, Terns and Cormorants.

The Reedy Lake system is significant for the breeding rookeries of Straw-necked and Australian White Ibis, Australasian Darters, Cormorants and Royal Spoonbills it supports. The use of these wetlands as part of the supply system for irrigation water severely limits the potential for restoring important ecosystem functions within them. However, Third Reedy Lake is likely to be returned to a wetting and drying wetland, which provides an excellent opportunity to restore the vegetation and ecosystems functions of this wetland.

Ninety-seven threatened fauna species have been recorded in the Kerang Wetlands cluster. A full list of the threatened fauna found in this region is provided in Appendix 2. Only nationally endangered wetlands species and those associated with Red Gum forests or woodlands (for example Superb and Regent Parrot) are listed in Table 11.

Photograph 25 Australian Little Bittern, Johnson Swamp

Table 11 Nationally threatened fauna recorded in the Kerang wetlands

COMMON NAME	SPECIES	EPBCA	FFG	DELWP
Australasian Bittern	*Botaurus poiciloptilus*	EN	L	en
Australian Painted Snipe	*Rostratula australis*	EN	L	cr
Curlew Sandpiper	*Calidris ferruginea*	CR		en
Eastern Curlew	*Numenius madagascariensis*	CR		vu
Flat-headed Galaxias	*Galaxias rostratus*	CR	X	vu
Great Knot	*Calidris tenuirostris*	CR	L	en
Greater Sand Plover	*Charadrius leschenaultii*	VU		cr
Growling Grass Frog[1]	*Litoria raniformis*	VU	L	en
Macquarie Perch	*Macquaria australasica*	EN	L	en
Murray Cod	*Maccullochella peelii*	VU	L	vu
Murray Hardyhead	*Craterocephalus fluviatilis*	EN	L	cr
Red Knot	*Calidris canutus*	EN		en
Regent Parrot	*Polytelis anthopeplus*	VU	L	vu
Silver Perch	*Bidyanus bidyanus*	CR	L	vu
Superb Parrot	*Polytelis swainsonii*	VU	L	en

[1] Note that there have been no records of the Growling Grass Frog in the Kerang Wetlands Ramsar site since the 1990s.

Table 12 Bioregional Conservation Status of EVCS in the Kerang wetlands

ECOLOGICAL VEGETATION CLASS	EVC#	BIOREGIONAL CONSERVATION STATUS
Alluvial Plains Semi-arid Grassland	806	Endangered
Aquatic Herbland	653	Endangered
Brackish Aquatic Herbland	537	Vulnerable
Brackish Lake Bed Herbland	539	Vulnerable
Intermittent Swampy Woodland	813	Endangered
Intermittent Swampy Woodland/Lake Bed Herbland Complex	A119	Endangered
Lake Bed Herbland	107	Depleted
Lignum Shrubland	808	Vulnerable
Lignum Swamp	104	Vulnerable
Lignum Swampy Woodland	823	Vulnerable
Riverine Chenopod Woodland	103	Vulnerable
Saline Aquatic Meadow	842	Rare
Samphire Shrubland	101	Depleted
Saltmarsh-grass Swamp	A113	Endangered
Submerged Aquatic Herbland	918	Endangered
Tall Marsh	821	Depleted

As mentioned above, the vegetation condition of many of the wetlands in this region is very poor because of past changes to hydrology and salinity. However, there are higher quality remnants of threatened EVCs at some sites, including Riverine Chenopod Woodland and Lignum Swampy Woodland at Cemetery Swamp, and Riverine Chenopod Woodland, Lignum Swampy Woodland and Intermittent Swampy Woodland/Lake Bed Herbland Complex at the Koorangie Marshes.

Vegetation condition at the Koorangie Marshes has been severely impacted by past salinisation, which caused the death of large areas of trees across the system. Floods which occurred in the Koorangie Marshes in 2011 and 2016 have had positive impacts on the condition of vegetation, with regeneration of River Red Gum and Black Box occurring around the perimeter of the wetlands. Some stressed old trees are showing signs of recovering in health and excellent growth of aquatic plants occurred when the wetlands were inundated (see Photograph 26), including the recruitment of large areas of threatened lake bed plant species, such as the endangered *Cullen cinereum* (Hoary Scurf-pea) and rare *Trigonella suavissima* (Sweet Fenugreek). These rare species colonised the bed of the wetlands as they dried out.

In 2017 and 2018, this natural regeneration was augmented by the planting of 11,000 River Red Gums and Eumong by members of the Barapa Barapa and Wemba Wemba communities across the beds of First and Second Marshes in order to assist tree canopy regeneration of the endangered EVC Intermittent Swampy Woodland/ Lake Bed Herbland Complex. These restoration works were funded by the Commonwealth Government and coordinated by the NCCMA.

▲ *Photograph 26* Aquatic vegetation in First Marsh, November 2017

▶ *Photograph 27* River Red Gum planted at Second Marsh following the draw down of the 2016 flood

4.5. LOWER LODDON FLOODPLAINWETLANDS (EXCLUDING WETLANDS IN THE KERANG RAMSAR WETLANDS SITE)

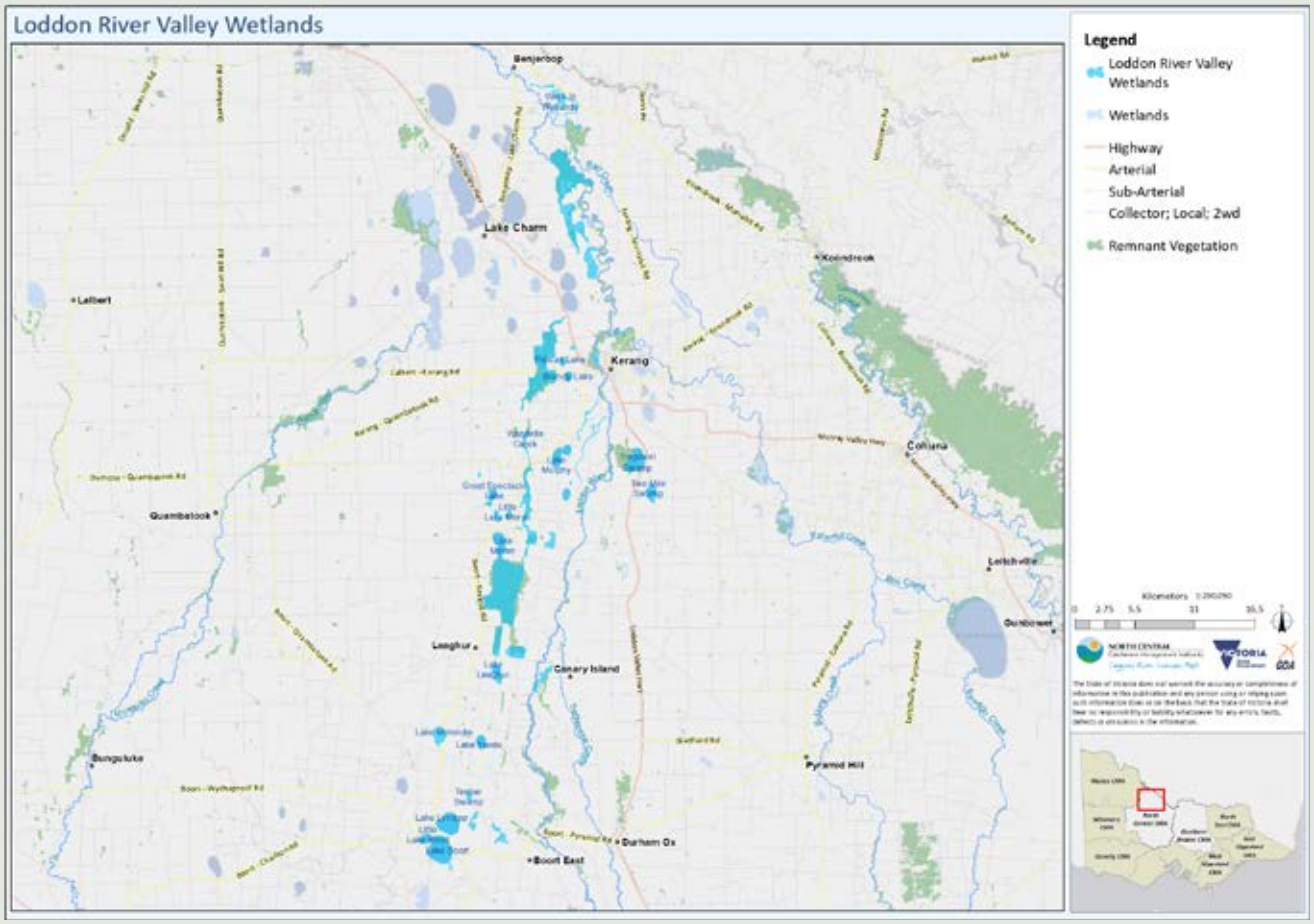
This cluster includes wetlands connected to the Lower Loddon River Floodplain from Lake Boort in the south to Benjeroop in the north, excluding wetlands in this area that are part of the Kerang Ramsar Wetland Site.

Wetlands in this region have been affected to varying degrees by river regulation, irrigation practices and salinisation. They vary in condition from poor to excellent depending on the level of impact of these processes.

The wetlands contained in Leaghur State Park are some of the largest and most intact Black Box dominated ecosystems in Victoria, including areas of vulnerable and endangered EVCs such as Lignum Swampy Woodland, Plains Woodland-Herb-rich Gilgai Wetland Complex and Black Box Wetland. They are generally in excellent condition and support 31 threatened plant species. The south-eastern block of this park supports Plains Grassy Wetland / Lignum Swamp Complex, which is a high-quality example of the nationally endangered, EPBC Act listed "Seasonal Herbaceous Wetland" community.

The Wirra-Lo Wetland complex occurs on private land protected by a Trust for Nature covenant on the lower Loddon River floodplain at Murrabit West. The property is owned by Ken and Jill Hooper, who covenanted it to protect the last significant remnant of native vegetation on private land in the area.

Map 7 Location of Lower Loddon Valley Wetlands



Vegetation in the Wirra-Lo complex consists of a high-quality example of Lignum Swampy Woodland and some more degraded areas of Intermittent Swampy Woodland that are being restored, as well as areas that were formerly irrigated pasture which are now being converted back into wetlands, native grasslands and grassy woodlands.

One wetland in the Wirra-Lo complex, known as Brolga Swamp, is being restored to create high quality Brolga breeding habitat. Using a combination of planting and direct seeding, the revegetation of this wetland has been extremely successful, with over 95% of the site being covered by indigenous wetland vegetation during the first two years of the project (see Photograph 28). This revegetation included the planting of 60 nationally endangered Stiff Groundsel *(Senecio behrianus)*, which are now spreading across shallower areas of the wetland (see Photograph 28). The nationally vulnerable Growling Grass Frog was heard calling in Brolga Swamp only two years after restoration began. Wirra-Lo Wetlands supports the only known existing population of the nationally vulnerable Growling Grass Frog in the northern area of the NCCMA region. Two new wetlands were created at Wirra-Lo in 2019 to provide breeding habitat for the Australasian Bittern.

'When irrigation was being removed from the area it was proposed to shut down the GMW number 4 channel and our wetlands would have been stranded without a water supply. After much discussion, and planning by the relevant agencies, the number 4 channel has been retained along the boundary of Wirra-Lo and this guarantees a water supply for our wetlands.

Environmental water can now be delivered to nurture the habitat we have protected for threatened species'

– Ken and Jill Hooper

Photograph 28 Brolga Swamp at Wirra-Lo Wetlands in January 2021, six years after ecological restoration works began

Most of the lakes and swamps at the southern end of this wetland complex had their natural hydrological regimes disrupted in the mid-1800s, when engineering works were completed that diverted more water into them from the Loddon River. This drowned many trees in wetlands including Lake Boort, Lake Lyndger, Lake Yando, Lake Leaghur and Lake Meran (Haw, 2010).

While large areas of canopy trees drowned in these wetlands, they still support endangered EVCs, including Intermittent Swampy Woodland/ Lake Bed Herbland Complex and Intermittent Swampy Woodland/ Floodway Pond Herbland Complex, plus significant populations of threatened species such as Hoary Scurf-pea *(Cullen cinereum)* and Downy Swainson-pea *(Swainsona swainsonoides)*.

Environmental water has been delivered to Lake Yando and Lake Meran and infrastructure exists to deliver water to Lakes Boort, Lyndger and Leaghur. The delivery of water has been successfully used to encourage the regeneration of River Red Gums at Lake Yando, and natural flooding has stimulated the recruitment of this species at Lake Boort. Colonial nesting bird species, including Australasian Darter and Little Pied Cormorant, have established rookeries in areas of River Red Gum regeneration at both Lake Boort and Lake Yando.

The vulnerable White-bellied Sea Eagle nests regularly at Lake Meran and after the 2016 floods there was a significant breeding event of Great Creasted Grebes at this wetland. The endangered Grey-crowned Babbler is regularly observed around Lakes Boort, Lyndger, Yando and Meran and, while more difficult to detect, the Murray-Darling Carpet Python is also occasionally recorded.

▲ *Photograph 29* The nationally endangered Stiff Groundsel *(Senecio behrianus)* planted at Wirra-Lo Wetlands

Seventy threatened fauna species have been observed in the Lower Loddon Floodplain Wetlands cluster. Only nationally endangered wetlands species and those associated with Red Gum forests or woodlands are listed in Table 13. A full list of threatened fauna found in this region is provided in Appendix 3.

Table 13 **Nationally threatened fauna species recorded in the Lower Loddon Floodplain Wetlands**

COMMON NAME	SPECIES	EPBCA	FFG	DELWP
Australian Painted Snipe	*Rostratula australis*	EN	L	cr
Curlew Sandpiper	*Calidris ferruginea*	CR		en
Flat-headed Galaxias	*Galaxias rostratus*	CR	X	vu
Grey-headed Flying-fox	*Pteropus poliocephalus*	VU	L	vu
Growling Grass Frog	*Litoria raniformis*	VU	L	en
Macquarie Perch	*Macquaria australasica*	EN	L	en
Murray Cod	*Maccullochella peelii*	VU	L	vu
Red Knot	*Calidris canutus*	EN		en
Silver Perch	*Bidyanus bidyanus*	CR	L	vu
Striped Legless Lizard	*Delma impar*	VU	L	en
Swift Parrot	*Lathamus discolor*	CR	L	en

Table 14 **Bioregional Conservation Status of EVCS in the Lower Loddon Floodplain wetlands**

ECOLOGICAL VEGETATION CLASS	EVC#	BIOREGIONAL CONSERVATION STATUS
Aquatic Herbland	653	Endangered
Black Box Wetland	369	Endangered
Brackish Aquatic Herbland	537	Vulnerable
Brackish Lake Bed Herbland	539	Vulnerable
Intermittent Swampy Woodland	813	Endangered
Intermittent Swampy Woodland/Floodway Pond Herbland Complex	A121	Endangered
Intermittent Swampy Woodland/Lake Bed Herbland Complex	A119	Endangered
Lake Bed Herbland	107	Depleted
Lignum Shrubland	808	Vulnerable
Lignum Swamp	104	Vulnerable
Lignum Swampy Woodland	823	Vulnerable
Plains Grassy Wetland/Lignum Swamp Complex	A101	Endangered
Plains Woodland- Herb-rich Gilgai Wetland Complex	235	Endangered
Tall Marsh	821	Depleted

Several ecological restoration projects were initiated in this wetland cluster during the drawdown of the 2016 floods. Members of the Dja Dja Wurung community planted several hundred River Red Gums at Lake Boort, and local landholder Paul Haw planted another 2,000 with several other volunteers. Members of the Barapa Barapa community planted over 1,000 River Red Gum and Eumong at Lake Leaghur, and understorey diversity enrichment plantings were successfully established at Lake Leaghur and Lake Yando through projects funded by DELWP (see Photograph 32).

▶ *Photograph 30* The nationally vulnerable Growling Grass Frog *(Litoria raniformis)*

▲ *Photograph 31* White-bellied Sea Eagle, Lake Meran

▶ *Photograph 32* The endangered Downy Swainson-pea *(Swainsona swainsonoides)* planted at Lake Leaghur

5. POTENTIAL PROJECTS

The following brief descriptions outline potential project ideas in each of the wetland clusters. Note that the timing of some of the projects depends on opportunities provided by natural flooding events, such as the restoration of the tree canopy at Third Marsh at Koorangie. Many of the other projects should be considered as complementary actions to the delivery of environmental water.

The delivery of environmental water provides many ecological benefits to wetlands where natural hydrology has been impacted by disconnection from water sources due to river regulation or the construction of levees, roads and other obstructions in flood pathways. Ecological benefits include the opportunity to restore ecological productivity, opportunities for feeding and recruitment of wetland biota, and re-instating ecological processes such as nutrient cycling.

Complementary management interventions, such as the installation of carp screens, weed control and planting or direct-seeding, have the potential to further optimise the benefits of the environmental watering of wetlands, particularly those that have been degraded by weeds, feral animals and past land and water management practices. These interventions are most successful when integrated into the watering program, as the correct timing of actions in relation to wetland filling or draw down is often critically important. For example, in wetlands where the tree canopy has been drowned due to artificially prolonged inundation, it may take a very long time for tree canopy cover health to recover simply by re-instating an appropriate wetting and drying cycle. It is likely, in this instance, that the necessary seed source is absent or depleted and trees should be planted as the wetland draws down, taking into account the following:

- No knockdown herbicide is required as all terrestrial weeds will have been drowned;
- Soil moisture availability for the establishment of the trees will be optimal, in particular deep soil moisture will likely be available for a relatively prolonged period following inundation;
- Planting directly after draw down gives wetland trees the maximum amount of time possible to grow to a height that will allow them to survive the next inundation event.

When planting indigenous, local provenance trees, it is necessary to plan seed collection and propagation and this should, therefore, be incorporated into overall environmental watering and ecological restoration planning.

Environmental watering should be used to the greatest advantage possible to maintain and increase populations of threatened plant and animal species. For example, water delivery and recession of flood waters need to be timed to critical parts of the life cycle of fauna species, such as wetland birds and Growling Grass Frogs. This will maximise the possibilities of successful breeding and recruitment.

Establishing populations of nationally endangered wetland plant species, such as Stiff Groundsel *(Senecio behrianus)* and Ridged Water Milfoil *(Myriophyllum porcatum)*, in areas of suitable habitat that receive environmental water will help to build the resilience of these species to extinction and should be a priority in several of the following projects.

Rather than carrying out many small-scale restoration projects, it would be better (both for the resource management agencies and for ecologists) to undertake a limited number of well-designed, large-scale projects. To date, at least in Australia, resource management agencies have shown a great reluctance to do this, even though we have a plethora of cases of large-scale ecosystem degradation. This reluctance is a major impediment to the development of restoration ecology.

(Lake, 2001)

5.1. AVOCA RIVER FLOODPLAIN WETLANDS

Key values: Freckled Duck, Hardhead, Australasian Shoveler, Growling Grass Frog, Carpet Python, intact endangered Ecological Vegetation Classes (EVCs)

Major wetland conservation issues: lack of detailed information to inform actions, limited areas of public land and conservation reserves, inappropriate grazing regimes and fragmentation of indigenous vegetation due to clearing and cropping.

Improving knowledge of the Bungaluke Wetlands

There is very little information available about the ecological and cultural significance of the Bungaluke wetlands. They were recommended for purchase in 1989 as they fulfil the high value criteria in the Wetlands Conservation Program for Victoria (ANCA 1993), however they remain in private ownership.

A potential project for Wetland Revival would be to contact landholders and get permission to begin to document the ecological values of these wetlands, potentially working with Traditional Owners to document cultural significance at the same time. Once relationships are developed with the landholders, options for improved management and securing the future conservation of the wetlands can then be negotiated.

5.2. KAMAROOKA WETLANDS

Key values: Brolga, Australasian Bittern, migratory waders, Ridged Water-milfoil, intact endangered EVCs

Major wetland conservation issues: restoring hydrology in wetlands on private land, protecting Brolga breeding sites and Australasian Bittern habitat.

Restoring the natural hydrology of Kamarooka Wetlands that have been drained

Many of the wetlands on private land in this complex are impacted by altered hydrology. Community drains were constructed through the area following wet periods in the 1970s, and these drains reduce the amount of time the wetlands remain inundated.

Restoring a more natural hydrology would be the most effective way of improving the condition of these wetlands. A method needs to be devised with which the farmers who own the wetlands would agree. This could involve sandbagging the wetlands at strategic points along the drains to restore their natural sill levels. Using sandbags initially may be a way to demonstrate to the landowners the benefits of restoring the wetlands without taking action that would prove difficult or costly to reverse. More permanent structures to restore the wetlands hydrology could be put in place if landowners became convinced that restoring the wetlands had greater overall benefits than costs to their farming enterprises.

Photograph 33 River Red Gums at the northern end of Gaynor Swamp were killed by prolonged inundation

5.3. COROP WETLANDS

Key species: Brolga, Australasian Bittern, Australian Painted Snipe, migratory waders, Stiff Groundsel, intact endangered EVCs

Major wetland conservation issues: restoring tree canopy cover at Gaynor Swamp, protecting Brolga breeding and flocking sites and Australasian Bittern habitat, ensuring the survival of Stiff Groundsel populations on roadsides and private land, and managing the transition of Greens Lake from an irrigation water storage to a wetland reliant on catchment flows.

Restoring the tree canopy of Gaynor Swamp

Gaynor Swamp is at the downstream end of the Cornella Creek catchment, to the south-east of Lake Cooper. It is 300 hectares in size and occurs within the Parks Victoria managed Gaynor Swamp Wildlife Reserve. The area is considered shared country by Yorta Yorta, Taungurung and Dja Dja Wurrung peoples. During wet periods in the 1970s, water from Lake Cooper backed up in Gaynor Swamp, causing prolonged inundation that killed River Red Gums over an area of about 200 hectares in the northern section of the swamp (see Photograph 33).

A structure has now been installed between Gaynor Swamp and Lake Cooper to prevent prolonged inundation of Gaynor Swamp in the future. A potential Wetland Revival project is to work with the Yorta Yorta, Taungurung and Dja Dja Wurrung to re-establish the River Red Gum canopy over the area where trees were drowned. This would involve planting and guarding hiko stock of River Red Gum seedlings as the water in the wetland draws down following environmental watering.

Monitoring and adaptively managing the transition of Greens Lake from a water storage to a wetland reliant on natural catchment

Goulburn-Murray Water (GMW) has ceased the operation of Greens Lake as a water storage and returned it to a wetland reliant on catchment flows. Before being used as a water storage, Greens Lake was an intermittent wetland that supported diverse native vegetation. The cycles of wetting and drying in intermittent wetlands are important ecological drivers and determine wetland productivity. Wetlands that wet and dry have been found to support about twice the diversity and ten times the abundance of wetland birds than wetlands that are managed as water storages and remain permanently full (Kingsford, 2004).

The response of wetland birds, frogs and other fauna and vegetation must be monitored at Greens Lake as it changes from being permanently full to wetting and drying. This will assist in the development of a plan to manage environmental weeds and set targets for the re-establishment of native vegetation adapted to the changed water regime. If re-establishment of native vegetation does not meet these targets, a revegetation strategy should be implemented (Cook, 2017).

Woody weed control at Greens Lake

Public land around Greens Lake supports large areas of endangered EVCs including Plains Grassy Wetland and Plains Grassy Woodland. These EVCs are threatened by woody weed invasion by species including Desert Ash *(*Fraxinus angustifolius)* and Swamp Oak *(*Casuarina glauca)*. These weeds currently occur at relatively low densities and could be easily removed from the site. Periodic follow up control will be required to remove seedlings regenerating from soil stored seed.

5.4. KERANG WETLANDS

Key values: Brolga, Australasian Bittern, Australian Painted Snipe, Freckled Duck, Magpie Goose and migratory waders, intact endangered EVCs

Major wetland conservation issues: loss of living canopy trees, loss of habitat and plant species diversity, lack of seed source to allow tree and understory regeneration, salinisation and lack of community awareness of the importance of the Kerang Wetlands Ramsar site.

Continuing to improve vegetation diversity and tree canopy cover at Johnson Swamp

The condition of much of the wetland vegetation at Johnson Swamp is very poor. Past prolonged flooding and salinisation killed large areas of tree canopy in areas of Intermittent Swampy Woodland and Lignum Swampy Woodland. Prolonged inundation also simplified understorey vegetation in both EVCs, reducing species diversity, simplifying habitat structure and allowing the establishment and spread of dense stands of Common Reed and Cumbungi.

The most recent environmental water delivery to Johnson Swamp was timed to contain the spread of Common Reed and Cumbungi and complementary actions as part of the watering included establishing plots of species-rich aquatic vegetation and planting areas of young River Red Gum and Eumong trees in areas of Intermittent Swampy Woodland (see Photograph 34).

▲ *Photograph 34* Development of planted aquatic vegetation at Johnson Swamp from Oct 2015 (top) to Jan 2016 (bottom)

Future deliveries of environmental water will provide opportunities to build on works that have been completed in areas of Intermittent Swampy Woodland. Improving the condition of the fringing Lignum Swampy Woodland EVC could begin by replanting canopy species, including Black Box and Eumong, and planting and direct seeding a diversity of understorey species.

Understorey planting and direct seeding should focus on restoring Brolga breeding habitat, including species used as nesting material such as Swamp Wallaby-grass *(Amphibromus nervosus)*, Southern Cane Grass *(Eragrostis infecunda)* and Common Spike-sedge *(Eleocharis acuta)*. Species that produce starchy tubers, such as Water Ribbons (*Cycnogeton* species), are part of the diet of Brolga and Magpie Geese, both of which are considered culturally significant animals by Barapa Barapa people.

Prior to the delivery of environmental water, there may be an opportunity to conduct some cultural burning to assist with the control of Common Reed, Cumbungi and Tangled Lignum, and re-create some mosaic patches of these species with open areas of more diverse vegetation structure.

Continuing to improve vegetation diversity and tree canopy cover at Hird Swamp

From the period between October 2017 and November 2018, members of the Barapa Barapa community were involved in ecological restoration works at Hird Swamp, including planting Black Box to restore the tree canopy in eastern section and western fringe of the swamp, River Red Gums to replace the tree canopy in the deepest, central part of the swamp and planting a diversity of aquatic and amphibious species to improve understorey diversity. These works were funded by the Australian Government through Ramsar funding to the NCCMA.

Additional tree and understorey plantings and control of the large areas of Common Reed and Cumbungi that occur in the swamp, potentially using cultural burning, are still required to improve the quality of breeding habitat for the threatened Brolga and Australian Little Bittern and nationally endangered Australasian Bittern.

Continuing to improve vegetation diversity and tree canopy cover at McDonald Swamp

From the period beginning October 2016 through to October 2018, members of the Barapa Barapa community were involved in ecological restoration works at McDonalds Swamp, including planting River Red Gums to replace the tree canopy in the northern part of the swamp (see Photograph 35) and planting a diversity of aquatic and amphibious species to improve understorey diversity. These works were funded by a landcare grant and a DELWP wetland restoration project.

Photograph 35 Members of the Barapa Barapa community at McDonalds Swamp in December 2018 with a River Red Gum that was planted in December 2016

These works have proven very successful and offer a framework to build on for continued restoration activities, which should include additional tree and understorey plantings and control of the large areas of Common Reed and Cumbungi that occur at the swamp, potentially using cultural burning.

Continued restoration of fauna habitat at McDonalds Swamp will potentially provide habitat for the nationally endangered Australasian Bittern and Australian Painted Snipe and increase the area of habitat available for the resident population of Grey-crowned Babblers.

Restoring hydrology, vegetation diversity and tree canopy cover at Red Gum Swamp

Red Gum Swamp is a wetland adjacent to McDonalds Swamp that is currently disconnected from its natural water source. Past water management drowned all the mature River Red Gums and degraded the understorey, leaving this wetland's vegetation in very poor condition (see Photograph 36).

Analysis of soil salinity and potential methods for re-instating natural wetting and drying cycles are required to inform the feasibility and planning of the restoration of Red Gum Swamp. If found to be viable, restoration could proceed in a similar way to what has occurred at McDonalds Swamp.

This wetland supports a high density of Aboriginal cultural sites and has been identified as a high priority for restoration by Barapa Barapa elders Uncle Ron Galway and Uncle Neville Wyman.

▲

Photograph 36 Large dead River Red Gums and weedy understorey vegetation at Red Gum Swamp

Barapa Barapa/Wemba Wemba Seed Bank

There are many wetlands on the traditional lands of the Barapa Barapa and Wemba Wemba that require ecological restoration works. Given the restrictive timeframes of some projects, it is not always possible to have enough lead time to ensure adequate indigenous seed can be collected to fulfil the requirements of direct seeding or plant propagation. Establishing a Barapa Barapa/Wemba Wemba indigenous seedbank would be one way to ensure a seed supply for future restoration projects.

Establishing a Barapa Barapa indigenous seed bank would involve training members of the Barapa Barapa community in plant identification, seed collection and seed cleaning techniques. This training could be done on the job over a few weeks in summer, when enough seed could be collected for most wetland restoration requirements for the next five years.

Restoration of Semi-arid Woodland on the lunette of Second Marsh, Koorangie State Game Reserve

Buloke woodlands of the Riverina and Murray-Darling Depression regions are listed as nationally endangered (DEWHA 2010). Remnant areas of Semi-arid Woodland on the lunettes to the east of Lake Bael Bael and Second Marsh are of high conservation significance as examples of this ecological community. However, as most of the lunette at Second Marsh has been cleared, the remnants of Semi-arid Woodland are small and fragmented. Just over 20 hectares of cleared lunette occurs on Parks Victoria managed land and this should be restored with Semi-arid Woodland through a combination of direct-seeding and planting.

The restoration of Slender Cypress Pine and Buloke woodlands was identified as a high priority by Wemba Wemba Traditional Owners at a workshop on 28 March 2019 at Lake Charm. The Red-tailed Black Cockatoo is an important totem animal for the Wemba Wemba and Slender Cypress Pine and Buloke seeds are favoured foods of this species. Although Red-tailed Black Cockatoos no longer occur in north western Victoria, the Wemba Wemba aspire to have them return.

▲

Photograph 37 Yorta Yorta/Barapa Barapa woman Rochelle Patten collecting seed from indigenous wetland vegetation at McDonalds Swamp

Photograph 38 Eumong *(Acacia stenophylla)* sapling becoming established in Third Marsh following the drawdown of the 2016 flood

Restoration of tree canopy at Third Marsh, Koorangie State Game Reserve

First and Second Marshes at the Koorangie State Game Reserve were completely inundated by flooding in October and November 2016. This provided an opportunity to restore the tree canopy across the beds of these wetlands as water receded over the period between April 2017 and April 2018.

During the 2016 flood, only a small portion of Third Marsh was inundated, and this area was planted as water receded in January 2017. 360 hectares of Third Marsh still require revegetation to assist with restoration of the tree canopy of Intermittent Swampy Woodland. During the drawdown of the next flood that inundates Third Marsh River, Red Gum and Eumong should be planted at a density of 25 trees per hectare, which will require approximately 9,000 trees.

Restoring a living tree canopy at Third Marsh will provide a large area of additional habitat for threatened woodland birds, such as the Grey-crowned Babbler, and provide nest sites for colonial nesting birds such as Cormorants and Darters when the wetland is inundated.

Raising awareness of the significance of the Kerang Ramsar Wetlands site in the local community

There is limited awareness of the significance of the Kerang Ramsar Wetlands among the local community. More awareness would foster appreciation and a greater sense of custodianship of the wetlands. As well as building awareness of ecological significance, the local community needs to understand the ecological goods and service values of the wetlands, so that people understand their economic benefits.

An education kit could be developed that relates the values in simple terms. It could use visually stunning pictures of the wetlands and waterbirds on posters, pamphlets and other educational materials. Organising of presentations at all the local schools would provide information that children could take home to their families. Local teachers should be encouraged to include studies of the wetlands into their science, geography and art curricula.

A self-guided tour of the wetlands could be developed so people can get out and see the wetlands for themselves. This project could also involve organising field days where people could have a picnic, hear from experts about the wetlands and go for a walk.

Vegetation restoration at Third Reedy Lake

A bypass channel has been built around Third Reedy Lake which allows this system to be managed as a wetting and drying wetland. This will improve the wetlands productivity for wildlife, allow the restoration of endangered wetland vegetation types including Intermittent Swampy Woodland/Lake Bed Herbland Complex and Aquatic Herbland, and potentially provide habitat for the nationally endangered Australasian Bittern and Australian Painted Snipe.

5.6. LOWER LODDON FLOODPLAIN WETLANDS

Key values: Growling Grass Frog, Carpet Python, White-bellied Sea Eagle, colonial nesting bird rookeries, intact endangered EVCs

Major wetland conservation issues: loss of living canopy trees, loss of habitat and plant species diversity, lack of seed source to allow tree and understory regeneration, salinisation.

Wirra-Lo Wetlands Management Plan and Operating Manual

Ken and Jill Hooper have been managing the Wirra-Lo Wetlands property for conservation for over 15 years. They have divided the site into different vegetation management zones to maintain a diversity of habitats and have developed management techniques to achieve specific ecological outcomes within each of the zones.

The NCCMA have developed a 10-year restoration and management plan for four of the wetlands on Wirra-Lo. This plan needs to be expanded to cover the whole property to assist future land and water management on the site.

An intrinsic element of managing the wetlands on Wirra-Lo is how water is delivered. The management plan will include an operating manual that will set out how the existing infrastructure for delivering environmental water to the Wirra-Lo wetlands should be operated, and describe the future works that need to be carried out to deliver water to currently unconnected wetlands on the site.

Continued restoration and management of Wirra-lo Wetlands

A trial planting of the nationally endangered Stiff Groundsel at Brolga Swamp has been very successful, with this species now spreading in shallow areas of the wetland. This population should be increased by planting another 100 individuals. The national vulnerable Ridged Water-milfoil was also planted, but is now so common no further planting is required. Other threatened plant species that should be established in appropriate habitats at Brolga Swamp include Trim Flat-sedge *(Cyperus concinnus)*, Downs Nutgrass *(Cyperus bifax)* and Long Eryngium *(Eryngium paludosum)*.

Ongoing maintenance will be required to manage weeds and invasive native species at this site. Continued restoration and management of fauna habitat at Wirra-Lo will potentially provide habitat for Brolga, the nationally endangered Australasian Bittern and Australian Painted Snipe as well as improve the habitat for the existing population of Growling Grass Frogs.

▲
Photograph 39 Lake Murphy would provide more diverse habitat structure if it supported living trees and a more diverse understorey

Restoration of tree canopy at Lake Murphy and improvement of habitat condition for Brolga and Australasian Bittern

In the past, Lake Murphy was artificially maintained at a high-water level for prolonged periods of time and consequently the wetland vegetation there is in very poor condition (see Photograph 39). Over the past 10 years the hydrology of the lake has been maintained with a wetting and drying cycle, creating conditions suitable for the restoration of the tree canopy and a more diverse understorey.

Re-establishment of a living tree canopy in areas of this wetland amongst the standing dead timber will improve habitat diversity, provide improved breeding opportunities for a range of wetland birds and contribute to nutrient cycling. Suitable tree species for this wetland include River Red Gum and Eumong for deeper areas and Black Box for shallower fringing areas. Understorey enrichment planting of species such as Southern Cane Grass *(Eragrostis infecunda)*, Robust Cane Grass *(Eragrostis australasica)*, and Common Spike-sedge *(Eleocharis acuta)* could be used to improve habitat structure for threatened species such as the Brolga and Australasian Bittern.

Restoration of tree canopy cover and understorey diversity at Lake Boort

Members of the Dja Dja Wurrung community planted several hundred trees, and local landholder Paul Haw planted another 2,000 River Red Gum and Eumong with volunteers following the drawdown of the 2016 floods at Lake Boort. These plantings will assist with the restoration of the tree canopy over about half of the wetland. Planting of another 2,000 trees is required following the drawdown of the next inundation event. This will ensure enough young trees are distributed across the wetland to enable the regeneration of the woodland canopy.

The delivery of environmental water will assist the establishment of trees planted following the drawdown of the 2016 flood, provide suitable conditions for establishing trees in areas that have yet to be planted, and allow species enrichment planting of aquatic and amphibious species.

Vegetation restoration at Lake Lyndger

The delivery of environmental water could be utilised to assist the establishment of trees across the 180 hectares of the wetland's bed, and allow species enrichment planting of aquatic and amphibious species.

Restoring a living tree canopy at Lake Boort and Lake lyndger will provide a large area of additional habitat for threatened woodland birds such as the Grey-crowned Babbler, and provide nest sites for colonial nesting birds such as Cormorants and Darters when the wetlands are inundated.

Vegetation restoration at Tragowel Swamp

An investigation is required to determine whether restoration of the tree canopy on the publicly owned area of this wetland is viable.

6. MONITORING

It is necessary to establish an ecosystem baseline inventory for individual wetland projects (SERA 2017).

A fundamental principle of ecological restoration is the identification of an appropriate reference ecosystem to act as a model to guide project targets and provide a basis for monitoring and assessing outcomes. This should include local indigenous plants, animals and other biota characteristic of the pre-degradation ecosystem. Identifying a reference ecosystem involves analysis of the composition (species), structure (complexity and configuration) and function (processes and dynamics) of the ecosystem to be restored on the site.

The model should also include descriptions of successional states that may be characteristic of the ecosystem's decline or recovery. Identifying functional components of a reference ecosystem is important to goal setting, but returning functions also facilitates restoration. That is, recovery is achieved by the processes of growth, reproduction and recruitment of the organisms themselves over time, which are facilitated by the return of appropriate cycles, flows, productivity levels and specific habitat structures or niches. Monitoring of the recovery process is required to identify whether acceptable trajectories of recovery are likely to result in a self-organising and functional ecosystem or whether further (or different) interventions are needed to remove barriers to recovery (SERA 2017).

Ecological restoration is a rapidly emerging science that often relies upon processes of trial and error, with monitoring increasingly being informed by scientific approaches. Formal field experiments can also be incorporated into restoration practice, generating new findings to both inform adaptive management and provide valuable insights for the natural sciences (SERA 2017).

6.1. MONITORING AND ADAPTIVE MANAGEMENT

Linking monitoring results with adaptive management is critically important when making management decisions, such as when to deliver environmental water to wetlands. Environmental watering is a new science and timing should be based on adaptively managing weeds, productivity for flora and fauna, tree health and recruitment, and whether any natural flooding occurs. Adaptive management should be informed by the monitoring that has occurred to date and ongoing future monitoring.

'Having well established monitoring and risk assessments at the outset means that at any time during the process, it is possible to tell whether what is being done is successful or not, and that when risks factors like climate change arise, there is a strategy to respond to it'

(Eckersley, 2013)

6.2. REPORTING RESULTS

The Wetland Revival Trust is committed to the continued development of wetland restoration and management techniques. To meet this end, the results of restoration projects will be published so that learnings will be shared. Renowned ecologist, Professor Sam Lake, stated that: 'The lack of reporting on the progress and outcomes of restoration projects is a major problem. Ideally, the outcomes of a project, along with its hypotheses and its rationale, would be reported in the refereed scientific literature (Lake, 2001).'

6.3. RELATIONSHIPS WITH UNIVERSITIES

Partnerships with universities and other institutions will be developed to optimise our ability to gain knowledge from restoration practice and ensure we are informed by science. Such partnerships will help optimise potential for innovative restoration approaches that provide reproducible data and robust guidance for future activities (SERA, 2017).

7. LINKING WITH OTHER STRATEGIES

In order to strengthen support and increase funding opportunities, Wetland Revival Trust projects will aim to align with existing wetland and biodiversity protection strategies.

The 2014-2022 North Central Waterway Strategy (NCCMA, 2014) states that "waterways (rivers and wetlands) provide environmental, economic, social and cultural benefits contributing to human health and wellbeing as well as community resilience. Our region values waterways highly and recognises that a coordinated and collaborative approach will improve their current condition (David Clark, Chair NCCMA 2014)."

The NCCMA Waterway Strategy (NCCMA, 2014) delivers key elements of the state-wide management approach outlined in the Victorian Waterway Management Strategy (DEPI 2013). There are eight regional goals, five of which are related to wetlands (bold). They were developed to assist in determining the priorities and top waterways that were to be targeted over the life of the strategy:

- Maintain or improve highly threatened or rare water-dependent species and communities within the North Central CMA region;
- Maintain or improve ecologically healthy or representative rivers;
- Protect or improve the ecological character of the Gunbower Forest and Kerang Wetlands Ramsar sites;
- Maintain or improve wetlands of national or regional importance as identified in the North Central Regional Catchment Strategy;
- Maintain or improve waterways within water supply protection areas to support long-term improvement in water quality;
- Improve environmental outcomes by efficiently managing environmental entitlements in partnership with water holders;
- Work with local communities (including urban communities) to better understand the values of local waterways, particularly where there is a high social value;
- Maintain or improve waterways that will provide adaptation under a variable climate.

Table 15 **Priorities for the 2014-22 North Central Waterway Strategy.**

BASIN	CAMPASPE	LODDON	AVOCA	AVON-RICHARDSON
Priority Rivers and Streams	Campaspe River, Five Mile Creek, Kangaroo Creek, Coliban River, Little Coliban River	Loddon River, Jim Crow Creek, Sailors Creek, Kangaroo Creek, Tullaroop Creek, Birch's Creek, Box Creek, Pyramid Creek, Serpentine Creek, Little Murray River, Gunbower Creek	Avoca River	Richardson River (reaches 77 & 78)
Priority Wetlands Ramsar Sites		Gunbower Forest Ramsar Site, Kerang Wetlands Ramsar Site (Black Swamp/ Town Swamp, Cemetery Swamp, Cullens Lake, Fosters Swamp, Hird Swamp, Johnson Swamp, Kangaroo Lake, Lake Charm, Lake Kelly, Lake Tutchewop, Third Reedy Lake, Lake William, Little Lake Charm, Little Lake Kelly, Middle Reedy Lake, Racecourse Lake, Reedy Lake, Stevenson Swamp, Third Lake)	Kerang Wetlands Ramsar Site (First Marsh, Second Marsh, Third Marsh, Lake Bael Bael)	
Priority Wetlands		Bakers Swamp - Moolort, Benjeroop State Forest, Benwell/Guttrum State Forest, Black Swamp - Moorlort, Brandy Lake/Lake Wandella, Cockatoo Lagoon, Frogmore Swamp, Golf Course Lake, Great Spectacle Lake, Gum Lagoon, Heart Lagoon, Lake Boort, Lake Elizabeth, Lake Leaghur, Lake Lyndger, Lake Marmal, Lake Meran, Lake Murphy, Lake Yando, Leaghur State Park, Long Swamp, McDonalds Swamp, Merin Merin Swamp, Middle Swamp near Clunes, Red Gum Swamp, Richardsons Lagoon, Round Lake, Safe Lagoon, Tang Tang Swamp/Taylors Lagoon, Thunder Swamp, Tragowel Swamp, Turner/Phyland Lagoon, Unregulated Lagoon, Walker's Swamp - Moorlort, Woolshed Swamp		Lake Buloke, Little Lake Buloke, York Plains Complex, Wimmera Mallee Pipeline supplied wetlands (Creswick Swamp, Cherrip Swamp, Davis Dam, Corack Lake, Jeffcott Wildlife Reserve, Jesse Swamp, Falla Dam)

Other relevant strategies that link to the Wetland Revival Trusts objectives include:

- Victorian northern plains landscape restoration plan 2016-2020 – Trust for Nature;
- Victorian Waterway Management Strategy (DEPI 2013).

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APPENDICES

APPENDIX 1

DEFINITIONS OF CONSERVATION STATUS FOR FAUNA AND FLORA SPECIES

STATUS	DESCRIPTION
Conservation Status in Australia (EPBC Act)	
Extinct (EX)	A taxon is extinct when there is no reasonable doubt that the last individual of the taxon has died.
Critically Endangered (CR)	A taxon is critically endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (EN)	A taxon is endangered when it is not critically endangered but is facing a very high risk of extinction in the wild in the near future.
Vulnerable (VU)	A taxon is vulnerable when it is not critically endangered or endangered but is facing a high risk of extinction in the wild in the medium-term future.
Conservation Dependent (CD)	A taxon is conservation dependent when it is the focus of a specific conservation program, the cessation of which would result in the taxon becoming vulnerable, endangered or critically endangered within a period of five years.
Listing under the Flora and Fauna Guarantee Act 1988 (FFG Act)	
Listed (L)	Listed as threatened.
Nominated (N)	Nominated for listing as threatened but has not yet been listed. In some cases, the taxon may have received a preliminary or final recommendation indicating that it is eligible or ineligible for listing. In other cases, the nomination might not yet have been considered.
Invalid or ineligible (I)	Nominated but rejected for listing as threatened on the basis that the taxon was considered to be invalid (either undescribed or not widely accepted) or ineligible (taxon does not satisfy any of the primary listing criteria) by the Scientific Advisory Committee (SAC).
Delisted (D)	Previously listed as threatened but subsequently removed from the Threatened List following nomination for delisting.

STATUS	DESCRIPTION
Conservation Status in Victoria (DELWP Advisory Lists)	
Extinct (EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual) and throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Regionally Extinct (RX)	As for Extinct but within a defined region (in this case the state of Victoria) that does not encompass the entire geographic range of the taxon. A taxon is presumed Regionally Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout the region have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Extinct in the Wild (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Critically Endangered (CR)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (IUCN Standards and Petitions Subcommittee 2010), and it is therefore considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (IUCN Standards and Petitions Subcommittee 2010), and it is therefore considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (IUCN Standards and Petitions Subcommittee 2010), and it is therefore considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for, or is likely to qualify for, a threatened category in the near future.
Data Deficient (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate.

APPENDIX 2

FULL LIST OF THREATENED FAUNA SPECIES RECORDED IN THE KERANG WETLANDS

COMMON NAME	SPECIES	CONSERVATION STATUS
Apostlebird	*Struthidea cinerea*	L
Australasian Bittern	*Botaurus poiciloptilus*	EN en L
Australasian Shoveler	*Spatula rhynchotis*	vu
Australian Bustard	*Ardeotis australis*	cr L
Australian Little Bittern	*Ixobrychus dubius*	en L
Australian Painted Snipe	*Rostratula australis*	EN cr L
Australian Pratincole	*Stiltia isabella*	nt
Azure Kingfisher	*Alcedo azurea*	nt
Baillon's Crake	*Porzana pusilla*	vu L
Barking Owl	*Ninox connivens*	en L
Black Falcon	*Falco subniger*	vu N
Black-eared Cuckoo	*Chrysococcyx osculans*	nt
Black-tailed Godwit	*Limosa limosa*	vu
Blue-billed Duck	*Oxyura australis*	en L
Bony Herring	*Nematalosa erebi*	X
Brolga	*Grus rubicunda*	vu L
Brown Toadlet	*Pseudophryne bibronii*	en L
Brown Treecreeper	*Climacteris picumnus*	nt
Bush Stone-curlew	*Burhinus grallarius*	en L
Carpet Python	*Morelia spilota metcalfei*	en L
Caspian Tern	*Hydroprogne caspia*	nt L
Chestnut Quail-thrush	*Cinclosoma castanotus*	nt
Chirruping Wedgebill	*Psophodes cristatus*	rx
Common Greenshank	*Tringa nebularia*	vu
Common Sandpiper	*Actitis hypoleucos*	vu
Crested Bellbird	*Oreoica gutturalis*	nt L
Curlew Sandpiper	*Calidris ferruginea*	CR en
Diamond Dove	*Geopelia cuneata*	nt L
Diamond Firetail	*Stagonopleura guttata*	nt L
Eastern Curlew	*Numenius madagascariensis*	CR vu
Eastern Snake-necked Turtle	*Chelodina longicollis*	dd

COMMON NAME	SPECIES	CONSERVATION STATUS
Elegant Parrot	*Neophema elegans*	vu
Emu	*Dromaius novaehollandiae*	nt
Fat-tailed Dunnart	*Sminthopsis crassicaudata*	nt
Flat-headed Galaxias	*Galaxias rostratus*	CR vu X
Freckled Duck	*Stictonetta naevosa*	en L
Freshwater Catfish	*Tandanus tandanus*	en L
Glossy Ibis	*Plegadis falcinellus*	nt
Golden Perch	*Macquaria ambigua*	nt X
Great Egret	*Ardea alba*	vu L
Great Knot	*Calidris tenuirostris*	CR en L
Greater Sand Plover	*Charadrius leschenaultii*	VU cr
Grey Falcon	*Falco hypoleucos*	en L
Grey Goshawk	*Accipiter novaehollandiae*	vu L
Grey-crowned Babbler	*Pomatostomus temporalis*	en L
Grey-headed Flying-fox	*Pteropus poliocephalus*	VU vu L
Grey-tailed Tattler	*Tringa brevipes*	cr L
Ground Cuckoo-shrike	*Coracina maxima*	vu L
Growling Grass Frog	*Litoria raniformis*	VU en L
Gull-billed Tern	*Gelochelidon nilotica macrotarsa*	en L
Hardhead	*Aythya australis*	vu
Hooded Robin	*Melanodryas cucullata*	nt L
Inland Dotterel	*Charadrius australis*	vu
Lace Monitor	*Varanus varius*	en
Latham's Snipe	*Gallinago hardwickii*	nt
Lewin's Rail	*Lewinia pectoralis*	vu L
Little Button-quail	*Turnix velox*	nt
Little Egret	*Egretta garzetta*	en L
Long-toed Stint	*Calidris subminuta*	nt
Macquarie Perch	*Macquaria australasica*	EN en L
Magpie Goose	*Anseranas semipalmata*	nt L
Major Mitchell's Cockatoo	*Lophocroa leadbeateri*	vu L
Marsh Sandpiper	*Tringa stagnatilis*	vu
Mitchell's Hopping-mouse	*Notomys mitchellii*	nt

COMMON NAME	SPECIES	CONSERVATION STATUS
Murray Cod	*Maccullochella peelii*	VU vu L
Murray Hardyhead	*Craterocephalus fluviatilis*	EN cr L
Murray River Rainbowfish	*Melanotaenia fluviatilis*	vu L
Murray River Turtle	*Emydura macquarii*	vu
Murray Spiny Crayfish	*Euastacus armatus*	nt L
Musk Duck	*Biziura lobata*	vu
Nankeen Night Heron	*Nycticorax caledonicus*	nt
Pacific Golden Plover	*Pluvialis fulva*	vu
Pectoral Sandpiper	*Calidris melanotos*	nt
Pied Cormorant	*Phalacrocorax varius*	nt
Plumed Egret	*Ardea plumifera*	en L
Red Knot	*Calidris canutus*	EN en
Red-backed Kingfisher	*Todiramphus pyrropygia*	nt
Red-chested Button-quail	*Turnix pyrrhothorax*	vu L
Regent Honeyeater	*Anthochaera phrygia*	CR cr L
Regent Parrot	*Polytelis anthopeplus*	VU vu L
Royal Spoonbill	*Platalea regia*	nt
Ruddy Turnstone	*Arenaria interpres*	vu
Rufous Fieldwren	*Calamanthus campestris*	nt
Sanderling	*Calidris alba*	nt
Silver Perch	*Bidyanus bidyanus*	CR vu L
Spotted Bowerbird	*Ptilonorhynchus maculatus*	cr L
Spotted Harrier	*Circus assimilis*	nt
Square-tailed Kite	*Lophoictinia isura*	vu L
Superb Parrot	*Polytelis swainsonii*	VU en L
Swift Parrot	*Lathamus discolor*	CR en L
Unspecked Hardyhead	*Craterocephalus stercusmuscarum fulvus*	L
Whiskered Tern	*Chlidonias hybridus*	nt
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	vu L
White-throated Needletail	*Hirundapus caudacutus*	vu
White-winged Black Tern	*Chlidonias leucopterus*	nt
Wood Sandpiper	*Tringa glareola*	vu

APPENDIX 3

FULL LIST OF THREATENED FAUNA SPECIES RECORDED IN THE LOWER LODDON FLOODPLAIN WETLANDS

COMMON NAME	SPECIES	CONSERVATION STATUS
Australasian Shoveler	*Spatula rhynchotis*	vu
Australian Painted Snipe	*Rostratula australis*	EN cr L
Baillon's Crake	*Porzana pusilla*	vu L
Black Falcon	*Falco subniger*	vu N
Black-eared Cuckoo	*Chrysococcyx osculans*	nt
Black-tailed Godwit	*Limosa limosa*	vu
Blue-billed Duck	*Oxyura australis*	en L
Bony Herring	*Nematalosa erebi*	X
Brolga	*Grus rubicunda*	vu L
Brown Toadlet	*Pseudophryne bibronii*	en L
Brown Treecreeper	*Climacteris picumnus*	nt
Bush Stone-curlew	*Burhinus grallarius*	en L
Carpet Python	*Morelia spilota metcalfei*	en L
Caspian Tern	*Hydroprogne caspia*	nt L
Common Greenshank	*Tringa nebularia*	vu
Common Sandpiper	*Actitis hypoleucos*	vu
Curlew Sandpiper	*Calidris ferruginea*	CR en
Diamond Dove	*Geopelia cuneata*	nt L
Diamond Firetail	*Stagonopleura guttata*	nt L
Eastern Snake-necked Turtle	*Chelodina longicollis*	dd
Emu	*Dromaius novaehollandiae*	nt
Fat-tailed Dunnart	*Sminthopsis crassicaudata*	nt
Flat-headed Galaxias	*Galaxias rostratus*	CR vu X
Freckled Duck	*Stictonetta naevosa*	en L
Freshwater Catfish	*Tandanus tandanus*	en L
Glossy Ibis	*Plegadis falcinellus*	nt
Golden Perch	*Macquaria ambigua*	nt X
Great Egret	*Ardea alba*	vu L
Grey-crowned Babbler	*Pomatostomus temporalis*	en L
Grey-headed Flying-fox	*Pteropus poliocephalus*	VU vu L

COMMON NAME	SPECIES	CONSERVATION STATUS
Growling Grass Frog	*Litoria raniformis*	VU en L
Gull-billed Tern	*Gelochelidon nilotica macrotarsa*	en L
Hardhead	*Aythya australis*	vu
Hooded Robin	*Melanodryas cucullata*	nt L
Hooded Scaly-foot	*Pygopus schraderi*	cr L
Lace Monitor	*Varanus varius*	en
Latham's Snipe	*Gallinago hardwickii*	nt
Little Button-quail	*Turnix velox*	nt
Little Egret	*Egretta garzetta*	en L
Long-toed Stint	*Calidris subminuta*	nt
Macquarie Perch	*Macquaria australasica*	EN en L
Magpie Goose	*Anseranas semipalmata*	nt L
Major Mitchell's Cockatoo	*Lophocroa leadbeateri*	vu L
Marsh Sandpiper	*Tringa stagnatilis*	vu
Murray Cod	*Maccullochella peelii*	VU vu L
Murray Hardyhead	*Craterocephalus fluviatilis*	EN cr L
Murray River Rainbowfish	*Melanotaenia fluviatilis*	vu L
Murray River Turtle	*Emydura macquarii*	vu
Murray Spiny Crayfish	*Euastacus armatus*	nt L
Musk Duck	*Biziura lobata*	vu
Nankeen Night Heron	*Nycticorax caledonicus*	nt
Pectoral Sandpiper	*Calidris melanotos*	nt
Pied Cormorant	*Phalacrocorax varius*	nt
Plumed Egret	*Ardea plumifera*	en L
Red Knot	*Calidris canutus*	EN en
Red-backed Kingfisher	*Todiramphus pyrropygia*	nt
Red-chested Button-quail	*Turnix pyrrhothorax*	vu L
Royal Spoonbill	*Platalea regia*	nt
Ruddy Turnstone	*Arenaria interpres*	vu
Silver Perch	*Bidyanus bidyanus*	CR vu L
Spotted Bowerbird	*Ptilonorhynchus maculatus*	cr L
Spotted Harrier	*Circus assimilis*	nt
Striped Legless Lizard	*Delma impar*	VU en L

COMMON NAME	SPECIES	CONSERVATION STATUS
Swift Parrot	*Lathamus discolor*	CR en L
Unspecked Hardyhead	*Craterocephalus stercusmuscarum fulvus*	L
Whiskered Tern	*Chlidonias hybridus*	nt
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	vu L
White-winged Black Tern	*Chlidonias leucopterus*	nt
Wood Sandpiper	*Tringa glareola*	vu
Woodland Blind Snake	*Anilios proximus*	nt

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