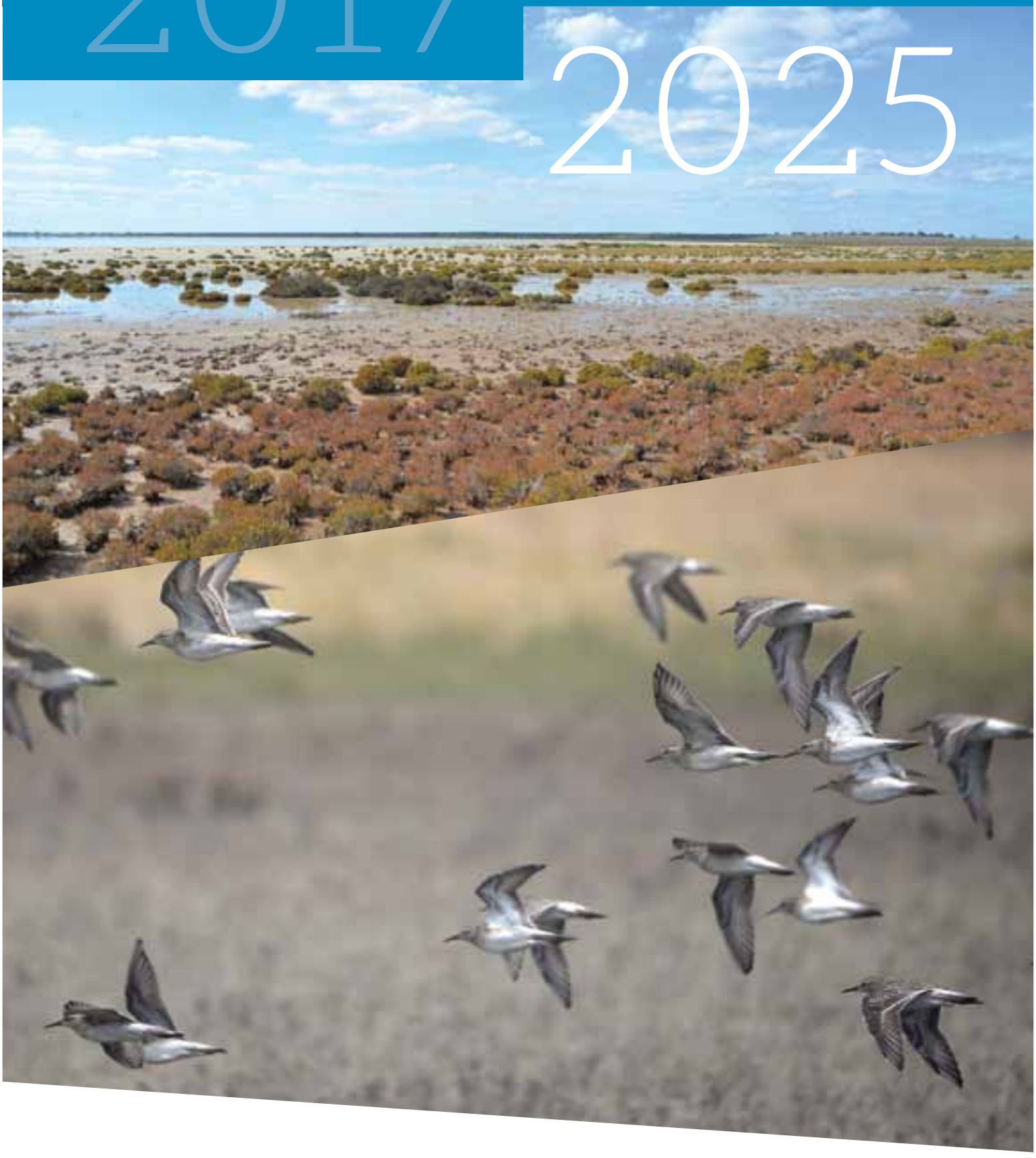
2017 KERANG WETLANDS RAMSAR SITE ACTION PLAN 2025



NORTH CENTRAL Catchment Management Authority
Connecting Rivers, Landscapes, People

VICTORIA State Government

Parks VICTORIA Healthy Parks Healthy People

GOULBURN-MURRAY WATER

GANNAWARRA Shire Council

Acknowledgement of Country

The North Central Catchment Management Authority acknowledges Aboriginal Traditional Owners within the region, their rich culture and spiritual connection to Country. We also recognise and acknowledge the contribution and interest of Aboriginal people and organisations in land and natural resource management.

North Central Catchment Management Authority

PO Box 18 Huntly Vic 3551
T: 03 5440 1800
F: 03 5448 7148
E: info@nccma.vic.gov.au
www.nccma.vic.gov.au

Acknowledgements

The North Central Catchment Management Authority (CMA) would like to thank:

- Members of the Kerang Wetlands Ramsar Action Plan Steering Committee for their input during meetings, workshops and feedback throughout the development of this document: Leeza Wishart and Bruce Wehner (Parks Victoria); Janet Holmes and Andrea Keleher (DELWP); Paul Saunders (Goulburn Murray Water); Octavian Manescu (Victorian Game Management Authority); Geoff Rollinson (Gannawarra Shire Council); Fiona Murdoch and Andrew Lush (Lower Murray Water); and Rohan Hogan (North Central CMA).
- The technical review panel: Rhonda Butcher for her guidance and expertise in development of this document; and Damien Cook for providing his considerable technical expertise and knowledge of the Kerang Wetlands.
- Mick Dedini (DELWP) and Leigh Hollingworth (Gannawarra Shire Council) for their input at the risk assessment workshop.
- Aunty Esther Kirby, Uncle Ron Galway, Uncle Ducky Charles, Uncle Neville Whyman, Sharnie Hamilton, Ken Stewart and Dixie Patton for sharing their traditional knowledge and connections to the Kerang Wetlands.
- Tom Lowe, Stan Archard, Anne Thompson, Stuart Simms, Angela Hird, Ron Kelly, Ben Hall, Colin Myers, and Keith Stockwell for sharing their considerable local knowledge and history of the Kerang Wetlands.

The author would like to thank North Central CMA staff members Bambi Lees, Michelle Maher, Adrian Martins, Louissa Rogers, Tim Shanahan, Robyn McKay, Bree Bisset and Kira Woods for providing their knowledge, data and assistance in the development of this plan.

The Kerang Wetlands Ramsar Site Action Plan 2017—2025 is part of a $222 million investment by the Victorian Government to improve the health of waterways and catchments.

Document control

Version	Date Issued	Prepared By	Reviewed By
1	July 2016	Genevieve Smith	Camille White
2	July 2016	Genevieve Smith	Project Steering Committee and Technical Reviewers
3	November 2016	Genevieve Smith	Project Steering Committee, Rohan Hogan
4	February 2017	Genevieve Smith	Project Steering Committee, community workshop participants, and Traditional Owner participants
5	April 2017	Genevieve Smith	Mal Brown
6	June 2017	Mal Brown	Genevieve Smith

Front cover from top: Lake Kelly Samphire shrubland. Sharp-tailed Sandpiper, Lake Cullen. Photography: Damien Cook

CONTENTS

CONTENTS

TABLES

TABLES

FIGURES

ACRONYMS

AAC	Activity Advisory Group
AAV	Aboriginal Affairs Victoria
ACHRIS	Aboriginal Cultural Heritage Register andInformation System
ANZECC	Australia and New Zealand Environment Conservation Council
BCDDS	Barr Creek Drainage Diversion Scheme
BE	Bulk Entitlement
Bonn CMS	The Convention on the Conservation of Migratory Species of Wild Animals (also known as the Bonn Convention)
CAMBA	China-Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authority
CPS	Components, Processes and Services
DEDJTR	Department of Economic Development, Jobs, Transport and Resources
DELWP	Department of Environment, Land, Water and Planning
DIWA	Directory of Important Wetlands in Australia
DEPI	Department of Environment and Primary Industries (Now an amalgamation, DELWP in 2015)
DPI	Department of Primary Industries (Now an amalgamation. DELWP in 2015)
DSE	Department of Sustainability and Environment (Now DELWP in 2015)
DSEWPAC	Department of Sustainability, Environment, Water, Population and Communities (now the Department of Environment and Energy)
EC	Electrical Conductivity (as it relates to salinity)
ECD	Ecological Character Description
EPBC	Environment Protection and Biodiversity Conservation Act 1999 (Cth)
EVC	Ecological Vegetation Class
EWMP	Environmental Water Management Plan
FFG	*Flora and Fauna Guarantee Act* 1988 (Vic)
GIS	Geographical Information System
GMW	Goulburn Murray Water
GMWCP	Goulburn Murray Water Connections Project
ha	hectares
IPA	Intellectual Property Agreement
IWC	Index of Wetland Condition
JAMBA	Japan-Australia Migratory Bird Agreement
km	kilometres
LAC	Limits of Acceptable Change
LMW	Lower Murray Water
MDBA	Murray-Darling Basin Authority (formerly Murray-Darling Basin Commission, MDBC)
mg/L	Milligrams per litre (a measure of electrical conductivity and salinity)
MHH	Murray Hardyhead
ML	Megalitre (one million litres)
ML/d	Megalitres per day
NCCMA	North Central Catchment Management Authority
NCWS	North Central Waterway Strategy
RAP	Regional Assessment Panel
RCS	Regional Catchment Strategy
RIS	Ramsar Information Sheet
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RCT	Resource Condition Target
SEPPs	State Environmental Planning Policies
SKM	Sinclair Knight Mertz
SWP	Seasonal Watering Proposal
TO	Traditional Owners
VAHC	Victorian Aboriginal Heritage Council
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway Management Strategy
µS/cm	Microsiemens per centimetre (measure of electrical conductivity (EC))

EXECUTIVE SUMMARY

Waders, Red-neck Stint and Red-capped Plovers.
Photo: Adrian Martins

The Kerang Wetlands Ramsar Site Action Plan 2017-2025 provides a framework for management agencies, in partnership with stakeholders, the Traditional Owners and the regional community to maintain and improve the ecological character of the Kerang Wetlands Ramsar Site.

In 1982 the Kerang Wetlands were listed as a Wetland of International Importance (Ramsar Site) under the Ramsar Convention, particularly for the critical habitat and resources it provides to support a high diversity of waterbirds and other wetland-dependent fauna. At both the overall site and individual wetland scale, the wetlands are of high environmental, cultural, social and economic importance to the region and its community.

The 2014-22 North Central Waterway Strategy (NCWS) provides an overarching regional strategy for the Kerang Wetlands Ramsar Site. The NCWS supports both national and state frameworks for managing Ramsar Sites in Australia and Victoria. However, current management arrangements at the Kerang Wetlands Ramsar Site are complex, as the site includes a variety of ecologically and hydrologically distinct wetland types, and a range of reserves with varying management purposes and land managers. In recognition of the complexities of management at the Kerang Wetlands Ramsar Site, one of the priority actions under the NCWS is to develop a detailed action plan in coordination with the multiple stakeholders with a role in managing these wetlands. Through a consultative process, the *Kerang Wetlands Ramsar Site Action Plan* (the *Action Plan*) recommends specific actions at each wetland over the next eight years, from 2017 to 2025, which will ensure the ecological character of the Ramsar Site as a whole is maintained, and where practicable, improved.

The primary objective of the Action Plan is:

> **"To maintain, and where necessary improve, the ecological character and promote conservation and wise use of the site."**

This aligns with the long-term resource condition target for the Kerang Wetlands Ramsar Site outlined in the NCWS:

> **"Protect and improve the ecological character of the Ramsar wetlands as measured by the Ecological Character Description."**

The Action Plan will achieve this by:

- Recommending specific management actions at each wetland
- Establishing a framework for strong coordination of management activities amongst the various site managers and stakeholders
- Establishing a framework for monitoring, evaluation, reporting and improvement.

Previous page: Eurasian Coots, Hird Swamp.
Photo: Damien Cook

Consultation

Stakeholder engagement for the Action Plan built on the approach undertaken for the NCWS and aligns with the Australian Ramsar Management Principles.

The Project Steering Committee (PSC), which oversaw the development of the Action Plan, comprised representatives from Goulburn Murray Water; Parks Victoria; Department of Environment, Land, Water and Planning; Gannawarra Shire Council; North Central Catchment Management Authority; and the Game Management Authority.

Barapa Barapa and Wamba Wamba First Peoples are recognised as the custodial stewards of the Kerang Wetlands. The involvement of First Nations people in the development of this Action Plan was essential in order to produce an effective and inclusive plan for the wetlands. The involvement of First Nations people has ensured that Aboriginal knowledge and cultural values are accurately and appropriately incorporated into the Action Plan; that management actions are culturally appropriate; and that opportunities are identified for future partnerships between Aboriginal people, land managers and other stakeholders in managing the Kerang Wetlands Ramsar Site.

Targeted engagement with the local community in developing the Action Plan allowed for the involvement of individuals known to be familiar with the wetlands in a range of capacities. The local community has filled key ecological and historical knowledge gaps; assisted in identifying a range of values across the Ramsar Site; and identified opportunities for partnerships with community groups to enhance the community experience of the site.

Technical experts in various fields were contacted individually for advice at various stages during the development of the Action Plan and invited to attend the risk assessment workshop and review the draft plan.

Key values and threats

A review of published and unpublished technical literature and datasets relating to the Kerang Wetlands Ramsar Site was undertaken to assist in identifying the ecological, cultural, social and economic values of the wetlands. This was augmented by discussions with agency stakeholders and experts, as well as the Traditional Owners and the local community. These activities assisted in identifying the key threats to those values, as well as any knowledge gaps.

Risk assessment was identified as a critical tool to inform how to manage threats and associated stressors that may adversely impact on Ramsar values. Over 105 threats to the values across the Kerang Wetlands Ramsar Site were identified. Some applied to all wetlands, while others were specific to a wetland type or to individual wetlands. The full risk assessment can be viewed in Appendix 4.

Resource Condition Targets

To develop appropriate management actions and ensure that they meet the overarching goal of maintaining the ecological character of the Ramsar Site, resource condition targets (RCTs) were developed for each key Ramsar value (Table 15). Where relevant, the targets have been developed for specific wetlands. Appendix 4 describes how the RCTs were derived.

The timeframe for achieving all RCTs is included within the eight-year life of the Action Plan, from 2017 to 2025, unless otherwise specified. It should be noted, however, that some indicators may take longer to become measurable, or may be confounded by extended periods of climatic stress, such as drought. In general, by 2025 there should be demonstrable progress towards the targets.

Agency staff and technical experts were consulted in developing the RCTs, and these were confirmed and refined with the PSC. Some RCTs may be refined as additional data is collected in the early stages of the life of the Action Plan.

Management Action Plans

The aim of developing specific management actions for the overall Ramsar Site and for individual wetlands is to assist the various land managers and partner agencies to understand what is required to improve or maintain the ecological character of the Ramsar Site. Unless specified, the time frame for achievement of all actions is within the eight-year life of this Action Plan up to 2024.

With agreement from the PSC, the scope of this Action Plan has been broadened beyond the specified Ramsar values (ecological) to consider the social and cultural aspects of the wetlands, which are in most cases considered to be interlinked with the ecology of the site.

Lead agencies have been identified for each action, as well as partners. The assignment of lead agencies should not preclude other agencies or interest groups from seeking funding to undertake management activities independently.

The achievement of all management actions is dependent on the availability of resources. All actions in the Action Plan are subject to available funding. Lead agencies and partners will seek investment to implement the Action Plan. All costs provided in this plan are indicative only and require further scoping prior to investment.

Vegetation at Lake Bael Bael.
Photo: Adrian Martins

Johnson Swamp

Monitoring

Currently, there are no structured monitoring programs that occur consistently across the Kerang Wetlands Ramsar Site. The majority of assessment programs that do exist have limited funding, timelines and scope. This has implications for maintaining an up-to-date understanding of the status of the ecological character of the wetlands. Section 7.1 provides an indication and recommendations for the monitoring that is required at the Kerang Wetlands Ramsar Site to monitor critical Ramsar values and key threats.

A more detailed and specific monitoring program will be developed to complement this Action Plan, that will include specific methodologies to monitor progress towards RCTs for the components, processes and services (CPS), threats to ecological character, and address knowledge gaps. The intention is that a stronger monitoring program across the site will assist in accurately assessing the status of the ecological character of the site. This will be developed in 2017.

Implementation

An action identified in the NCWS is the establishment of a coordinating committee to ensure integrated management of the Kerang Wetlands Ramsar Site. The PSC for this Action Plan, in combination with an existing committee already in operation, will work together to form the coordinating committee. It is envisaged that the coordinating committee will build on previous and current collaboration efforts to develop integrated delivery approaches; inform annual action planning; support cross-agency investment opportunities; coordinate monitoring, evaluation of implementation, and reporting; and review progress of the Action Plan at annual or bi-annual intervals.

Ongoing strong partnerships between management agencies, Traditional Owners, community groups and individuals are critical to the successful implementation of the Action Plan.

The Action Plan provides a clear direction and priorities for management over the next eight years. The successful implementation of the Action Plan will be influenced by available funding and strong agency and community support. Investment proposals to support actions of the Action Plan will be developed as investment opportunities arise.

The North Central CMA, in conjunction with ecologists and land managers, will lead the development of a works program to identify specific locations at each wetland that require conservation, protection or rehabilitation works. This will be undertaken in 2017.

1 INTRODUCTION

In 1982 the Kerang Wetlands were listed as a Wetland of International Importance (Ramsar Site) under the Ramsar Convention. The ***2014-22 North Central Waterway Strategy*** (NCWS) provides an overarching management plan for the Kerang Wetlands Ramsar Site that sits within the framework for managing Ramsar Sites in Australia and the state of Victoria. The NCWS includes a strategic works program of management activities for priority wetlands in the North Central CMA region, including Ramsar Sites.

Current management arrangements at the Kerang Wetlands Ramsar Site are complex. This is because the site includes a variety of ecologically and hydrologically distinct wetland types; a range of reserves with varying management purposes and several land managers. At both the overall site and individual wetland scales, the wetlands are of high environmental, cultural, social and economic importance to the region and its community.

In recognition of the complexities of management at the Kerang Wetlands Ramsar Site, one of the priority actions under the NCWS is to develop a detailed Action Plan in coordination with the multiple stakeholders who have a role in managing these wetlands. Through a consultative process, the *Kerang Wetlands Ramsar Site Action Plan* recommends specific actions at each wetland over the next eight years, from 2017 to 2025, which will ensure the ecological character of the Ramsar Site as a whole is maintained, and where practicable, improved.

1.1 Kerang Wetlands Ramsar Site Action Plan Objectives

The primary objective of the Kerang Wetlands Ramsar Site Action Plan (the Action Plan) is:

> **"To maintain, and where necessary improve, the ecological character and promote conservation and wise use of the site."**

This aligns with the long-term Resource Condition Target (RCT) for the Kerang Wetlands Ramsar Site outlined in the NCWS:

> **"Protect and improve the ecological character of the Ramsar wetlands as measured by the Ecological Character Description."**

The Action Plan will achieve this by:

- Recommending specific management actions at each wetland
- Establishing a framework for strong coordination of management activities amongst the various site managers and stakeholders
- Establishing a framework for monitoring, evaluation, reporting and improvement.

1.2 The Ramsar Convention in Australia

The Convention on Wetlands of International Importance (the Ramsar Convention) is an intergovernmental treaty which aims to halt and, where possible, reverse the worldwide loss of wetlands and conserve those that remain. The Ramsar Convention provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Australia was one of the first signatories to the Convention which was signed in Ramsar, Iran, in 1971. The Kerang Wetlands were listed as a Wetland of International Importance under the Ramsar Convention in 1982.

1.2.1 Ecological Character

As a contracting party to the Ramsar Convention, Australia is required to maintain the ecological character of Ramsar Sites, and to develop and implement planning to promote the sustainable, wise use of wetlands.

The ecological character is defined by the Convention as "the combination of the ecosystem components, processes and benefits/services that characterise the wetlands at a given point in time". A change in ecological character is defined as "the human induced adverse alteration of any ecosystem component, process and or ecosystem benefit/service". Under Article 3.2 of the Ramsar Convention, a notification of change is required if the ecological character of the site has changed, is changing or is likely to change as a result of human interference.

Ramsar Site management in Australia involves the establishment and regular review of key documents and processes. These are:

Ecological Character Description (ECD): The ECD of a wetland provides the baseline description of the wetland at a given point in time (usually at the time of listing) and can be used to assess changes in the ecological character of these sites (Department of Environment 2016). An ECD was completed for the Kerang Wetlands Ramsar Site in 2011 (KBR 2011), with a recent review and update in 2016 (Butcher and Hale in prep.). The 2011 ECD and draft addendum identify the ecosystem services/benefits (values) and physical, chemical and biological ecosystem components and processes that are considered critical to the ecological character of the Ramsar Site. They also define the limits of acceptable change (LACs) for the critical components, processes and services (CPS).

Previous page: Waders, Red-neck Stint and Red-capped Plovers at Lake Cullen.
Photo: Adrian Martins

Ramsar Information Sheet (RIS): The RIS is a reporting mechanism to the Ramsar Secretariat that provides essential data on each Ramsar Site, in order to allow analysis of Ramsar-listed wetlands around the world, provide baseline data for measuring changes in the ecological character, and provide material for publications which inform the public about Ramsar Sites. Contracting parties have committed to providing updated RISs at intervals of six years or when there are significant changes to the ecological character. An update of the 1999 RIS for the Kerang Wetlands Ramsar Site is currently under development.

Ramsar Rolling Review: Australia monitors the ecological character of its Ramsar Sites through a national Ramsar Site rolling review every three years, and reports the findings in Australia's national report to the Conventions of Contracting Parties to the Ramsar Convention. The rolling review provides regular information on the status of a site's ecological character, which then informs targeted management actions required to address the highest priority threats. The last Kerang Wetlands review was done in 2015.

Management planning: Management of Victoria's Ramsar Sites was previously covered by individual Ramsar Site management strategies. The previous Kerang Wetlands Ramsar Site management plan was completed in 2004 (DSE 2004). However, the 2013 Victorian Waterway Management Strategy (VWMS) established a new policy of incorporating Ramsar Site management planning in regional waterway strategies for most sites. The overarching Kerang Wetlands management plan is embedded in the NCWS. Given the complexities of the site, however, it was deemed that a more detailed approach to developing management actions for the site was required.

The Action Plan is not intended to replace the management plan for the Ramsar Site set out in the NCWS. Instead, it augments the NCWS by providing additional specific guidance to management agencies. The Action Plan has been prepared in accordance with the relevant Australian Ramsar management principles (Schedule 6, Environment Protection and Biodiversity Conservation Regulations 2000). These principles are set out in Appendix 1.

Bird watching at the Kerang Wetlands Ramsar Site

1.3 Roles and responsibilities for Ramsar obligations in the Australian context

The act of designating a wetland as a Ramsar Site carries with it certain obligations, including managing the site to retain its ecological character and to have procedures in place to detect if any threatening processes are likely to, or have altered the ecological character (Ramsar 2005). The expectation is that Ramsar Sites are listed in perpetuity. As a Contracting Party to the Ramsar Convention, Australia is obliged to promote the conservation of listed sites including considering appropriate management measures after designation. Meeting Australia's obligations under the Ramsar Convention is a shared responsibility across the Australian, state and territory governments as well as site managers.

The *Australian National Guidelines for Ramsar Wetlands* (DSEWPAC 2012) sets out the obligations and responsibilities for managing Ramsar Sites. Those relevant to the Kerang Wetlands Ramsar Site are set out in Figure 1.

1.3.1 Australian Government

The Australian Government is responsible for:

- working with state and territory governments to promote the conservation of Ramsar sites, and review Ramsar site condition;
- reporting any changes to the ecological character of Australia's listed wetlands and responding to the Secretariat's inquiries about reports from third parties (Ramsar Convention 2002a);
- using its best endeavours to ensure there are management plans for wetlands listed under the Ramsar Convention that are not wholly within Commonwealth areas;
- regulating actions that will have, or are likely to have, a significant impact on the ecological character of a Ramsar wetland. This includes relevant actions that occur outside the boundaries of a Ramsar wetland;
- providing advice on the Ramsar Convention and any agreed assistance to wetland managers; and
- reporting to the regular Conference of the Contracting Parties.

1.3.2 State governments

The state governments are responsible for:

- coordinating and updating information on Ramsar sites within the state (e.g. Ramsar National Report).

In addition to the above, the state government is the site manager or landowner for many sites and has the same management responsibilities as outlined in the site manager section below.

1.3.3 Site Managers/ Landowners

The site manager is generally the landowner or legal manager of the land within the Ramsar site.

The site manager/landowner is required under the EPBC Act to seek approval prior to undertaking an action within or outside a declared Ramsar wetland if the action has, will have or is likely to have a significant impact on the ecological character of the Ramsar wetland. The action could be a project, a development, an undertaking, an activity or series of activities, or an alteration to any of these things.

Site managers/landowners are encouraged to consider the Australian Ramsar Management Principles (Appendix 1) when developing management arrangements, including:

- managing the Ramsar site(s) to maintain ecological character through applying the principles of wise use and sustainable resource management. This may be through the development and implementation of a management plan or system for the site;
- having procedures and monitoring in place to detect if any threatening processes are likely to, or have altered the site's ecological character. This will help to identify if there are any actual or likely changes to ecological character of the site; and
- taking action to manage or remediate Ramsar sites that have undergone an actual or likely change in ecological character.

Site managers/landowners are also encouraged to:

- report any actual or likely changes in ecological character to the Australian Government;
- undertake required site level updates and reporting as required (e.g. Ramsar Information Sheet updates);
- seek guidance and assistance about managing and representing the needs of wetlands, if required;
- inform the Australian and relevant state governments of any intention to transfer ownership or otherwise sell land on which the wetland is situated; and notify future land managers of the property's Ramsar status, should the property be sold or otherwise change ownership.

Figure 1. Roles and responsibilities for Ramsar management in Australia (DSEWPAC 2012).

1.4 Roles and responsibilities for the Kerang Wetlands Ramsar Site

Many different entities are responsible for various aspects of management of the Kerang Wetlands Ramsar Site. Roles and responsibilities for the management of Ramsar wetlands in Australia have been documented by the Australian government (DSEWPAC 2012). In addition, there are a range of organisations and communities that have a role in managing the Kerang Wetlands Ramsar Site. Table 1 outlines roles and responsibilities for organisations specific to the Kerang Wetlands Ramsar Site, as identified in the NCWS (North Central CMA 2014).

Kerang Weir Pool and Back Swamp

Table 1. Lead management agencies, organisations and communities of the Kerang Wetlands Ramsar Site and their roles and responsibilities (adapted from North Central CMA 2014).

Partners	Roles and responsibilities
	State government agencies and statutory bodies
Department of Environment, Land, Water and Planning (DELWP)	The Department of Environment, Land, Water and Planning (DELWP) is responsible for developing waterway policy, co-ordinating the implementation of and reporting on the Ramsar Convention in Victoria, co-ordinating regional delivery and prioritisation of Government investment in waterways. DELWP is also responsible for sustainable water resource management; catchment planning for integrated catchment management; managing biodiversity and threatened species; and managing public land, including licensing and compliance; bushfire management. Specifically for the Kerang Wetlands Ramsar Site, DELWP provides policy advice on Ramsar management; biodiversity and threatened species; and statutory approvals.
Department of Economic Development, Jobs, Transport and Resources (DEDJTR)	The Department of Economic Development, Jobs, Transport and Resources (DEDJTR) is responsible for sustainable fisheries and recreational fishing in waterways; investing in and delivering farming programs on private land where waterways occur, including those adjacent to the Kerang Wetlands; overseeing the management of biosecurity, including aquatic invasive species; and providing strategic and operational catchment management services including salinity management, water quality monitoring and management.
Parks Victoria (PV)	Parks Victoria manages parks and conservation reserves in which many waterways are located, including national, state, wilderness, metropolitan and regional parks, marine national parks and conservation and natural features reserves. PV creates, manages and maintains visitor sites and manages a range of assets, including visitor facilities and access points, piers and jetties, sporting facilities and navigation aids, many of which are associated with waterways. Specifically, PV is the designated land manager for 12 wetlands in the Kerang Wetlands Ramsar Site.
Victorian Environmental Water Holder (VEWH)	The Victorian Environmental Water Holder (VEWH) is appointed under the Water Act 1989 to manage Victoria's environmental water entitlements. The VEWH works with the waterway managers, Commonwealth Environmental Water Holder (CEWH), Murray–Darling Basin Authority, storage operators and land managers to ensure environmental water entitlements are used to achieve the best environmental outcomes. The VEWH works with North Central CMA and other stakeholders to enable delivery of environmental water to three wetlands in the Kerang Wetlands Ramsar Site, including Lake Cullen, Johnson Swamp and Hird Swamp.
North Central Catchment Management Authority (CMA)	Established under the *Catchment and Land Protection Act 1994* the North Central CMA is the designated responsible manager of waterways, drainage and floodplains in the North Central CMA region. The North Central CMA's key functions include authorising works on waterways and acting as a referral body for planning applications and licences for water extraction; regional strategic and operational planning for waterway health and management; identifying regional priorities for environmental watering and facilitate water delivery; providing input and assistance in managing regional drainage, water allocation processes; and responding to natural disasters and incidents affecting waterways such as bushfires and floods. The North Central CMA works with land managers of the Kerang Wetlands to enable delivery of environmental water, undertake environmental and cultural heritage conservation works and undertake strategic and operational planning for management of the Ramsar Site.

Partners	Roles and responsibilities
State government agencies and statutory bodies	
Game Management Authority (GMA)	The Game Management Authority (GMA) is an independent statutory authority responsible for the regulation of game hunting in Victoria. GMA is responsible for issuing game licences, managing open and closed seasons for game species, enforcing game hunting laws, and educating the hunting community on how to hunt legally and responsibly. The GMA has an important role across Victoria to ensure the sustainable harvest of game species, the humane treatment of animals in relation to hunting, the minimisation of any negative impacts on non-game wildlife, including protected and threatened species, and the conservation of wildlife habitats. As many of the wetlands within the Kerang Wetlands Ramsar Site are State Game Reserves or public land open to hunting, the GMA is responsible for regulating hunting activities in the area, undertaking surveys and analysis to understand the potential impacts of game hunting and management, and working with partner agencies to ensure optimal management of public land where hunting is permitted.
Environment Protection Authority Victoria	The Environment Protection Authority Victoria (EPA) is an independent body responsible for the protection and improvement of Victoria's environment by establishing environmental standards, regulating and working with organisations to meet these standards. At the Kerang Wetlands, they may assist to monitor water quality; investigate polluting incidents; and licence sewage and other discharges, including at Fosters Swamp.
Water corporations	
Goulburn Murray Water Lower Murray Water	Water corporations in Victoria are established under the *Water Act 1989* and provide a range of water services to customers within their service areas. Water corporations provide a combination of irrigation services, domestic and stock services, bulk water supply services and urban water and wastewater services in the North Central CMA Region. Specifically, Goulburn Murray Water is the designated land manager for 11 wetlands within the Kerang Wetlands Ramsar Site. They are also responsible for the operation of water infrastructure; water resource management in the permanent wetlands and salt disposal basins; and assist in regional strategic and operational planning for delivery of environmental water. Lower Murray Water is the manager of the Kerang Sewage Treatment Plant that discharges into Fosters Swamp. They manage the sewage ponds which are not part of the wetland, but are within the Ramsar Site.
Local government	
Gannawarra Shire Council	Councils are involved in managing waterways in Victoria through their role as responsible planning authorities, managers of stormwater drainage and on-site domestic wastewater systems, users of integrated water systems, land managers, emergency management bodies, and supporters of community groups. Specifically, Gannawarra Shire Council acts as a Committee of Management over part of Kangaroo Lake and the rehabilitated landfill at Cemetery Swamp. They are also responsible for providing strategic direction and implementation on tourism and community experience across the Ramsar Site.
Traditional Owners	
Traditional Owner Boards/ Councils	Traditional Owners (TOs), with recognised native title rights or formal agreements with the State, are important in land and water management. The TOs of the Kerang Wetlands are Barapa Barapa and Wamba Wamba. At present, the Native Title claim that encompasses the Kerang Wetlands is unresolved, however the ongoing engagement of the TO groups in strategic and operational planning and works is essential to the sustainable, appropriate management of the Kerang Wetlands Ramsar Site.
Community	
Landholders	Landholders near or adjacent to the Kerang Wetlands can have an impact on the Ramsar Site, as works on private land, or land management practices, can have a substantial impact on catchment health. Under the *Catchment and Land Protection Act 1994* landholders are required to protect water resources; avoid causing or contributing to land degradation which causes, or may cause, damage to land of another owner; conserve soil; eradicate regionally prohibited weeds and prevent the growth and spread of regionally controlled weeds; and prevent the spread of, and as far as possible eradicate, established pest animals.
Community groups	Community individuals or groups (such as Landcare, Waterwatch, 'Friends of' groups) participate in regional planning, priority setting and implementing regional works programs. They also participate in monitoring and reporting of waterway condition and can undertake projects in priority areas. There are a number of community groups that operate in and around the Kerang Wetlands that can undertake important conservation works, provide important information or data, and spread awareness of the importance of the site.

1.5 Policy context

A range of natural resource management legislation, policies and strategies at international, federal, state and regional levels has influence over governance of the Kerang Wetlands Ramsar Site. A summary of these is presented in Table 2 with more detail provided in Appendix 2.

Australasian Bittern, Lake Cullen. Photo: Damien Cook

Table 2. Relevant legislation, policy and strategies for management of the Kerang Wetlands Ramsar Site.

International treaties and agreements
Ramsar Convention In 1982 the Kerang Wetlands were listed as a Wetland of International Importance under the Ramsar Convention. The Ramsar Convention provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
Bilateral agreements and conventions for migratory species – Japan – Australia Migratory Bird Agreement (JAMBA): the Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds in Danger of Extinction and their Environment, 1974 – China – Australia Migratory Bird Agreement (CAMBA): the Agreement between the Government of the People's Republic of China and the Government of Australia for the Protection of Migratory Birds and their Environment, 1986 – Republic of Korea – Australia Migratory Bird Agreement (ROKAMBA): the Agreement between the Government of the Republic of Korea and the Government of Australia for the Protection of Migratory Birds and their Environment, 2006 – Convention on the Conservation of Migratory Species of Wild Animals (known as CMS or Bonn Convention) – adopts a framework in which countries with jurisdiction over any part of the range of a particular species cooperate to prevent migratory species becoming endangered. For Australian purposes, many of the species are migratory birds.
Indigenous peoples The Australian Government has ratified several international human rights instruments that recognise and protect Indigenous peoples' special connection to land and waters and provide for the right to practice, revitalise, teach and develop culture, customs and spiritual practices and to utilise natural resources (for example, the United Nations Declaration of Rights of Indigenous Peoples). The Ramsar Culture Network has also developed the *Guiding principles for taking into account the cultural values of wetlands for the effective management of sites*, used in development of this Action Plan.
Federal legislation and policy
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places defined in the Act as matters of national environmental significance. The EPBC Act also establishes a framework for managing Ramsar-listed wetlands through the Australian Ramsar Management Principles (Appendix 1).
Native Title Act 1993 *The Native Title Act 1993* (Cth) provides a framework for the protection and recognition of native title.
Water Act 2007 *The Water Act 2007* (Cth) established the Murray-Darling Basin Authority (MDBA) and requires the MDBA to prepare and implement the Basin Plan – a strategic plan for the integrated and sustainable management of water resources in the Murray-Darling Basin.
Murray-Darling Basin Plan The *Murray-Darling Basin Plan* provides guidance to governments, regional authorities and communities to sustainably manage and use the waters of the Basin. The overarching aim of the plan is to strike a balance between access to water for Basin communities and provision of adequate water for the environment (MDBA 2016).

Victorian state legislation

Aboriginal Heritage Act 2006

All Aboriginal places, objects and human remains are protected under the *Aboriginal Heritage Act 2006*. The Act provides for the management of Victoria's cultural heritage.

The *Aboriginal Heritage Amendment Act 2016* (the Amendment Act) establishes new provisions and changes to the *Aboriginal Heritage Act 2006*.

Catchment and Land Protection Act 1994

The *Catchment and Land Protection Act 1994* provides an integrated catchment management framework and facilitates the management and wise use of land and water resources at a whole-of-catchment scale. Catchment management authorities (CMAs) are established under this Act to develop and implement a regional catchment strategy.

Crown Land (Reserves) Act 1978

Under the *Crown Land (Reserves) Act 1978*, land is reserved for a variety of public uses, managed either by DELWP, or another land manager on their behalf. Amongst the Kerang Wetlands, this is Parks Victoria and Goulburn Murray Water.

Environment Protection Act 1970

The *Environment Protection Act 1970* provides a regulatory framework for protection of environmental assets, particularly water quality. The Act aims to prevent pollution and environmental damage by setting environmental quality objectives and establishing programs to meet them.

Fisheries Act 1995

The *Fisheries Act 1995* provides for the regulation, management and conservation of fisheries and aquatic habitats, together with the reform of law relating to fisheries.

Flora and Fauna Guarantee Act 1988 (FFG Act)

This is the key piece of Victorian legislation for the conservation of threatened species and communities and for the management of potentially threatening processes.

Parks Victoria Act 1998

The *Parks Victoria Act 1998* enables Parks Victoria to provide services to the State and its agencies for the management of parks, reserves and other public land.

Planning and Environment Act 1987

The *Planning and Environment Act 1987* establishes objectives for planning in Victoria and outlines the planning process and requirements for planning schemes. Under all Victorian Planning Schemes a planning permit is required to remove, lop or destroy native vegetation, including dead trees of a particular height or width, unless a relevant exemption applies.

Water Act 1989

The *Victorian Water Act 1989* provides the framework for allocating surface water and groundwater throughout Victoria. The Act details the Crown's entitlements to water and private entitlements to water from all rivers, streams and groundwater systems in Victoria.

Wildlife Act 1975

The *Wildlife Act 1975* provides for the protection of all native wildlife and habitat. Regulations under the Act ensure that the consumptive use or other interactions with flora and fauna in Victoria does not threaten the sustainability of wild populations, while facilitating cultural and recreational pursuits in a humane, safe, ethical and sustainable manner. The Act regulates the hunting, trading and taking of wildlife. The Act also provides fo the establishment of State Game Reserves. Many of the Kerang Wetlands are also State Game Reserves.

Victorian state policy and strategies

Victorian threatened flora and fauna species advisory lists

The Threatened Species Advisory Lists are maintained by the Victorian Government and are based on technical information and advice obtained from a range of experts. There are no direct legal requirements or consequences that flow from inclusion of a species in advisory lists, although their habitat is afforded some protection through the permitted clearing of native vegetation – Biodiversity Assessment Guidelines.

Victorian Waterway Management Strategy (VWMS)

This strategy outlines the direction for the Victorian Government's investment over an eight year period (beginning in 2012-13). The overarching management objective is to maintain or improve the environmental condition of waterways to support environmental, social, cultural and economic values (DEPI 2013a). Chapter 12 of the strategy sets out actions for Ramsar sites.

River Red Gum Parks Management Plan (under development)

Parks Victoria is developing a management plan for parks and conservation reserves under its management. The plan will guide the protection of Victoria's River Red Gum floodplain parks and reserves, which includes wetlands, cultural sites and the management of tourism and recreation in these areas. The final plan is expected in 2017 and will include conservation reserves in the Kerang Wetlands Ramsar Site managed by Parks Victoria.

Sustainable Hunting Action Plan

The Sustainable Hunting Action Plan outlines the direction for investment to ensure the long-term sustainability of hunting in Victoria, including promoting responsible hunting, improving hunting, improving hunting opportunities and maximising the economic, environmental and social benefits of the sport.

Regional strategies and plans
North Central Regional Catchment Strategy (RCS)
The 2013-19 North Central RCS provides the long-term vision for natural resource management in the North Central CMA region. It sets regional priorities for managing natural assets, and also sets the overall direction for investment and coordination. The Kerang Wetlands is identified as a key priority wetland asset in the RCS that supports highly depleted wetland types and significant threatened flora and fauna species.
North Central Waterway Strategy (NCWS)
This regional strategy (2014 – 2022) is an action out of the VWMS. The NCWS is an integrated strategy for managing and improving the region's waterways (rivers, streams and wetlands). The NCWS incorporates provisions for the management planning of Ramsar sites, including the Kerang Wetlands. The management planning arrangements set out in the strategy supersede the *Kerang Wetlands Ramsar Site Strategic Management Plan 2004*.
Local plans
Environmental Water Management Plans
Environmental Water Management Plans are ten year management plans that set out long-term objectives for the priority environmental values of a wetland, and outline a watering regime to achieve these objectives. Within the Kerang Wetlands Ramsar Site, environmental water management plans are complete for Lake Cullen, Johnson Swamp and Hird Swamp.
Land and On-water Management Plans
Goulburn Murray Water facilitates the preparation of land and on-water management plans for specific water storages. These plans aim to provide guidance for Goulburn Murray Water and other agencies to manage activities, facilities and development on and around the storages. Amongst the Kerang Wetlands, land and on-water management plans will be developed for Lake Charm and Kangaroo Lake.

1.6 Consultation

Stakeholder engagement for the Action Plan built on the approach undertaken for the NCWS and aligns with the Australian Ramsar Management Principles. The major stakeholders involved in developing this Action Plan are included here.

Traditional owner engagement for the Action Plan.

1.6.1 Project Steering Committee

The Project Steering Committee (PSC) included representatives of agencies with responsibility for some aspect of management of the Ramsar Site, including Parks Victoria (PV), Goulburn Murray Water (GMW), North Central CMA, Department of Environment, Land, Water and Planning (DELWP), Game Management Authority (GMA), Gannawarra Shire Council, Lower Murray Water (LMW), and the Victorian Environmental Water Holder (VEWH). The Steering Committee was involved in the risk assessment, developing resource condition targets and actions, as well as being interviewed separately to gain an understanding of current management arrangements at the Kerang Wetlands.

1.6.2 Traditional Owners

Barapa Barapa and Wamba Wamba First Peoples are recognised as the custodial stewards of the Kerang Wetlands. Involving First Nations people in developing the Action Plan was essential in order to produce an effective and inclusive Plan for the wetlands. Their involvement has ensured that Aboriginal knowledge and cultural values are accurately and appropriately incorporated into the Action Plan; that management actions are culturally appropriate; and has assisted in identifying opportunities for future partnerships between Aboriginal people, land managers and other stakeholders in managing the Kerang Wetlands Ramsar Site. Developing the Action Plan has been guided by the Ramsar Culture Network's *'Guiding Principles for taking into account the cultural values of wetlands for the effective management of sites'*.

Engaging with the Traditional Owners (TOs) involved a two-day site visit to the Kerang Wetlands, and included Barapa Barapa and Wamba Wamba TOs and North Central CMA staff. During the site visit, TOs pointed out important cultural resources and discussed the history, importance and management of the site. As an additional method of gathering information, each TO was provided with a survey adapted from the 'Barapa Cultural Health Assessments Project' recently undertaken in nearby Gunbower Forest. The survey is based on the Indigenous Water Assessment tool under development by the Murray Lower Darling Rivers Indigenous Nations.

Aboriginal intellectual property consists of intangible cultural expressions such as stories, songs, language, tradition and knowledge. This intellectual property is linked to an individual's sense of identity and connection to Country. There have been instances where Aboriginal intellectual property has been misappropriated, misused or used without authority. There are also opportunities for Aboriginal people to benefit from partnerships where the

sharing of intellectual property will achieve mutual outcomes, i.e. to conserve cultural heritage. In these circumstances free, prior and informed consent must be given and the nature, extent and use must be agreed to, and culturally appropriate. The Ramsar guiding principles support the protection of intellectual property and encourage the development of intellectual property agreements.

Establishing an intellectual property agreement with the TOs recognises their rights of ownership over their intellectual property while allowing for it to be shared and/or collected for the purposes of achieving the specific project's objectives.

In developing the Action Plan, engagement with TOs was subject to an Intellectual Property Agreement (IPA) with the participants. The specific project objectives are to:

- Determine the cultural values of the Kerang Wetlands that should be considered by management agencies during planning and delivery of projects

  Promote awareness of and respect for Barapa Barapa and Wamba Wamba culture and values

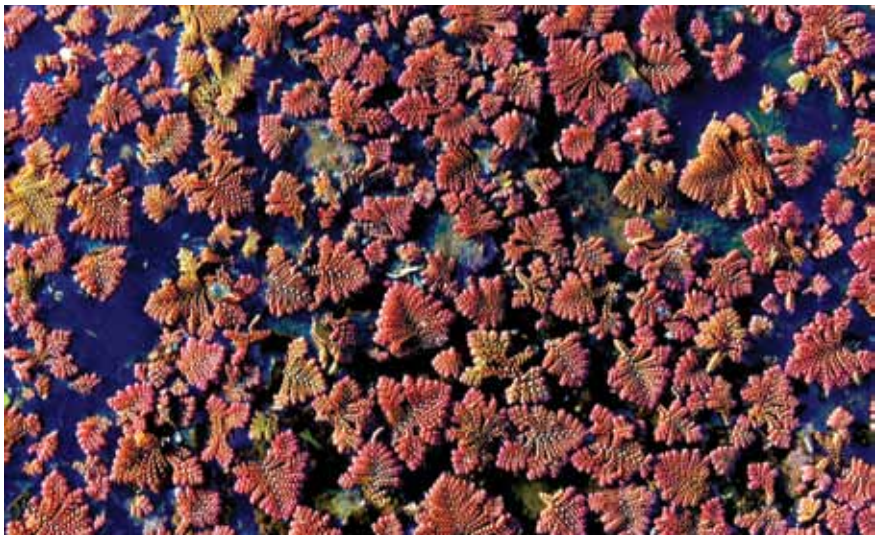
  Foster increased opportunities for Barapa Barapa and Wamba Wamba people to become more involved in management of the Ramsar Site.

The information that was gathered was for the purposes of:

  Describing the cultural importance and values of the Kerang Wetlands

  Describing management activities relating to cultural values and engagement with Barapa Barapa and Wamba Wamba.

See Section 2.5 for further discussion of the cultural values and importance of the Kerang Wetlands.



Azolla

1.6.3 Community engagement

Engaging with the local community in developing the Action Plan took the form of targeted engagement with individual community members known to be familiar with the wetlands in a range of capacities. The individuals had participated in a range of community-based organisations or groups, including the local Kerang Landcare, Birdlife Australia, Field and Game, the Central Murray Wetlands Environmental Water Advisory Group, the Salinity Management Plan consultative committees, irrigation advisory boards and committees, as well as having been consulted as community members for previous investigations. A number of people have also worked on the land and are familiar with local floodplain, irrigation and infrastructure projects. These individuals were recommended through discussions with the Project Steering Committee and/or as people who had contributed to previous management planning undertaken by the North Central CMA or other agencies.

See Section 2.6 for further discussion of the community values and importance of the Kerang Wetlands.

1.6.4 Technical expertise

Technical experts in various fields were contacted individually for advice and input at various stages of the Action Plan development, and were invited to attend the risk assessment workshop and review the draft Action Plan.

2 RAMSAR SITE OVERVIEW

2.1 Site location

The Kerang Wetlands Ramsar Site is located approximately 250 km north of Melbourne in the state of Victoria in south-east Australia (Figure 2). The Ramsar Site is a cluster of 23 distinct wetlands that cover an area of 9,793 ha, and is part of a larger system of wetlands on the lower floodplains of the Murray, Loddon and Avoca Rivers.

Brolga nest, Johnson Swamp.
Photo: Damien Cook

Cemetery Swamp

2.2 Catchment setting

The Kerang Wetlands Ramsar Site stretches from Lake Tutchewop, northwest of Kerang, to Hird Swamp in the southeast. The Ramsar Site is recognised for its diversity of wetland types, including freshwater, brackish and saline wetlands. The site features a variety of permanent and temporary wetlands, including permanent open freshwater lakes, permanent freshwater marshes, freshwater tree-dominated wetlands, shrub-dominated wetlands, intermittent saline/brackish lakes, permanent saline/hypersaline lakes. Part of one wetland functions as a wastewater treatment area. The wetlands are situated at the junction of three large river systems, receiving water from the Murray River (via the Torrumbarry Irrigation System), and the Avoca and Loddon Rivers.

Within the surrounding landscape, the wetlands in the Ramsar Site form part of a much larger system of over 120 wetlands, 25 of which are also listed in the Directory of Important Wetlands in Australia (DIWA). Another Ramsar Site, the Gunbower Forest Ramsar Site, is approximately 20 km to the east along the Murray River.

The Kerang Wetlands Ramsar Site is situated within a rural agricultural region of cattle and sheep grazing, irrigated crops and pasture, vineyards and orchards (KBR 2011). The landscape has been heavily modified by clearing and the construction of irrigation infrastructure which first commenced in the 1920s with the establishment of the Torrumbarry Irrigation System. The wetlands now provide important refuges in the landscape for flora and fauna, and are popular places for recreational pursuits such as bird-watching, water activities, camping, recreational fishing and hunting. In addition, the permanent wetlands enable a substantial irrigation industry which underpins the welfare of the local community (S. Simms [local community], pers. comm. May 2016). Importantly, the Barapa Barapa and Wamba Wamba First Nations peoples maintain a living association with the Kerang Wetlands, a place of great cultural significance for them.

Climate

The Kerang region receives relatively low rainfall in an average year, with the winter and early spring months substantially wetter than summer and autumn (Macumber 2002). Summer temperatures often exceed 30°C, while winters are relatively mild with minimum temperatures rarely below zero (BOM 2016). Evaporation rates can exceed 200 mm per month in summer (data supplied by R & E Jones, 2013).

Hydrogeological setting

The Kerang Wetlands Ramsar Site spans the Victorian Riverina bioregion in the north and the Murray Fans bioregion in the south, in a landscape that is characterised by a flat to gently undulating landscape on recent unconsolidated sediments. Both bioregions demonstrate evidence of former, occasionally braided stream channels, river meanders, and broad floodplain areas associated with major river systems (DEPI 2014). These ancient rivers and streams deposited alluvial sediments that have resulted in a thick layer of mixed clay and sand, known as the Shepparton Formation, which can extend up to 40 metres below the surface and overlies Parilla Sand and Renmark Group sediments (SKM 2001). The local catchment area is low-lying and prone to flooding, resulting in surface sediments that are rich in clay and of low permeability. Flood events and surface water movement, rather than groundwater, generally dominate wetlands formed in this area (SKM 2001).

Previous page: Royal Spoonbills
Photo: David Kleinert

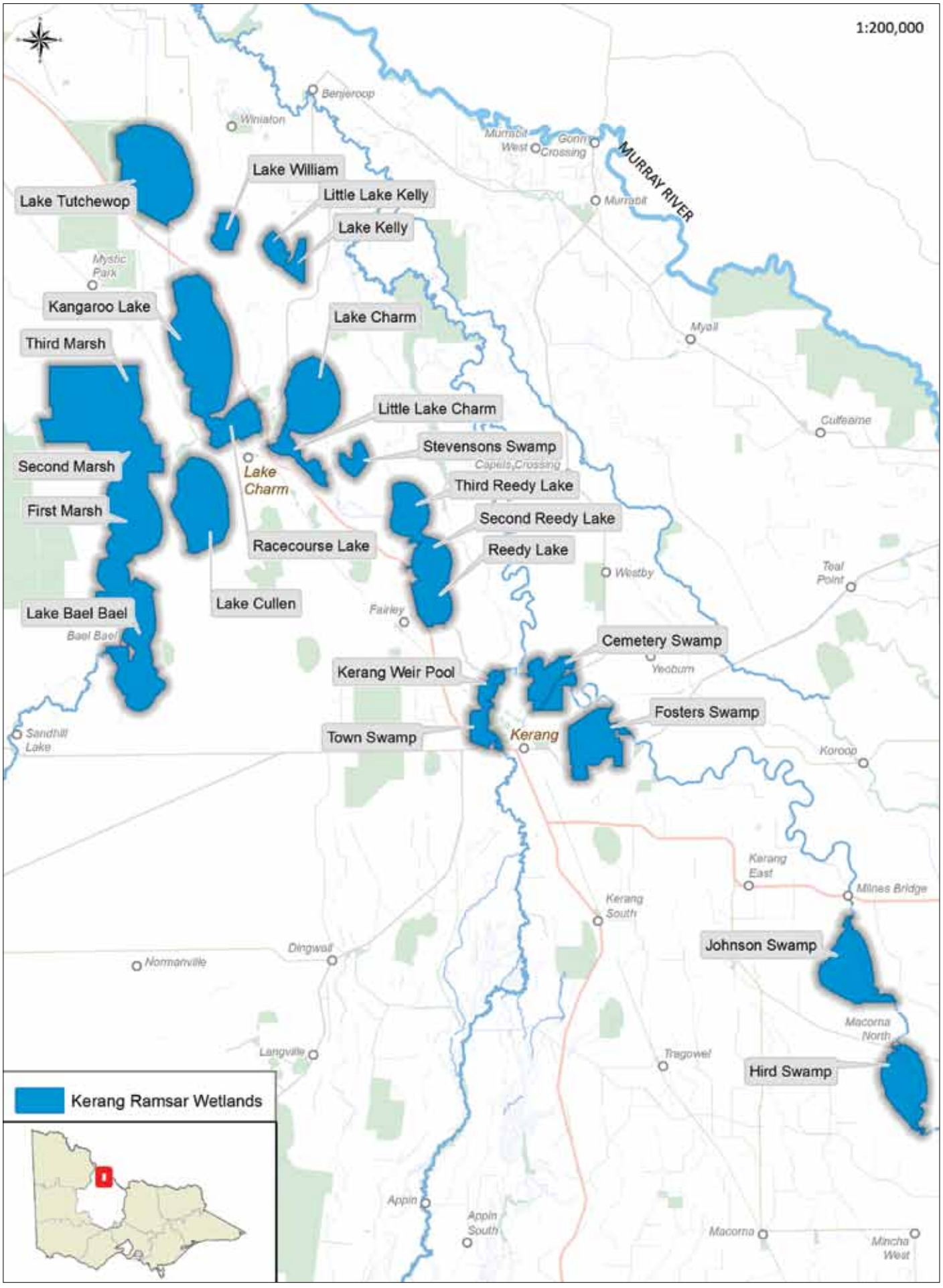


Figure 2. Location of Kerang Wetlands Ramsar Site

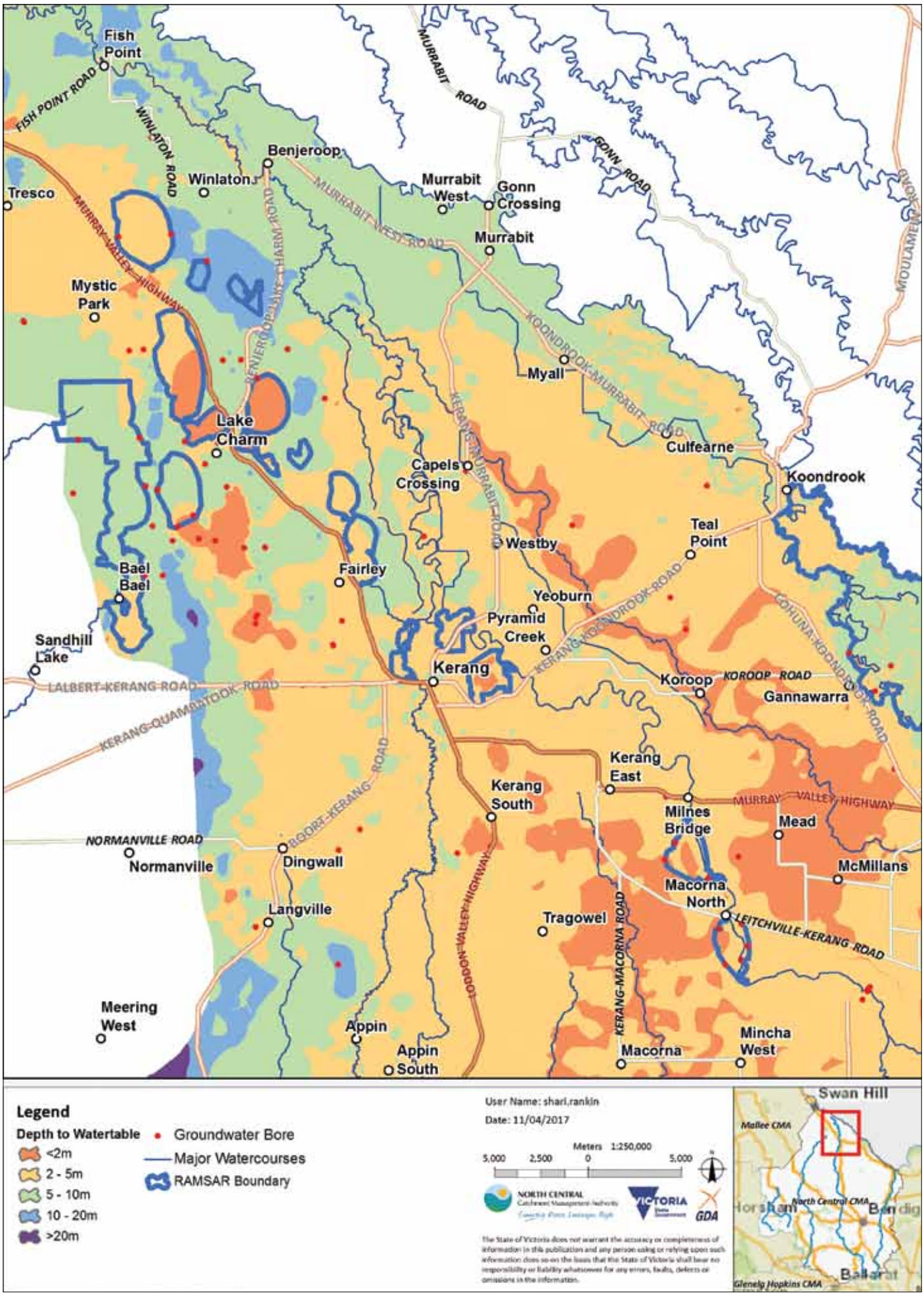


Figure 3. Depth to groundwater mapping in spring 2016 (North Central CMA)

Hydrological regimes

The establishment of the Torrumbarry Irrigation Area in the 1920s had a significant impact on the water sources and management purposes of the Kerang Wetlands. Some wetlands can receive water from the Murray River via irrigation infrastructure, while others are unregulated and receive water only during flood events along natural pathways, such as the Avoca Marshes which receive flood water from the Avoca River. Four wetlands are used as salt disposal basins, receiving saline drainage water from the Barr Creek in order to reduce salt loads entering the Murray River. One wetland, Fosters Swamp, receives treated wastewater in a small portion of the wetland. The hydrological regime of each wetland is discussed further in each wetland description (Section 6).

Within the ECD and other subsequent planning documents, the wetlands in the Ramsar Site have been broadly grouped into four hydrological categories that reflect a combination of Ramsar wetland type and management arrangements. For clarity, these categories have been modified in this document to better represent wetland type. These categories and their linkage to Ramsar wetland types are listed in Table 3.

Significance

In addition to the Ramsar status, all wetlands in the Ramsar Site are also listed in *A Directory of Important Wetlands in Australia* (DIWA) except for Lake Tutchewop, Little Lake Kelly and the Kerang Weir Pool.

Wetlands in the site vary in area, depth and salinity, supporting a high diversity of wetland vegetation communities, which in turn support a high diversity of waterbirds and other wetland fauna. With respect to waterbirds, the Kerang Wetlands is the second most species-rich Ramsar Site in southern Australia after the Coorong and Lake Alexandrina and Albert Ramsar Sites (Butcher and Hale in prep.). The Ramsar Site supports fauna and flora of national and state conservation significance, and migratory waterbirds protected under international agreements. The wetlands are important breeding grounds for waterfowl, colonial nesting waterbird species, and other waterbirds of high conservation significance such as the nationally threatened Australasian Bittern (*Botaurus poiciloptilus*).

Table 3. Ramsar wetland types and four hydrological categories as represented in the Kerang Wetlands Ramsar Action Plan.

Wetland	Area (ha)	Ramsar wetland type
1. Regulated freshwater permanent wetlands		
Kangaroo Lake	984	O – Permanent freshwater lakes (over 8 hectares)
Racecourse Lake	235	
Lake Charm	520	
Little Lake Charm		
Scotts Creek	113	
First Reedy Lake	196	
Middle Reedy Lake	196	Tp – Permanent freshwater marshes/pools
Third Reedy Lake	234	W – Shrub-dominated wetlands
2. Regulated freshwater intermittent wetlands		
Kerang Weir	46	W – Shrub-dominated wetlands
Town Swamp	80	
Johnson Swamp	411	Ts – Seasonal/intermittent freshwater marshes
Hird Swamp	344	W – Shrub-dominated wetlands
Lake Cullen	632	R – Seasonal/intermittent saline/brackish/alkaline marshes/pools
3. Saline / sewage disposal and drainage wetlands		
Lake Tutchewop	752	Q - Permanent saline/brackish/alkaline lakes
Lake William	96	
Lake Kelly	270	
Little Lake Kelly	60	
Fosters Swamp	225	R – Seasonal/intermittent saline/brackish/alkaline marshes/pools
		Q – Permanent saline/brackish/alkaline lakes
		8 – Wastewater treatment area
4. Unregulated freshwater intermittent wetlands		
Stevenson Swamp[1]	80	R – Seasonal/intermittent saline/brackish/alkaline marshes/pools
Lake Bael Bael	647	P – Seasonal/intermittent freshwater lakes (over 8 hectares)
First Marsh	780	
Second Marsh	238	W – Shrub-dominated wetlands
Third Marsh	1205	
Cemetery Swamp	89	

[1] Stevenson Swamp was noted as freshwater in DSE 2004 and saline in DSE 2010.

2.3 Land tenure

The legacy of many decades of changing land use planning has meant that the Kerang Wetlands Ramsar Site comprises numerous parcels of various tenures and purposes. Land managers were consulted regarding the boundaries of Crown land and freehold parcels, land tenure and licences. For simplicity, the primary reserve purpose of the wetland and the land manager, as determined through this consultation, is listed in Table 4.

Update of wetland names (see Butcher and Hale in prep.)

The original nomination document for the Kerang Wetlands Ramsar Site listed Town Swamp and Back Swamp as two of the wetlands comprising the Ramsar Site (Ministry of Conservation 1982). In the 2011 ECD for the site, the two are named within one polygon as "Back / Town Swamp" (Kellogg Brown and Root 2011). Community consultation for the Action Plan revealed some confusion about the names of wetlands adjacent to the Kerang township. Discussion with local stakeholders and a recent review of mapping layers has revealed that the correct names for the wetlands are: Town Swamp (south of the railway line and to the west of the Loddon River) and within the Ramsar Site; Town Common (south of the railway line, to the east of the Loddon River) and mostly outside the Ramsar Site boundary; and Kerang Weir Pool (the weir pool and associated marshes north of the railway line), with the western portion lying within the Ramsar Site boundary. Parts of this wetland were formerly labelled as "Back Swamp" (Figure 4). The name on the boundary description has been changed to "Town Swamp / Kerang Weir Pool" to more accurately reflect official names (DELWP in prep.).

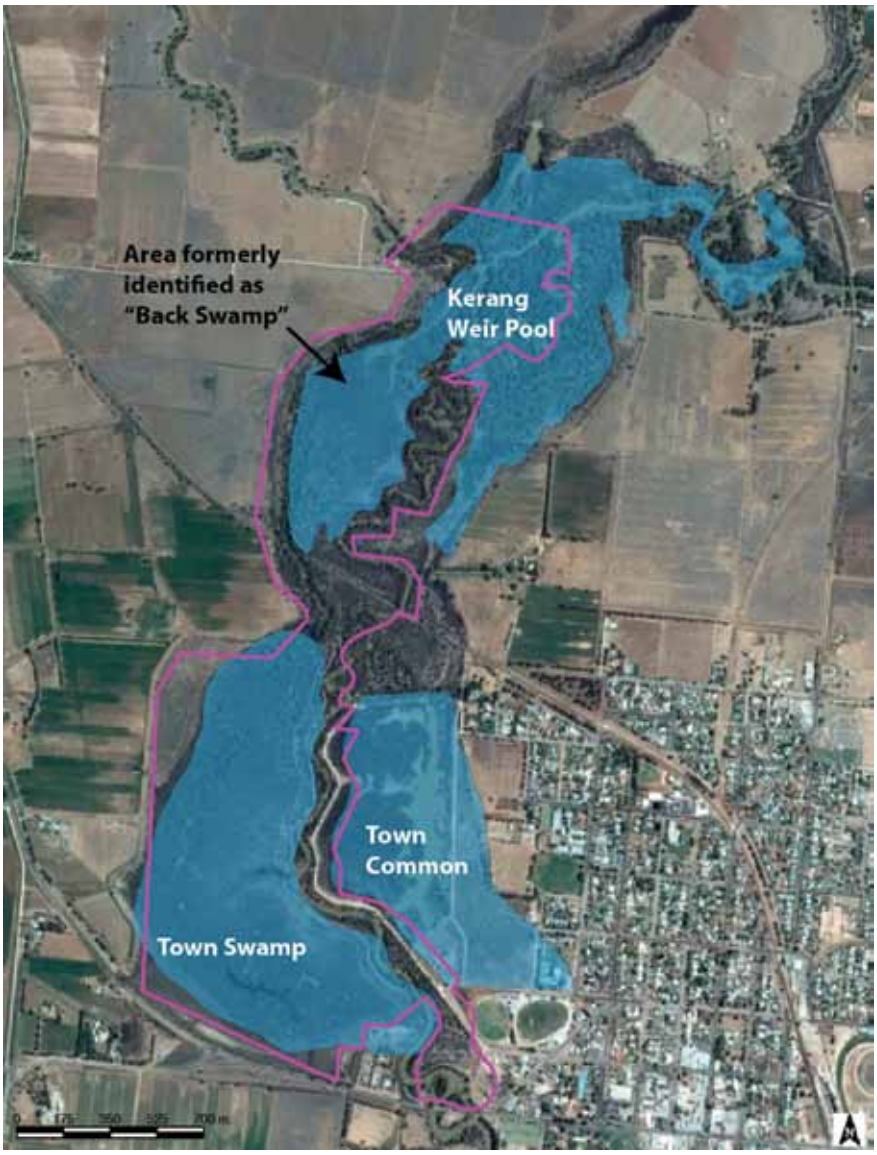


Figure 4. Aerial view of 'Town Swamp / Kerang Weir Pool' located within the Ramsar Site boundary (pink line) and 'Town Common', which is not part of the Kerang Wetlands Ramsar Site.

Table 4. Wetland Reserve status and Land Manager.

Wetland	Reserve status	Land Manager
Permanent regulated fresh open water wetlands		
Kangaroo Lake	Water supply reserve *(Crown Land (Reserves) Act 1978)*	Goulburn Murray Water
Racecourse Lake		Goulburn Murray Water
Lake Charm		Goulburn Murray Water
Little Lake Charm	Freehold land owned by Goulburn Murray Water	Goulburn Murray Water
Scotts Creek	Natural features reserve / *State Wildlife Reserve (Crown Land (Reserves) Act 1978* and *Wildlife Act 1975)*	Parks Victoria
First Reedy Lake	Water Supply Reserve *(Crown Land (Reserves) Act 1978)*	Goulburn Murray Water
Middle Reedy Lake		Goulburn Murray Water
Third Reedy Lake		Goulburn Murray Water
Regulated freshwater intermittent wetlands		
Kerang Weir Pool	Public purposes *(Crown Land (Reserves) Act 1978)*	Parks Victoria
Town Swamp		Parks Victoria
Lake Cullen	Natural features reserve / State Wildlife Reserve *(Crown Land (Reserves) Act 1978 and Wildlife Act 1975)*	Parks Victoria
Johnson Swamp		Parks Victoria
Hird Swamp		Parks Victoria
Saline / sewage disposal and drainage wetlands		
Lake Tutchewop	Salinity disposal reserves *(Crown Land (Reserves) Act 1978)*	Goulburn Murray Water
Lake William		Goulburn Murray Water
Lake Kelly		Goulburn Murray Water
Little Lake Kelly		Goulburn Murray Water
Fosters Swamp	Natural features reserve / State Game Reserve *(Crown Land Legislation Amendment (Canadian Regional Park* and *Other Matters) Act 2015 and Wildlife Act 1975)* [Fosters Swamp was incorporated into the newly created Kerang State Wildlife Reserve in July 2016.]	Parks Victoria
	Sewage purposes reserve *(Crown Land (Reserves) Act 1978)*	Lower Murray Water
Unregulated freshwater intermittent wetlands		
Stevenson Swamp	Natural features reserve / State Wildlife Reserve *(Crown Land (Reserves) Act 1978* and *Wildlife Act 1975)*	Parks Victoria
Cemetery Swamp	Natural features reserve / State Game Reserve *(Crown Land Legislation Amendment (Canadian Regional Park and Other Matters) Act 2015* and *Wildlife Act 1975)* [Cemetery Swamp was incorporated into the newly created Kerang State Wildlife Reserve in July 2016.]	Parks Victoria
	Municipal purposes reserve *(Crown Land (Reserves) Act 1978* and *Wildlife Act 1975)*	Gannawarra Shire Council
Lake Bael Bael	Natural features reserve / State Wildlife Reserve *(Crown Land (Reserves) Act 1978* and *Wildlife Act 1975)*	Parks Victoria
First Marsh		
Second Marsh		
Third Marsh		

2.4 Ecological Character

The ecological character of the Kerang Wetlands Ramsar Site is described in detail in the ECD (KBR 2011) and the ECD addendum (Butcher and Hale in prep.). The site includes six Ramsar wetland types and meets four of the nine Ramsar criteria (Section 2.4.1). The site supports eleven critical components, processes and services that significantly contribute to the recognised ecosystem value and importance of the site, and is characterised by several others.

2.4.1 Ramsar criteria that are met

The 2011 ECD determined that the Kerang Wetlands met six of the nine criteria for a designated Ramsar Site. Four criteria are still met at the site, with a potential fifth (Criterion 6) that requires further data to confirm (Table 5). Discussion of how the site meets these criteria is found in the draft ECD addendum (Butcher and Hale in prep.).

2.4.2 Critical components, processes and services

In the 2011 ECD, four critical components, processes and services (CPS) were identified that significantly contribute to the recognised ecosystem value and importance of the site. In the 2016 ECD review, a further three critical CPS were identified. Descriptions of each CPS can be found in the 2011 ECD (KBR 2011) and ECD review (Butcher and Hale in prep.).

All seven are listed below:

- Hydrology (percentage full, depth/volume, frequency of inundation) is a critical process that influences water quality, habitat and wetland type
- Salinity is a critical physiochemical component that maintains wetland type and distinctive flora and fauna assemblages
- Waterbird abundance and diversity are critical components that contribute to the site's Ramsar listing
- Waterbird breeding is a critical process at the site contributing to the site's Ramsar listing. In particular, colonial breeding/nesting waterbirds (ibis, darters, cormorants, spoonbills) are significant at the site
- Vegetation diversity (component)
- Supports a diversity of wetland types (service)
- Supports threatened wetland species (service).

Table 5. Ramsar criteria met by the Kerang Wetlands Ramsar Site.

Ramsar Criteria	Met at Kerang Wetlands?
Criterion 1: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.	Not met at Kerang Wetlands
Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.	Y
Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.	Y
Criterion 4: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their lifecycles, or provides refuge during adverse conditions.	Y
Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.	Y
Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.	Insufficient data
Criterion 7: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.	Not met at Kerang Wetlands
Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.	Not met at Kerang Wetlands
Criterion 9: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.	Not met at Kerang Wetlands

Hydrology

Key aspects which shape the hydrology of the Kerang Wetlands Ramsar Site include the source of water, its movement (connectivity) and the frequency, duration and timing of inundation. Hydrology is identified as a critical process in the system as it has the potential to impact directly on salinity (including risks of hypersalinity), and reduction in biodiversity, loss of community vegetative structure and species distribution and loss of habitat and food resources (KBR 2011).

Salinity

The Ramsar Site exhibits a full range of salinities from very fresh to hypersaline, including deep permanent freshwater lakes with salinity typically less than 500 EC, wetlands that range between 4000 and 50,000 EC and hypersaline salt disposal basins (100,000 EC+). Salinity is identified as a critical component in the system as it directly impacts on the ability of biota to survive. Salinity is affected by rising saline groundwater, saline surface water run-off, disposal of drainage water, lack of regular flushing and prolonged inundation.

Waterbird abundance

The occurrences of waterbirds at the Kerang Wetlands Ramsar Site are highly variable over time and across the individual wetlands at the site. In the decade following the time of listing, annual counts regularly exceeded 40,000, reaching almost 300,000 waterbirds in 1987 (KBR 2011). Numbers were reduced during the drought in the early 2000s. In recent years, count data across the site have been inconsistent, though an aerial survey in 2010 indicated almost 30,000 birds (Butcher and Hale in prep.), and over 18,000 birds were recorded at Johnson Swamp alone in February 2016 (Dedini 2016). The Kerang Wetlands meet several Ramsar criteria based on the site's value as waterbird habitat.

Royal Spoonbill, Lake Cullen. Photo: Adrian Martins

Waterbird diversity

Since the time of listing, 86 species of waterbirds have been recorded at the Ramsar Site (Butcher and Hale in prep.). Of these, many are threatened in Victoria and two are nationally threatened (under the EPBC Act). In addition, 24 recorded waterbird species are listed under international migratory species agreements. The Kerang Wetlands is the third most species rich of the non-alpine southern Murray-Darling Basin Ramsar Sites, reflecting the variability of habitat types that it provides including marshes with reed beds, tree-dominated wetlands, open water with exposed shorelines, mudflats and brackish/saline wetlands.

Waterbird breeding – colonial nesting waterbirds

The Kerang Wetlands provide significant habitat at the bioregional scale to support large waterbird breeding events (Butcher and Hale in prep.). Since the time of listing, 28 species of colonial nesting waterbirds have been recorded breeding in over a hundred events (KBR 2011; Dedini 2016). The Ramsar Site provides a diverse range of breeding habitat which varies by wetland type and hydrology source. First Marsh, Second Marsh, Third Marsh, and Middle Reedy Lake are particularly significant for the number of breeding events they have supported (KBR 2011).

Vegetation diversity

The Kerang Wetlands support a range of vegetation species and communities, including Black Box and River Red Gum, Tangled Lignum, Chenopod shrubland, grassland, reed bed and aquatic plant communities (Butcher and Hale in prep.). To date, twelve wetland Ecological Vegetation Classes (EVCs) have been mapped across the Ramsar Site, nine of which are endangered or vulnerable (Frood and Papas 2016). Tangled Lignum and River Red Gum areas are particularly important as they support colonial nesting waterbirds, while areas of reed beds and rushes support other threatened species, such as the Australasian Bittern. Vegetation is also important as it plays a significant role in the wetland food web and provision of habitat for other species such as small-bodied native fish (Butcher and Hale in prep.).

Over 170 wetland dependent flora species have been recorded within the Ramsar Site, which include a broad range of species including freshwater and saline tolerant flora (Butcher and Hale in prep.).

Supports a diversity of wetland types

The Kerang Wetlands Ramsar Site supports seven Ramsar wetland types, providing diverse habitats for wetland-dependent flora and fauna brought about by the interactions between hydrology, geomorphology and vegetation. Groundwater and surface water interactions, and salinity, are particularly key drivers of the ecological character and underpin all other services supported at the site (Butcher and Hale in prep.). Change in wetland type, particularly if the freshwater elements of the site are lost or the water regime is significantly altered, will have a detrimental impact on most of the other critical CPS (Butcher and Hale in prep.).

Supports threatened species

There is sufficient information to indicate that the site regularly supports two threatened species (Butcher and Hale in prep.):

- Australasian Bittern (*Botaurus poiciloptilus*)
- Curlew Sandpiper (*Calidris ferruginea*)
- Murray Cod (*Maccullochella peelii*)
- Silver Perch (*Bidyanus bidyanus*).

Species and communities which are listed at the national or international level and which are regularly found within the site are considered as contributing to this critical service. Two threatened fish species, Murray Cod (*Maccullochella peelii*) and Silver Perch (*Bidyanus bidyanus*) are also found in some of the permanent wetlands, but they are not considered critical to ecological character in that if they were no longer present, it would not indicate a change in character (Butcher and Hale in prep). They are both predominantly river species that prefer flowing environments and occasionally use wetland habitats. The permanent wetlands therefore do not provide core habitat (Butcher and Hale in prep.). Historically, Murray Cod were stocked by Fisheries Victoria at various densities into First Reedy Lake, Kangaroo Lake, and Lake Charm annually from 2003 to 2008 (Hunt et al. 2011).

The Australasian Bittern has recently been recorded at Johnson Swamp and Hird Swamp (Rakali 2015; Dedini 2016), with breeding occurring at Johnson Swamp (Rakali 2015). The Curlew Sandpiper has also been recorded at several wetlands across the site, mostly brackish or saline (VBA 2015). The site is considered to provide critical habitat for these two species, particularly Australasian Bittern as 1 per cent of the flyaway population is likely to be supported between Johnson Swamp and Hird Swamp.

A small number of Curlew Sandpiper are regularly recorded in the Kerang Wetlands Ramsar Site, most often observed in the saline wetlands of Lake Tutchewop (60 per cent of records) and Lake Cullen (8 per cent of records), with occasional sightings at Lake Kelly, Foster Swamp Lake Bael Bael and Hird and Johnson Swamp (Victorian Biodiversity Atlas; Atlas of Living Australia).

2.4.3 Other components, processes and services

In addition to the eleven critical CPS the Kerang Wetlands Ramsar Site also provides a number of other CPS, including:

- Physical form (component)
- Soils (component)
- Physiochemical - nutrients and nutrient cycling (process)
- Agriculture (provisioning service) – see Section 2.7
- Irrigation (provisioning service) – see Section 2.7
- Flood mitigation (regulating service) – see Section 2.7
- Culture (cultural service) – see Section 2.5
- Recreation and tourism (cultural service) – see Section 2.6
- Ecological connectivity (supporting service)
- Pollution control - trapping, storage and/or treatment of contaminants (regulating service) – see Section 2.7.

Physical form

Physical form plays a crucial role in determining the character of each individual wetland of the Ramsar Site. Fluvial geomorphology and bathymetry are intertwined with many of the processes and components of the site, forming the area's hydrology and influencing groundwater interactions and wetland physical characteristics such as depth. The variability in wetland depth throughout the site provides for a variety of flora and fauna species to inhabit the area while supporting species during different life stages (KBR 2011).

Soils

The soil characteristics throughout the Kerang Wetlands Ramsar Site (mixed sand and clay) allow for groundwater interactions and water storage capacity. Variability in water storage capacity across the site contributes to the range of habitat types for flora and fauna and collectively forms a unique wetlands system (KBR 2011).

Physiochemical - nutrients and nutrient cycling

Nutrient cycling is driven by inputs from hydrology, climate and biological activity, entering the system through rainfall, run-off or through surface water or groundwater. Land use can also impact the nutrient cycle, an important consideration at the Kerang Wetlands which are situated in a predominantly agricultural landscape. Nutrient cycling is impacted by wetting and drying phases of wetlands, altering the availability of nutrients for plant growth which in turn can impact the base of food webs (KBR 2011).

Ecological connectivity

Hydrological connectivity has been impacted by infrastructure development throughout the region, with levees and modifications to natural flow paths impacting the water regimes of several wetlands. However, ecological connectivity continues to occur through species that use multiple sites; movement of fish through connected waterways where possible; and the spread of seed propagules and other material between riverine and floodplain environments when connected.

2.4.4 Limits of Acceptable Change and Current Condition

All critical CPS have Limits of Acceptable Change (LAC) developed and form the basis of future assessments of change in ecological character. The 2011 ECD had limited data available to develop suitable LAC. The 2016 addenda aimed to rectify this, updating existing LAC where they were required and adding new ones if required (Butcher and Hale in prep.). The revised LAC are presented in Table 6.

Note that a 'Cascade LAC' is when a LAC for one critical CPS is already covered by another CPS.

Table 6. Limits of Acceptable Change for critical components, processes and services.

Critical CPS	Revised LAC
Hydrology	Kangaroo Lake, Racecourse Lake, Lake Charm and Little Lake Charm: permanently inundated, not to exceed 1000 mm range of fluctuation in water levels two years in a row.
	First Reedy Lake and Middle Reedy Lake: permanently inundated, not to exceed 600 mm range of fluctuation in water levels two years in a row.
	Third Reedy Lake: permanently inundated, not to exceed 400 mm range of fluctuation in water levels two years in a row.
	Cemetery Swamp: Not continuously wet for 10 or more years. Not continuously dry for nine or more years.
	Lake Bael Bael: Not continuously wet for five or more years. Not continuously dry for nine or more years.
	First Marsh: Not continuously wet for three or more years. Not continuously dry for six or more years. Second and Third Marshes: Not continuously wet for three or more years. Not continuously dry for 10 or more years. Note: Double LAC - both elements of the LAC would need to be exceeded to indicate a potential change in character.
	Insufficient data to determine a LAC for Town Swamp and the Kerang Weir Pool wetland, however once data is available it would be expected that two LAC are required – one for each wetland.
	Lake Cullen: Not continuously wet for five or more years. Not continuously dry for eight or more years.
	Johnson Swamp: not dry for five or more consecutive years. Not wet for two or more consecutive years.
	Hird Swamp: not dry for five or more consecutive years. Not wet for two or more consecutive years.
Salinity	Greater than 4000 EC when more than 75% full, at any of the following wetlands: Kangaroo Lake; Racecourse Lake; Little Lake Charm; First Reedy Lake; Middle Reedy Lake; Third Reedy Lake: Cemetery Swamp; Lake Bael Bael; Avoca Marshes; Kerang Weir Pool; Town Swamp; Johnson Swamp; Hird Swamp. **OR** Lake Cullen salinity greater than 10,000 – 12,000 EC when lake is more than 75% full.
Waterbirds – abundance	The 10 year rolling average for annual maximum waterbirds across the site is not < 10,000.
Waterbirds – breeding	No more than 10 consecutive years in which there are no colonial nesting events of at least 1000 nests in the Kerang Wetlands Ramsar Site. Species may include any of the following: Australasian Darter (*Anhinga novaehollandiae*), Australian White Ibis (*Threskiornis molucca*), Great Cormorant (*Phalacrocorax carbo*), Pied Cormorant (*Phalacrocorax varius*), Royal Spoonbill (*Platalea regia*), Straw-necked Ibis (*Threskiornis spinicollis*), Yellow-billed Spoonbill (*Platalea flavipes*).
Waterbird diversity	Total annual species richness of wetland-dependent birds shall not be less than 22.
Vegetation diversity	The total extent of the following vegetation communities will not be less than:
	– Freshwater herb/grass/sedge/forb – 2400 hectares
	– Brackish herb/grass/sedge/forb – 450 hectares
	– Samphire – 220 hectares
	– Lignum dominated – 1170 hectares
	– Intermittent swampy woodland – 975 hectares
	The species richness of native wetland-dependent plant species will not be less than 125.
Supports a diversity of wetland types	See LAC for hydrology, salinity and vegetation.
Supports threatened species – waterbirds	Australasian Bittern (Botaurus poiciloptilus) present within the Ramsar Site in no less than five out of 10 years.
	Curlew Sandpiper (Calidris ferruginea) recorded within the Ramsar Site in no less than five years out of 10.

2.5 Aboriginal values

2.5.1 Protection and management of Aboriginal cultural heritage

The Victorian Government and management agencies recognise that the authority and responsibility with respect to Aboriginal culture rests with the Traditional Owners (TOs), and that the health of wetlands is intrinsically linked to the cultural and spiritual health of Aboriginal people. The Barapa Barapa and Wamba Wamba First Peoples have had a living connection with the Kerang Wetlands for tens of thousands of years, and are recognised as the primary guardians, keepers and knowledge holders of Aboriginal cultural heritage around the site.

The Kerang Wetlands are rich in Aboriginal cultural heritage and significance, with over 400 recorded sites on the Aboriginal Cultural Heritage Register and Information System (ACHRIS). These sites include mounds, scar trees, middens, burials, hearths, surface scatters and isolated artefacts, evidence of which is frequently observable around the Ramsar Site. The wetlands continue to function as places of spiritual and cultural connection, and provide habitat to native flora and fauna that are important resources for food and medicine. These values are recognised under the Ramsar Convention, which also promotes the integration of cultural values, practices and perspectives into planning and management.

There are a number of corporations established to support the aspirations of Barapa and Wamba people in both Victoria and New South Wales. In Victoria, both Barapa and Wamba are registered claimant groups, in accordance with the *Native Title Act 1993* (C'wealth) and as such are recognised by government as having rights and interests in land and water. Native Title still exists on Crown land within the Wadi Wadi Wemba Wamba Barapa Barapa First Nations Aboriginal Corporation (VC00/5).

Traditional owner engagement for the Action Plan.

Registered Aboriginal Parties (RAPs) are the voice of Aboriginal people in the management and protection of Aboriginal cultural heritage in Victoria. The Victorian Aboriginal Heritage Council received an application from the Wadi Wadi Wemba Wamba Barapa Barapa First Nations Aboriginal Corporation to become a RAP on 19 August, 2014. It was rejected on 15 June 2015. However, that does not negate the states' commitment to free, prior and informed consent in relation to decision making processes that may affect the rights and interests of TOs and/or the management of cultural heritage. Neither does it negate the states' obligation and commitment to recognise the inherent connection of land and people.

The *Aboriginal Heritage Amendment Act 2016* (the Amendment Act) establishes new provisions and changes to the *Aboriginal Heritage Act 2006*. New provisions of the Amendment Act that may be applicable to the Action Plan are:

- Enabling the Secretary to establish an Activity Advisory Group (AAG) of TOs for a project in an area where there is no appointed RAP, to advise on the proposed activity and its impact on Aboriginal cultural heritage
- The Victorian Aboriginal Heritage Council (VAHC) to coordinate the management, return and protection of Aboriginal ancestral remains within Victoria
- A process to enable registration of Aboriginal intangible heritage on the Victorian Aboriginal Heritage Register. Aboriginal intangible heritage agreements will allow TOs to decide on whether and how their traditional knowledge is used and for what purpose
- Fees and charges collected under the Act, relevant government appropriation, such as funds allocated to support RAPs, additional gifts and interest earned on investments, to go into an Aboriginal Cultural Heritage Management Fund, to be managed by the VAHC. On the VAHC's recommendation, funds will be used to facilitate Aboriginal cultural heritage management and protection projects.

Saltbush

Bardi grub

2.5.2 Kerang Wetlands cultural values

Some themes arose from discussions on Country with TOs about cultural values and importance of the site, as well as managing the various wetlands. In addition to the abundance of cultural heritage sites throughout the Ramsar Site, many wetlands were considered by the TOs to be important places for ceremonial or spiritual purposes; places of gathering and social meetings; camp sites; fishing or food gathering sites; and places of trade. There are numerous women's and men's sites throughout the area, as well as burial and ceremonial sites. These sites are not always registered, as a means of privacy and protection from the general public.

The presence and quality of water is the largest influential factor on the cultural health of the wetlands. Water itself is considered to be a cultural value simply by its presence, and its' wide ranging effects on other cultural resources. At the time of visiting there was a significant blue-green algal bloom in the permanent freshwater wetlands, which reduced the condition and therefore cultural health of the wetland by rendering the water un-useable for humans and potentially impacting wildlife. A drier-than-natural watering regime was evident at some of the temporary wetlands, with trees showing stress or mortality, and cultural resources that would normally be expected were absent. Causes of this regime were largely attributed to artificial changes to hydrology, as well as a changing climate with below average rainfall in recent decades. A common suggestion for management was to reinstate more natural watering regimes, wherever possible.

Another recommendation for management of a threat that was ubiquitous at all wetlands was pest plant and animal control. The ability of food and medicine plants to thrive, as well as birds and other wetland fauna, is widely impacted by the proliferation of non-native, invasive species.

While the TOs may not live permanently on Country around the Kerang Wetlands, due to displacement after European occupation, they are intrinsically linked to the place through their long ancestry in the area and inherent connection to the land. In recent years, some TOs have been involved in cultural and wetland restoration projects, including some cultural mapping, on-ground works (through the Barapa Works Crew), and revegetation of wetland species at Johnson and Hird Swamp. Their increased involvement in future management of the Kerang Wetlands is invaluable in ensuring that cultural aspects of wetlands are linked with those of water, and that they are conserved and protected into the future.

While the increased involvement of TOs in managing the wetlands is encouraging, there remains much to learn about the history of the Barapa and Wamba clans in the area, and about how the Kerang Wetlands were, and can be, utilised and valued over time. Actions for the protection and enhancement of Aboriginal values can be found in Section 6.8.

2.6 Community values

The Kerang Wetlands are a valuable resource for recreation and tourism, and support a variety of social values. Many of these stem from the site's natural ecological assets. The Kerang Wetlands are notable in particular for bird-watching, as they support some of the highest waterbird biodiversity amongst Victoria's Ramsar Sites (Butcher and Hale in prep.). Johnson Swamp, Hird Swamp and Lake Tutchewop are most notable for bird-watching (K. Stockwell [Birdlife Australia] pers. comm. May 2016), as well as the ibis rookery at Middle Reedy Lake. Bird and nature photographers are frequent visitors to the sites, especially when the wetlands are in flood and the boost in productivity translates into high diversities of wetland fauna. Bushwalking does occur, though specific walking tracks are limited. School groups often come up to the Kerang Wetlands for field visits.

The Ramsar Site also provides places for social gatherings, including picnicking and day trips, and support recreational sports including swimming, boating and canoeing, especially at the permanent wetlands. Some of the wetlands provide high value duck hunting grounds, particularly Johnson Swamp and Hird Swamp.

Camping and holidaying is also quite common around these wetlands. Some of the permanent wetlands are stocked with native fish each year, providing good areas for fishing. In addition, the wetlands are places of connection to nature, and for many of the local community in the area, are places that have been frequented over the course of a lifetime.

Table 7 shows which wetlands are most important for a number of social values as identified by the community.

Actions for enhancing the community experience of the Kerang Wetlands can be found in Section 6.9.

Table 7. Important social values at the Kerang Wetlands.

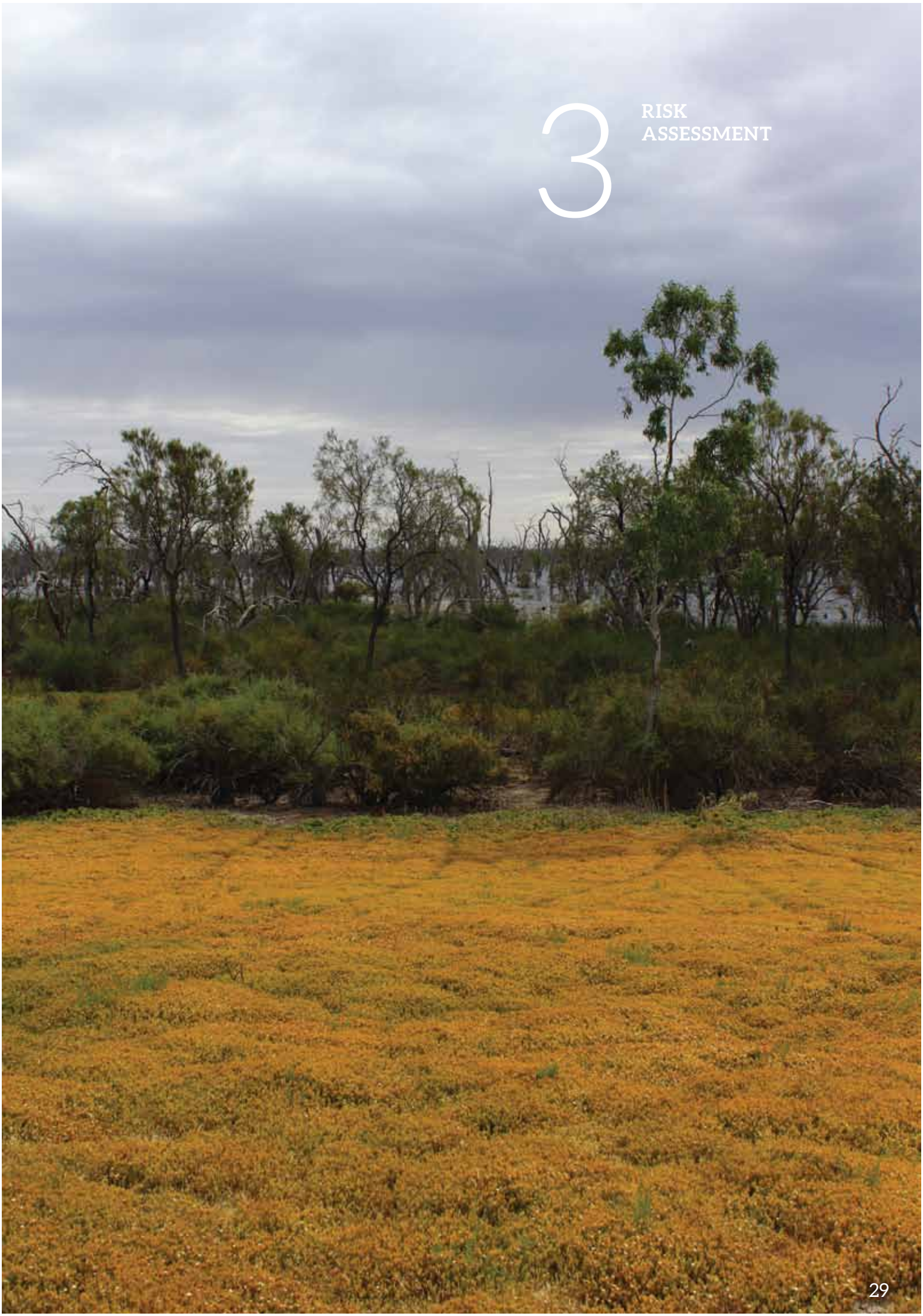
Social Values	Wetlands
Birdwatching	– Johnson Swamp, Hird Swamp, Middle Reedy Lake and Lake Tutchewop were rated the highest for birdwatching.
	– Most wetlands were rated highly for birdwatching which is consistent with the Ramsar criteria for listing, and Ramsar status which particularly aims to protect habitat for waterbirds. Some wetlands were rated at medium/low value for birdwatching though, including Kangaroo Lake, Lake Charm, Cemetery Swamp and Stevenson Swamp.
Camping	– Kangaroo Lake, Lake Charm, Racecourse Lake, Lake Cullen and First Reedy Lake were rated the highest for camping
Swimming	– Kangaroo Lake, Racecourse Lake, First Reedy Lake and Lake Charm were rated highest for swimming.
Boating	– Kangaroo Lake and Lake Charm were rated highest for boating
Canoeing	– Kangaroo Lake, Racecourse Lake, Lake Charm, Little Lake Charm, First Reedy Lake, Kerang Weir Pool, Town Swamp and Hird Swamp were rated highest for canoeing.
Fishing	– Kangaroo Lake, Racecourse Lake, Lake Charm, Town Swamp and the Kerang Weir Pool were rated highest for fishing.
Duck hunting	– Johnson Swamp and Hird Swamp were rated highest for hunting, as well as Little Lake Charm, Lake Cullen, Lake Bael Bael, First Marsh, Second Marsh and Third Marsh.
Picnicking	– Kangaroo Lake, Racecourse Lake, Lake Charm, Kerang Weir Pool and Town Swamp were rated highest for picnicking.

2.7 Economic values

Many of the Kerang Wetlands are 'working' wetlands, in that they have long supported an agriculture and service-based local economy, estimated to be worth $283 million per year across the Gannawarra Shire (Gannawarra Shire Council, 2015). The surrounding landscape supports large areas of irrigated agriculture that produces horticultural, viticultural, dairy, meat and grain products (DSE 2004). The permanent wetlands are used year-round to store and regulate water for irrigation, domestic and stock use (KBR 2011).

Most wetlands in the Ramsar Site can be used for flood mitigation, storing excess water during very large flood events. The saline wetlands are also used as salt disposal basins, capturing saline drainage water to reduce the salt loads entering the Murray River downstream. At times, salt harvesting has been an industry at these wetlands, particularly Lake William, but it is not currently occurring.

The Kerang Wetlands are a significant hub for recreation and tourism in the region, drawing people from all over Australia for water sports and nature-based tourism such as bird-watching and duck hunting. The future input to the local economy, particularly hospitality and service-based industries, from these activities is expected to be significant.



3 RISK ASSESSMENT

Desert Spinach (*Tetragonia eremaea*)
Photo: Bonnie Humphreys

Australian Smelt

3.1 Method

Risk assessment was identified as a critical tool to inform the management of threats and associated stressors that may adversely impact on Ramsar values. The risk assessment methodology adopted for the Action Plan is based on US EPA Guidelines for Ecological Risk Assessment and uses the same principles and steps as the Australian/ New Zealand Standard for Risk Assessment (AS/NZS 4360:2004).

Due to the large number of wetlands, and similarities between many of them, the risk assessment was completed for each of the four hydrological groups as defined in the ECD (see Section 2.2). Any exceptions have been noted.

A review of published and unpublished technical literature and datasets relating to the Kerang Wetlands Ramsar Site was undertaken to assist with identification of ecological, cultural, social and economic values of the wetlands. This was augmented by discussions with agency stakeholders and experts, as well as the TOs and the community. These activities also highlighted threats and associated stressors to those values.

Prioritisation

Prioritisation of values and threats occurs in other Ramsar management plans. . However, given the focus of this Action Plan is at an individual wetland scale with specific actions, it was decided that no prioritisation would take place as all identified values are considered to be important (at the relevant wetlands). Undertaking a prioritisation process may preclude some actions from being stated, and the intent of this plan is to be inclusive of all actions that would contribute to the maintenance or improvement of ecological character at each wetland. Prioritisation may instead take place through the coordinating group (to be established as part of the implementation of the plan), as well as in developing a works program for each wetland which will provide spatially and temporally specific activities.

Risk identification

An impact pathway approach was adopted for the risk assessment which considered the following:

- Value – the variable that is impacted by the threat. The values are consistent with the critical components, processes and services as per the ECD, though there are a number of additional values identified in an effort to be inclusive of important social, cultural and economic values
- Threats – the action or activity that could affect some aspect of the ecological character
- Stressor – the physical, biological or chemical changes that could result from the threat
- Effect description – the potential impact on the value.

This approach highlighted the range of pathways through which a particular threatening activity can have an impact. Technical literature, including the conceptual models described in the ECD, local knowledge and expert opinion assisted in identifying the plausible range of threats and stressors.

Risk analysis

Each impact pathway was assigned a likelihood and consequence of the impact occurring, based on the framework in Table 8. Both environmental and social consequence categories of risk were developed. The risk matrix determined the final risk rating (Table 9).

Table 8. Risk attribute definitions.

	Level	Description of risk category
Likelihood	Very Low	Exposure is remotely likely and/or weak and/or occurs to an insignificant spatial extent. Only occurs in exceptional circumstances.
	Low	Exposure is rare and/or mild and/or occurs in a localised or patchy spatial extent. Could occur but not expected.
	Moderate	Exposure is common and/or intense and/or occurs broadly. Could occur.
	High	Exposure is frequent or constant and/or intense and/or widespread. Will probably occur in most circumstances.
Consequence	Very Minor	Environmental – The effect on the value is negligible, with no detectable change to survival, health or event success. Recovery would take days.
		Social – Short term or negligible restrictions to recreational or resource use (days). No harmful impacts to people.
	Minor	Environmental – The effect on the value is minor, with limited detectable change to survival, health or event success. Recovery would take several weeks to months.
		Social – Temporary restrictions to recreational or resource use (weeks to months). Minor injuries/ illness requiring medical attention would occur.
	Moderate	Environmental – The effect on the value is moderate, with a clearly detectable change to survival, health or event success. Recovery would take months to a year.
		Social – Moderate, longer term restrictions to recreational or resource use (months to a year). Significant injuries/illness requiring hospitalisation or ongoing medical attention would occur.
	Major	Environmental – The value is severely affected resulting in death, population loss or event failure etc. Recovery would take longer than a year.
		Social – Major, long term restrictions to recreational or resource use (over a year). Major harm (extensive or permanent injury/illness or death) to people would occur.

Table 9. Risk matrix.

	Consequence			
Likelihood	**Very Minor**	**Minor**	**Moderate**	**Major**
Very Low	Very Low	Very Low	Low	Moderate
Low	Very Low	Low	Low	Moderate
Moderate	Low	Low	Moderate	High
High	Moderate	Moderate	High	Very High

3.2 Risk assessment for the regulated freshwater permanent wetlands

Ninety-nine threat/value combinations were assessed for the regulated freshwater permanent wetlands. 'High' and 'Very High' risks are shown in Table 10. The full risk assessment is presented in Appendix 4 and shows linkages with Ramsar values. The 'High' and 'Very High' risks are associated with climate change (high temperatures); invasive non-native plants and animals, including rabbits, foxes, cats, pigs and carp; loss of standing timber habitat; resource use (grazing); nearby residential and commercial development; and recreational visitors and campers.

Table 10. Identified High and Very High risks at the regulated freshwater permanent wetlands, including Kangaroo Lake, Racecourse Lake, Lake Charm, Little Lake Charm, First Reedy, Middle Reedy and Third Reedy Lakes.

Value	Threat	Stressor	Effect description	Risk rating
Recreation	Climate change and severe weather events - Higher temperatures	Increased occurrence of toxic algal blooms in the system	Reduced capacity for recreational activities	High
Water quality	Climate change and severe weather events - Higher temperatures	Increased occurrence of toxic algal blooms in the system	Low dissolved oxygen or toxic impacts to aquatic fauna	High
Public health	Climate change and severe weather events - Higher temperatures	Increased occurrence of toxic algal blooms in the system	High levels of certain types of algae can be toxic to humans, livestock, native fauna	High
Water supply	Climate change and severe weather events - Higher temperatures	Increased occurrence of toxic algal blooms in the system	Economic impact on consumptive use - irrigation water, stock water, domestic use	High
Aquatic fauna	Climate change and severe weather events - Higher temperatures	Higher temperatures changing environmental triggers for fish spawning	For many fish, spawning is often related to water temperatures - not too cold or warm. Too high temperatures can mean fish will not have the climatic cue to spawn e.g. Golden Perch	High
Waterbirds	Climate change and severe weather events - Higher temperatures	Higher temperatures resulting in increased mortality of juvenile waterbirds	Juvenile waterbirds unable to survive high temperatures	Very High
Native flora	Invasive non-native species - woody weeds	Increased competition for water and nutrients	Displacement of native flora and reduced biodiversity around wetland riparian zones	High
Native flora	Invasive non-native species - non-woody weeds e.g. creepers	Increased competition for water and nutrients	Displacement of native flora and reduced biodiversity around wetland riparian zones	High
Native flora	Invasive non-native species - aquatic vegetation e.g. Arrowhead	Increased competition for water and nutrients	Displacement of native flora and reduced biodiversity	High
Native flora	Invasive non-native species: Rabbits	Overgrazing of native emergent, understory and overstorey flora	Reduced abundance and diversity of native flora	Very High
Native flora	Invasive non-native species: Rabbits	Grazing of threatened native flora	Loss of threatened flora species	Very High
Aboriginal values	Invasive non-native species: Rabbits	Burrowing habits and overgrazing	Disturbance of cultural heritage	Very High
Soils	Invasive non-native species: Rabbits	Burrowing habits	Degradation of soil structure and erosion	High
Waterbirds; Aquatic fauna	Invasive non-native species: Cats	Increased predation on native fauna e.g. turtles, waterbirds, and their eggs	Reduced abundance and diversity of native fauna	Very High
Recreation	Invasive non-native species: Cats	Increased predation on waterbirds	Impacts to waterbird abundance affect opportunities for recreational activities, i.e. bird watching	High
Waterbirds; Aquatic fauna	Invasive non-native species: Foxes	Increased predation on native fauna e.g. turtles, waterbirds, and their eggs	Reduced abundance and diversity of native fauna	Very High

Value	Threat	Stressor	Effect description	Risk rating
Recreation	Invasive non-native species: Foxes	Increased predation on waterbirds	Impacts to waterbird abundance affect opportunities for recreational activities i.e. bird watching	High
Native flora	Invasive non-native species: Pigs	Wallowing, grazing and uprooting of native flora species	Reduced abundance and diversity of native flora	Very High
Waterbirds; Terrestrial fauna; Aquatic fauna	Invasive non-native species: Pigs	Wallowing, grazing and uprooting of native flora species	Impacts to vegetation reduce availability of habitat for birds, reptiles, mammals, amphibians	Very High
Aboriginal values	Invasive non-native species: Pigs	Wallowing, grazing and uprooting of native flora species	Disturbance of cultural heritage	Very High
Waterbirds	Invasive non-native species: Pigs	Increased predation on eggs and fledgling waterbirds	Mortality of waterbirds resulting in reduced abundance of waterbirds.	High
Aquatic fauna	Invasive non-native species: carp and Gambusia	Increased predation on native fish and frog eggs and larvae, and competition for food	Reduced diversity and abundance of native fish and frogs	High
Water quality; Native Flora; Aquatic fauna	Invasive non-native species: carp and Gambusia	carp feeding habits i.e. mumbling	carp stir up sediments through their feeding methods, increasing turbidity which inhibits growth of vegetation and reduces visibility for native fauna, which in turn may reduce their ability to feed	Very High
Native flora	Invasive non-native species: carp and Gambusia	carp feeding habits i.e. mumbling	Uprooting of aquatic and emergent vegetation reduces abundance and diversity of vegetation	Very High
Waterbirds; Terrestrial fauna; Aquatic fauna	Loss of standing timber habitat	Dead trees (from previous change to water management) are unstable and falling over with limited regeneration throughout the wetlands	Reduced availability of feeding, nesting and roosting habitat for birds, bats and mammals	Very High
Terrestrial fauna; Aquatic fauna	Recreational activities - camping	Increased collection of firewood	Reduced physical habitat diversity for native fauna	High
Aboriginal values	Recreational activities - visitors	Intentional or unintentional disturbance of cultural sites	Disturbance, destruction or removal of cultural heritage	High
Recreation	Residential and commercial development	Increased illegal dumping of rubbish	Impacts the aesthetic value of the wetland	High
Native flora	Resource use - grazing licenses	Grazing of livestock within the Ramsar Site	Reduced native flora abundance and diversity at wetlands with a grazing license: the Reedy Lakes, Kangaroo and Racecourse Lakes, Lake Charm	High
Aboriginal values	Resource use - grazing licenses	Grazing of livestock within the Ramsar Site	Disturbance of cultural heritage sites at wetlands with a grazing license: the Reedy Lakes, Kangaroo Lake, Racecourse Lake, Lake Charm	High
Waterbirds	Flood mitigation	Raised water levels flooding out nests.	Increased water levels at the Reedy Lakes above a certain level would inundate nests and cause mortality of juveniles.	High

3.3 Risk assessment for the salt / sewage disposal and drainage wetlands

Ninety-two threat/value combinations were assessed for the salt / sewage disposal and drainage wetlands. 'High' and 'Very High' risks are shown in Table 11. The full risk assessment is presented in Appendix 4 and shows linkages with Ramsar values. The 'High and 'Very High' risks are associated with climate change (drought and high temperatures); invasive non-native plants and animals, including rabbits, foxes, cats, pigs and carp; resource use (grazing); nearby residential and commercial development; and recreational visitors and campers.

Table 11. Identified High and Very High risks at the salt / sewage disposal wetlands, including Fosters Swamp, Lake Tutchewop, Lake William, Lake Kelly and Little Lake Kelly.

Value	Threat	Stressor	Effect description	Risk rating
Refuge	Water resource use and regulation	Decreased inflows	Reduced availability of water in the landscape impacts on availability of drought refuge	High
Native flora	Water resource use and regulation	Decreased inflows	Changed frequency and duration of inflows could go beyond hydrological tolerances of vegetation	High
Waterbirds	Water resource use and regulation	Decreased inflows	Reduced opportunities for waterbird breeding	High
Refuge	Climate change and severe weather events - Drought	Decreased inflows	Reduced permanency of water storages or reduced availability of water in the landscape impacts on drought refuge	High
Native flora	Climate change and severe weather events - Drought	Decreased inflows	Changed frequency and duration of inflows could go beyond hydrological tolerances of vegetation	High
Waterbirds	Climate change and severe weather events - Drought	Decreased inflows	Reduced opportunities for waterbird breeding	High
Native flora	Invasive non-native species - woody weeds e.g. willows, boxthorn, blackberry, briar rose	Increased competition for water and nutrients	Displacement of native flora and reduced biodiversity around wetland riparian zones	High
Native flora	Invasive non-native species - non-woody weeds e.g. creepers	Increased competition for water and nutrients	Displacement of native flora and reduced biodiversity around wetland riparian zones	High
Native flora	Invasive non-native species: Rabbits	Overgrazing of native emergent, understory and overstorey flora	Reduced abundance and diversity of native flora	Very High
Native flora	Invasive non-native species: Rabbits	Grazing of threatened native flora	Loss of threatened flora species	Very High
Aboriginal values	Invasive non-native species: Rabbits	Burrowing habits and overgrazing	Disturbance of cultural heritage	Very High
Soils	Invasive non-native species: Rabbits	Burrowing habits	Degradation of soil structure and erosion	High

Value	Threat	Stressor	Effect description	Risk rating
Waterbirds; Aquatic fauna	Invasive non-native species: Cats	Increased predation on native fauna e.g. turtles, waterbirds, and their eggs	Reduced abundance and diversity of native fauna	Very High
Recreation	Invasive non-native species: Cats	Increased predation on waterbirds	Impacts to waterbird abundance affect opportunities for recreational activities i.e. bird watching	High
Waterbirds; Aquatic fauna	Invasive non-native species: Foxes	Increased predation on native fauna e.g. turtles, waterbirds, and their eggs	Reduced abundance and diversity of native fauna	Very High
Recreation	Invasive non-native species: Foxes	Increased predation on waterbirds	Impacts to waterbird abundance affect opportunities for recreational activities i.e. bird watching	High
Aboriginal values	Invasive non-native species: Pigs	Wallowing, grazing and uprooting of native flora species	Disturbance of cultural heritage	Very High
Waterbirds	Invasive non-native species: Pigs	Increased predation on eggs and fledgling waterbirds	Mortality of waterbirds resulting in reduced abundance of waterbirds	High
Waterbirds	Recreational activities - hunting	Hunting of non-game waterbird species	Loss of non-game waterbirds and/or threatened species	High
Aboriginal values	Recreational activities - visitors	Intentional or unintentional disturbance of cultural sites	Disturbance, destruction or removal of cultural heritage	High
Recreation	Residential and commercial development	Increased illegal dumping of rubbish	Impacts the aesthetic value of the wetland	High
Native flora	Resource use - grazing licenses	Grazing of livestock within the Ramsar Site	Reduced abundance and diversity of native flora at wetlands with a grazing license. Relates to Lake Kelly and Lake William	High
Aboriginal values	Resource use - grazing licenses	Grazing of livestock within the Ramsar Site	Disturbance of cultural heritage sites at wetlands with a grazing license: Lake Kelly and Lake William	High
Native flora; Water quality	Resource use - Unlicensed grazing.	Unlicensed grazing of livestock within the Ramsar Site.	Same as risks for grazing licenses.	High

3.4 Risk assessment for the regulated freshwater intermittent wetlands

Ninety-seven threat/value combinations were assessed for the regulated freshwater intermittent wetlands. 'High' and 'Very High' risks are shown in Table 12. The full risk assessment is presented in Appendix 4 and shows linkages with Ramsar values. The 'High' and 'Very High' risks are associated with water resource use and regulation in terms of decreased inflows and altered timing of inflows; climate change (drought and high temperatures); invasive non-native plants and animals, including rabbits, foxes, cats, pigs and carp; wild fire; resource use (grazing); nearby residential and commercial development; and recreational visitors and campers.

Table 12. Identified High and Very High risks at the regulated freshwater intermittent wetlands, including Johnson Swamp, Hird Swamp, Lake Cullen, Town Swamp and the Kerang Weir Pool.

Value	Threat	Stressor	Effect description	Risk rating
Waterbirds	Water resource use and regulation	Altered timing of inundation	Impact on waterbird breeding cycles as flows may come at the wrong time of year to miss the breeding season, or could inundate nests of birds that create platforms for breeding (i.e. bitterns, swamphens)	High
Refuge	Water resource use and regulation	Decreased inflows	Reduced availability of water in the landscape impacts on availability of drought refuge	High
Recreation	Water resource use and regulation	Decreased inflows	Reduced permanency of water storages or reduced inflow to wetlands impacts on recreational activities e.g. boating, duck hunting	High
Native flora	Water resource use and regulation	Decreased inflows	Changed frequency and duration of inflows could go beyond hydrological tolerances of vegetation	High
Waterbirds	Water resource use and regulation	Decreased inflows	Reduced opportunities for waterbird breeding	High
Waterbirds	Climate change and severe weather events – Unseasonal flooding	Altered timing of inundation	Impact on waterbird breeding cycles as changing weather patterns mean that flows may come at the wrong time of year to miss the breeding season, or could inundate nests of birds that create platforms for breeding (i.e. bitterns, swamphens)	High
Wetland type	Climate change and severe weather events - Drought	Decreased availability of water in the system	Reduced percentages of environmental water allocations are available for watering actions	High
Refuge	Climate change and severe weather events - Drought	Decreased inflows	Reduced availability of water in the landscape impacts on drought refuge	High
Recreation	Climate change and severe weather events - Drought	Decreased inflows	Reduced inflow to wetlands impacts on recreational activities e.g. boating, duck hunting	High
Native flora	Climate change and severe weather events - Drought	Decreased inflows	Changed frequency and duration of inflows could go beyond hydrological tolerances of vegetation	High
Waterbirds	Climate change and severe weather events - Drought	Decreased inflows	Reduced opportunities for waterbird breeding	High
Waterbirds	Climate change and severe weather events - Higher temperatures	Higher temperatures resulting in increased mortality of juvenile waterbirds	Juvenile waterbirds unable to survive high temperatures	Very High
Native flora	Invasive non-native species - woody weeds e.g. willows, boxthorn, blackberry, briar rose	Increased competition for water and nutrients	Displacement of native flora and reduced biodiversity around wetland riparian zones	High
Native flora	Invasive non-native species - non-woody weeds e.g. creepers	Increased competition for water and nutrients	Displacement of native flora and reduced biodiversity around wetland riparian zones	High
Native flora	Invasive native species - aquatic vegetation e.g. Cumbungi and Typha	Increased dominance and extent of these species	Displacement of other native flora and reduced biodiversity	Very High
Native flora	Invasive non-native species: Rabbits	Overgrazing of native emergent, understory and overstorey flora	Reduced abundance and diversity of native flora	Very High

Value	Threat	Stressor	Effect description	Risk rating
Native flora	Invasive non-native species: Rabbits	Grazing of threatened native flora	Loss of threatened flora species	Very High
Aboriginal values	Invasive non-native species: Rabbits	Burrowing habits and overgrazing	Disturbance of cultural heritage	Very High
Soils	Invasive non-native species: Rabbits	Burrowing habits	Degradation of soil structure and erosion	High
Waterbirds; Aquatic fauna	Invasive non-native species: Cats	Increased predation on native fauna e.g. turtles, waterbirds, and their eggs	Reduced abundance and diversity of native fauna	Very High
Recreation	Invasive non-native species: Cats	Increased predation on waterbirds	Impacts to waterbird abundance affect opportunities for recreational activities i.e. bird watching	High
Waterbirds; Aquatic fauna	Invasive non-native species: Foxes	Increased predation on native fauna e.g. turtles, waterbirds, and their eggs	Reduced abundance and diversity of native fauna	Very High
Recreation	Invasive non-native species: Foxes	Increased predation on waterbirds	Impacts to waterbird abundance affect opportunities for recreational activities i.e. bird watching	High
Native flora	Invasive non-native species: Pigs	Wallowing, grazing and uprooting of native flora species	Reduced abundance and diversity of native flora	Very High
Waterbirds; Terrestrial fauna; Aquatic fauna	Invasive non-native species: Pigs	Wallowing, grazing and uprooting of native flora species	Impacts to vegetation reduce availability of habitat for birds, reptiles, mammals, amphibians	Very High
Aboriginal values	Invasive non-native species: Pigs	Wallowing, grazing and uprooting of native flora species	Disturbance of cultural heritage	Very High
Waterbirds	Invasive non-native species: Pigs	Increased predation on eggs and fledgling waterbirds	Mortality of waterbirds resulting in reduced abundance of waterbirds	High
Native flora	Wild fire	Destruction of native flora species or communities	Loss of native flora species	High
Waterbirds; Terrestrial fauna; Aquatic fauna	Wild fire	Destruction of habitat and resources (e.g. standing dead timber, vegetation)	Reduced availability of feeding, nesting and roosting habitat for birds, bats, reptiles and mammals	High
Waterbirds	Recreational activities - hunting	Hunting of non-game waterbird species	Loss of non-game waterbirds and/or threatened species	High
Aboriginal values	Recreational activities - visitors	Intentional or unintentional disturbance of cultural sites	Disturbance, destruction or removal of cultural heritage	High
Recreation	Residential and commercial development	Increased illegal dumping of rubbish	Impacts the aesthetic value of the wetland	High
Native flora; Water quality	Resource use - Unlicensed grazing	Unlicensed grazing of livestock within the Ramsar Site.	Same as risks for grazing licenses. Has occurred at the Kerang Weir.	Very High

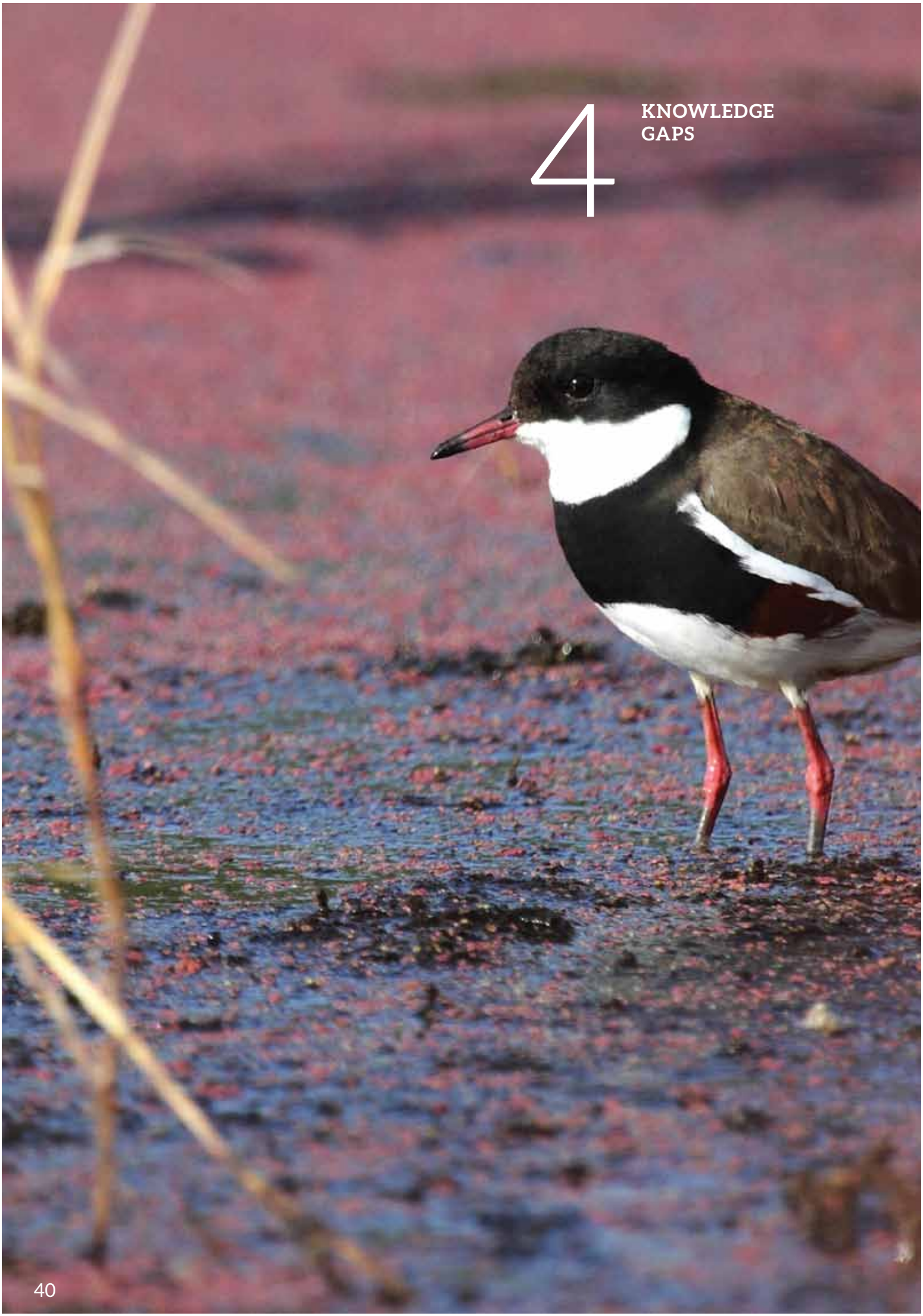
3.5 Risk assessment for the unregulated freshwater intermittent wetlands

Ninety-two threat/value combinations were assessed for the regulated freshwater intermittent wetlands. 'High' and 'Very High' risks are shown in Table 13. The full risk assessment is presented in Appendix 4 and shows linkages with Ramsar values. The 'High' and 'Very High' risks are associated with water resource use and regulation in terms of decreased inflows and altered timing of inflows; climate change (drought and high temperatures); invasive non-native plants and animals, including rabbits, foxes, cats, pigs and carp; wild fire; resource use (grazing); nearby residential and commercial development; and recreational visitors and campers.

Table 13. Identified High and Very High risks at the unregulated freshwater intermittent wetlands, including Lake Bael Bael, First, Second and Third Marsh, Stevenson Swamp and Cemetery Swamp.

Value	Threat	Stressor	Effect description	Risk rating
Waterbirds	Water resource use and regulation	Altered timing of inundation	Impact on waterbird breeding cycles as flows may come at the wrong time of year to miss the breeding season, or could inundate nests of birds that create platforms for breeding (i.e. bitterns, swamphens)	High
Refuge	Water resource use and regulation	Decreased inflows	Reduced availability of water in the landscape impacts on availability of drought refuge	High
Recreation	Water resource use and regulation	Decreased inflows	Reduced permanency of water storages or reduced inflow to wetlands impacts on recreational activities e.g. boating, duck hunting	High
Native flora	Water resource use and regulation	Decreased inflows	Changed frequency and duration of inflows could go beyond hydrological tolerances of vegetation	High
Waterbirds	Water resource use and regulation	Decreased inflows	Reduced opportunities for waterbird breeding	High
Waterbirds	Climate change and severe weather events – Unseasonal flooding	Altered timing of inundation	Impact on waterbird breeding cycles as flows may come at the wrong time of year to miss the breeding season, or could inundate nests of birds that create platforms for breeding (i.e. bitterns, swamphens)	High
Refuge	Climate change and severe weather events - Drought	Decreased inflows	Reduced permanency of water storages or reduced availability of water in the landscape impacts on drought refuge	High
Recreation	Climate change and severe weather events - Drought	Decreased inflows	Reduced permanency of water storages or reduced inflow to wetlands impacts on recreational activities e.g. boating, duck hunting	High
Native flora	Climate change and severe weather events - Drought	Decreased inflows	Changed frequency and duration of inflows could go beyond hydrological tolerances of vegetation	High
Waterbirds	Climate change and severe weather events - Drought	Decreased inflows	Reduced opportunities for waterbird breeding	High
Waterbirds	Climate change and severe weather events - Higher temperatures	Higher temperatures resulting in increased mortality of juvenile waterbirds	Juvenile waterbirds unable to survive high temperatures	Very High
Native flora	Invasive non-native species - woody weeds e.g. willows, boxthorn, blackberry, briar rose	Increased competition for water and nutrients	Displacement of native flora and reduced biodiversity around wetland riparian zones	High
Native flora	Invasive non-native species - non-woody weeds e.g. creepers	Increased competition for water and nutrients	Displacement of native flora and reduced biodiversity around wetland riparian zones	High
Native flora	Invasive non-native species: Rabbits	Overgrazing of native emergent, understory and overstorey flora	Reduced abundance and diversity of native flora	Very High
Native flora	Invasive non-native species: Rabbits	Grazing of threatened native flora	Loss of threatened flora species	Very High

Value	Threat	Stressor	Effect description	Risk rating
Aboriginal values	Invasive non-native species: Rabbits	Burrowing habits and overgrazing	Disturbance of cultural heritage	Very High
Soils	Invasive non-native species: Rabbits	Burrowing habits	Degradation of soil structure and erosion	High
Waterbirds; Aquatic fauna	Invasive non-native species: Cats	Increased predation on native fauna e.g. turtles, waterbirds, and their eggs	Reduced abundance and diversity of native fauna	Very High
Recreation	Invasive non-native species: Cats	Increased predation on waterbirds	Impacts to waterbird abundance affect opportunities for recreational activities i.e. bird watching	High
Waterbirds; Aquatic fauna	Invasive non-native species: Foxes	Increased predation on native fauna e.g. turtles, waterbirds, and their eggs	Reduced abundance and diversity of native fauna	Very High
Recreation	Invasive non-native species: Foxes	Increased predation on waterbirds	Impacts to waterbird abundance affect opportunities for recreational activities i.e. bird watching	High
Native flora	Invasive non-native species: Pigs	Wallowing, grazing and uprooting of native flora species	Reduced abundance and diversity of native flora	High
Waterbirds; Terrestrial fauna; Aquatic fauna	Invasive non-native species: Pigs	Wallowing, grazing and uprooting of native flora species	Impacts to vegetation reduce availability of habitat for birds, reptiles, mammals, amphibians	High
Aboriginal values	Invasive non-native species: Pigs	Wallowing, grazing and uprooting of native flora species	Disturbance of cultural heritage	Very High
Waterbirds	Invasive non-native species: Pigs	Increased predation on eggs and fledgling waterbirds	Mortality of waterbirds resulting in reduced abundance of waterbirds	High
Native flora	Wild fire	Destruction of native flora species or communities	Loss of native flora species	High
Waterbirds; Terrestrial fauna; Aquatic fauna	Wild fire	Destruction of habitat and resources (e.g. standing dead timber, vegetation)	Reduced availability of feeding, nesting and roosting habitat for birds, bats, reptiles and mammals	High
Waterbirds	Recreational activities - hunting	Hunting of non-game waterbird species	Loss of non-game waterbirds and/or threatened species	High
Aboriginal values	Recreational activities - visitors	Intentional or unintentional disturbance of cultural sites	Disturbance, destruction or removal of cultural heritage	High
Recreation	Residential and commercial development	Increased illegal dumping of rubbish	Impacts the aesthetic value of the wetland	High
Native flora	Resource use - grazing licenses	Grazing of livestock within the Ramsar Site	Reduced abundance and diversity of native flora at wetlands with a grazing license. Relates to Stevenson Swamp	High
Aboriginal values	Resource use - grazing licenses	Grazing of livestock within the Ramsar Site	Disturbance of cultural heritage sites at wetlands with a grazing license. Relates to Stevenson Swamp	High
Native flora; Water quality	Resource use - Unlicensed grazing	Unlicensed grazing of livestock within the Ramsar Site.	Same as risks for grazing licenses. Occurs at Avoca Marshes.	Very High



4 KNOWLEDGE GAPS

Thirteen knowledge gaps were identified through the risk assessment and engagement processes that link to both critical and supporting CPSs. These are listed in Table 14.

Table 14. Identified knowledge gaps for the Kerang Wetlands.

#	Component/process/service	Knowledge gaps
1	Hydrology	Water regime of Town Swamp, the Kerang Weir Pool, and Cemetery Swamp, and potential for modification if required.
2	Vegetation	Current condition and extent of native vegetation and presence/absence of threatened species at Kangaroo Lake, Lake Charm, Cemetery Swamp, Town Swamp, the Kerang Weir Pool and Fosters Swamp.
3		Extent of weed infestations at each wetland.
4		Extent of grazing licenses over wetlands (e.g. within inundation footprint) and buffer zones, stocking rates of each license, and potential impacts to ecological values within the Ramsar Site. These wetlands include: Lake William, First Reedy Lake, Middle Reedy Lake, Third Reedy Lake, Kangaroo Lake, Racecourse Lake, Lake Charm, Stevenson Swamp, Lake Kelly.
5		Length of time Common Carp (*Cyprinus carpio*) can be in a wetland before significant damage to wetland vegetation occurs.
6	Waterbird abundance and diversity	Frequency of waterbird abundance over 20,000 individuals across the Ramsar Site.
7		Relationships between waterbird abundance/diversity and habitat availability/hydrology are poorly understood across the Ramsar Site.
8		Habitat use by the Curlew Sandpiper across the Ramsar Site.
9	Physical habitat	Extent and severity of bed and bank erosion from wave action, carp etc.
10	Water quality	Impact of nutrients in run-off/drainage water from adjacent land uses i.e. animal industries, fertilisers.
11		Frequency and impact of blackwater events in the Kerang Wetlands.
12		Quantitative data for salinity at each wetland is inconsistently monitored.
14		Pollution (chemicals, high nutrient loads, other contaminants) of floodwaters from the wider catchment and impacts.
15	Soils	Risk of current watering regime exposing acidic wetland sediments at Town Swamp and the Kerang Weir Pool.
16		Metal loading of soils or water at wetlands at risk of acidification.

Previous page: Red-kneed Dotterel
Photo: David Kleinert

5 RESOURCE CONDITION TARGETS

To guide the development of appropriate management actions and ensure that they meet the overarching goal of maintaining the ecological character of the Ramsar Site, resource condition targets (RCTs) were developed for each critical CPS (Table 15). Where relevant, the targets have been developed for specific wetlands. The derivation of the RCTs is presented in Appendix 4.

As part of the development of the ECD (and subsequent ECD review), Limits of Acceptable Change (LAC) were developed for each critical CPS. These are a formal tool for assessing whether the character of a wetland may have changed (DoE 2016). LACs represent the point at which a particular component or process has undergone a significant change, such that it may constitute a change in the ecological character. Therefore, RCTs must aim for a better condition than the LAC (Cottingham et al. 2016).

The timeframe for achievement of all resource condition targets is within the life of the Action Plan, from 2017 to 2025, unless otherwise specified. It should be noted, however, that some indicators may take a longer timeframe to become measurable, or may be confounded by extended periods of climatic stress such as drought. In general, by 2025 there should be demonstrable progress towards the targets.

RCTs were developed in consultation with agency staff and technical experts, and confirmed and refined with the Project Steering Committee at a meeting on 20 June 2016. Some RCTs may be refined as additional data is collected in the early stages of the life of the Action Plan.

Table 15. Resource condition targets for the Kerang Wetlands Ramsar Site.

Note that EVC benchmarks refer to benchmarks published by DSE (now DELWP) in 2004 for the Victorian Riverina bioregion and the Murray Fans bioregion.

RCT #	Component / Process / Service	Resource condition targets
1	Hydrology (process)	Maintain annual water regimes of each wetland in accordance with wetland type, regime cycle and operating ranges (if relevant) in all years.
2	Salinity (component)	Maintain average salinity levels below 1900 EC when more than 75% full at the following wetlands: Kangaroo Lake, Racecourse Lake, Little Lake Charm, First Reedy Lake, Middle Reedy Lake, Third Reedy Lake, Cemetery Swamp, Lake Bael Bael, First Marsh, Second Marsh, Third Marsh, Town Swamp, Kerang Weir Pool, Johnson Swamp and Hird Swamp. Maintain average salinity levels below 7000 EC when more than 75% full at Lake Cullen.
3	Waterbird abundance (component)	Large waterbird abundances continue to be supported on a regular basis, with annual count data greater than 10,000 in any rolling 10 year period.
4	Waterbird diversity (component)	The average number of recorded wetland-dependent birds is 35 species or greater in any rolling five-year period.
5a	Waterbird breeding (process)	At least six colonial nesting waterbird breeding events across the Ramsar Site in any rolling 10 year period.
5b		Opportunistic breeding events of colonial nesting species or other significant wetland-dependent species/events at Johnson Swamp, Hird Swamp and Lake Cullen are supported if required using environmental water.
6a	Threatened species - Australasian Bittern (service)	Suitable feeding and nesting habitat is provided for Australasian bittern in six years out of ten at any of the wetlands for which there are historic count data by 2025 (presence has been recorded at Johnson Swamp, Hird Swamp and Lake Cullen).
6b		Opportunistic breeding events at Johnson Swamp or Hird Swamp are supported if required e.g. extending an inundation event by providing environmental water. wetlands for which there are historic count data by 2025 (presence has been recorded at Johnson Swamp, Hird Swamp and Lake Cullen).
7	Threatened species - Curlew Sandpiper (service)	Suitable feeding habitat is provided for curlew sandpiper in seven years out of ten by 2025 across wetlands for which there are historic count data (presence has been recorded at Lake Tutchewop, Lake Kelly and Little Lake Kelly, Lake Cullen, Fosters Swamp, Hird Swamp)
8	Threatened species - fish (service)	Maintain existing hydrologic connectivity between waterways and wetlands when water is present. Maintain permanent annual watering regimes in the Reedy Lakes, Lake Charm and Little Lake Charm, Racecourse Lake and Kangaroo Lake to provide refuge for native fish species.
9	Wetland diversity (service)	Wetland type is a product of hydrology, salinity and vegetation. See targets for hydrology, salinity and vegetation.

Continued over page

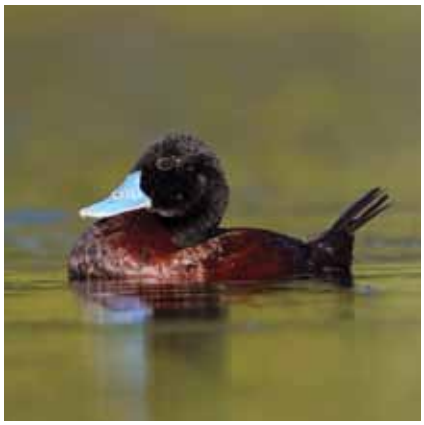
Photo previous page: Sally Jarvis

Table 15. Resource condition targets for the Kerang Wetlands Ramsar Site. (Cont.)

Note that EVC benchmarks refer to benchmarks published by DSE (now DELWP) in 2004 for the Victorian Riverina bioregion and the Murray Fans bioregion.

RCT #	Component / Process / Service	Resource condition targets
10a	Vegetation diversity (component)	Reduce the extent of *Typha* spp. and density of *Phragmites* spp. in Tall Marsh (EVC 821) by 2025, with a corresponding increase in Aquatic Herbland (EVC 653) at Johnson Swamp, and maintain the current extent of *Typha* and *Phragmites* at Hird Swamp (see Rakali 2014b baseline).
10b		Improve the riparian vegetation condition, structure and diversity towards EVC benchmarks at Hird Swamp by 2025 (see Rakali 2014a for baseline).
10c		Improve the riparian vegetation condition, structure and diversity towards EVC benchmarks at Johnson Swamp by 2025 (see Rakali 2014a for baseline).
10d		Maintain the extent and improve the species richness of submerged macrophytes and herbs at Lake Cullen as per EVC mapping (Australian Ecosystems 2012 and Rakali 2014a) and benchmarks when inundated.
10e		Improve riparian vegetation structure towards the EVC benchmark for the current extent of Semi-arid Chenopod Woodland at Lake William by 2025 (Rakali 2014a).
10f		Improve the native lakebed and riparian vegetation structure according to EVC benchmarks at Lake Bael Bael, First Marsh, Second Marsh and Third Marsh by 2025 (Rakali 2014a).
10g		Maintain the extent and improve the structure and species richness of the Semi-arid Woodland EVC at Lake Bael Bael and Second Marsh towards the EVC benchmark (Rakali 2014a).
10h		Improve the native riparian vegetation structure towards EVC benchmarks at Lake Tutchewop, Lake Kelly and Little Lake Kelly by 2025 (Rakali 2014a).
10i		Improve the diversity of native wetland vegetation towards benchmarks of dominant EVCs at Cemetery Swamp by 2025 (baseline vegetation assessments to be undertaken in 2016/17).
10j		Improve the native wetland vegetation structure and diversity towards benchmarks of dominant EVCs at Kerang Weir by 2025 (baseline vegetation assessments to be undertaken in 2016/17).
10k		Improve the native wetland vegetation structure and diversity towards benchmarks of dominant EVCs at Town Swamp by 2025 (baseline vegetation assessments to be undertaken in 2016/17).
10l		Improve the structure of native riparian vegetation at Fosters Swamp towards EVC benchmarks by 2025 (baseline vegetation assessments to be undertaken in 2016/2017).
10m		Maintain the extent, structure and diversity of Lignum Swamp at First Reedy Lake and Middle Reedy Lake as per EVC mapping (Rakali 2014a) and benchmarks.
10n		Maintain the extent, and improve the structure and diversity of native vegetation at Third Reedy Lake as per EVC mapping (Rakali 2014a) and benchmarks (except Aquatic Herbland – see below).
10o		Improve the extent of herbaceous aquatic and amphibious species characteristic of Aquatic Herbland at the permanent wetlands (First Reedy Lake, Middle Reedy Lake, Third Reedy Lake, Kangaroo Lake, Racecourse Lake, Lake Charm and Little Lake Charm) towards the EVC benchmark by 2025.
10p		Maintain the extent and diversity of native emergent and riparian vegetation at Racecourse Lake and Little Lake Charm (including Scotts Swamp) as per EVC mapping (Rakali 2013) and benchmarks.
10q		Maintain the extent and diversity of native emergent and riparian vegetation at Lake Charm and Kangaroo Lake as per dominant EVC benchmarks (baseline vegetation assessments to be undertaken in 201617).
10r		Maintain the native vegetation extent at Stevenson Swamp (North Central CMA 2016b).

6 MANAGEMENT ACTION PLANS



Blue-billed Duck

Robust Water-Milfoil (*Myriophyllum papillsoum*)
Photo: Ian Higgins

Carpet Python

6.1 Wetland Action Plans

The aim of developing specific management actions for the overall Ramsar Site and for individual wetlands is to assist the various land managers and partner agencies to understand what is required to improve or maintain the ecological character of the Ramsar Site. To provide the context for management activities, a summary description of each wetland is provided with each individual action plan, along with maps and notable characteristics e.g. threatened species or communities. Further wetland-specific information is provided in the appendices that may assist with management, such as species lists and EVC mapping where available.

The PSC has agreed to broaden the scope of this Action Plan beyond the specified Ramsar values (ecological) to consider the social and cultural aspects of the wetlands, which are in most cases considered to be interlinked with the ecology of the site. The majority of these actions relate to the whole site, which can be viewed in Sections 6.8 and 6.9, though a small number of actions are wetland-specific and have been listed in the individual wetland action plans. While they are not intended to support all social and cultural values around the site, the actions specified should offer some guidance in strengthening and enhancing the cultural and social values of the Ramsar Site.

Lead agencies have been identified for each action, as well as partners. The lead agency is intended to represent the agency with the greatest level of responsibility and/or organisational expertise to carry out the action. Partners have also been identified to provide support to the lead agency, recognising that there is frequent coordination and cooperation amongst agencies, community and interest groups. The assignment of lead agencies should not preclude other agencies or interest groups from seeking funding to undertake management activities independently, though certain approvals may be required from the lead agency and collaboration is advised.

The achievement of all management actions is dependent on the availability of resources. All actions in the Action Plan are subject to available funding. Lead agencies and partners will seek investment to implement the Action Plan. All costs provided in this plan are indicative only and require further scoping prior to investment.

Unless specified, the time frame for achievement of all actions is within the eight-year life of this Action Plan up to 2025.

Previous page: Brolga nest, Johnson Swamp
Photo: Damien Cook

6.2 Management since 2004

In 2004 Parks Victoria developed the *Kerang Wetlands Ramsar Site Strategic Management Plan* on behalf of the Victorian Government. The plan provides some useful information about values and threats to the Ramsar Site, and lists a number of management strategies aimed at maintaining or restoring the ecological character of the site.

In the twelve years since the *Strategic Management Plan* was completed, many of these strategies have been acted upon by the various lead agencies. However, no reporting mechanism was established and implemented, making it difficult to formally ascertain how many of the management strategies have been completed, or at least progressed. Despite this, an examination of recent and current projects across the site shows that many of the strategies have been, or continue to be, implemented (many are ongoing), in the areas of:

- Pest plant and animal control
- Protecting and enhancing native vegetation
- Developing and implementing appropriate water regimes and negotiating environmental water allocations to supply these
- Developing and constructing infrastructure to enable delivery of water to the wetlands
- Ensuring that wetlands have not been adversely impacted by water infrastructure upgrades and system efficiencies
- Consulting and engaging with the community and Traditional Owners
- Promoting greater awareness and understanding of the Ramsar Site through extension and voluntary programs to encourage community involvement
- Monitoring recreational impact and encouraging minimal impacts to protect the Ramsar Site.

Black-winged Stilt. Photo: David Kleinert

There remain some significant investigations yet to be undertaken that would inform the appropriate management and wise use of the Ramsar Site.

The legislative context in which the Kerang Wetlands Ramsar Site is managed has also changed since the 2004 *Strategic Management Plan*, with the *Water Act 2007* and the Murray-Darling Basin Plan coming into force. These have reshaped the way water is managed in the Murray-Darling Basin. In particular, it has strengthened environmental water management, which has had a positive influence on the Kerang Wetlands Ramsar Site through more structured provision of environmental water to three wetlands, Lake Cullen, Hird Swamp and Johnson Swamp.

6.3 Action plan for the overall Kerang Wetlands Ramsar Site

An Action Plan for the overall Kerang Wetlands Ramsar Site is presented in Table 16. These actions are consistent across all, or many, wetlands. For example, the need for non-native animal control is ubiquitous across the site, and it is recommended that an overall program be developed with land managers. This differs from pest plant control, which may or may not require specific actions at a particular wetland e.g. aquatic weeds are currently unlikely to be an issue at the saline wetlands as salinity levels are too high for any currently established weed species (note that this situation could change in the event of the invasion of new, salt-tolerant weed species).

Unless specified, the time frame for achievement of all actions is within the eight-year life of this Action Plan up to 2025.

Note that an implementation program will be developed in 2017 that will identify more spatially specific areas, details and costs for on-ground actions. As mentioned above, the achievement of all actions is subject to available funding and resources.

Table 16. Action Plan for the overall Kerang Wetlands Ramsar Site.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
		Administrative / knowledge gaps				
1		Investigate the feasibility and cost of undertaking a review of the Ramsar boundary by 2018, with the potential to extend the boundary to include additional wetlands and/or adjacent land with high ecological value.	-	To be costed.	DELWP	GMW, Parks Victoria, Gannawarra Shire Council, North Central CMA
2		Develop a site-wide implementation program in conjunction with land managers to identify and cost specific areas at each wetland that require pest plant or animal control, revegetation, or other protective or restorative works by 2017.	-	Funded	North Central CMA	GMW, Parks Victoria, Gannawarra Shire Council, DELWP
3	All	Develop and implement a site-wide monitoring program that includes specific methodologies to monitor progress towards resource condition targets for the CPS, threats to ecological character, and address knowledge gaps as outlined in Section 7 by 2017. These programs should specifically include: – Targeted monitoring of threatened species that are regularly supported by the site such as Australasian Bittern and the Curlew Sandpiper – Mapping and analysis of physical habitat for waterbirds across the site – Water quality monitoring, including nutrient loads, salinity and potential blackwater – Vegetation condition assessments every 4 years (next due in 2018 for majority of wetlands).	-	To be costed.	North Central CMA	GMW, Parks Victoria, Gannawarra Shire Council, DELWP
4	11, 12a, 12b, 13	Review waterbird surveys across agencies to form a better understanding of existing monitoring, identify gaps in monitoring for this component of the ecological character, and implement a coordinated monitoring program to fill these.	-	$10,000	North Central CMA	Parks Victoria, DELWP, North Central CMA, Birdlife Australia, GMA
5		Undertake baseline vegetation surveys including EVC mapping, species diversity, threatened species, and condition assessments by 2017 for wetlands where no current information is available (Lake Charm, Kangaroo Lake, Fosters Swamp, Cemetery Swamp, Town Swamp, Kerang Weir Pool).	6	Funded	North Central CMA	GMW, Parks Victoria, Gannawarra Shire Council, DELWP
6		Assess the level of runoff from land adjacent to the wetlands and its nutrient content (including stormwater) by 2025.	-	To be costed.	DEDTJR	DELWP, GMW, Parks Victoria, North Central CMA
7	1, 3, 4, 10v	Investigate the potential to control the timing of fluctuations (if any) in water level at the permanent wetlands to align with natural seasonal wetting and drawdown phases by 2025 e.g. to expose mudflats and restore a slightly more natural wetting/drawdown regime.	1	To be examined through development of on-water and land plans.	GMW	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 3, 9b, 10v	Investigate the impacts from erosion on wetland bed and banks at permanent wetlands (potentially caused by carp or wave action) by 2018.	1	To be costed.	GMW	DELWP, North Central CMA
9	1, 3	Investigate management options for controlling carp or mitigating carp impacts in the wetlands by 2018, especially in alignment with the release of the carp herpes virus if released.	1	Costed individually.	GMW, North Central CMA	DELWP, Parks Victoria
10	2, 9	Ensure that any proposed water infrastructure applications actively consider implications to connectivity at a wetland and landscape scale.	As required.	-	All	

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
		Non-native animal control programs				
11	1, 3, 10	Assess the ecological and physical impacts of licensed stock grazing within the Ramsar boundary by 2020.	1	$10,000	DELWP	GMW, Parks Victoria, North Central CMA, Gannawarra Shire Council
12	1, 3, 10	Investigate the feasibility and timeframe for the cessation of grazing licenses within the Ramsar Site, and implement where possible, by 2020.	1	-	DELWP GMW	Parks Victoria, North Central CMA, Gannawarra Shire Council
13	1, 3, 10	Assess the need for stock exclusion fencing of wetlands or particularly sensitive areas at wetlands subject to grazing license by 2020: Lake William, First Reedy, Middle Reedy, Third Reedy, Kangaroo Lake, Racecourse Lake, Lake Charm, Stevenson, Lake Kelly.	1	To be assessed through works program.	Parks Victoria, GMW	DELWP, North Central CMA, Gannawarra Shire Council
14	1, 3, 10	Undertake annual surveys of local rabbit populations to inform frequency and intensity of control program. [Rabbit surveys can be undertaken at the same time as foxes, cats and deer.]	23 / year	$28,000 total	GMW, Parks Victoria	DELWP, Gannawarra Shire Council, North Central CMA
15	1, 3, 10	Undertake culturally sensitive rabbit control measures (under development) and educational activities to encourage landholders to undertake control on neighbouring land. Consider rabbit proof fences for particularly sensitive areas.	23 / year if required.	Up to $20,000 per wetland. To be assessed further through works program.	GMW, Parks Victoria	DELWP, Gannawarra Shire Council, North Central CMA, Community
16	1, 10, 12a, 12b, 13	Utilise local knowledge and incidental observations of impacts from foxes on ecological values to determine the need to undertake fox control measures. Consider seasonal requirements i.e. bird breeding/nesting season at inundated wetlands. [Fox surveys can be undertaken at the same time as rabbits, cats and deer.]	23	See costs for Action 14.	GMW, Parks Victoria	DELWP, Gannawarra Shire Council, North Central CMA
17	1, 10, 12a, 12b, 13	Undertake fox control measures when required (e.g. if bird breeding is observed) using an appropriate scale and methodology depending on the level of cross-tenure support, and educational activities to encourage landholders to undertake control on neighbouring land.	23 / year if required.	Up to $20,000 per wetland. To be assessed further through works program.	GMW, Parks Victoria	DELWP, Gannawarra Shire Council, North Central CMA, Community
18	1, 10, 12a, 12b, 13	Undertake initial baseline surveys to determine current size of cat populations to inform a cat control program by 2019. [Cat surveys can be undertaken at the same time as rabbits, foxes and deer.]	23	See costs for Action 14.	GMW, Parks Victoria	DELWP, Gannawarra Shire Council, North Central CMA
19	1, 10, 12a, 12b, 13	Undertake cat control measures using non-lethal trapping when required using an appropriate scale and methodology depending on the level of cross-tenure support, and educational activities to encourage landholders to undertake control on neighbouring land.	23 / year if required.	To be costed.	GMW, Parks Victoria	DELWP, Gannawarra Shire Council, North Central CMA, Community
20	1, 10, 12a, 12b, 13	Undertake seasonally appropriate visual or aerial surveys to determine the Index of Activity for pigs (as required).	23	$5,000 per aerial survey	GMW, Parks Victoria	DELWP, Gannawarra Shire Council, North Central CMA
21	1, 10, 12a, 12b, 13	Undertake pig control measures as required if determined to be an active threat to ecological values.	As required.	To be assessed further through works program.	GMW, Parks Victoria	DELWP, Gannawarra Shire Council, North Central CMA
22	1, 10	Monitor for presence of deer using visual or aerial surveys (as required). [Deer surveys (visual) can be undertaken at the same time as rabbits, foxes and cats.]	23	See costs for Action 14.	GMW, Parks Victoria	DELWP, Gannawarra Shire Council, North Central CMA
23	1, 10	Implement a control program as required to minimise impacts of deer, if determined to be an active threat to ecological values.	As required.	To be assessed further through works program.	GMW, Parks Victoria	DELWP, Gannawarra Shire Council, North Central CMA

6.4.1 Lake Charm / Lake Tyarm (Wemba Wemba language)

Wetland Characteristics

Lake Charm is a 520 ha permanent freshwater lake, maintained at artificially high, constant levels since its inclusion in the Torrumbarry Irrigation System in the 1920s. Lake Charm, along with the other water storages, receives diverted water from the Murray River at the Torrumbarry Weir, which flows into Pyramid Creek and the Kerang Weir. Flows pass along Washpen Creek and into the Reedy Lakes, before entering the No. 7 channel or Scotts Creek which both flow into Little Lake Charm, the latter of which is directly connected to Lake Charm in the south (Figure 5). Lake Charm can also receive flood flows from the Loddon River via similar pathways. While Lake Charm is connected to the storage system via Little Lake Charm, it can be isolated when required e.g. algal bloom events. Water is extracted from Lake Charm for irrigation and domestic and stock supply (KBR 2011). It is also a key wetland for recreational activities, popular for power boats, swimming, camping, and picnicking.

An overview of the wetland characteristics is provided in Table 17.

Table 17. Lake Charm Wetland Characteristics.

Characteristics	Description
Name	**Lake Charm**
Land manager and reserve status	Goulburn Murray Water – Water Supply Reserve
Area (ha)	519.8 ha
Bioregion	Victoria Riverina
Water regime	Permanent, can fluctuate within a 0.9 m range (73.00 to 73.93 (0.93 m))
Water supply	Historical: – Floodwater from the Loddon River
	Current: – Diversions from the Murray River through Kow Swamp, Pyramid Creek, Reedy Lakes, Scotts Creek to Little Lake Charm. – Floodwater from the Loddon River
Ramsar wetland category	O: permanent freshwater lakes (over 8 ha)
1788 wetland category (Corrick and Norman)	Permanent Open Freshwater
1994 wetland category (Corrick and Norman)	Category: Permanent Open Freshwater Sub-category: Shallow
2013 Victorian wetland classification (DELWP 2016c)	Permanent Freshwater Lake
Mapping ID	Corrick: 7626-555560, DELWP: 43192

Above: Lake Charm and Little Lake Charm.
Photo: Michelle Maher

Ecological Values and Significance

Thirty-two species of waterbirds have been recorded at Lake Charm, nine of which are threatened or protected including the Eastern Great Egret (*Ardea modesta*) and White-bellied Sea-eagle (*Haliaeetus leucogaster*), both of which are listed under the FFG Act. Lake Charm also supports 40 terrestrial bird species, including the FFG-listed Grey-crowned Babbler (*Pomatostomus temporalis*), as well as two species of turtles including the Murray River Turtle (*Emydura macquarii*) which is vulnerable in Victoria (Ho et al. 2006).

The most recent EVC mapping for Lake Charm was undertaken in 2006, and focused only on the wetland's littoral zones. At the time, only two EVCs were identified: Brackish Aquatic Herbland (537) and Tall Marsh (821) (Ho et al. 2006). It is possible that Brackish Aquatic Herbland was incorrectly mapped, as Lake Charm is likely too fresh to support this EVC. Instead, Lake Charm may have once supported Aquatic Herbland (653) or Submerged Aquatic Herbland (918) (D. Cook [wetland ecologist, Rakali], pers. comm. 10 August 2016). Tall Marsh is currently listed as depleted. In this same survey, only a very small area of submerged macrophytes or aquatic vegetation was detected; however, previous surveys and local knowledge suggest that Lake Charm once had a significant amount of submerged and aquatic vegetation. Anecdotally, it was once difficult to take a boat over it as vegetation would get caught in motors and it was hazardous to dive into deep water (T. Lowe [field naturalist] pers. comm. 31 May 2016; S. Simms [local community] pers. comm. March 2017). The loss of aquatic vegetation is likely attributed to the feeding habits of carp, as they uproot and feed on plants throughout the water column. The community have noticed a change in the species of waterbirds that utilise Lake Charm and the other permanent wetlands, from foragers (plant eaters) and ducks to large fish-eaters (S. Simms [local community] pers. comm. March 2017).

The 2006 survey identified a reasonably high abundance of standing dead River Red Gums (*Eucalyptus camaldulensis*), presumed to have died when the wetland became permanent (Ho et al. 2006). It is assumed that historically there is likely to have been a greater coverage of trees, which were removed as a results of the clearing and dredging that was undertaken to establish water storages, or removed for safety reasons particularly along the western shore. The presence of these dead trees suggests that the pre-European wetland vegetation was likely to have been more reflective of wetland EVCs that contain canopy trees, such as Intermittent Swampy Woodland which was once widespread in the area (Rakali 2014a). The remaining dead timber is likely to provide roosting habitat for waterbirds, fish, turtles and bats; however, as this timber ages and falls over, it will reduce the available habitat for fauna with no replacement trees recruiting.

Records for flora species at Lake Charm are data poor, with only 18 species identified from databases and reports, and many of these over 100 years old.

Lake Charm is known to have higher salinities than the other permanent wetlands, with an average EC of 2155 microSiemens per centimetre (µS/cm) recorded in 2006. A peak of 5600 µS/cm was recorded prior to the Millennium Drought (S. Simms, pers. comm. March 2017). Since the start of the Mid-Murray Storages operating plan and the floods of 2011, the EC has reduced to between 1000 and 2000 µS/cm (J. Runciman [GMW] pers. comm. 28 September 2016).

Figure 5 Lake Charm location and key features

Perons Tree Frog

Musk Lorikeet.
Photo: Adrian Martins

Current Condition

The most recent ecological survey of Lake Charm was undertaken in 2006 (Ho et al. 2006), which is not considered recent enough to provide a clear understanding of the wetland's current condition. However, the results are described here to provide an indication of wetland ecosystem health.

Fish populations at Lake Charm have been influenced greatly by ongoing stocking programs as well as recreational and commercial fishing, though the latter ceased in 2002. In 2006, neither Silver Perch (*Bidyanus bidyanus*) nor Freshwater Catfish (*Tandanus tandanus*) were sampled, despite being previously recorded in the area (Ho et al. 2006). At the time of survey in 2006, Lake Charm supported a high number of small-bodied fish including Flathead Gudgeon (*Philypnodon grandiceps*), Bony Bream (*Nematalosa erebi*) and Australian Smelt (*Retropinna semoni*). Exotic species such as Common Carp (*Cyprinus carpio*) and Gambusia (*Gambusia holbrooki*) were found in relatively low abundance. Overall Lake Charm supported a low species richness, which was attributed to the low diversity of habitat types as Lake Charm is mostly open water. The low number of turtles and frogs captured in the same survey at Lake Charm was attributed to a lower availability of undisturbed native wetland vegetation or large woody debris than other wetlands.

In the 2006 surveys, 17 waterbirds were recorded at Lake Charm, none of which were breeding though they were elsewhere at the time (Ho et al. 2006).

Water quality parameters were all considered within acceptable ranges. Salinity levels in Lake Charm were also higher than other permanent wetlands (maximum of 2630 uS/cm), though as mentioned in the previous section, in recent years the EC has reduced to between 1000 and 2000 uS/cm. All macroinvertebrates that were sampled were considered to be tolerant to pollutants and other physio-chemical stressors (Ho et al. 2006).

Records of submerged macrophytes were limited, despite records of aquatic vegetation (O'Donnell 1990) and historical observations of extensive submerged macrophytes beds (T. Lowe pers. comm. 31 May 2016). Dead standing timber was somewhat more abundant compared to other wetlands, though most has been removed on the western side, assumed to have been removed for recreational and safety purposes (Ho et al. 2006). The scarcity of dead or live timber contributes to a lack of woody debris that can provide habitat for aquatic biota.

Threats

Key threats that relate to the permanent wetlands are presented in Section 3.2. Of particular concern at Lake Charm is the threat from algal blooms, which can impact on native flora and fauna, but also impact on economic values, public health, and the capacity for recreational pursuits. Lake Charm is one of the most frequently visited wetlands, including for water sports, as well as providing water for irrigation, stock and domestic use, which are directly affected by algal blooms. However, Lake Charm can be isolated from the system if toxic algal blooms are threatening the wetland (J. Runciman [GMW] pers. comm. 28 September 2016).

Non-native invasive species are also a concern at Lake Charm, with both terrestrial and aquatic weeds a potential threat. A range of terrestrial and aquatic pest animals are present at Lake Charm, including carp, Redfin and Gambusia which have significant impacts on aquatic life and may be responsible in part for the lack of submerged aquatic vegetation in the shallower zones.

Lake Charm also is subject to a grazing licence. Details and impacts of the grazing is currently unknown, but if occurs above a certain stocking rate, is likely to have a significant impact on native riparian flora and potentially the nutrient input to the wetland.

Table 18. Management Actions and Responsibilities for Lake Charm/Tyarm.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 4, 10o, 10q, 13	Undertake baseline ecological surveys, including Index of Wetland Condition (IWC) , EVC mapping and fauna surveys by 2017.	1	$8,000	GMW	DELWP, North Central CMA
2	1, 2, 3, 4, 5, 8, 9, 10o, 10q, 11	Manage the water regime consistent with the hydrological requirements of permanent freshwater lakes.	-	-	GMW	DELWP, North Central CMA
3	1, 10q	Investigate the necessity and if required, undertake revegetation of suitable canopy tree species in the riparian zone according to wetland type and EVC benchmarks (consistent with the current/acquired EVCs) by 2022.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
4	1, 10o	Trial revegetation or enable regeneration of characteristic Aquatic Herbland species that are currently absent, ensuring that carp are excluded (e.g. carp exclusion plots) by 2020.	10 plots	$12,000	GMW	DELWP, Gannawarra Shire Council, Landcare, TOs, community groups
5	1, 2, 4, 10o	Investigate the potential to control the timing of fluctuations (if any) in water level to align with natural seasonal wetting and drawdown phases e.g. to expose mudflats and increase productive processes on the wetland fringe by 2025.	1	See overall action list	GMW	DELWP, Gannawarra Shire Council, North Central CMA
6	3	Investigate the erosion of wetland bed and banks e.g. from carp and/or wave action from power boats.	1	$5,000	GMW	DELWP, North Central CMA
Actions to manage threats to ecological character						
7	1, 3, 10o, 10q	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. alligator weed, arrowhead) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 3, 10o, 10q	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	GMW	DELWP, Gannawarra Shire Council, North Central CMA
9	1, 3, 10q, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA
10	1, 10q	Lake Charm is subject to a grazing licence. See overall actions to address impacts from stock grazing across the Ramsar Site, including installing stock exclusion fencing of the wetland or particularly sensitive areas if impacted.	1	See overall action list	DELWP, GMW	Parks Victoria, North Central CMA, Gannawarra Shire Council

6.4.2 Little Lake Charm

Wetland Characteristics

Little Lake Charm is a 113 ha permanent freshwater lake, maintained at artificially high, relatively constant levels since its inclusion in the Torrumbarry Irrigation System in the 1920s. Little Lake Charm, along with the other water storages, receives diverted water from the Murray River at the Torrumbarry Weir, which flows into Pyramid Creek and the Kerang Weir. Flows pass along Washpen Creek and into the Reedy Lakes, before entering the No. 7 channel or Scotts Creek which both flow into Little Lake Charm (6). Little Lake Charm is directly connected to Lake Charm to the north of the wetland. Little Lake Charm can also receive flood flows from the Loddon River via similar pathways. Water is extracted from Little Lake Charm for domestic and stock supply (KBR 2011). Operating rules for the wetland normally maintain water levels at full supply, though a 1000 mm fluctuation is allowed.

Included within the Ramsar Site at Little Lake Charm is an area to the south-east that incorporates part of Scotts Creek. The creek is maintained permanently through backfill from Little Lake Charm (North Central CMA 2013a).

An overview of the wetland characteristics is provided in Table 19.

Table 19. Little Lake Charm Wetland Characteristics.

Characteristics	Description
Name	**Little Lake Charm**
Land manager and reserve status	Goulburn Murray Water – Water Supply Reserve
	Goulburn Murray Water – freehold
	Parks Victoria – reserved for management of wildlife and the preservation of wildlife habitat (Scotts Creek)
Area (ha)	145 ha
Bioregion	Victoria Riverina
Water regime	Permanent, can fluctuate within a 0.8m range (73.10 to 73.93 (0.83 m))
Water supply	Historical: – Floodwater from the Loddon River
	Current: – Diversions from the Murray River through Kow Swamp, Pyramid Creek, Reedy Lakes, Scotts Creek to Little Lake Charm. – Floodwater from the Loddon River
Ramsar wetland category	O: permanent freshwater lakes (over 8 ha)
1788 wetland category (Corrick and Norman)	Shallow Freshwater Marsh
1994 wetland category (Corrick and Norman)	Category: Permanent Open Freshwater Sub-category: Shallow
2013 Victorian wetland classification (DELWP 2016c)	Permanent Freshwater Lake
Mapping ID	Corrick: 7626-546544, DELWP 43189

Above: Lake Charm and Little Lake Charm.
Photo: Michelle Maher

Black Box tree (*Eucalyptus largiflorens*)

Ecological Values and Significance

Little Lake Charm

The vegetation of Little Lake Charm is highly modified due to the altered hydrology; however, the vegetation had already shifted to one more characteristic of a permanent wetland by the time of listing.

The majority of Little Lake Charm is occupied by open water, with a narrow band of vegetation in the surrounding littoral and riparian zones made up of rushes and reeds (North Central CMA 2013a). Five EVCs were recorded at Little Lake Charm in 2013, including four that are threatened and one that is not listed for the Victorian Riverina (Rakali 2013). A low abundance of dead Black Box (*Eucalyptus largiflorens*) trees provide evidence of the pre-European vegetation, estimated to have largely been Lignum Swampy Woodland and Intermittent Swampy Woodland in the bed of the wetland, with Riverine Chenopod Woodland in the higher elevations. Intermittent Swampy Woodland is severely depleted in the region. Riverine Chenopod Woodland and Lignum Swampy Woodland are still present in small areas in the southern riparian zone (Rakali 2013). Within these EVCs, 42 native flora species have been recorded at Little Lake Charm, including the Branching Groundsel (*Senecio cunninghamii var. cunninghamii*) and Spiny Lignum (*Duma horrida subsp. horrida*) which are rare in Victoria.

Little Lake Charm supports a total of 33 waterbird species, 10 of which are of conservation significance, including the FFG-listed Gull-billed Tern (*Sterna nilotica*). The wetland also supports 30 terrestrial bird species, six native fish species, six frog species and two turtles including the vulnerable Murray River Turtle (*Emydura macquarii*).

Figure 6. Little Lake Charm and Scotts Swamp location and key features

Scotts Creek

Eight EVCs were mapped in the Scotts Creek area in 2013, seven of which are threatened in Victoria. The creek is invaded primarily by various forms of Tall Marsh, including rushes, reeds and sedges. The south-west side of the creek supports Riverine Chenopod Woodland, though many of the Black Box trees have died and salt-tolerant species are present. The north side of the creek supports more sedgy understoreys that survive from the permanent inundation, which has otherwise killed a number of River Red Gums (Rakali 2013).

Thirty-nine native flora species have been recorded at Scotts Swamp, including the rare Small Monkey-Flower (*Mimulus prostratus*).

Fauna species lists for Little Lake Charm and Scotts Creek are combined as the sites are contiguous. Of note, however, is that the threatened Brolga (*Grus rubicundus*) has been observed breeding in flooded vegetation at the southern edge of Scotts Creek, though it was thought to be unsuccessful due to pressures from foxes.

Swamp Crassula (*Crassula helmsii*)
Photo: Ian Higgins

Scotts Creek. Photo: Michelle Maher

Current Condition

IWC assessments were undertaken for both Little Lake Charm and Scotts Creek in 2013 (Rakali 2013). The overall condition of both Little Lake Charm and Scotts Creek was determined to be 'moderate' when assessed against current EVC benchmarks rather than pre-European, for which the score was 'very poor' and 'poor' respectively. However, as the hydrology was already altered at the time of listing, and vegetation has changed accordingly, the focus remains on current EVCs.

Up until the 1990s, much of Little Lake Charm supported extensive areas of Water Ribbon (*Triglochin procera*), Robust Water-Milfoil (*Myriophyllum papillosum*) and Swamp Crassula (*Crassula helmsii*) (O'Donnell 1990). However, these species were not recorded in 2013 surveys.

Scotts Creek suffers from sediment deposition and high water turbidity as a result of backfilling from the permanent inundation from Little Lake Charm (Biosis 2013). As mentioned, foxes are likely to have had an impact on the success of brolga breeding. Another pressure may come from livestock grazing; local knowledge indicates that grazing does occur in the area (S. Simms [community] pers. comm. 31 May 2016).

Threats

Key threats that relate to the permanent wetlands are presented in Section 3.2. Of particular concern at Little Lake Charm is the loss of aquatic plant species that were once more prevalent. The cause is speculated to be due to an increase in carp, which can cause turbidity which reduces a plant's ability to grow, or damage the plant itself.

Little Lake Charm and Scotts Creek is also impacted by algal blooms in the system, which can be caused by excess nutrients in catchment run-off, particularly when combined with increasing temperatures which are expected under a drying climate.

Foxes are a particular threat around Scotts Creek, if as thought, they are disturbing native birds during breeding season.

Table 20. Management actions and responsibilities for Little Lake Charm (including Scotts Creek).

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 8, 9, 10o, 10p, 11	Manage the water regime consistent with the hydrological requirements of permanent freshwater lakes.	-	-	GMW	DELWP, North Central CMA
2	1, 10p	Investigate the necessity and if required, undertake revegetation of suitable canopy tree species in the riparian zone according to wetland type and EVC benchmarks (consistent with the current/acquired EVCs) by 2022.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Parks Victoria, Landcare, TOs, community groups
3	1, 10o	Trial revegetation or enable regeneration of characteristic Aquatic Herbland species that are currently absent, ensuring that carp are excluded (e.g. carp exclusion plots) by 2020.	10 plots	$12,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Parks Victoria, Landcare, TOs, community groups
4	1, 2, 4, 10o	Investigate the potential to control the timing of fluctuations (if any) in water level to align with natural seasonal wetting and drawdown phases e.g. to expose mudflats and increase productive processes on the wetland fringe by 2025.	1	See overall action list	GMW	DELWP, Gannawarra Shire Council, North Central CMA
Actions to manage threats to ecological character						
5	1, 3, 10o, 10p	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. alligator weed, arrowhead) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 10o, 10p	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	GMW	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 10p, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Parks Victoria
8	1, 10p	Support potential Brolga breeding sites by investigating the current grazing situation (licensed or unlicensed) at Scotts Swamp and whether it can be limited (e.g. fencing), and undertaking targeted fox control during the breeding season.	1	To be assessed through works program.	GMW, Parks Victoria	DELWP, North Central CMA

6.4.3 First Reedy Lake / Pingerampert (Wemba Wemba language)

Wetland Characteristics

First Reedy Lake is a 197 ha permanent freshwater lake that is maintained at artificially high, constant levels since its inclusion in the Torrumbarry Irrigation System in the 1920s. First Reedy Lake, along with the other water storages, receives diverted water from the Murray River at the Torrumbarry Weir, which flows into Pyramid Creek and the Kerang Weir. Flows pass along Washpen Creek and into First Reedy Lake, which spills into Middle Reedy and Third Reedy beyond, before entering the No. 7 channel and flowing to the other water storages and the Little Murray River. First Reedy Lake can also receive flood flows from the Loddon River via similar pathways. Flood flows from the Wandella Creek can also enter the southern side of First Reedy Lake (GMW 2010). Water is extracted from First Reedy Lake for irrigation and domestic and stock supply (KBR 2011). Operating rules for the wetland normally maintain water levels at full supply, though a 600 mm fluctuation is allowed.

An overview of the wetland characteristics is provided in Table 21.

Table 21. First Reedy Lake Wetland Characteristics.

Characteristics	Description
Name	**First Reedy Lake**
Land manager and reserve status	Goulburn Murray Water – Water Supply Reserve
Area (ha)	196.5 ha
Bioregion	Victoria Riverina
Water regime	Permanent, can fluctuate within a 0.4m range (74.47 to 74.88 (0.41 m))
Water supply	Historical: – Floodwater from the Loddon River
	Current: – Diversions from the Murray River through Kow Swamp, Pyramid Creek, Reedy Lakes. – Floodwater from the Loddon River
Ramsar wetland category	O: permanent freshwater lakes (over 8 ha)
1788 wetland category (Corrick and Norman)	Deep Freshwater Marsh
1994 wetland category (Corrick and Norman)	Category: Permanent Open Freshwater Sub-category: Shallow
2013 Victorian wetland classification (DELWP 2016c)	Permanent Freshwater Lake
Mapping ID	Corrick: 7626-604477, DELWP: 43217

Above: First Reedy Lake.
Photo: Michelle Maher

Ecological Values and Significance

Reedy Lake is characterised largely by open water lacking any aquatic vegetation, with a narrow band of Tall Marsh within the littoral zone. Nine EVCs have been mapped at Reedy Lake, all of which are threatened except one that is not listed for the Victorian Riverina. The riparian zone supports a number of woodland EVCs, which may have once spread further into the wetland. However, the wetland was probably too deep in areas to support trees, and more likely supported a mix of herblands which are still found in small patches. Now, the most dominant vegetation in the littoral zone is Tall Marsh, consisting of reeds, rushes and some aquatic herbs.

The riparian zone supports an area of Lignum Swamp, in which a particularly robust stand of Tangled Lignum (*Muehlenbeckia florulenta*) grows in permanent water, a highly unusual habit for this species. Usually this species is tolerant to low rainfall and infrequent inundation, however in Reedy and Middle Reedy Lake it has adapted to withstand permanent inundation. It is the only known community of its kind in Australia (Roberts and Marston 2011).

First Reedy Lake Picnic Area. Photo: Michelle Maher

In total, 53 species of waterbirds have been recorded at Reedy Lake, including sixteen species of conservation significance such as the White-winged Black Tern (*Chlidonias leucopterus*) and the Royal Spoonbill (*Platalea regia*) that are near-threatened in Victoria. The stand of Tangled Lignum (*Muehlenbeckia florulenta*) provides important habitat for colonial nesting waterbirds at Reedy Lake. Five breeding events have been recorded at Reedy Lake between 1990 and 2012 (North Central CMA 2013b).

In addition, 62 terrestrial bird species have been recorded at Reedy Lake, including the endangered Grey-crowned Babbler (*Pomatostomus temporalis*). Twelve fish species have been recorded in Reedy Lake, including the Freshwater Catfish (*Tandanus tandanus*) and Murray-Darling Rainbowfish (*Melanotaenia fluviatilis*). Reedy Lake is stocked with Murray Cod (*Maccullochella peelii*) and Golden Perch (*Macquaria ambigua*) to support local recreational fishing.

Figure 7. First Reedy Lake location and key features

Rainbow Fish
Photo: MDBA

Tangled Lignum (*Muehlenbeckia florulenta*)
Photo: Ian Higgins

Entry to First Reedy Lake. Photo: Michelle Maher

Current Condition

Recent ecological assessments suggest that in the riparian zones of Reedy Lake, many of the canopy trees that would once have existed are no longer present (Rakali 2013), possibly removed during construction of water infrastructure in the 1920s.

IWC assessments indicate that the overall condition of the wetland is 'poor' when assessed against the pre-European benchmarks. However, against current EVC benchmarks, the wetland was considered to be in 'moderate' condition, when accounting for the values that have been acquired at the wetland since regulation, and as they were at the time of listing.

An assessment of tree condition throughout the Reedy Lakes in 2014 determined that most River Red Gum trees at the wetland were generally in good to excellent condition, with relatively dense crowns and abundant flower buds, indicating reproductive potential (Rakali 2014a).

Threats

Key threats that relate to the permanent wetlands are presented in Section 3.2. Of particular concern at Reedy Lake is the loss of aquatic plant species that were once more prevalent, possibly due to impacts from carp and turbidity. Loss of standing timber is also a concern at Reedy Lake, as dead timber inevitably rots and collapses, with little opportunity for natural regeneration.

There is also a significant infestation of willows on the shoreline of Reedy Lake, which are likely to contribute to reinfestation throughout the landscape by propagules that drift in the water column to colonise areas along the banks and further down the system e.g. Middle or Third Reedy Lake.

Reedy Lake is also impacted by algal blooms in the system, which can be caused by excess nutrients in catchment run-off, particularly when combined with increasing temperatures which are expected under a drying climate.

Reedy Lake is also subject to a small grazing licence. Details and impacts of grazing at Reedy Lake are considered a knowledge gap.

Table 22. Management Actions and Responsibilities for Reedy Lake.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 9, 10o, 10m, 11	Manage the water regime consistent with the hydrological requirements of permanent freshwater lakes.	-	-	GMW	DELWP, North Central CMA
2	1, 3, 10m	Investigate the suitability of restoring canopy trees, and which species, around the wetland to replace those that have died or been removed. If suitable, undertake revegetation of suitable canopy tree species in the riparian zone according to wetland type and EVC benchmarks (consistent with the current/ acquired EVCs) by 2022.	To be assessed through works program.	$10,000 for surveys	GMW	DELWP, North Central CMA
3	1, 10o	Trial revegetation or enable regeneration of characteristic Aquatic Herbland species that are currently absent, ensuring that carp are excluded (e.g. carp exclusion plots) by 2020.	10 plots	$12,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
4	1, 2, 4, 10o	Investigate the potential to control the timing of fluctuations (if any) in water level to align with natural seasonal wetting and drawdown phases e.g. to expose mudflats and increase productive processes on the wetland fringe by 2025.	1	See overall action list	GMW	DELWP, Gannawarra Shire Council, North Central CMA
5	3	Investigate the erosion of wetland bed and banks e.g. from carp by 2025.	1	$5,000	GMW	DELWP, North Central CMA
Actions to manage threats to ecological character						
6	1, 3, 10o, 10m	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. Alligator Weed, Arrowhead) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 10o, 10m	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	GMW	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 3, 10m, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA

6.4.4 Middle Reedy Lake

Wetland Characteristics

Middle Reedy Lake is a 197 ha permanent freshwater lake that is maintained at artificially high, constant levels since its inclusion in the Torrumbarry Irrigation System in the 1920s. Middle Reedy Lake, along with the other water storages, receives diverted water from the Murray River at the Torrumbarry Weir, which flows into Pyramid Creek and the Kerang Weir. Flows pass along Washpen Creek and into Reedy Lake, which spills into Middle Reedy Lake and Third Reedy Lake beyond, before entering the No. 7 channel and flowing to the other water storages. Middle Reedy Lake can also receive flood flows from the Loddon River via similar pathways. Water is extracted from Middle Reedy Lake for irrigation and domestic and stock supply (KBR 2011). Operating rules for the wetland normally maintain water levels at full supply from August to January to support the ibis rookery. A 400 mm fluctuation is allowed at other times of the year (North Central CMA 2013c).

Historically, Middle Reedy Lake would have filled intermittently in response to flooding events in the Loddon River and Wandella Creek catchments. The wetland would have filled irregularly, less frequently than Reedy Lake which would fill first.

An overview of the wetland characteristics is provided in Table 23.

Table 23. Middle Reedy Lake Wetland Characteristics.

Characteristics	Description
Name	**Middle Reedy Lake**
Land manager and reserve status	Goulburn Murray Water – Water Supply Reserve
Area (ha)	196.4 ha
Bioregion	Victoria Riverina
Water regime	Permanent, can fluctuate within a 0.4m range (74.47 to 74.88 (0.41 m))
Water supply	Historical: – Floodwater from the Loddon River
	Current: – Diversions from the Murray River through Kow Swamp, Pyramid Creek, Reedy Lakes. – Floodwater from the Loddon River
Ramsar wetland category	Tp: permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season
1788 wetland category (Corrick and Norman)	Deep Freshwater Marsh
1994 wetland category (Corrick and Norman)	Category: Permanent Open Freshwater Sub-category: Shallow
2013 Victorian wetland classification (DELWP 2016c)	Permanent Freshwater Swamp
Mapping ID	Corrick: 7626-605495, DELWP: 43218

Above: Ibis rookery at Middle Reedy Lake.
Photo: Heath Dunston

Ecological Values and Significance

Middle Reedy Lake would have once supported deeper areas of herbland, fringed by River Red Gum woodlands as evidenced by the dead stags around the shallow lake edges (Rakali 2014a). Now the wetland supports vegetation that has adapted to withstand permanent inundation. Middle Reedy Lake supports nine EVCs, including Tall Marsh which is dominated by a number of reed and rush species in different locations. Around the water's edge is a zone that supports herbaceous species that are characteristic of seasonal inundation, suggesting that these areas still experience a wetting and drying regime (North Central CMA 2013c). Submerged aquatic vegetation was once more prevalent at the wetland (O'Donnell 1990) but is now depleted (Rakali 2013).

All recorded EVCs are depleted, vulnerable or endangered in Victoria, except one which is not listed in the Victorian Riverina. The wetland supports a variety of habitat types, including open water at its deepest points; reed, rushes and sedges; dead timber; and extensive stands of Tangled Lignum (*Muehlenbeckia florulenta*). This lignum is unusual in that it continues growing despite permanent inundation, which is an unusual habit for this species. While the lignum is not a threatened species in itself, it is considered critical habitat for colonial nesting waterbirds, particularly ibis.

Waterbird rookery at Middle Reedy Lake. Photo: Genevieve Smith

Middle Reedy Lake has supported 47 species of waterbirds, including the FFG-listed Gull-billed Tern (Gelochelidon nilotica) and near threatened Pied Cormorant (*Phalacrocorax varius*). The majority of waterbirds are fish-eaters and shoreline foragers (North Central CMA 2013c). Twelve species of waterbirds have been recorded breeding at Middle Reedy Lake since 1985, including colonial nesting species which utilise the lignum swamp areas in standing in permanent water to breed (North Central CMA 2013c). These areas form part of a large ibis breeding rookery, including Australian White Ibis (*Threskiornis molucca*) and Straw-necked Ibis (*Threskiornis spinicollis*).

Middle Reedy Lake also provides habitat for 49 native terrestrial birds, including the near-threatened Spotted Harrier (*Circus assimilis*). Ten native fish species have been recorded at the wetland, with

Figure 8. Middle Reedy Lake location and key features

a mixture of large, medium and small-bodied fish including one unusual record of Murray Hardyhead (*Craterocephalus fluviatilis*) (Biosis 2013). It is possible that the extensive submerged vegetation may provide refuge for the species (Biosis 2013). Middle Reedy Lake also supports at least four amphibians, two turtle species of conservation significance, as well as skinks and snakes.

Ibis nests at Middle Reedy Lake. Photo: Heath Dunstan

Ibis chicks. Photo: Heath Dunstan

Connection between Middle Reedy Lake and Third Reedy Lake. Photo: Michelle Maher

Current Condition

IWC assessments in 2013 indicated that against the pre-European benchmarks, Middle Reedy Lake was considered to be in 'poor' condition. However, against current EVC benchmarks, the wetland was considered to be in 'moderate' condition, when accounting for the values that have been acquired at the wetland since regulation (Rakali 2014a).

An assessment of tree condition throughout the Reedy Lakes in 2014 determined that most River Red Gum trees at Middle Reedy Lake were generally in good to excellent condition, with relatively dense crowns and abundant flower buds, indicating reproductive potential (Rakali 2014a).

Threats

Key threats that relate to the permanent wetlands are presented in Section 3.2. Of particular concern at Middle Reedy Lake is the possibility that raised water levels in the Reedy Lakes during flood events may potentially inundate the ibis rookery and cause the abandonment of nests and mortality of waterbirds. This is possible when there are tensions between the need for dispersal of flood waters through the system, protection of private property, and the need to protect the ibis rookery. At present, the system downstream of the Reedy Lakes does not have the capacity for enough water to pass through to maintain water levels below the critical level (C. White [North Central CMA] pers. comm. January 2017).

Another concern is the potential loss of the submerged lignum community that is critical to the ibis rookery. In addition, the loss of standing timber is also a key threat, as dead timber inevitably rots and collapses with little opportunity for natural regeneration at Middle Reedy Lake. The loss of aquatic plant species is also a concern at Middle Reedy Lake, possibly due to impacts from carp and turbidity.

Middle Reedy Lake is also impacted by algal blooms in the system, which can be caused by excess nutrients in catchment run-off, particularly when combined with increasing temperatures which are expected under a drying climate.

Middle Reedy Lake is also subject to a small grazing licence between the south-east corner and Reedy Lake. Details and impacts of grazing at Middle Reedy Lake are considered a knowledge gap.

Table 24. Management actions and responsibilities for Middle Reedy Lake.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 8, 9, 10o, 10m, 11	Manage the water regime consistent with the hydrological requirements of permanent freshwater lakes.	-	-	GMW	DELWP, North Central CMA
2	1, 3, 10m	Investigate the suitability of restoring canopy trees, and which species, around the wetland to replace those that have died or been removed. If suitable, undertake revegetation of suitable canopy tree species in the riparian zone according to wetland type and EVC benchmarks (consistent with the current/ acquired EVCs) by 2022.	To be assessed through works program.	$10,000 for surveys	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
3	1, 10o	Trial revegetation or enable regeneration of characteristic Aquatic Herbland species that are currently absent, ensuring that carp are excluded (e.g. carp exclusion plots) by 2020.	10 plots	$12,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
4	3	Investigate the erosion of wetland bed and banks e.g. from carp by 2025.	1	$5,000	GMW	DELWP, North Central CMA
Actions to manage threats to ecological character						
5	1, 3, 10o, 10m	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. Alligator Weed, Arrowhead) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 10o, 10m	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	GMW	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 10m, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 10m	Middle Reedy Lake is subject to a grazing licence. See overall actions to address impacts from stock grazing across the Ramsar Site, including installing stock exclusion fencing of the wetland or particularly sensitive areas if impacted.	1	See overall action list	DELWP, GMW	PV, North Central CMA, Gannawarra Shire Council
9		Develop a protocol within the Gannawarra Flood Emergency Plan for operational decision-making during flood events to balance the flood risk to the local community and protection of the ibis rookery.	-	-	North Central CMA	DELWP, GMW, PV, Gannawarra Shire Council
10		Identify potential on-ground works that may be required to improve the flow of water through and downstream of the Reedy Lakes system, which would enable greater control over water levels during large flood events in order to protect the ibis rookery.	-	To be determined during planning	North Central CMA	DELWP, GMW, PV, Gannawarra Shire Council

6.4.5 Third Reedy Lake

Wetland Characteristics

Third Reedy Lake is a permanent freshwater lake that is maintained at artificially high, constant levels since its inclusion in the Torrumbarry Irrigation System in the 1920s. Third Reedy Lake, along with the other water storages, receives diverted water from the Murray River at the Torrumbarry Weir, which flows into Pyramid Creek and the Kerang Weir. Flows pass along Washpen Creek and into Reedy Lake, which spills into Middle Reedy Lake and Third Reedy Lake beyond, before entering the No. 7 channel and flowing to the other water storages. Third Reedy Lake can also receive flood flows from the Loddon River via similar pathways. Water is extracted from Third Reedy Lake for irrigation and domestic and stock supply (KBR 2011). Operating rules for the wetland normally maintain water levels at full supply, though a 1000 mm fluctuation is allowed.

An overview of the wetland characteristics is provided in Table 25.

Above: Third Reedy Lake.
Photo: Michelle Maher

Table 25. Third Reedy Lake Wetland Characteristics.

Characteristics	Description
Name	**Third Reedy Lake**
Land manager and reserve status	Goulburn Murray Water – Water Supply Reserve
Area (ha)	233.7 ha
Bioregion	Victoria Riverina
Water regime	Permanent, can fluctuate within 0.2m range (74.40 – 74.57 (0.17 m))
Water supply	Historical: – Floodwater from the Loddon River
	Current: – Diversions from the Murray River through Kow Swamp, Pyramid Creek, Reedy Lakes. – Floodwater from the Loddon River
Ramsar wetland category	Tp: permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season.
1788 wetland category (Corrick and Norman)	Deep Freshwater Marsh
1994 wetland category (Corrick and Norman)	Category: Permanent Open Freshwater Sub-category: Dead Timber
2013 Victorian wetland classification (DELWP 2016c)	Permanent Freshwater Lake
Mapping ID	Corrick: 7626-596516, DELWP: 43207

NB: Third Reedy Lake was chosen as the most feasible option for a potential bypass of the Reedy Lakes, which would change its watering regime to an intermittent wetland and thereby change the ecological character of the wetland. It has recently undergone a series of assessments to determine what actions would be required if this took place. The project is in preliminary stages of approval, though as yet it is unconfirmed. This Action Plan accounts only for management of the wetland as it currently is. Any changes will be subject to state and federal environmental legislative assessments. Should the bypass proceed to implementation, this section of the Action Plan will be revised.

Ecological Values and Significance

Vegetation patterns, including a high density and abundance of dead River Red Gums throughout the wetland bed, indicate that Third Reedy Lake once supported a swampy woodland habitat, rather than open water. Now however, the deepest parts of the wetland are open water, with no aquatic vegetation and dead trees scattered throughout (Rakali 2013). The wetland previously supported some aquatic vegetation (O'Donnell 1990), though in recent surveys this was lacking. The wetland's habitat features include areas of rushes, reeds and sedges; lignum stands; and dead River Red Gums that provide both standing and in-water woody debris (North Central CMA 2013d).

Permanent inundation of Third Reedy Lake has resulted in an outward shift in the zone once occupied by River Red Gums, and now the Intermittent Swamp Woodland EVC occupies a zone that once supported Black Box trees instead (Rakali 2013). Seven EVCs have been mapped at the wetland, all considered to be endangered, vulnerable or depleted except for one that is not listed for the Victorian Riverina. Within these EVCs, 67 native flora species have been recorded including the FFG listed Short Water-starwort (*Callitriche brachycarpa*).

Third Reedy Lake. Photo: Michelle Maher

Thirty-five species of waterbirds have been recorded at Third Reedy Lake, with eight of them of conservation significance including the Caspian Tern (*Hydroprogne caspia*) and Musk Duck (*Bisiura lobata*). Four species have been observed breeding at the site, including the Australian White Ibis (*Threskiornis moluccus*) and Straw-necked Ibis (*Threskiornis spinicollis*), which have formed small rookeries in the northern section of the wetland (North Central CMA 2013d).

Third Reedy Lake has also supported 37 terrestrial bird species, including the near-threatened Brown Treecreeper (*Climacteris picumnus*). The wetland has also supported nine fish species, with a mixture of large, medium and small-bodied fish. Several of the larger fish species are stocked, and the nativeness of the population in Third Reedy Lake is unknown. In addition, Third Reedy Lake also supports three amphibians, two threatened turtle species, two mammals including the Swamp Wallaby (*Wallabia bicolor*) and the White-striped Freetail Bat (*Tadarida australis*) and a variety of skinks and snakes.

Figure 9. Third Reedy Lake location and key features

River Red Gum (*Eucalyptus camaldulensis*)
Photo: Ian Higgins

Third Reedy Lake regulator.
Photo: Michelle Maher

Third Reedy Lake. Photo:

Current Condition

Third Reedy Lake has seen a depletion of aquatic vegetation, despite it being prevalent in the 1990s (O'Donnell 1990). Similar to the other water storages, this could be due to impacts from carp and associated turbidity.

IWC assessments in 2013 determined that against pre-European benchmarks, Third Reedy Lake was considered to be in poor condition. However, against current EVC benchmarks, the wetland was considered to be in 'moderate' condition, when accounting for the values that have been acquired at the wetland since regulation (Rakali 2014a).

An assessment of tree condition throughout the Reedy Lakes in 2014 determined that most River Red Gum trees at Third Reedy Lake were mostly in moderate to poor condition, with poor canopy densities and extents and some signs of stress (Rakali 2014a).

Threats

Key threats that relate to the permanent wetlands are presented in Section 3.2. Of particular concern at Third Reedy Lake is the loss of standing timber, as dead timber inevitably rots and collapses, with little opportunity for natural regeneration. Live trees around the wetland fringes could potentially provide further support to colonial nesting waterbirds. The loss of aquatic plant species is also a concern at Third Reedy Lake, possibly due to impacts from carp and turbidity.

Third Reedy Lake is also impacted by algal blooms in the system, which can be caused by excess nutrients in catchment run-off, particularly when combined with increasing temperatures which are expected under a drying climate.

Table 26. Management actions and responsibilities for Third Reedy Lake.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 8, 9, 10o, 10n, 11	Manage the water regime consistent with the hydrological requirements of permanent freshwater lakes.	-	-	GMW	DELWP, North Central CMA
2	1, 3, 10n	Investigate the suitability of restoring canopy trees, and which species, around the wetland to replace those that have died or been removed. If suitable, undertake revegetation of suitable canopy tree species in the riparian zone according to wetland type and EVC benchmarks (consistent with the current/ acquired EVCs) by 2022.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
3	1, 3, 10o	Trial revegetation or enable regeneration of characteristic Aquatic Herbland species that are currently absent, ensuring that carp are excluded (e.g. carp exclusion plots) by 2020.	10 plots	$12,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
4	1, 2, 4, 10o	Investigate the potential to control the timing of fluctuations (if any) in water level to align with natural seasonal wetting and drawdown phases e.g. to expose mudflats and increase productive processes on the wetland fringe by 2025.	1	See overall action list	GMW	DELWP, Gannawarra Shire Council, North Central CMA
5	3	Investigate the erosion of wetland bed and banks e.g. from carp by 2025.	1	$5,000	GMW	DELWP, North Central CMA
Actions to manage threats to ecological character						
6	1, 3, 10o, 10n	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. Alligator Weed, Arrowhead) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 10o, 10n	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	GMW	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 3, 10n, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA
9	1, 10n	Third Reedy Lake is subject to a grazing licence. See overall actions to address impacts from stock grazing across the Ramsar Site, including installing stock exclusion fencing of the wetland or particularly sensitive areas if impacted.	1	See overall action list	DELWP, GMW	PV, North Central CMA, Gannawarra Shire Council

6.4.6 Racecourse Lake

Wetland Characteristics

Racecourse Lake is a 235 ha permanent freshwater lake that has been artificially kept at or near its maximum depth since its inclusion in the Torrumbarry Irrigation System in the 1920s. Along with the other water storages, Racecourse Lake receives diverted water from the Murray River at the Torrumbarry Weir, which flows into Pyramid Creek and the Kerang Weir. Flows pass along Washpen Creek and into the Reedy Lakes, before entering the No. 7 channel or Scotts Creek which both flow into Little Lake Charm and subsequently, Racecourse Lake (Figure 10). Racecourse Lake can also receive flood flows from the Loddon River via similar pathways. Water is extracted from Racecourse Lake for irrigation and domestic and stock supply (KBR 2011). Operating rules for the wetland normally maintain water levels at full supply, though a 600 mm fluctuation is allowed.

An overview of the wetland characteristics is provided in Table 27.

Note: The bathymetry of Racecourse Lake shows that the wetland is almost divided by a narrow isthmus. Although it does not show on most commercial maps, the western part is sometimes referred to as Bertram's Lake. However, for the purposes of this document, the whole site is referred to as Racecourse Lake.

Table 27. Racecourse Lake Wetland Characteristics.

Characteristics	Description
Name	**Racecourse Lake**
Land manager and reserve status	Goulburn Murray Water – Water Supply Reserve
Area (ha)	234.1 ha
Bioregion	Victoria Riverina
Water regime	Permanent, can fluctuate within a 0.8m range (73.10 to 73.93 (0.83 m))
Water supply	Historical: – Floodwater from the Loddon River
	Current: – Diversions from the Murray River through Kow Swamp, Pyramid Creek, Reedy Lakes, Scotts Creek to Little Lake Charm. – Floodwater from the Loddon River
Ramsar wetland category	O: permanent freshwater lakes (over 8 ha)
1788 wetland category (Corrick and Norman)	Permanent Open Freshwater
1994 wetland category (Corrick and Norman)	Category: Permanent Open Freshwater Sub-category: Shallow
2013 Victorian wetland classification (DELWP 2016c)	Permanent Freshwater Lake
Mapping ID	Corrick: 7626-528557, DELWP: 43176

Above: Racecourse Lake.
Photo: Michelle Maher

The wetlands are home to two turtles - the Murray River and Eastern Long-necked Turtles

FFG-listed Salt Paperbark (*Melaleuca halmaturorum subsp. halmaturorum*)
Photo: Ian Higgins

Ecological Values and Significance

The majority of Racecourse Lake is occupied by open water, supporting no aquatic vegetation (Rakali 2013). Most vegetation occurs instead within the littoral and riparian zones. Seven EVCs have been mapped at Racecourse Lake, including five that are considered threatened in Victoria. The vegetation has been significantly modified from its pre-European state, when the wetland was likely dominated by a mixture of herblands and woodlands, as evidenced by the standing dead Black Box trees in the littoral zone areas that are now categorised as Tall Marsh. It is likely that the wetland would have supported areas of Intermittent Swampy Woodland, which is still present in small patches in the riparian zone. Now, however, different vegetation communities have formed which can withstand permanent inundation and provide different habitat values for fauna.

Racecourse Lake has supported a total of 58 native vascular flora species, five of which are threatened including one individual of the FFG-listed Salt Paperbark (*Melaleuca halmaturorum subsp. halmaturorum*) which is thought to have been more abundant prior to regulation (Rakali 2013).

The wetland has supported a total of 29 waterbirds, most of which are considered fish eaters or deep water foragers. This includes eight species of conservation significance, including the Freckled Duck (*Stictonetta naevosa*) and Whiskered Tern (*Chlidonias hybridus*). Waterbird feeding has been observed at the wetland (Ho and Roberts 2006), and it is suggested that there may be occasional colonial nesting species breeding (North Central CMA 2013e).

In addition, nine native fish species have been recorded in Racecourse Lake, including a mixture of large and small-bodied fish. The wetland is also known to support at least four frog species, two turtles including the Murray River and Eastern Long-necked Turtles, as well as Swamp Wallabies and Water Rats (Biosis 2013; Rakali 2013).

Figure 10. Racecourse Lake location and key features

Bottom end of Kangaroo Lake and full Racecourse Lake. Photo: Michelle Maher

Current Condition

Ecological assessments in 2006 and again in 2013 identified a significant infestation of Spiny Rush. Aquatic plants were recorded in the deeper zones of the wetland in 2006 (Ho and Roberts 2006). Few or no submerged aquatic vegetation was observed in 2013. It is possible that submerged vegetation was disturbed in the 2011 floods.

IWC assessments as measured against pre-European EVCs determined that Racecourse Lake was in 'poor' condition. However, against current EVC benchmarks, the wetland was considered to be in 'moderate' condition, when accounting for the values that have been acquired at the wetland since regulation (Rakali 2014a).

Threats

Key threats that relate to the permanent wetlands are presented in Section 3.2. Of particular concern at Racecourse Lake is the threat from algal blooms, which can impact on native flora and fauna, but also impact on economic values, public health, and the capacity for recreational pursuits. Racecourse Lake is one of the more frequently visited wetlands, as well as providing water for irrigation, stock and domestic use, which are directly affected by algal blooms.

Non-native invasive species are also a concern at Racecourse Lake, with both terrestrial and aquatic weeds a potential threat. In 2006, there were large areas of willow infestation around the whole wetland perimeter. All identified pest animals are present at Racecourse Lake, including carp, Redfin and Gambusia which have significant impacts on aquatic life and may be responsible in part for the current lack of submerged aquatic vegetation.

Loss of standing timber is another key threat at Racecourse Lake, as the dead Black Box trees will inevitably rot and collapse, removing an important habitat component with possibility of natural replacement.

Racecourse Lake is also subject to numerous grazing licences along the north-western shore. Details and impacts of the grazing are currently unknown, but if grazing occurs above a certain stocking rate, it is likely to have a significant impact.

Table 28. Management actions and responsibilities for Racecourse Lake.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 8, 9, 10o, 10p, 11	Manage the water regime consistent with the hydrological requirements of permanent freshwater lakes.	-	-	GMW	DELWP, North Central CMA
2	1, 3, 10n	Investigate the suitability of restoring canopy trees, and which species, around the wetland to replace those that have died or been removed. If suitable, undertake revegetation of suitable canopy tree species in the riparian zone according to wetland type and EVC benchmarks (consistent with the current/ acquired EVCs) by 2022.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
3	1, 10o	Trial revegetation or enable regeneration of characteristic Aquatic Herbland species that are currently absent, ensuring that carp are excluded (e.g. carp exclusion plots) by 2020.	10 plots	$12,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
4	1, 2, 4, 10o	Investigate the potential to control the timing of fluctuations (if any) in water level to align with natural seasonal wetting and drawdown phases e.g. to expose mudflats and increase productive processes on the wetland fringe by 2025.	1	See overall action list	GMW	DELWP, Gannawarra Shire Council, North Central CMA
5	3	Investigate the erosion of wetland bed and banks e.g. from carp or wave action from power boats by 2025.	1	$5,000	GMW	DELWP, North Central CMA
Actions to manage threats to ecological character						
6	1, 3, 10o, 10p	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. Alligator Weed, Arrowhead) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 10o, 10p	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	GMW	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 3, 10p, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA
9	1, 10p	Racecourse Lake is subject to a grazing licence. See overall actions to address impacts from stock grazing across the Ramsar Site, including installing stock exclusion fencing of the wetland or particularly sensitive areas if impacted.	1	See overall action list	DELWP, GMW	PV, North Central CMA, Gannawarra Shire Council
Actions to enhance visitor experience						
10		Investigate the feasibility of providing additional facilities (e.g. toilets) to improve amenity by 2025.	1	To be costed.	GMW	Gannawarra Shire Council, DELWP, North Central CMA

6.4.7 Kangaroo Lake / Tintya (Wemba Wemba language)

Wetland Characteristics

Kangaroo Lake is a 984 ha permanent freshwater lake maintained at artificially high, relatively constant levels since its inclusion in the Torrumbarry Irrigation System in the 1920s. The wetland is the largest and deepest of the water storages, and is a significant contributor to the Torrumbarry Irrigation System. Kangaroo Lake, along with the other water storages, receives diverted water from the Murray River at the Torrumbarry Weir, which flows into Pyramid Creek and the Kerang Weir. Flows pass down Washpen Creek and into the Reedy Lakes, before entering the No. 7 channel or Scotts Creek which both flow into Little Lake Charm and subsequently Racecourse Lake. Kangaroo Lake is connected to Racecourse Lake via a short conduit. Kangaroo Lake can also receive flood flows from the Loddon River via similar pathways. In times of flood, Kangaroo Lake can be used to store floodwaters by filling to a higher level than normal. Operating rules for the wetland normally maintain water levels at full supply, though a 600 mm fluctuation is allowed.

Kangaroo Lake is a popular wetland for holiday visitors. There is also some residential development around the wetland, and it is largely surrounded by horticultural land.

An overview of the wetland characteristics is provided in Table 29.

Table 29. Kangaroo Lake Wetland Characteristics.

Characteristics	Description
Name	**Kangaroo Lake**
Land manager and reserve status	Goulburn Murray Water – Water Supply Reserve
Area (ha)	983.2 ha
Bioregion	Victoria Riverina
Water regime	Permanent, can fluctuate within a 0.8m range (73.10 to 73.93 (0.83 m))
Water supply	Historical: – Floodwater from the Loddon River
	Current: – Diversions from the Murray River through Kow Swamp, Pyramid Creek, Reedy Lakes, Scotts Creek to Little Lake Charm. – Floodwater from the Loddon River
Ramsar wetland category	O: permanent freshwater lakes (over 8 ha)
1788 wetland category (Corrick and Norman)	Permanent Open Freshwater
1994 wetland category (Corrick and Norman)	Category: Permanent Open Freshwater Sub-category: Shallow
2013 Victorian wetland classification (DELWP 2016c)	Permanent Freshwater Lake
Mapping ID	Corrick: 7626 515585, DELWP: 43164

Above: Bottom end of Kangaroo Lake
Photo: Michelle Maher

Ecological Values and Significance

Kangaroo Lake has supported 45 species of waterbirds, 11 of which are of conservation significance including the Common Sandpiper (*Actitis hypoleucos*) and Musk Duck (*Biziura lobata*). Four species were noted breeding at Kangaroo Lake in 2000, including the Sacred Kingfisher (*Todiramphus sanctus*) and the Australian Reed-warbler (*Acrocephalus australis*).

Seven native fish species and five exotic have been recorded at Kangaroo Lake, including the threatened Freshwater Catfish (*Tandanus tandanus*). Kangaroo Lake is stocked with native fish to support local recreational fishing, which has in itself likely altered the food web of Kangaroo Lake as it is often top predator species that are stocked e.g. Murray Cod (*Maccullochella peelii*) (KBR 2011). This also provides a food source for fish-eating waterbirds.

The most recent EVC mapping for Kangaroo Lake was undertaken in 2006, and focused only on the littoral zones of the wetland. At the time, three EVCs were identified: Dwarf Floating Aquatic Herbland, Aquatic Herbland and Tall Marsh (821) (Ho et al. 2006). Aquatic Herbland and Tall Marsh are currently listed as depleted, while Dwarf Floating Aquatic Herbland does not currently have a conservation status. In this same survey, only a small area of submerged macrophytes or aquatic vegetation was detected; however, previous surveys and local knowledge suggest that Kangaroo Lake once had a significant amount of submerged and aquatic vegetation (Ho et al. 2006).

Freckled Duck. Photo: Ian Mayo

The 2006 survey identified a low abundance of standing dead Black Box trees, presumed to have died when the wetland became permanent (Ho et al. 2006). It is assumed that historically there is likely to have been a greater coverage of trees, which were removed as a result of the clearing and dredging that was undertaken during the establishment of the water storages, or removed for safety reasons. The presence of these dead trees suggests that the pre-European wetland vegetation was likely to have been more reflective of wetland EVCs that contain canopy trees, such as Intermittent Swampy Woodland which was once widespread in the area (Rakali 2014a). The remaining dead timber may still provide roosting habitat for waterbirds, fish, turtles and bats; however,

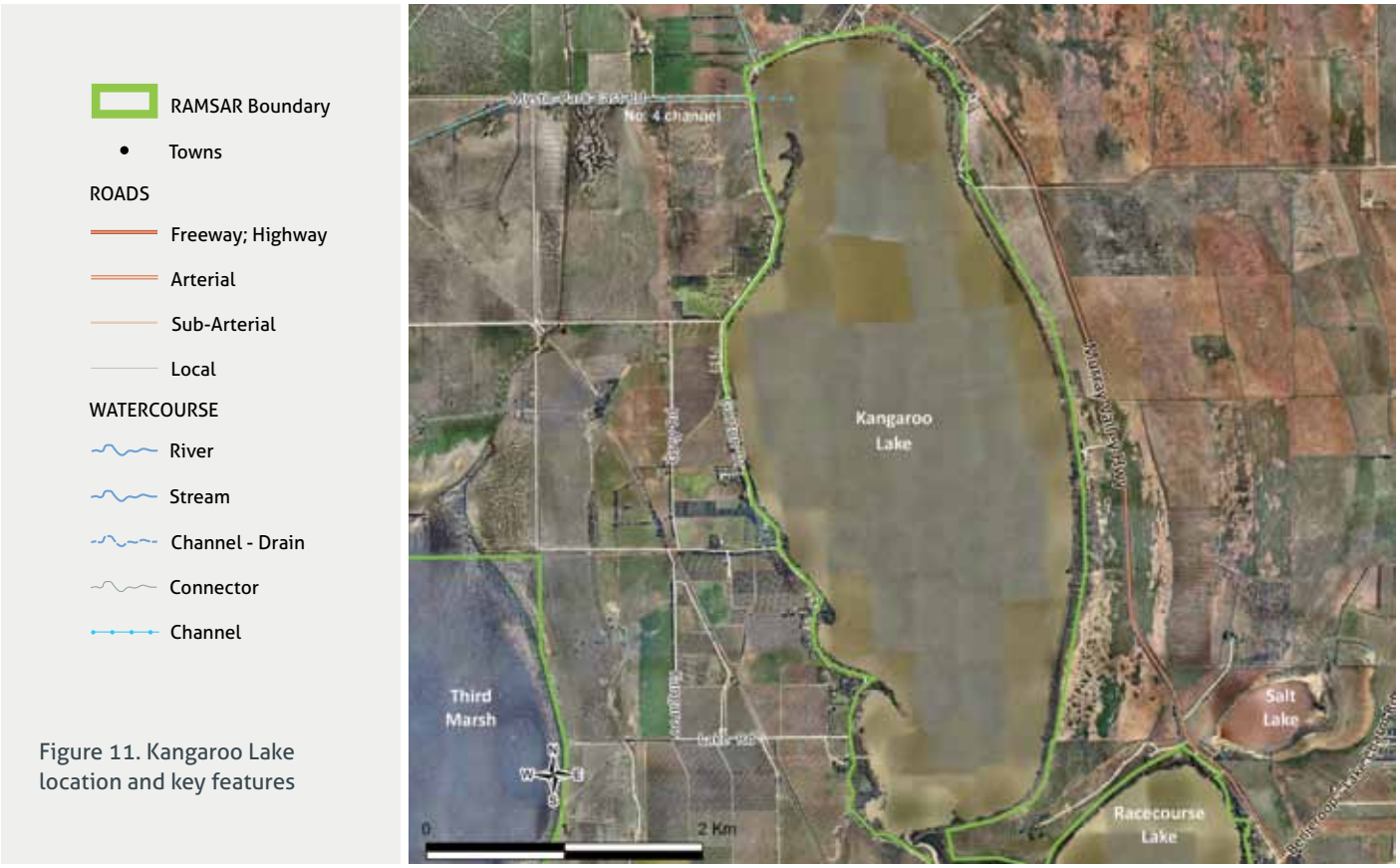


Figure 11. Kangaroo Lake location and key features

as this timber ages and falls over, it will reduce the available habitat for fauna with no replacement trees recruiting.

Forty-three flora species have been recorded at Kangaroo Lake, including the rare Spiny Lignum (*Duma horrida subsp. Horrida*) and vulnerable Twiggy Sida (*Sida intricata*).

Kangaroo Lake. Photo: Sonia Robinson

Current Condition

The most recent ecological survey of Kangaroo Lake was undertaken in 2006, which is not considered recent enough to provide a clear understanding of the wetland's current condition. However, the results are described here to provide an indication of wetland ecosystem health.

Fish populations at Kangaroo Lake have been influenced greatly by ongoing stocking programs as well as recreational and commercial fishing, though the latter ceased in 2002. In 2006, neither Silver Perch (*Bidyanus bidyanus*) nor Freshwater Catfish (*Tandanus tandanus*) were sampled, despite being previously recorded in the area (Ho et al. 2006). The low number of turtles and frogs captured in the same survey at Kangaroo Lake was thought to possibly be attributed to a lower availability of undisturbed native wetland vegetation or large woody debris than other wetlands.

In the 2006 surveys, 16 waterbirds were recorded at Kangaroo Lake, none of which were breeding though they were elsewhere at the time.

Water quality parameters were all considered within acceptable ranges except for an elevated level of nitrogen. Though the source was unknown, it was thought that this could potentially be derived from irrigation run-off within the wetland catchment.

Records of submerged macrophytes were limited, despite historical observations of extensive submerged macrophytes beds (T. Lowe pers. comm. 31 May 2016). Dead standing timber was also less abundant than in other wetlands, assumed to have been removed for recreational and safety purposes. The scarcity of dead or live timber contributes to a lack of woody debris that can provide habitat for aquatic biota.

Threats

Key threats that relate to the permanent wetlands are presented in Section 3.2. Of particular concern at Kangaroo Lake is the threat from algal blooms, which can impact on native flora and fauna, but also impact on economic values, public health, and the capacity for recreational pursuits. Kangaroo Lake is one of the most frequently visited wetlands, including for water sports, as well as providing water for irrigation, stock and domestic use, which are directly affected by algal blooms.

Non-native invasive species are also a concern at Kangaroo Lake, with both terrestrial and aquatic weeds a potential threat. In 2006, there were large areas of willow infestation around the whole wetland perimeter. All identified pest animals are present at Kangaroo Lake, including carp, Redfin and Gambusia which have significant impacts on aquatic life and may be responsible in part for the current lack of submerged aquatic vegetation.

Kangaroo Lake also is subject to numerous grazing licences along the eastern shore. Details and impacts of the grazing are currently unknown, but if grazing occurs above a certain stocking rate, it is likely to have a significant impact.

Table 30. Management action and responsibilities for Kangaroo / Tintya Lake.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 4, 10o, 10q, 13	Undertake baseline ecological surveys, including IWC, EVC mapping and fauna surveys by 2017.	1	$8,000	GMW	DELWP, North Central CMA
2	1, 2, 3, 4, 5, 8, 9, 10o, 10q, 11	Manage the water regime consistent with the hydrological requirements of permanent freshwater lakes.	-	-	GMW	DELWP, North Central CMA
3	1, 10o	Trial revegetation or enable regeneration of characteristic Aquatic Herbland species that are currently absent, ensuring that carp are excluded (e.g. carp exclusion plots) by 2020.	10 plots	$12,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
4	1, 2, 4, 10o	Investigate the potential to control the timing of fluctuations (if any) in water level to align with natural seasonal wetting and drawdown phases e.g. to expose mudflats and increase productive processes on the wetland fringe by 2025.	1	See overall action list	GMW	DELWP, Gannawarra Shire Council, North Central CMA
5	3	Investigate the erosion of wetland bed and banks e.g. from carp or wave action from wake boats by 2025.	1	$5,000	GMW	DELWP, North Central CMA
Actions to manage threats to ecological character						
7	1, 3, 10o, 10q	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. Alligator Weed, Arrowhead) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 3, 10o, 10q	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	GMW	DELWP, Gannawarra Shire Council, North Central CMA
9	1, 3, 10q, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA
10	1, 10q	Kangaroo Lake is subject to a grazing licence. See overall actions to address impacts from stock grazing across the Ramsar Site, including installing stock exclusion fencing of the wetland or particularly sensitive areas if impacted.	1	See overall action list	DELWP, GMW	PV, North Central CMA, Gannawarra Shire Council

6.5.1 Lake Cullen

Wetland Characteristics

Lake Cullen is a 629 ha intermittent saline wetland with a fringing black box overstorey situated near the junction of the Avoca and Loddon Rivers. While First Marsh and Lake Bael Bael on the Avoca floodplain system are located less than one kilometre to the west of Lake Cullen, a large sand lunette isolates the two wetland systems and defines the surface floodplain boundary (Figure 12). Lake Cullen is more associated with the Loddon River, and historically would have received natural overflow from Kangaroo Lake and Racecourse Lake. However, since the development of the Torrumbarry Irrigation System and river regulation, Lake Cullen has become isolated from the floodplain. Now, the wetland is reliant on channel deliveries of diverted floodwaters or environmental water, as it received during the 2011 and 2016 floods. Lake Cullen is a terminal wetland which naturally becomes hyper-saline as it recedes (Macumber 2003).

Although Lake Cullen is not associated with the Avoca Marshes through surface water, there is some degree of groundwater interaction between Lake Cullen, Lake Bael Bael and First Marsh (Macumber 2003). It is understood that if there is water in Lake Cullen, the hydraulic gradient will direct groundwater to flow towards the other two wetlands, and vice versa (North Central CMA 2013f).

Table 31. Lake Cullen Wetland Characteristics.

Characteristics	Description
Name	**Lake Cullen**
Land manager and reserve status	Parks Victoria – Natural Features / State Wildlife Reserve
Area (ha)	629 ha
Bioregion	Victoria Riverina
Water regime	Intermittent wetland, optimum regime of 2 events in 10 years (North Central CMA 2011)
Water supply	Historical: – Floodwater from the Loddon River via Kangaroo Lake and Racecourse Lake
	Current: – Regulated flow from irrigation channel linking to Racecourse and Kangaroo Lakes
Ramsar wetland category	R: seasonal/intermittent saline/brackish/ alkaline lakes and flats
1788 wetland category (Corrick and Norman)	Permanent Saline
1994 wetland category (Corrick and Norman)	Category: Permanent Saline Sub-category: Shallow
2013 Victorian wetland classification (DELWP 2016c)	Temporary Saline Lake
Mapping ID	Corrick: 626-510523, DELWP: 43161

An overview of the wetland characteristics is provided in Table 31.

Black Swans at Lake Cullen
Photo: Adrian Martins

Juvenile Whiskered Tern
Photo: Damien Cook

Ecological Values and Significance

Lake Cullen contributes to the Ramsar listing by virtue of its size and capacity to support both a large abundance and diversity of waterbirds (Lugg et al 1989). In 1987, over 250,000 waterbirds were recorded at the wetland, several times more than any other wetland in the Ramsar Site (KBR 2011). Lake Cullen is relatively fresh when full, with salinity levels increasing as the wetland draws down. A wide variety of birds are attracted to the varying salinity levels, contributing to the high diversity of waterbirds supported at the wetland. Lake Cullen provides habitat for numerous types of waterbirds listed under the Flora and Fauna Guarantee Act 1988, including deep-water foragers such as the Blue-billed Duck (*Oxyura australis*), large waders such as the Brolga (*Grus rubicunda*) and the Royal spoonbill (*Platalea regia*), and fish-eaters like the Caspian Tern (*Hydroprogne caspia*) and Eastern Great Egret (*Ardea modesta*) (Rakali 2014a). Lake Cullen also supports a number of migratory waterbirds such as the Glossy Ibis (*Plegadis falcinellus*) and Black-tailed Godwit (*Limosa limosa*). Waterbirds also use floating platforms of vegetation for nesting, as was seen in 2016. The FFG-listed Magpie Goose (*Anseranas semipalmata*) was recording breeding over summer 2016-17.

In addition to waterbirds, Lake Cullen also supports other birds such as the vulnerable Regent Parrot (*Plytelis anthopeplus*). Other fauna, such as the vulnerable Flathead Galaxias (*Galaxias rostratus*) and the Water Rat (*Hydromys chrysogaster*), have also been recorded at the wetland.

All EVCs that have been recently mapped at Lake Cullen (Australian Ecosystems 2012; Rakali 2014a) are threatened, including the rare Saline Aquatic Meadow (EVC 842) and endangered Intermittent Swampy Woodland (EVC 813). Over 80 species of indigenous plants have been recorded at Lake Cullen, including seven rare or threatened plants such as the rare Spiny Lignum (*Duma horrida subsp. Horrida*) and vulnerable Cane Grass (*Eragrostis australasica*). Large-fruit Tassel (*Ruppia megacarpa*) is a critical aquatic macrophyte at the wetland, providing structure and habitat for fish, macroinvertebrates and waterbirds (Environment Australia 2001). In addition, macro-algae such as *Lamprothamnium compactum* is also very important at Lake Cullen (D. Cook [wetland ecologist, Rakali] pers. comm. 10 August 2016).

Figure 12. Lake Cullen location and key features

Australasian Bittern
Photo: Damien Cook

Photo: Adrian Martins

Lake Cullen

Current Condition

An IWC assessment of Lake Cullen, focusing on the biota sub-index, was undertaken in 2012 when it was holding water. The overall IWC biota score for this wetland was assessed as 17 out of 20, indicating it was in good condition (Australian Ecosystems 2012). The assessment was repeated in 2014 and the overall IWC biota score had reduced to 10.57, indicating that it was in poor condition. The decline in condition was attributed to the dry lake bed not supporting the expected cover and diversity of lake bed herbs, and had been invaded by Black-seeded Glasswort. In these two surveys, 38 species of non-native plants were recorded.

Tree condition was assessed in 2012 for over thirty Black Box canopy trees at Lake Cullen. The assessment showed that most trees are in good health, showing abundant reproductive behaviour (flowering and fruiting) and with the majority of trees showing no leaf die-off, with intact bark and no mistletoes (Australian Ecosystems 2012). However, more recently Black Box trees on the southern edge of the lake are showing signs of decline (D. Cook [wetland ecologist, Rakali] pers. comm. 10 August 2016).

Threats

Key threats that relate to the regulated semi-permanent wetlands are presented in Section 3.4. Of particular concern at Lake Cullen is the impact from invasive species such as rabbits and foxes. Rabbit warrens are common in the sandy areas around the lake margin. Rabbits have particularly hampered the recruitment of woody species and caused disturbance to the ground layer (Australian Ecosystems 2012).

As Lake Cullen is now largely cut off from its natural flow paths, it is reliant on the delivery of either environmental or flood water via the regulated irrigation system. Its natural watering regime is approximately two years in 10, but this may be threatened by a reduced frequency of flooding events (North Central CMA 2013f). While it can receive environmental water, the volume of water required is so large that it is only likely to occur in very wet years when flood waters can be diverted to the wetland. Under a drying climate, these may become fewer and further between.

Table 32. Management actions and responsibilities for Lake Cullen.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 7, 9, 10d, 11, 12b, 13	Manage the water regime as per the Environmental Water Management Plan.	-	-	North Central CMA	DELWP, GMW, PV, VEWH
2	1, 2, 3, 4, 5, 7, 9, 10d, 11, 12b, 13	Undertake annual environmental water planning and prioritisation according to regional and statewide seasonal watering plan processes.	1	Funded through Environmental Water Program	North Central CMA	DELWP, GMW, PV, VEWH
3	1, 2, 13	Use blackwater tool prior to water delivery to determine the risk of hypoxic blackwater development.	As required.	-	North Central CMA	DELWP, GMW, PV, VEWH
	1, 3, 13	Undertake revegetation of suitable canopy tree species according to wetland type and EVC benchmarks (consistent with the current/acquired EVCs) by 2022.	To be assessed through works program	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
	1, 3, 4, 10d, 13	Undertake revegetation of characteristic wetland vegetation species that are currently absent, including aquatic (if appropriate), submergent and emergent, and understory species, using wetland type and EVC benchmarks as a guide by 2020.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
Actions to manage threats to ecological character						
4	1, 3, 10d,	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. Water Couch, Spiny Rush) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	PV	DELWP, Gannawarra Shire Council, North Central CMA
5	1, 3, 10d	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	PV	DELWP, Gannawarra Shire Council, North Central CMA
10	1, 3, 4, 7, 10d, 12b, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16). At Lake Cullen, this is especially important during and after watering events when birds are breeding and plants are recruiting.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
11	1, 10d	Investigate the necessity, feasibility and installation of carp screens on wetland water delivery infrastructure by 2020.	1	$20,000	North Central CMA	DELWP, GMW, PV

6.5.2 Hird Swamp

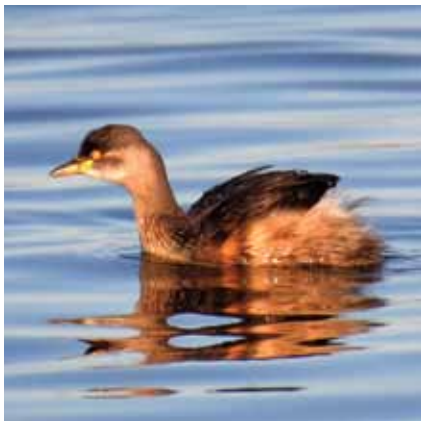
Wetland Characteristics

Hird Swamp is a 345 ha temporary freshwater marsh, divided by Pyramid Creek into two distinct wetland habitat types. Historically it experienced periodic wetting and drying in response to overflow from Pyramid Creek (a tributary of the Loddon River with upstream connection to Gunbower Creek via Kow Swamp and Taylors Creek) however the development of the Torrumbarry Irrigation System, most notably the dredging of Pyramid Creek in 1967, has excluded the wetland from all but major flood events. Combined with a history of prolonged inundation, fire and salinity issues, the vegetation composition of Hird Swamp is now significantly modified from its pre-European state, though continues to provide a high level of habitat and species diversity. The wetland now receives environmental water through the irrigation system to support its key ecological values (North Central CMA 2013g).

An overview of the wetland characteristics is provided in Table 33.

Table 33. Hird Swamp Wetland Characteristics.

Characteristics	Description
Name	**Hird Swamp**
Area (ha)	345.3 ha
Bioregion	Victoria Riverina
Water regime	Intermittent wetland with an optimum range of 4-5 events in 10 years (North Central CMA 2013).
Water supply	Historical: – Floodwater/overflow from the Pyramid Creek – Local catchment runoff from south and south east (approx. 300 ha) (SKM 2001)
	Current: – Regulated: – Western section: Regulated flow from Torrumbarry 1/7/2 channel. Maximum outfall rate to the wetland is 50ML/day. – Eastern section: 375mm siphon from western section – Natural: – West and eastern section: Significant overbank flooding from Pyramid Creek (>2,000 ML/day) required to overtop banks
Ramsar wetland category	Ts: seasonal/intermittent freshwater marshes/pools on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes. W: shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils
1788 wetland category (Corrick and Norman)	Shallow Freshwater Marsh
1994 wetland category (Corrick and Norman)	Category: Deep Marsh Sub-category: Open Water
2013 Victorian wetland classification (DELWP 2016c)	Temporary Freshwater Marshes and Meadows
Mapping ID	Corrick: 7726-380275, DELWP: 45231



Australasian Grebe
Photo: Damien Cook

Frog spawn

Ecological Values and Significance

A key value of Hird Swamp lies in its ability to act as significant drought refuge for a diverse range of fauna species at different stages of their life cycle, and as such regularly supports waterbird breeding including a number of colonial nesting species (North Central CMA 2013g). When inundated, the wetland hosts a high carrying capacity of waterbirds belonging to a diverse range of species and feeding guilds, and including at least five migratory species. The wetland also regularly supports the FFG-listed Brolga (*Grus Rubicunda*), Australasian Bittern (*Botaurus poiciloptilus*), Blue-billed Duck (*Oxyura australis*) and Freckled Duck (*Stictonetta naevosa*) as well as historical records of the EPBC listed Australian painted-snipe (*Rostratula australis*) (North Central CMA 2013g).

The diverse vegetation assemblage at Hird Swamp also supports a diversity of other fauna species including a range of frogs, reptiles and terrestrial bird species. Up until the 1980s it supported a population of Growling Grass Frog (*Litoria raniformis*), a species now listed as nationally vulnerable. Carpet Python (*Morelia spilota*) and Bush Stone-curlew (*Burhinus grallarius*) have also been the recorded in the fringing woodland zone.

Five EVCs were mapped in 2012 and 2014 at Hird Swamp, with three listed as depleted and two listed as vulnerable. The principle habitat types recorded were dominated by black box, River Red Gums (mainly dead although some live fringing specimens remain), tangled lignum, cumbungi, rushes and a high cover of indigenous aquatic and amphibious plant species. Across the two surveys, indigenous species represent 63 per cent of all species records with four listed as endangered or threatened (Australian Ecosystems 2012; Rakali 2014a).

Current Condition

In 2009 during a dry phase, an IWC assessment was undertaken at Hird Swamp (west only). The assessment scored the wetland as moderate for overall condition although the biota component was scored as very poor due to its low vegetation diversity, health and high weediness.

In 2012 and 2014, the biota sub-index was re-assessed with scores of 7 and 8.28 given, respectively. The change in score was likely attributed to the wetland being dry in 2012 and wet in 2014, and thus an improvement in condition due to the drowning out of large areas of weeds and reduced overall

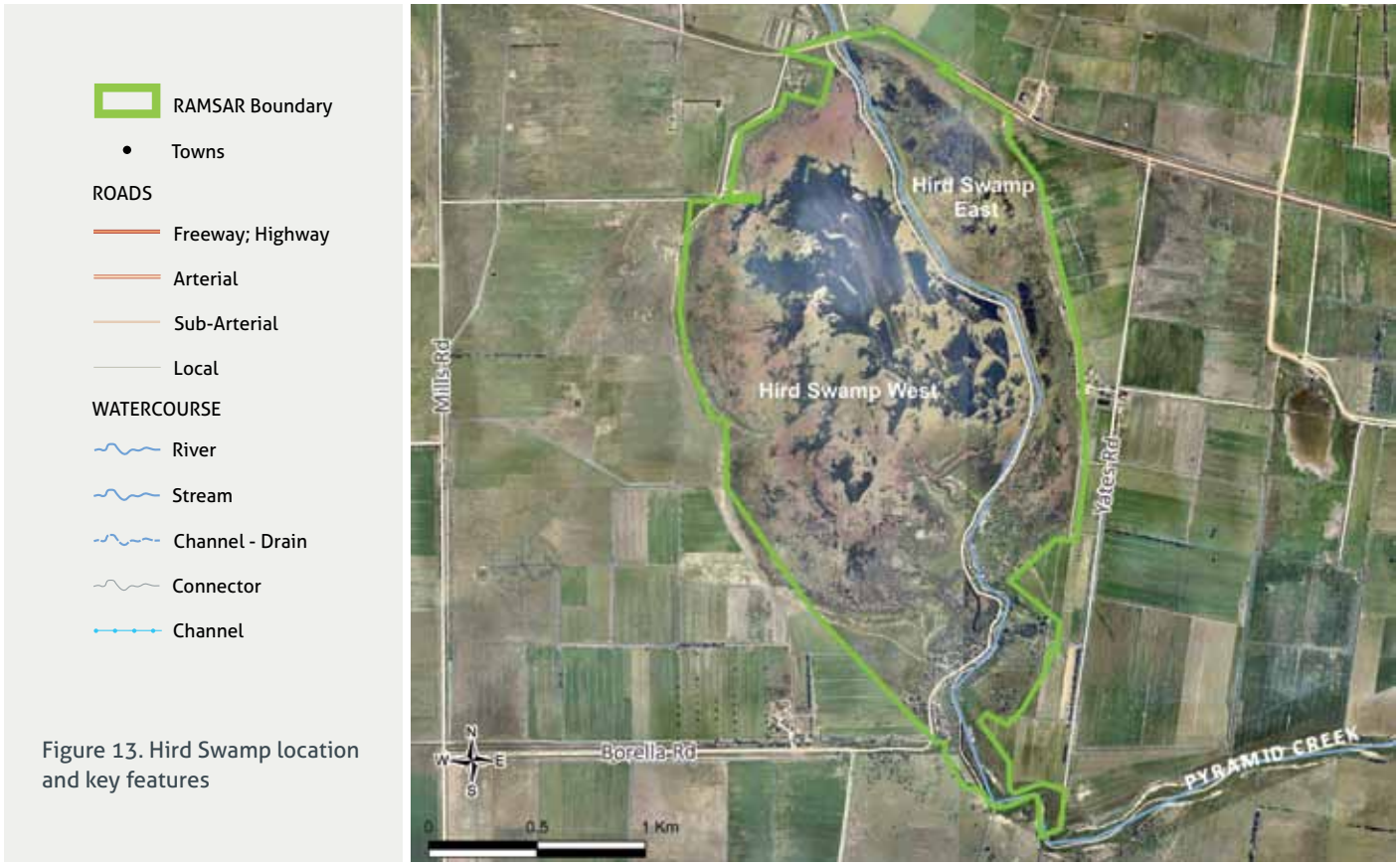


Figure 13. Hird Swamp location and key features

weed cover as well as the growth of indigenous aquatic and amphibious species (Rakali 2014a).

Tree condition of 30 River Red Gum trees was assessed as part of the 2012 survey at Hird Swamp. The assessment showed that most of the survey trees were in good health, with 77 per cent of trees presenting attributes of reproductive behaviour. The assessment does not however adequately represent the overall tree health in the wetland with a large portion of fringing and basin trees dead. These trees are the relicts of periods of permanent to near-permanent inundation, fire and or rising groundwater impacts (Rakali 2014a).

Threats

Key threats that relate to the regulated semi-permanent wetlands are presented in Section 3.4. Of particular concern at Hird Swamp is the displacement of native vegetation by common reed and cumbungi. These species are advantaged by the altered hydrological conditions and have become abundant to the detriment of species diversity in the open water zone of the wetland (Rakali 2014b).

Climatic events such as prolonged drought and high temperatures are high threats to the ecological values of Hird Swamp, in that less water availability can impact breeding success of waterbirds, and high temperatures can cause mortality in juveniles. In addition, there would be increased competition for environmental water (Table 12).

In addition, the inability to provide an independent water supply to Hird Swamp East reduces the flexibility of environmental water management particularly during drought years. Independent connection of Hird Swamp East is currently being investigated as part of the North Central CMA's *Environmental Water Technical Investigations, Works and Measures Program 2016-2020*.

Another key threat at Hird Swamp are predatory invasive species such as foxes and pigs, which can pose a serious threat to nesting waterbirds, as eggs and juveniles are predated on and nests disturbed.

Eurasian Coots. Photo: Damien Cook

Red-necked Avocets and Banded Stilt. Photo: Damien Cook

Table 34. Management actions and responsibilities for Hird Swamp.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 6a, 6b, 7, 9, 10a, 10b, 11, 12b, 13	Manage the water regime as per the Environmental Water Management Plan.	-	-	North Central CMA	DELWP, GMW, PV, VEWH
2	1, 2, 3, 4, 5, 6a, 6b, 7, 9, 10a, 10b, 11, 12b, 13	Undertake annual environmental water planning and prioritisation according to regional and statewide seasonal watering plan processes.	1	Funded through Environmental Water Program	North Central CMA	DELWP, GMW, PV, VEWH
3	1, 2, 13	Use blackwater tool prior to water delivery to determine the risk of hypoxic blackwater development.	As required.	-	North Central CMA	DELWP, GMW, PV, VEWH
4	1, 3, 10b, 13	Undertake revegetation of suitable canopy tree species according to wetland type and EVC benchmarks (consistent with the current/acquired EVCs) by 2022.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
5	1, 3, 10b, 13	Undertake revegetation of characteristic wetland vegetation species that are currently absent, including aquatic (if appropriate), submergent and emergent, and understory species, using wetland type and EVC benchmarks as a guide by 2020.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
6	1, 2	Create through flow conditions by rehabilitating lateral connectivity between Hird Swamp and Pyramid Creek by 2020.	1	To be assessed through Environmental Water Program	North Central CMA	DELWP, GMW, PV
Actions to manage threats to ecological character						
7	1, 3, 10b	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. water couch, spiny rush) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	PV	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 3, 10b	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program	$1,500/day	PV	DELWP, Gannawarra Shire Council, North Central CMA
9	1, 3, 4, 6a, 6b, 10b, 12b, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16). At Hird Swamp, this is especially important during and after watering events when birds are breeding and plants are recruiting.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
10	1, 3, 10a, 13	Investigate the benefits and appropriate methodology of a slashing program to control Typha by 2020.	1	To be assessed through Environmental Water Program	North Central CMA	DELWP, PV, TOs
11	1, 3, 10a, 13	Investigate controlled burning as a tool for management of Typha spp. by 2022.	1	To be costed	PV	DELWP, North Central CMA, TOs
12	1, 10b	Investigate the feasibility and installation of carp screens on wetland water delivery infrastructure by 2020.	1	$20,000	North Central CMA	DELWP, GMW, PV

6.5.3 Johnson Swamp

Wetland Characteristics

Johnson Swamp is a 399 ha temporary freshwater swamp, transected by Pyramid Creek into east and west components (Figure 14). Historically the wetland received overflow from Pyramid Creek (a tributary of the Loddon River with upstream connection to Gunbower Creek via Kow Swamp and Taylors Creek) as well as intermittent flooding originating from the large catchment area to the south and southeast of the wetland. The development of the Torrumbarry Irrigation area, most notably the dredging of Pyramid Creek in 1967, has hydraulically disconnected Johnson Swamp from its natural flow path. The wetland now receives environmental water through the irrigation system to support its ecological values (North Central CMA 2016a).

An overview of the wetland characteristics is provided in Table 35.

Table 35. Johnson Swamp Wetland Characteristics.

Characteristics	Description
Name	**Johnson Swamp**
Area (ha)	399 hectare wetland (west 351 ha; east 48 ha) (NLS 2015) within a 464 hectare reserve
Bioregion	Victorian Riverina with eastern edge in Murray Fans bioregion
Water regime	Intermittent wetland with optimum regime of 4 events in 10 years (North Central CMA 2016).
Water supply	Historical: – Floodwater/overflow from the Pyramid Creek – Local catchment runoff from south and south east (approx. 300 ha) (SKM 2001)
	Current: – Regulated: – Western section: flows from Torrumbarry 4/7/2 channel (capacity of 160 ML/day) outfalling to an environmental water delivery conduit (80 ML/day) – Natural: – West and eastern section: Significant overbank flooding from Pyramid Creek (>2,000 ML/day) required to overtop banks.
Ramsar wetland category	Ts: seasonal/intermittent freshwater marshes/pools on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.
1788 wetland category (Corrick and Norman)	Shallow freshwater marsh (< 8 months duration, <0.5 m depth)
1994 wetland category (Corrick and Norman)	Category: Deep freshwater marsh (<2 m depth) Sub-category: reed (233 ha), open water (123 ha), lignum (54 ha)
2013 Victorian wetland classification (DELWP 2016c)	Temporary freshwater marsh[1]
Mapping ID	Corrick: 7726-355320, DELWP: 45222

[1] Under the 2013 ANAE classification, Johnson Swamp is classified as an 'unknown' wetland type. However, based on the criteria for each wetland type, Johnson Swamp has been classified by the North Central CMA as a temporary freshwater marsh.

Aquatic planting- EPBC *Myriophyllum porcatum*
Photo: Damien Cook

Australian Little Bittern
Photo: Damien Cook

Ecological Values and Significance

Johnson Swamp is a wetland of international importance, meeting all six of the Ramsar Convention criteria (at the timing of listing) supported by the larger Kerang Wetland Ramsar Site (KBR 2011). It is recognised predominantly for its habitat value for over 60 species of feeding and breeding waterbirds, including EPBC listed Australasian Bittern and FFG listed Brolga. Johnson Swamp further supports at least nine migratory waterbird species including the Marsh Sandpiper (*Tringa stagnatilis*), Wood Sandpiper (*Tringa glareola*) and the FFG-nominated Latham's Snipe (*Galllinago hardwickii*) (North Central CMA 2016a).

The diversity of habitat types at Johnson Swamp also provides resources to a variety of other water dependent fauna species including historical records of the EPBC listed Growling Grass Frog (*Litoria raniformis*) and nesting Eastern Long-necked Turtle (*Chelodina longicollis*). Its fringing vegetation zone has also supported the FFG-listed Carpet Python (*Morelia spilota*), Grey-crowned Babbler (*Pomatostomus temporalis*) and White-bellied Sea-eagle (*Haliaeetus leucogaster*).

In 2012 and 2014, five EVCs were mapped at Johnson Swamp (Australian Ecosystems 2012; Rakali 2014a). The majority of these are classified as either endangered and/or vulnerable in their respective bioregions, and include Riverine Chenopod Woodland (EVC 103) and Lignum Swamp Woodland (EVC 823). Indigenous species represent 64 per cent of all species records, with at least ten listed as either nationally or regionally significant. The wetland is particularly significant for the diversity of habitat types it provides including dense stands of reeds, open aquatic zones, fringing sedges and rushes, lignum, as well as live and dead River Red Gum and Black Box fringe (North Central CMA 2016a).

RAMSAR Boundary
Towns
ROADS
Freeway; Highway
Arterial
Sub-Arterial
Local
WATERCOURSE
River
Stream
Channel - Drain
Connector
Channel

Figure 14. Johnson Swamp location and key features

Growling Grass Frog
Photo: Lydia Fucsko, Species Selection

Revegetation of aquatic plants, Johnson Swamp

Current Condition

In 2012 and 2014, a partial IWC assessment was undertaken at Johnson Swamp to assess the biota sub-indices only. The wetland was in a dry phase during both assessments with a score of 'very poor' given during both surveys (5.37 for 2012 and 6.50 for 2014 out of 20). The poor condition of Johnson Swamp is attributed to the significant loss in the original tree canopy, with areas of low indigenous species diversity, high weediness and the proliferation of common reed and cumbungi (Australian Ecosystems 2012; Rakali 2014a).

Tree condition of twenty-three Black Box and seven River Red Gum trees were assessed as part of the 2012 survey at Johnson Swamp. The assessment showed that most of the survey trees were in good health, although little epicormic or new tip growth was noted. As only live trees are surveyed for the purposes of monitoring tree health, the assessment does not represent the overall tree health in the wetland, with the majority of trees fringing and in the bed of the wetland dead. These trees are the relicts of periods of permanent to near-permanent inundation and or rising groundwater impacts (Rakali 2015).

Threats

Key threats that relate to the regulated semi-permanent wetlands are presented in Section 3.4. Of particular concern at Johnson Swamp is the displacement of native vegetation by Typha spp. is a key threat at Johnson Swamp. These species are advantaged by the altered hydrological conditions and have become abundant to the detriment of species diversity in the open water zone of the wetland (North Central CMA 2016). In addition, the inability to actively water the eastern side of the wetland prohibits the achievement of the long-term management goal for rehabilitation of this important vegetation community.

Climatic events such as prolonged drought and high temperatures are high threats to the ecological values of Johnson Swamp, in that less water availability can impact breeding success of waterbirds, and high temperatures can cause mortality in juveniles. In addition, there would be increased competition for environmental water (Table 12).

Another key threat at Johnson Swamp are predatory invasive species such as foxes and pigs, which can pose a serious threat to nesting waterbirds, as eggs and juveniles are predated on and nests disturbed.

Eel grass

Table 36. Management actions and responsibilities for Johnson Swamp.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 6a, 6b, 7, 9, 10a, 10c, 11, 12b, 13	Manage the water regime as per the Environmental Water Management Plan.	-	-	North Central CMA	DELWP, GMW, PV, VEWH
2	1, 2, 3, 4, 5, 6a, 6b, 7, 9, 10a, 10c, 11, 12b, 13	Undertake annual environmental water planning and prioritisation according to regional and statewide seasonal watering plan processes.	1	Funded through Environmental Water Program	North Central CMA	DELWP, GMW, PV, VEWH
3	1, 2, 13	Use blackwater tool prior to water delivery to determine the risk of hypoxic blackwater development.	As required.	-	North Central CMA	DELWP, GMW, PV, VEWH
4	1, 3, 10c, 13	Undertake revegetation of suitable canopy tree species in the wetland bed according to EVC benchmarks (consistent with the current/acquired EVCs) by 2022.	1	To be assessed through works program.	PV	DELWP, North Central CMA, Landcare, TOs, community groups
5	1, 3, 10c, 13	Undertake revegetation of characteristic wetland vegetation species that are currently absent, including aquatic (if appropriate), submergent and emergent, and understory species, using wetland type and EVC benchmarks as a guide by 2020.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
6	1, 2	Create through flow conditions by rehabilitating lateral connectivity between Johnson Swamp and Pyramid Creek by 2020.	1	To be assessed through Environmental Water Program	North Central CMA	DELWP, GMW, PV
7	10c	Investigate the feasibility of installing 'islands' within the wetland to improve roosting habitat and areas for hunting by 2025.	1	To be costed.	PV	DELWP, Game Management Authority, Gannawarra Shire Council, North Central CMA, Field and Game, TOs, VEWH
Actions to manage threats to ecological character						
8	1, 3, 10c	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. water couch, spiny rush) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	PV	DELWP, Gannawarra Shire Council, North Central CMA
9	1, 3, 10c	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	PV	DELWP, Gannawarra Shire Council, North Central CMA
10	1, 3, 4, 6a, 6b, 10c, 12b, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16). At Johnson Swamp, this is especially important during and after watering events when birds are breeding and plants are recruiting.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
11	1, 3, 10a, 13	Investigate the benefits and appropriate methodology of a slashing program to assist with management of Typha spp. by 2020.	1	To be assessed through Environmental Water Program	North Central CMA	DELWP, PV, TOs
12	1, 3, 10a, 13	Investigate controlled burning as a tool for management of Typha spp. by 2020.	1	To be costed.	PV	DELWP, North Central CMA, TOs
13	1, 10c	Investigate the feasibility and installation of carp screens on wetland water delivery infrastructure by 2020.	1	$20,000	North Central CMA	DELWP, GMW, PV

6.5.4 Kerang Weir Pool

Wetland Characteristics

As mentioned in Section 2.3, the Kerang Weir Pool and associated wetland has previously been labelled as Town/Back Swamp throughout Ramsar documentation until, through the development of this action plan, it became apparent that the actual Town Swamp is to the east of the Loddon River opposite Town Common. The Kerang Weir and associated marsh and swampy areas are formed by water that is backed up behind the weir structure. While there are large areas of deep open water, there is also a swampy area upstream of the confluence of the Loddon River and Washpen Creek (Figure 15). The lower lying areas hold water at the same level as the weir pool (KBR 2011). The wetland area also includes patchy areas of lignum-dominated wetland between Washpen Creek and the train line.

The Kerang Weir is classified as an 80 ha freshwater tree-dominated wetland (KBR 2011) or a temporary freshwater swamp (current wetlands layer, DEPI 2014). While this may be an appropriate classification for part of the wetland, some lower lying areas are also permanently or at least very regularly inundated by backed

Table 37. Kerang Weir Pool Wetland Characteristics.

Characteristics	Description
Name	**Kerang Weir Pool**
Land manager and reserve status	PV – reserved for Public Purposes
Area (ha)	80 ha
Bioregion	Victoria Riverina
Water regime	Areas of intermittent wetland interspersed with permanently inundated zones, influenced by the Kerang Weir Pool.
Water supply	Historical: – Overbank flows from the Loddon River
	Current: – Overbank flows from the Loddon River – Backed up flows from the Kerang Weir, 300m downstream of the wetland.
Ramsar wetland category	W: shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils
1788 wetland category (Corrick and Norman)	Shallow Freshwater Marsh
1994 wetland category (Corrick and Norman)	Category: Shallow Marsh Sub-category: Herb
2013 Victorian wetland classification (DELWP 2016c)	Temporary Freshwater Swamp
Mapping ID	Corrick: 7626-630442, DELWP: 43229

Above: Kerang Weir Pool in flood, 2011.
Photo: Adrian Martins

up flows from the Kerang Weir. Particularly when irrigation flows are passing down the Loddon River and Pyramid Creek simultaneously, water levels in the Kerang Weir wetland can rise substantially.

Historically, the wetland would have formed part of the Loddon River floodplain. The current water regime of the wetland is governed by passing flows in the Loddon River, particularly when irrigation water is being delivered downstream. Inflows to the wetland can be seasonally inversed, with irrigation flows in the Loddon River and Pyramid Creek occurring in spring, summer and autumn and dropping off in winter. The wetland also receives overbank flows from the Loddon River during flooding. The actual wetting and drying of the Kerang Weir wetland is considered a knowledge gap.

An overview of the wetland characteristics is provided in Table 37.

Ecological Values and Significance

Information on the ecological values of the Kerang Weir are limited beyond an understanding of which fish use the waterway, as the Kerang Weir was modified in 2008 to enable fish passage. No known ecological surveys have been undertaken of the wetland area. Incidental observations and aerial imagery (Google, accessed 8 June 2016) suggest the wetland supports large areas of sedges and reeds, and lignum communities on the elevated areas (G. Smith [North Central CMA] pers. obs. 4 May 2016). River Red Gums are present along the Loddon River, while further back Black Box trees once dominated, enough to support two wood mills (C. Myers [community] 24 May 2016).

Fauna records for the Kerang Weir are limited. Only nine species of waterbirds have been recorded, including the threatened Freckled Duck (*Stictonetta naevosa*). It is likely that with further survey effort, more waterbird species would be recorded. An additional 24 terrestrial birds have been recorded, as well as two amphibians. Recent fish surveys in the Loddon River at the Murray Valley Highway recorded four native fish species including the threatened Silver Perch (*Bidyanus bidyanus*) (Jacobs 2016a). An additional species was recorded in the weir pool up Pyramid Creek (Jacobs 2016b). Of these five species, two are large-bodied species and three are small to medium-bodied. It is possible that these fish species may also utilise some of the permanently inundated areas of the Kerang Weir wetland.

Kerang Weir Pool in flood

Figure 15. Kerang Weir (wetland) location and key features

Current Condition

In the northern part of the wetland, there are a large number of dead trees in the areas further from the permanently inundated areas, though the species and cause of death is unknown (G. Smith [North Central CMA] pers. obs. 4 May 2016). In areas of slightly higher elevation, there appears to be an interface where Black Box and River Red Gum are intermingled, unusual for these species, but perhaps indicating a modified hydrology.

In the absence of detailed ecological surveys, the current condition of the Kerang Weir wetland is considered a knowledge gap.

Threats

Key threats that relate to the regulated semi-permanent wetlands are presented in Section 3.4. Of particular concern at the Kerang Weir wetland is the occasional unlicensed grazing that has been known to occur in the northern part of the wetland.

Invasive species are also considered to be a key threat to the wetland. Of note, pigs have been observed in the nearby Washpen Creek (S. Simms [community] pers. comm. 31 May 2016) and could likely be present in the wetland itself. Four exotic fish species have also been recorded in the adjacent Loddon River and in Pyramid Creek, though it is unknown whether they utilise the Kerang Weir wetland. In addition, there may be a threat to flora diversity of the wetland as it appears that in areas, Tangled Lignum (*Muehlenbeckia florulenta*) grows in large mono-specific patches. The Kerang Weir wetland is also expected to be impacted by a warmer, drying climate.

Kerang Weir Pool area

Black box dying, dry area

Table 38. Management actions and responsibilities for the Kerang Weir Pool wetland.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 4, 10j, 13	Undertake baseline ecological surveys, including IWC, EVC mapping and fauna surveys by 2017.	1	$8,000	North Central CMA	DELWP, PV
2	1, 2, 3, 5, 9, 10j, 13	Determine the current water regime at the Kerang Weir Pool and whether any changes are required and feasible by 2017.	1	Funded	North Central CMA	DELWP, PV
3	1, 3, 10j, 13	Following ecological assessments, undertake revegetation of characteristic wetland vegetation species that are currently absent, including aquatic (if appropriate), submergent and emergent, and understory species, using wetland type and EVC benchmarks as a guide by 2025.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
4	1, 3, 10j, 13	Investigate the suitability of restoring canopy trees, and which species, around the wetland to replace those that have died. If suitable, undertake revegetation of suitable canopy tree species in the riparian zone according to wetland type and EVC benchmarks (consistent with the current/acquired EVCs) by 2022.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
Actions to manage threats to ecological character						
5	1, 3, 10j	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. alligator weed, arrowhead) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	PV / GMW	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 10j	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	PV / GMW	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 4, 10j, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 10j	Investigate management options for controlling carp or mitigating carp impacts by 2025.	1	See overall action list	PV	DELWP, GMW, PV
9	1, 10j	Assess the need for stock exclusion fencing of the wetland or particularly sensitive areas to prevent unlicensed grazing by 2020.	1	To be assessed through works program.	PV	DELWP, North Central CMA

6.5.5 Town Swamp

Wetland Characteristics

Town Swamp is a 130 ha freshwater semi-permanent wetland dominated by large areas of tangled lignum and black box. The wetland runs adjacent to the Loddon River, between the railway and the Murray Valley Highway (Figure 16). LiDAR shows that the eastern parts of the wetland, adjacent to the Loddon River, are at higher elevations than the western part of the wetland, which shows a shallow, slightly braided system. These areas appear to be influenced by backed up water from the Kerang Weir, though most likely to a lesser degree than the Kerang Weir wetland. It is unknown how frequently these areas are inundated. Town Swamp can also receive overbank flows from the Loddon River. Available data from 1990 to 2005 indicates that Town Swamp was wet in five of ten years that data had been recorded (KBR 2011). The source of water at these times is unclear. Presumably, as with the Kerang Weir wetland, Town Swamp is influenced when there are high irrigation flows passing down the Loddon River and Pyramid Creek. The hydrology of Town Swamp is considered a knowledge gap.

An overview of the wetland characteristics is provided in Table 39.

Table 39. Town Swamp Wetland Characteristics.

Characteristics	Description
Name	**Town Swamp**
Land manager and reserve status	PV – reserved for Public Purposes
Area (ha)	130 ha
Bioregion	Victoria Riverina
Water regime	Areas of intermittent wetland interspersed with permanently inundated zones, influenced by the Kerang Weir Pool.
Water supply	Historical: – Overbank flows from the Loddon River Current: – Overbank flows from the Loddon River – Backed up flows from the Kerang Weir, 300m downstream of the wetland.
Ramsar wetland category	W: shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils
1788 wetland category (Corrick and Norman)	Shallow Freshwater Marsh
1994 wetland category (Corrick and Norman)	Category: Shallow Marsh Sub-category: Lignum
2013 Victorian wetland classification (DELWP 2016c)	Temporary Freshwater Swamp
Mapping ID	Corrick: 7626-621421, DELWP: 43226

Above: Town Swamp in flood, 2011.
Photo: Adrian Martins

Ecological Values and Significance

Ecological information for native vegetation values of Town Swamp is limited. No known vegetation surveys have been undertaken of the wetland area. The type of vegetation supported by the wetter areas in the western part of the wetland is unknown, though aerial imagery (Google, accessed 9 June 2016) suggests that most of the wetland is dominated by lignum. The eastern part of the wetland appears drier, and supports dense lignum communities (G. Smith [North Central CMA] pers. obs. 4th May 2016). River red gums are present along the banks of the Loddon River, while further back black box trees once dominated, enough to support two wood mills (C. Myers [community] 24 May 2016).

Yellow-billed Spoonbills. Photo: Adrian Martins

Fauna records for Town Swamp have largely been combined with Town Swamp across the river, and cannot be separated to give a specific idea of fauna use of Town Swamp. However, it is assumed that most fauna would be able to move across the river. Forty-eight species of waterbirds have been recorded, including 13 of conservation significance. These include the FFG-listed Baillon's Crake (*Porzana pusilla*) and the Intermediate Egret (*Ardea intermedia*), as well as nine migratory species protected under international agreements. Town Swamp also supports a high diversity of terrestrial birds, with 55 species recorded including the FFG-listed Grey-crowned Babbler (*Pomatostomus temporalis*).

Habitat use of the site by waterbirds is considered a knowledge gap.

Figure 16. Town Swamp location and key features

Australasian Bittern
Photo: Damien Cook

Cane Grass (*Eragrostis australasica*)
Photo: Ian Higgins

Black-winged Stilt. Photo: Adrian Martins

Current Condition

In the absence of detailed ecological surveys, the current condition of Town Swamp is considered a knowledge gap. However, incidental observations and local knowledge suggest that dense mono-specific stands of Tangled Lignum (*Muehlenbeckia florulenta*) persist throughout the wetland at the expense of regeneration of canopy species and other plant diversity (G. Smith [North Central CMA] pers. obs. 4 May 2016). The altered hydrology of the Loddon River, including both backed up irrigation flows and a reduction in frequency of overbank floods may have also had an impact on the ecology of the wetland.

Threats

Key threats that relate to the regulated semi-permanent wetlands are presented in Section 3.4. Invasive species are considered to be a key threat to the wetland, including the aforementioned tangled lignum that, although native, appears to be advantaged at the expense of other wetland flora. Four exotic fish species have also been recorded in the adjacent Loddon River and in Pyramid Creek, though it is unknown whether they would utilise the backwaters of Town Swamp. Town Swamp is also expected to be impacted by a warmer, drying climate.

Table 40. Management actions and responsibilities for Town Swamp.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 4, 10k, 13	Undertake baseline ecological surveys, including IWC, EVC mapping and fauna surveys by 2017.	1	$8,000	North Central CMA	DELWP, PV
2	1, 2, 3, 5, 9, 10k, 13	Determine the current water regime at Town Swamp and whether any changes are required and feasible by 2017.	-	Funded	North Central CMA	DELWP, PV
3	1, 3, 10k, 13	Following ecological assessments, undertake revegetation of characteristic wetland vegetation species that are currently absent, including aquatic (if appropriate), submergent and emergent, and understory species, using wetland type and EVC benchmarks as a guide by 2025.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
4	1, 3, 10k, 13	Investigate the suitability of restoring canopy trees, and which species, around the wetland to replace those that have died. If suitable, undertake revegetation of suitable canopy tree species in the riparian zone according to wetland type and EVC benchmarks (consistent with the current/acquired EVCs) by 2022.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
Actions to manage threats to ecological character						
5	1, 3, 10k	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. alligator weed, arrowhead) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	PV	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 10k	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	PV	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 4, 10k, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 10k	Investigate management options for controlling carp or mitigating carp impacts by 2025.	1	To be costed	North Central CMA	DELWP, GMW, PV

6.6.1 Lake Tutchewop / Kutyewap (Wemba Wemba language)

Wetland Characteristics

Lake Tutchewop is a 755 ha permanent saline lake that is managed as a saline drainage disposal basin for the Barr Creek Drainage Diversion Scheme (BCDDS). Lake Tutchewop lies at the northern end of the terminal region of the Avoca floodplain, and is the largest of the 'Tutchewop Lakes' that also comprise Lake William, Lake Kelly and Little Lake Kelly (Figure 17).

Prior to regulation, Lake Tutchewop was a relatively fresh lake with a salinity range of <10,000 mg/L to 35,000 mg/L. It would have flooded episodically from the south via small remnant channels of the Avoca River (MDBA 2011), and was marginally influenced occasionally by saline groundwater discharge (Australian Geological Survey Organisation 1997). The hydrogeological characteristics of the sediments underlying and adjacent to Lake Tutchewop influenced the formation of the saline groundwater system that is now evident at the lake. Watertables deepened and the area was able to support trees and other vegetation, until these conditions changed as European settlement brought irrigation and vegetation clearance. This resulted in enhanced groundwater recharge, raising watertables and mobilising salt (Macumber 1991).

Table 41. Lake Tutchewop Wetland Characteristics.

Characteristics	Description
Name	**Lake Tutchewop**
Land manager and reserve status	Goulburn Murray Water (on behalf of the Murray Darling Basin Authority) – Salinity Disposal Reserve
Area (ha)	754.8 ha
Bioregion	Victoria Riverina
Water regime	Permanent saline wetland cut off from natural flooding, but receives saline water subject to operating rules of the Barr Creek Drainage Diversion Scheme, and can be influenced by groundwater.
Water supply	Historical: – Floodwaters from the Avoca River via the Marshes
	Current: – Barr Creek Drainage Diversion Scheme – Groundwater interactions
Ramsar wetland category	Q: permanent saline/brackish/alkaline lakes
1788 wetland category (Corrick and Norman)	Permanent Saline
1994 wetland category (Corrick and Norman)	Category: Permanent Saline Sub-category: Shallow
2013 Victorian wetland classification (DELWP 2016c)	Permanent Saline Lake
Mapping ID	Corrick: 7626-495662, DELWP: 43158

Above: Lake Tutchewop
Photo: Adrian Martins

Community bird watching event
Photo: Adrian Martins

Murray Hardyhead found in Tutchewop drain

In the early 1900s, Avoca River flood water was diverted from entering the lake to be contained in the Avoca floodway to the west of the lake, though a siphon still enabled water to flow into Lake Tutchewop. The Avoca floodway is outside the Ramsar boundary, though it is considered to have good ecological values. Between 1923 and 1935 the lake was maintained as a water storage for the Torrumbarry Irrigation Scheme. Post-1935 and the construction of the BCDDS, the wetland reportedly received water from floods or surplus irrigation, and was used for swimming (MDBA 2011). Reportedly, in years when the wetland was dry, the bed of the wetland was used for cereal cropping (MDBA 2011; S. Simms (community) pers. comm. March 2017). The Avoca floodway became hydraulically separated from the wetland during construction of the BCDDS.

Barr Creek was the single largest point source of salt entering the Murray River prior to establishment of the BCDDS in 1968. The scheme prevents highly saline Barr Creek flows from reaching the River Murray by diverting the flows to the Tutchewop Lakes for evaporative disposal. The Tutchewop Lakes are currently operated as terminal evaporation basins.

As a result, salt loads in the lakes are steadily rising.

Up until the early 2000s, the BCDDS diverted between 2000 and 12,000 ML of water per year, removing an estimated 20,000 to 60,000 tonnes of salt from the system. Since the commencement of the BCDDS, Lake Tutchewop has experienced rising salinity, from less than 30,000 EC in 1973 to 100,000 EC by 1990 (Aquaterra Simulations 2006). Salinity levels in the wetland can fluctuate due to slight freshening when there are inflows, but the lake will remain hypersaline (<100,000) indefinitely.

Significant change has occurred in the region in the last fifteen years, including the ongoing drought, water traded out of the district, changed land use and farm consolidation with the Barr Creek catchment (MDBA 2011). These changes have led to a reduction in the amount of water required to be diverted into Lake Tutchewop and the other saline drainage basins in recent years. A review of the Barr Creek Catchment Strategy is due in 2018, which will consider how the catchment has changed and should be operated in future.

Figure 17. Lake Tutchewop / Kuteywop location and key features

An overview of the wetland characteristics is provided in Table 41.

Ecological Values and Significance

The vegetation and landscape of Lake Tutchewop have been heavily modified due to clearing and the rising salinity of the wetland. The wetland would have once supported more diverse vegetation and habitat types associated with fresher water. Three EVCs were mapped at Lake Tutchewop, two of which are threatened in Victoria. Within these vegetation types, 51 flora species have been recorded, including five species of conservation significance in Victoria such as the vulnerable Blackseed Glasswort (*Tecticornia pergranulata*) and the poorly known Desert Spinach (*Tetragonia eremaea s.l.*).

Lake Tutchewop is well-regarded as supporting a high diversity of waterbirds, particularly as the salinity of the wetland attracts different types of waterbirds than are found elsewhere in the Ramsar Site. In particular, Tutchewop has provided highly productive habitat for wading waterbirds (T. Lowe [field naturalist] pers. comm. February 2017). The wetland provides a large expanse of open water habitat, in which Ruppia spp. used to grow, though it is no longer present due to the shift in salinity levels. The wetland also often provides extensive mudflat habitat as waters recede, or after freshening rainfalls, which can stimulate growth in macroinvertebrate populations. These conditions appear to draw a large number of migratory waterbirds, with 21 species protected under international migratory bird agreements. The wetland has seen an extremely high diversity of bird species, with over 160 different species recorded, most within the last decade. These include 80 species of waterbirds, 40 of which are threatened or protected species, as well as one unusual record of the Long-billed Dowitcher (*Limnodromus scolopaceus*), the only known record in Australia.

Mountain ducks. Photo: Adrian Martins

In addition to these, Lake Tutchewop has in the past supported a number of fish species, both large and small-bodied fish. However, the rising salinity levels have deterred any fish from inhabiting the wetland. Murray Hardyhead, a nationally threatened small-bodied fish species, was recorded in the wetland in the 1970's but it is expected that the wetland is too saline to support it now. However, it has been recorded in the adjacent drain, which is outside the Ramsar Site. The species could potentially use the wetland in a large, significantly freshening flood event, but it is not likely to be supported regularly at Lake Tutchewop.

Current Condition

As part of the 2014 ecological vegetation assessment, tree condition assessments were generally undertaken. However, at Lake Tutchewop, there were not enough trees remaining to undertake the assessment. Most of the areas classified as chenopod woodland have had their canopy layers almost completely removed, with only a small number of Black Box, Moonah and Eumong trees remaining (Rakali 2014). The Moonah trees are of particularly high cultural and conservation importance.

Only one EVC was included in the biota component of the IWC Assessment, Samphire Shrubland, which was considered to be in good condition. Overall, the wetland was considered to be in 'good' condition when assessed against current benchmarks of the acquired values (Rakali 2014).

Threats

Key threats that relate to the saline drainage wetlands are presented in Section 3.3. Of particular concern at Lake Tutchewop is the continued ability of the wetland to provide value as a saline drainage basin, as evaporative capacity reduces over time. This could have significant downstream impacts on Murray River salinity levels. The evaporative capacity of the wetland may be affected by changes to the operational regime. In addition, a reduction of inflows will reduce the available open water habitat and potential mudflat habitat that is important for migratory waterbirds.

Another key threat at Lake Tutchewop is non-native species, particularly rabbits and foxes in the riparian zones of the wetland. Rabbits have had a significant impact on the regeneration of canopy and understorey species around the wetland. High threat weeds at the site are Giant Reed (*Arundo donax*), Spiny Rush, and woodier species such as Boxthorn. The loss of canopy trees has seen the removal of an important habitat component at the wetland.

Table 42. Management actions and responsibilities for Lake Tutchewop / Kutyewap.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 7, 9, 13	Investigate the feasibility of developing a watering regime for the wetland based on the ecological requirements of the site, and opportunities to implement it within the scope of existing operating rules for salt management by 2025.	-	To be costed	GMW	DELWP, Gannawarra Shire Council, North Central CMA
2	1, 3, 10h, 13	Undertake revegetation of suitable canopy tree species according to EVC benchmarks for Semi-arid Chenopod Woodland and Riverine Chenopod Woodland by 2018.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
3	1, 3, 10h	Install rabbit-proof fencing around areas of Semi-arid Chenopod Woodland with the most intact shrub layer, and areas of higher quality Riverine Chenopod Woodland including existing stands of trees by 2018.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
Actions to manage threats to ecological character						
4	1, 3, 10h	Identify areas of significant weed infestation around the wetland, including woody, non-woody and any new salt-tolerant weeds to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA
5	1, 3, 10h	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required.	To be assessed through works program.	$1,500/day	GMW	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 10h	Undertake culturally sensitive rabbit control measures (under development) particularly on the lunette of the wetland, and educational activities to encourage landholders to undertake control on neighbouring land by 2020.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, PV, North Central CMA, Landcare, TOs, community groups
7	1, 3, 4, 7, 10h, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA
Actions to enhance visitor experience						
8		Investigate the feasibility of providing additional facilities (e.g. toilets) to improve amenity or signage to direct people to the nearby Lake Charm service area by 2025.	1	To be costed	GMW	Gannawarra Shire Council, North Central CMA

6.6.2 Lake William

Wetland Characteristics

Lake William is a 96 ha permanent saline lake that is managed as a saline drainage disposal basin for the BCDDS. Lake William lies at the northern end of the terminal region of the Avoca floodplain, and forms part of the 'Tutchewop Lakes' system (Figure 18).

Lake William, along with Lake Kelly and Little Lake Kelly, is different to Lake Tutchewop in that it was a naturally saline wetland prior to regulation, influenced by saline groundwater springs that discharged into the lake. The evaporation of groundwater would have resulted in naturally produced, highly saline surface brines and evaporites (Australian Geological Survey Organisation 1997). This is evidenced by the salt harvesting that occurred at Lake William until the construction of the BCDDS.

Barr Creek was the single largest point source of salt entering the Murray River prior to establishment of the BCDDS in 1968. The scheme prevents highly saline Barr Creek flows from reaching the River Murray by diverting the flows to the Tutchewop Lakes for evaporative disposal. The Tutchewop Lakes are currently operated as terminal evaporation basins. As a result, salt loads in the lakes are steadily rising.

Table 43. Lake William Wetland Characteristics.

Characteristics	Description
Name	**Lake William**
Land manager and reserve status	Goulburn Murray Water (on behalf of the Murray Darling Basin Authority) – Salinity Disposal Reserve
Area (ha)	95.7 ha
Bioregion	Victoria Riverina
Water regime	Permanent hypersaline wetland cut off from natural flooding, but receives saline water subject to operating rules of the Barr Creek Drainage Diversion Scheme, and can be influenced by groundwater.
Water supply	Historical: – Floodwaters from the Avoca River via the Marshes
	Current: – Barr Creek Drainage Diversion Scheme – Groundwater interactions
Ramsar wetland category	Q: permanent saline/brackish/alkaline lakes
1788 wetland category (Corrick and Norman)	Semi-Permanent Saline
1994 wetland category (Corrick and Norman)	Category: Permanent Saline Sub-category: Shallow
2013 Victorian wetland classification (DELWP 2016c)	Permanent Saline Lake
Mapping ID	Corrick: 7626-524637, DELWP: 43172

Above: Lake William.
Photo: Adrian Martins

Up until the early 2000s, the BCDDS diverted between 2000 and 12,000 ML of water per year, removing an estimated 20,000 to 60,000 tonnes of salt from the system. Since the commencement of the BCDDS, Lake William has experienced rising salinity (Aquaterra Simulations 2006). In the early 1990s, the average salinity of surface water in the wetland was around 300,000 mg/L (Australian Geological Survey Organisation 1997). Salinity levels can fluctuate due to the slight freshening when there are inflows, and subsequent evaporation as the wetland dries, but the wetland will remain hypersaline. A proposal to harvest salt at Lake William did not proceed as planned in 2000.

Significant change has occurred in the region in the last fifteen years, including the ongoing drought, water traded out of the district, changed land use and farm consolidation with the Barr Creek catchment (MDBA 2011). These changes have led to a reduction in the amount of water required to be diverted into Lake William and the other saline drainage basins in recent years. A review of the Barr Creek Catchment Strategy is due in 2018, which will consider how the catchment has changed and should be operated in future.

An overview of the wetland characteristics is provided in Table 43.

Lake William (pink) and Lake Tutchewop. Photo: Michelle Maher

Ecological Values and Significance

Historically, Lake William would have experienced longer drying periods than at present. The wetland was a saline lake prior to being brought in to the BCDDS in the 1960s. However, the salinity of the wetland now regularly exceeds 100,000 EC, making it hypersaline. At this threshold, the wetland's ability to support wetland flora and fauna is severely limited. In addition to this, development around the wetland has further modified the vegetation communities through clearing.

Two EVCs were mapped at Lake William, both threatened in Victoria. Canopy trees would have once been present, however, has since been cleared. Within these EVCs, 39 native flora species have been recorded, including four species of conservation significance such as the rare fuzzy New-Holland Daisy (*Vittadinia cuneata*).

Figure 18. Lake William location and key features

Of the 86 native bird species that have been recorded at Lake William, 31 are waterbirds, the majority of which are ducks and waders. In addition, terrestrial birds have been recorded there. Habitat provided at Lake William is largely open water and mudflats, though there is a substantial layer of salt on many of these. No aquatic vegetation is present due to the hypersaline nature of the wetland. The samphire communities around the wetland's riparian zone may provide some habitat for woodland birds.

Following flooding that brings an influx of fresher water the lake has been known to support a large population of Brine Shrimp, which would also provide a food source for waterbirds. However, natural floodwater is rarely received into Lake William.

Current Condition

The IWC assessment in 2014 assessed only one EVC, Samphire Shrubland. This was determined to be in 'good' condition. The overall assessment determined that the wetland was in 'moderate' condition (Rakali 2014), though it should be noted that the riparian EVCs were not assessed and are somewhat more degraded due to the loss of canopy species.

As part of the 2014 ecological vegetation assessment, tree condition assessments were generally undertaken. However, at Lake William, there were not enough trees remaining to undertake the assessment (Rakali 2014).

Lake William

Threats

Key threats that relate to the saline drainage wetlands are presented in Section 3.3. Of particular concern at Lake William is the continued ability of the wetland to provide value as a saline drainage basin, as evaporative capacity reduces over time. This could have significant downstream impacts on Murray River salinity levels. The evaporative capacity of the wetland may be reduced by changes to the operational regime. The increase in salinity over time has significantly reduced the environmental value of the wetland; however, this process had already taken place at the time of listing.

Another key threat at Lake William is non-native species, particularly rabbits and foxes. Rabbits have had a significant impact on the regeneration of canopy and understorey species around the wetland. High threat weeds at the site are Spiny Rush and woodier species such as Boxthorn. The loss of canopy trees has seen the removal of an important habitat component at the wetland.

Table 44. Management actions and responsibilities for Lake William.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 7, 9, 13	Investigate the feasibility of developing a watering regime for the wetland based on the ecological requirements of the site, and opportunities to implement it within the scope of existing operating rules for salt management by 2025.	-	To be costed	GMW	DELWP, Gannawarra Shire Council, North Central CMA
2	1, 3, 10e	Undertake revegetation of suitable canopy tree species throughout Semi-arid Chenopod Woodland according to EVC benchmarks by 2018.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
3	1, 3, 10e	Undertake stabilising revegetation (ground cover, understorey and canopy species if suitable) of the north eastern lunette according to EVC benchmarks for Semi-arid Chenopod Woodland by 2020.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
4	1, 3, 10e	Install rabbit-proof fencing around areas of Semi-arid Chenopod Woodland with the most intact shrub layer by 2018.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
Actions to manage threats to ecological character						
5	1, 3, 10e	Identify areas of significant weed infestation around the wetland, including woody, non-woody and any new salt-tolerant weeds to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 10e	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required.	To be assessed through works program.	$1,500/day	GMW	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 4, 7, 10e, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 10e	Lake William is subject to a grazing licence. See overall actions to address impacts from stock grazing across the Ramsar Site, including installing stock exclusion fencing of the wetland or particularly sensitive areas if impacted.	1	See overall action list	DELWP, GMW	PV, North Central CMA, Gannawarra Shire Council

6.6.3 Lake Kelly

Wetland Characteristics

Lake Kelly is an approximately 270 ha permanent saline lake that is managed as a saline drainage disposal basin for the BCDDS. Lake Kelly lies at the northern end of the terminal region of the Avoca floodplain, and forms part of the 'Tutchewop Lakes' system, in close proximity to Little Lake Kelly. Only 107 ha of the wetland are within the Ramsar boundary (Figure 19). Lake Kelly is connected to Little Lake Kelly via an artificial channel. Historically, they were separate wetlands that were divided by a lunette (Figure 19).

Lake Kelly, along with Lake William and Little Lake Kelly, is different to Lake Tutchewop in that it was a naturally saline wetland prior to regulation, influenced by saline groundwater springs that discharged into the wetland. Lake Kelly and Little Lake Kelly would have been intermediate between Lake Tutchewop and Lake William in terms of the ratio of groundwater to surface water influence. At times, Lake Kelly could potentially have received floodwaters from the Loddon River to the east, providing freshening inflows (Australian Geological Survey Organisation 1997).

Barr Creek was the single largest point source of salt entering the Murray River prior to establishment of the BCDDS in 1968. The scheme prevents highly saline Barr Creek flows from reaching the River

Table 45. Lake Kelly Wetland Characteristics.

Characteristics	Description
Name	**Lake Kelly**
Land manager and reserve status	Goulburn Murray Water (on behalf of the Murray Darling Basin Authority) – Salinity Disposal Reserve
Area (ha)	239.6 ha
Bioregion	Victoria Riverina
Water regime	Permanent hypersaline wetland cut off from natural flooding, but receives saline water subject to operating rules of the Barr Creek Drainage Diversion Scheme, and can be influenced by groundwater.
Water supply	Historical: – Floodwaters from the Avoca River via the Marshes
	Current: – Barr Creek Drainage Diversion Scheme – Groundwater interactions
Ramsar wetland category	Q: permanent saline/brackish/alkaline lakes
1788 wetland category (Corrick and Norman)	Semi-Permanent Saline
1994 wetland category (Corrick and Norman)	Category: Permanent Saline Sub-category: Shallow
2013 Victorian wetland classification (DELWP 2016c)	Permanent Saline Lake
Mapping ID	Corrick: 7626-555628, DELWP: 43193

Above: Lake Kelly Samphire shrubland.
Photo: Adrian Martins

Murray by diverting the flows to the Tutchewop Lakes for evaporative disposal. The Tutchewop Lakes are currently operated as terminal evaporation basins. As a result, salt loads in the lakes are steadily rising.

Up until the early 2000s, the BCDDS diverted between 2000 and 12,000 ML of water per year, removing an estimated 20,000 to 60,000 tonnes of salt from the system. Since the commencement of the BCDDS, Lake Kelly has experienced rising salinity. In the early 1990s, the average salinity of surface water in the wetland was around 100,000 mg/L (Australian Geological Survey Organisation 1997). Salinity levels can fluctuate due to the slight freshening when there are inflows, and subsequent evaporation as the wetland dries, but the wetland will remain hypersaline.

Lake Kelly revegetation. Photo: Adrian Martins

Significant change has occurred in the region in the last fifteen years, including the ongoing drought, water traded out of the district, changed land use and farm consolidation with the Barr Creek catchment (MDBA 2011). These changes have led to a reduction in the amount of water required to be diverted into Lake Kelly and the other saline drainage basins in recent years, compared to the period between 1980 and 2003 when Lake Kelly was kept relatively permanent (KBR 2011). A 2018 review of the Barr Creek Catchment Strategy will consider how the catchment has changed and should be operated in future.

An overview of the wetland characteristics is provided in Table 45.

Figure 19. Lake Kelly location and key features

Ecological Values and Significance

Large areas of Lake Kelly are open water lacking in any vegetation, presumably as a result of the high salinity of the wetland. Three EVCs were mapped in the wetland fringes, two of which are threatened communities in Victoria. Within these, 87 native flora species were recorded, seven of which are threatened species including the Pale Plover-daisy (*Leiocarpa leptolepis*) and Giant Hop-bush (*Dodonaea viscosa subsp. angustifolia*) which are endangered in Victoria.

Of the 84 recorded bird species at Lake Kelly, 45 are waterbirds including 14 of conservation significance, such as the FFG-listed Freckled Duck (*Stictonetta naevosa*) and Curlew Sandpiper (*Calidris ferruginea*), endangered in Victoria. In addition, Lake Kelly also supports 39 terrestrial bird species. The Eastern Long-necked Turtle (*Chelodina longicollis*) was recorded at the wetland in 2014, for which data is deficient in Victoria (Rakali 2014).

Murray Hardyhead (*Craterocephalus fluviatilis*), a nationally threatened small-bodied fish species, was recorded in the wetland in 2012 but it is expected that the wetland is too saline to support it now. However, it has been recorded in the adjacent drain, which is outside the Ramsar Site. The species uses Lake Kelly in a large, significantly freshening flood event, as occurred in the 2010-11 floods, but it is not likely to be supported regularly at the wetland.

Eastern Long-necked Turtle. Photo: David Kleinert

Current Condition

Ecological assessments undertaken in 2014 included scores for Lake Kelly and Little Lake Kelly combined, due to their close proximity.

Similarly to Lake William, the IWC assessment in 2014 assessed only one EVC at Little Lake Kelly, Samphire Shrubland. This was determined to be in 'good' condition. The overall assessment determined that the wetland was in 'moderate' condition (Rakali 2014), though it should be noted that the riparian EVCs were not assessed and are somewhat more degraded due to the loss of canopy species.

An assessment of tree condition at Lake Kelly in 2014 determined that most Black Box trees at the wetland varied in good to poor condition, with some having poor canopy densities and extents and exhibiting some signs of stress. The large old Moonah trees fringing the wetlands, particularly on the north side of Lake Kelly, are of high conservation significance. There is currently no evidence of recruitment of trees and shrubs in the chenopod woodland areas of the wetland, possibly as a result of high grazing pressure from rabbits (Rakali 2014).

Threats

Key threats that relate to the saline drainage wetlands are presented in Section 3.3. Of particular concern at Lake Kelly is the continued ability of the wetland to provide value as a saline drainage basin, as evaporative capacity reduces over time. This could have significant downstream impacts on Murray River salinity levels. The evaporative capacity of the wetland may be affected by changes to the operational regime. In addition, a reduction of inflows will reduce the available open water habitat and potential mudflat habitat that is important for migratory waterbirds.

Non-native species is another key threat at Lake Kelly, particularly rabbits and foxes. Rabbits have had a significant impact on the regeneration of canopy and understorey species around the wetland. High threat weeds at the site are spiny rush and woodier species such as boxthorn. The loss of canopy trees has seen the removal of an important habitat component at the wetland.

The large section of Lake Kelly that is outside the Ramsar boundary is subject to a grazing licence. Details and impacts of grazing are unknown, but are a potentially high threat to the ecological character of the wetland.

Table 46. Management actions and responsibilities for Lake Kelly.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 7, 9, 13	Investigate the feasibility of developing a watering regime for the wetland based on the ecological requirements of the site, and opportunities to implement it within the scope of existing operating rules for salt management by 2025.	-	To be costed	GMW	DELWP, Gannawarra Shire Council, North Central CMA
2	1, 3, 10h	Undertake revegetation of suitable canopy tree species throughout Riverine Chenopod Woodland and Semi-arid Chenopod Woodland according to EVC benchmarks by 2018.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
3	1, 3, 10h	Install rabbit-proof fencing around stands of the mature trees to facilitate recruitment by 2018.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
Actions to manage threats to ecological character						
4	1, 3, 10h	Identify areas of significant weed infestation around the wetland, including woody, non-woody and any new salt-tolerant weeds to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA
5	1, 3, 10h	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required.	To be assessed through works program.	$1,500/day	GMW	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 10h	Undertake culturally sensitive rabbit control measures (under development) particularly on the lunette of the wetland, and educational activities to encourage landholders to undertake control on neighbouring land by 2020.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 4, 7, 10h, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 10h	Lake Kelly is subject to a grazing licence. See overall actions to address impacts from stock grazing across the Ramsar Site, including installing stock exclusion fencing of the wetland or particularly sensitive areas if impacted.	1	See overall action list	GMW	DELWP, PV, North Central CMA, Gannawarra Shire Council
9	1, 3, 10h	Restrict vehicle access to the wetland's lunette by 2020.	2.5km fence	$15,000	GMW	North Central CMA

6.6.4 Little Lake Kelly

Wetland Characteristics

Little Lake Kelly is an approximately 60 ha permanent saline lake that is managed as a saline drainage disposal basin for the BCDDS. Little Lake Kelly lies at the northern end of the terminal region of the Avoca floodplain, and forms part of the 'Tutchewop Lakes' system, in close proximity to Lake Kelly. Little Lake Kelly is connected to Lake Kelly via an artificial channel. Historically, they were separate wetlands that were divided by a lunette (Figure 19).

Little Lake Kelly, along with Lake William and Lake Kelly, is different to Lake Tutchewop in that it was a naturally saline wetland prior to regulation, influenced by saline groundwater springs that discharged into the wetland. Lake Kelly and Little Lake Kelly would have been intermediate between Lake Tutchewop and Lake William in terms of the ratio of groundwater to surface water influence.

Historically, Little Lake Kelly had its own local surface runoff catchment and, being low in the landscape, would have been influenced by the local saline watertable (Rakali 2014a). Little Lake Kelly was previously a saline wetland, though salinity levels have increased extensively with the delivery of saline drainage water over the years. Salinity levels can fluctuate due to slight freshening when there are inflows, but is largely hypersaline.

Table 47. Little Lake Kelly Wetland Characteristics.

Characteristics	Description
Name	**Little Lake Kelly**
Land manager and reserve status	Goulburn Murray Water (on behalf of the Murray Darling Basin Authority) – Salinity Disposal Reserve
Area (ha)	60.8 ha
Bioregion	Victoria Riverina
Water regime	Permanent hypersaline wetland cut off from natural flooding, but receives saline water subject to operating rules of the Barr Creek Drainage Diversion Scheme, and can be influenced by groundwater.
Water supply	Historical: – Floodwaters from the Avoca River via the Marshes
	Current: – Barr Creek Drainage Diversion Scheme – Groundwater interactions
Ramsar wetland category	Q: permanent saline/brackish/alkaline lakes
1788 wetland category (Corrick and Norman)	Semi-Permanent Saline
1994 wetland category (Corrick and Norman)	Category: Permanent Saline Sub-category: Shallow
2013 Victorian wetland classification (DELWP 2016c)	Permanent Saline Lake
Mapping ID	Corrick: 7626-543628, DELWP: 43188

Lake Kelly and Little Lake Kelly (pink)
Photo: Michelle Maher

Barr Creek was the single largest point source of salt entering the Murray River prior to establishment of the BCDDS in 1968. The scheme prevents highly saline Barr Creek flows from reaching the River Murray by diverting the flows to the Tutchewop Lakes for evaporative disposal. The Tutchewop Lakes are currently operated as terminal evaporation basins. As a result, salt loads in the lakes are steadily rising.

Up until the early 2000s, the BCDDS diverted between 2000 and 12,000 ML of water per year, removing an estimated 20,000 to 60,000 tonnes of salt from the system. Since the commencement of the BCDDS, Little Lake Kelly has experienced rising salinity. It is expected that salinity levels would be similar to Lake Kelly, around 100,000 mg/L or greater on average. Salinity levels can fluctuate due to the slight freshening when there are inflows, and subsequent evaporation as the wetland dries, but the wetland will remain hypersaline.

Wetland bird flock. Photo: Adrian Martins

Significant change has occurred in the region in the last fifteen years, including the ongoing drought, water traded out of the district, changed land use and farm consolidation with the Barr Creek catchment (MDBA 2011). These changes have led to a reduction in the amount of water required to be diverted into Little Lake Kelly and the other saline drainage basins in recent years, where Little Lake Kelly was kept relatively permanent between 1980 and 2003 (KBR 2011). A 2018 review of the Barr Creek Catchment Strategy will consider how the catchment has changed and should be operated in future.

An overview of the wetland characteristics is provided in Table 47.

Figure 19B. Little Lake Kelly location and key features

Glasswort (*Halosarcia pergranulata*)
Photo: Ian Higgins

Samphire shrubland
Photo: Damien Cook

Ecological Values and Significance

Flora and fauna surveys of Little Lake Kelly have been combined with Lake Kelly and cannot be separated. Therefore, ecological values of Little Lake Kelly are assumed to be similar to Lake Kelly.

Current Condition

Ecological assessments undertaken in 2014 included scores for Lake Kelly and Little Lake Kelly combined, due to their proximity.

Similarly to Lake William, the IWC assessment in 2014 assessed only one EVC at Little Lake Kelly, Samphire Shrubland. This was determined to be in 'good' condition. The overall assessment determined that the wetland was in 'moderate' condition (Rakali 2014), though it should be noted that the riparian EVCs were not assessed and are somewhat more degraded due to the loss of canopy species.

An assessment of tree condition at Little Lake Kelly in 2014 determined that most Black Box trees at the wetland varied in good to poor condition, with some having poor canopy densities and extents and exhibiting some signs of stress. The large old Moonah trees fringing the wetlands, particularly on the north side of Little Lake Kelly, are of high conservation significance. There is currently no evidence of recruitment of trees and shrubs in the chenopod woodland areas of the wetland, possibly as a result of high grazing pressure from rabbits (Rakali 2014).

Threats

Key threats that relate to the saline drainage wetlands are presented in Section 3.3. Of particular concern at Little Lake Kelly is the continued ability of the wetland to provide value as a saline drainage basin, as evaporative capacity reduces over time. This could have significant downstream impacts on Murray River salinity levels. The evaporative capacity of the wetland may be affected by changes to the operational regime. In addition, a reduction of inflows will reduce the available open water habitat and potential mudflat habitat that is important for migratory waterbirds.

Non-native species is another key threat at Little Lake Kelly, particularly rabbits and foxes. Rabbits have had a significant impact on the regeneration of canopy and understorey species around the wetland. High threat weeds at the site are spiny rush and woodier species such as boxthorn. The loss of canopy trees has seen the removal of an important habitat component at the wetland.

Table 48. Management actions and responsibilities for Little Lake Kelly.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 7, 9, 13	Investigate the feasibility of developing a watering regime for the wetland based on the ecological requirements of the site, and opportunities to implement it within the scope of existing operating rules for salt management by 2025.	-	To be costed	GMW	DELWP, Gannawarra Shire Council, North Central CMA
2	1, 3, 10h	Undertake revegetation of suitable canopy tree species according to EVC benchmarks for Riverine Chenopod Woodland and Semi-arid Chenopod Woodland by 2018.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
3	1, 3, 10h	Install rabbit-proof fencing around stands of the mature trees to enable recruitment by 2018.	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
Actions to manage threats to ecological character						
4	1, 3, 10h	Identify areas of significant weed infestation around the wetland, including woody, non-woody and any new salt-tolerant weeds to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	GMW	DELWP, Gannawarra Shire Council, North Central CMA
5	1, 3, 10h	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required.	To be assessed through works program.	$1,500/day	GMW	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 10h	Undertake culturally sensitive rabbit control measures (under development) particularly on the lunette of the wetland, and educational activities to encourage landholders to undertake control on neighbouring land by 2020.	To be assessed through works program.	To be assessed through works program.	See overall action list	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 4, 7, 10h, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	GMW	DELWP, Gannawarra Shire Council, North Central CMA

6.6.5 Fosters Swamp

Wetland Characteristics

Fosters Swamp is a 225 ha intermittent saline or brackish wetland, and has been used for treated wastewater drainage since 1936. Prior to human influence, it would have been a shallow freshwater marsh (Corrick and Norman 1750 Classification, DELWP 2016). Historically, Fosters Swamp would have received overbank flows from Pyramid Creek; now, however, it is cut off from natural flood pathways (Figure 20). It receives treated wastewater discharge from the Kerang Waste Water Treatment Plant, as well as urban stormwater from Kerang and surface water run-off.

Until recently, the entirety of Fosters Swamp was reserved for sewage purposes. Now, the wetland area is classified as a Wildlife Reserve, open to hunting, except for the sewage treatment ponds which remain under the governance of Lower Murray Water. Fosters Swamp is now part of the broader Kerang State Game Reserve. Approximately three per cent of the wetland is influenced by the discharged wastewater (GHD 2006). A risk assessment undertaken in 2006 determined the influence of the wastewater on the ecological character of the wetland in accordance with State guidelines. The assessment determined that halting the discharge of treated wastewater would remove an important source of water to a wetland with limited other sources, despite the salt and nutrient quality of the wastewater (GHD 2006).

Table 49. Fosters Swamp Wetland Characteristics.

Characteristics	Description
Name	**Fosters Swamp**
Land manager and reserve status	Parks Victoria – State Wildlife Reserve (part of the larger Kerang State Game Reserve)
Area (ha)	313.3 ha
Bioregion	Murray Fans
Water regime	Brackish/saline mostly intermittent wetland that is largely cut off from the floodplain and now receives water predominantly from storm water runoff, with a small area that remains permanently inundated due to discharge from adjacent sewage treatment ponds.
Water supply	Historical: – Floodwater from the Murray River via Pyramid Creek. – Possibly floodwater from the Loddon River. Current: – Treated wastewater discharge from Kerang Waste Water Treatment Plant. – Urban stormwater – Regional and local surface water run-off
Ramsar wetland category	Q: permanent saline/brackish/alkaline lakes
1788 wetland category (Corrick and Norman)	Shallow Freshwater Marsh
1994 wetland category (Corrick and Norman)	Category: Semi-Permanent Saline Sub-category: Salt Pan
2013 Victorian wetland classification (DELWP 2016c)	Temporary Saline Lake
Mapping ID	Corrick: 7626-668415, DELWP: 43237

An overview of the wetland characteristics is provided in Table 49.

Above: Sewerage pond input into Fosters Swamp

Saline-affected lake bed at Fosters Swamp

Birds using sewerage ponds

Ecological Values and Significance

GHD conducted the only known ecological assessment of vegetation values at Fosters Swamp. EVCs were not mapped, though six vegetation types were determined. Of the 90 species of flora that have been recorded at the wetland, 50 per cent of these were native. These included six species of conservation significance, including the rare Spiny Lignum (*Duma horrida subsp. Horrida*) and Blackseed Glasswort (*Tecticornia pergranulata*), considered vulnerable in Victoria. Fosters Swamp has also supported, when full, an undescribed Althenia species, one of only few records in Victoria (D. Cook [wetland ecologist, Rakali], pers. comm. 10 August 2016).

The 2007 assessment determined that the primary ecological values of Fosters Swamp are for macroinvertebrates and waterbirds. Fosters Swamp has supported 48 species of waterbirds, including ten migratory species that are internationally protected such as the FFG-listed Caspian Tern (*Hydroprogne caspia*) and the recently FFG-nominated Latham's Snipe (*Gallinago hardwickii*). The wetland particularly supports wading birds, which feed on the on the large numbers of macroinvertebrates that are present in respond to the wastewater discharge (GHD 2007).

Fosters Swamp supports a relatively high number of waterbirds, and the constant source of water from treated wastewater discharge and the permanent sewage ponds has meant that the wetland can act as a refuge in dry periods. At the height of the drought in 2007, 53 species were observed, including 38 at the sewage ponds (GHD 2007).

The wetland also supports a variety of terrestrial bird species, two amphibians and two mammals.

GHD (2007) suggest that the primary food source for waterbirds at Fosters Swamp is macroinvertebrates, with aquatic plants as a secondary, less critical food source. There were more observations found in the discharge area and the sewage ponds than in the dry areas of the wetland. The sewage ponds themselves appear to support a moderate diversity and abundance of birds, providing nutrient and planktonic rich food sources.

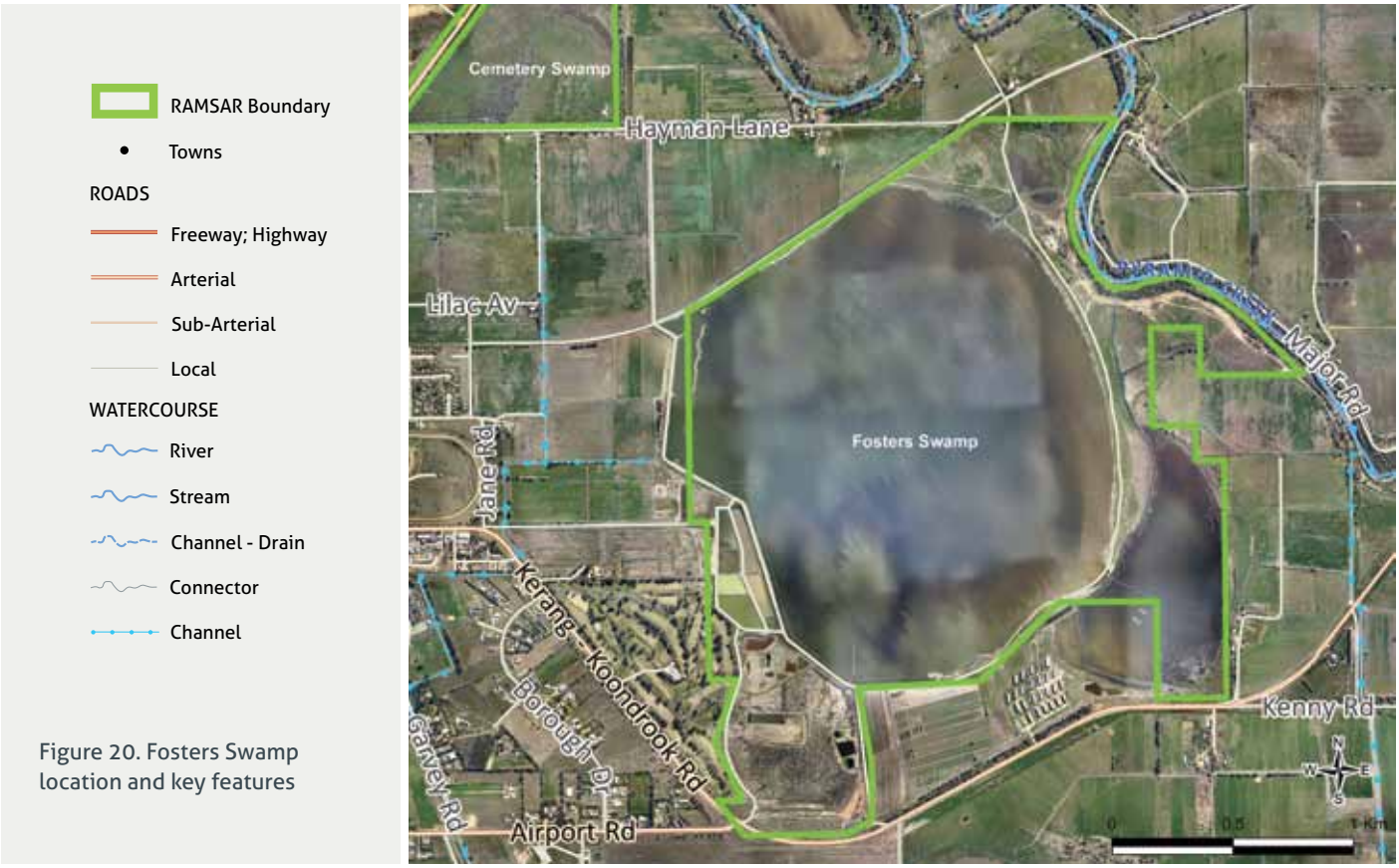


Figure 20. Fosters Swamp location and key features

Current Condition

The vegetation of Fosters Swamp is heavily influenced by the high salinity of the wetland, and was considered to be lacking in numbers or variety of species (GHD 2007). Much of the wetland bed was devoid of vegetation, while other areas hosted a monoculture of glasswort. The most diverse vegetation occurred on the wetland fringes.

Glasswort is known to be tolerant of salinity and waterlogging, which explains its dominance over much of the wetland. The salinity of the wetland is evidenced by the predominantly salt-tolerant species that survive there, but also by the death of trees in the wetland bed and the poor health of canopy trees in the fringing vegetation (GHD 2007).

The high number of non-native species recorded also suggests the wetland is a heavily modified environment than it may have previously been.

Threats

Key threats that relate to the saline and sewage drainage wetlands are presented in Section 3.3. Of particular concern at Fosters Swamp are non-native species, particularly rabbits, hares and foxes. Another key threat is the drier watering regime, as Fosters Swamp is now mostly cut off from the floodplain. While it still receives inflows from man-made sources, this does not reach pre-regulation levels.

While the potential for rising salinity at the wetland, and impacts from increased nutrient levels stemming from the treated wastewater, are real concerns, these are monitored frequently and managed in accordance with EPA guidelines.

Inlet from sewerage ponds to Fosters Swamp

Fosters Swamp aerial. Photo: Michelle Maher

Table 50. Management actions and responsibilities for Fosters Swamp.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 2, 3, 4, 5, 9, 10l, 13	Undertake baseline ecological surveys, including IWC, EVC mapping and fauna surveys by 2017.	1	Funded	PV	DELWP, North Central CMA
2	1, 3, 10l, 13	Following ecological assessments, undertake revegetation of characteristic wetland vegetation species that are currently absent, including aquatic (if appropriate), submergent and emergent, and understory species, using wetland type and EVC benchmarks as a guide by 2022.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
3	1, 3, 10l, 13	Undertake revegetation of suitable canopy tree species according to wetland type and EVC benchmarks (consistent with the current/acquired EVCs) by 2022.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
Actions to manage threats to ecological character						
4	1, 3, 10l	Identify areas of significant weed infestation around the wetland, including woody, non-woody and any new salt-tolerant weeds to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	PV	DELWP, Gannawarra Shire Council, North Central CMA
5	1, 3, 10l	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required.	To be assessed through works program.	$1,500/day	PV	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 4, 7, 10l, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
Actions to enhance visitor experience						
7		Investigate the feasibility of installing a viewing area to enable safe viewing of the sewage ponds and wetland by 2025.	1	To be costed	PV	Game Management Authority, Birdlife Australia, DELWP, North Central CMA, Gannawarra Shire Council, Lower Murray Water
8		Install signage at the wetland entrance to identify the reserve and indicate appropriate places for bird watching by 2018.	1	$1,500	PV	DELWP, North Central CMA, Gannawarra Shire Council

6.7.1 Cemetery Swamp

Wetland Characteristics

Cemetery Swamp is an 89 ha freshwater tree-dominated wetland located northeast of the Kerang township, approximately 300 m upstream of confluence of Pyramid Creek with the Loddon River (Figure 21). The wetland is adjacent to Pyramid Creek, separated by a levee. Cemetery Swamp is separated by the Kerang-Murrabit Road into two distinct areas, with a throughflow pipe enabling flows to enter the south-eastern part of the wetland. The northern part of the wetland receives inflows in large floods when the Creek overtops, through an open pipe in the levee of the western boundary (Nolan-ITU 2001). Cemetery Swamp also can receive water from nearby Fosters Swamp in the south-east via a drain, which occurred in the 2011 floods (A. Thompson [community] pers. comm. 31 May 2016). It can also receive stormwater and run-off from the Kerang township. Aerial imagery (Google 2016) suggests that the south-western part of the wetland (north of the Kerang-Murrabit Road) is influenced by the Kerang Weir, with waters backing up Pyramid Creek and spilling into Cemetery Swamp.

Above: Cemetery Swamp
Photo: Michelle Maher

Table 51. Cemetery Swamp Wetland Characteristics.

Characteristics	Description
Name	**Cemetery Swamp**
Land manager and reserve status	Parks Victoria – Natural Features Reserve / State Wildlife Reserve (part of the larger Kerang State Game Reserve)
Area (ha)	110.9 ha
Bioregion	Murray Fans
Water regime	Intermittent wetland that receives natural inflows from the Pyramid Creek. At the time of writing, the water regime is unknown, but as the wetland is dominated by lignum and black box it is estimated to be approximately 3-4 years in ten or less.
Water supply	Historical: – Overbank flows from Pyramid Creek
	Current: – Overbank flows from Pyramid Creek – Stormwater – Overflow from Fosters Swamp via drain (in large floods)
Ramsar wetland category	W: shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils
1788 wetland category (Corrick and Norman)	Shallow Freshwater Marsh
1994 wetland category (Corrick and Norman)	Category: Shallow Marsh Sub-category: Lignum
2013 Victorian wetland classification (DELWP 2016c)	Temporary Freshwater Swamp
Mapping ID	Corrick: 7626-656436, DELWP: 43335

Cemetery Swamp

Included within the Ramsar boundary at Cemetery Swamp is the site of the former Kerang landfill which closed in 1999 (DSE 2004). The site has been rehabilitated, but has the potential to impact the Ramsar Site through leachate, which is tested for regularly by Gannawarra Shire Council. Some illegal rubbish dumping still occurs within the wetland.

An overview of the wetland characteristics is provided in Table 51.

Ecological Values and Significance

Information regarding the values of Cemetery Swamp is limited. A 2001 study investigated options for improving the inlet and outlet structures, which provides some discussion of ecological values. While the study did not identify EVCs as such, it did identify vegetation zones including Black Box dominated community in the north-east, including Tangled Lignum (*Muehlenbeckia florulenta*) and various chenopods; an area of River Red Gum mixed with Black Box on the north-western edge adjacent to the Creek; and some areas of a mixture of lignum and chenopods.

Fauna records for Cemetery Swamp are mostly from the 1980s and early 1990s, with ten waterbirds recorded including the FFG-listed Eastern Great Egret (*Ardea modesta*). Other records include the Carpet Python (*Morelia spilota*), endangered in Victoria (2001) and a limited assortment of terrestrial and water-dependent mammals, one reptile and one amphibian. The current fauna values of Cemetery Swamp are, however, relatively unknown.

Figure 21. Cemetery Swamp location and key features

Current Condition

The current condition of Cemetery Swamp is unknown, as no monitoring appears to have taken place. Discussions with various locals suggest that it has suffered from a lack of flood water in some parts, and from overwatering from stormwater or irrigation drainage in others. The levee initially did not allow flood waters to drain out of the wetland and it held water until it evaporated; however, the pipe was put in which has enabled drainage to occur and it seemed the condition improved (Nolan-ITU 2011). The 2001 assessment suggested that the vegetation of the swamp was in good health. However, post 2001 there was the extended drought and floods of 2010-11, which may have altered the wetland's health.

Cemetery Swamp

Threats

Key threats that relate to the unregulated semi-permanent wetlands are presented in Section 3.5. Of particular concern at Cemetery Swamp is the illegal dumping of rubbish that occurs despite the closure of the Kerang landfill. Some compliance has been undertaken to deter potential perpetrators (L. Wishart [PV] pers. comm. 20 June 2016). It includes household and garden refuse which can have deleterious impacts on multiple values of the wetland.

Other threats to the wetland include a changed watering regime resulting from alterations to the landscape, either from overwatering or extended dry periods as natural flood pathways have been altered or from a drying climate.

Pest plant and animals were also identified as a high threat, as well as the potential for bushfires. It was noted that some unlicensed grazing has or does occur on occasion at Cemetery Swamp.

Cemetery Swamp

Table 52. Management actions and responsibilities for Cemetery Swamp.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 4, 10i, 13	Undertake baseline ecological surveys, including IWC, EVC mapping and fauna surveys by 2017.	1	Funded	PV	DELWP, North Central CMA
2	1, 2, 3, 5, 9, 10i, 13	Determine the current water regime at Cemetery Swamp and whether any changes are required and feasible, including investigating the potential benefits or impacts of restoring a more natural watering regime using environmental water or an enhanced connection to natural flood pathways by 2019.	To be assessed through works program.	Funded	North Central CMA	DELWP, PV
3	1, 3, 10i, 13	Following ecological assessments, undertake revegetation of characteristic wetland vegetation species that are currently absent, including aquatic (if appropriate), submergent and emergent, and understory species, using wetland type and EVC benchmarks as a guide.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
4	1, 3, 10i, 13	Investigate the suitability of restoring canopy trees, and which species, around the wetland to replace those that have died. If suitable, undertake revegetation of suitable canopy tree species in the riparian zone according to wetland type and EVC benchmarks (consistent with the current/acquired EVCs) by 2022.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
Actions to manage threats to ecological character						
5	1, 3, 10i	Identify areas of significant weed infestation around the wetland, including woody, non-woody and aquatic weeds (e.g. Alligator Weed, Arrowhead) to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	PV	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 10i	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	PV	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 4, 10i, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 10i	Investigate management options for controlling carp or mitigating carp impacts.	1	See overall action list	PV	DELWP, GMW, PV
9	1, 10i	Assess the need for stock exclusion fencing of the wetland or particularly sensitive areas to prevent unlicensed grazing.	1	See overall action list	PV	DELWP, North Central CMA
10	1, 3	Develop and implement a local educational campaign, and/or signage to a) halt illegal rubbish dumping, and b) encourage visitors to take rubbish away with them.	-	To be costed	PV	Gannawarra Shire Council, North Central CMA

6.7.2 Stevenson Swamp

Wetland Characteristics

Stevenson Swamp is a 115 ha intermittent brackish lake, though only 80 hectares is within the Ramsar boundary. LiDAR data shows that before disruption of natural hydrology, Stevenson Swamp would have been primarily fed by Scotts Creek. This waterway is a distributary of the Loddon River that takes Loddon River overflows from the Kerang Weir Pool into the Reedy Lakes and via Scotts Creek into Scotts Swamp and Stevenson Swamp (Figure 22). At times of high water levels, Stevenson Swamp would have been contiguous with Scotts Swamp, but is now isolated by the levee bank on the north side of the channelised Scotts Creek, which isolates Stevenson Swamp from inflows in all but very large floods. This means the season of inundation has changed to another (more or less non-existent) season and the hydrological regime category has changed to 'periodically inundated-episodic'.

The natural salinity regime for Stevenson Swamp was probably fresh, perhaps becoming brackish as water levels dropped (North Central CMA 2016b). The information available from nearby bores shows that groundwater has been highly saline (some from 50 to 80 per cent of seawater) and close enough to the surface to influence the salinity of the wetland and for capillary action to bring salts to the surface of the lake bed when dry. The complete

Table 53. Stevenson Swamp Wetland Characteristics.

Characteristics	Description
Name	**Stevenson Swamp**
Land manager and reserve status	Parks Victoria – Natural Features and State Wildlife Reserve
Area (ha)	79.5 ha
Bioregion	Victoria Riverina
Water regime	Intermittent saline/brackish wetland that is cut off from the floodplain. Has not received water in several decades.
Water supply	Historical: – Floodwater/ overflow from the Loddon River via Reedy Lakes and Scotts Creek
	Current: – Overflow from Scotts Creek but only in very large floods.
Ramsar wetland category	R: seasonal/intermittent saline/brackish/ alkaline lakes and flats
1788 wetland category (Corrick and Norman)	Semi-Permanent Saline
1994 wetland category (Corrick and Norman)	Category: Semi- Saline Sub-category: Salt Pan
2013 Victorian wetland classification (DELWP 2016c)	Temporary Saline Lake
Mapping ID	Corrick: 7626-578537, DELWP: 43203

Above: Stevenson Swamp
Photo: Ian Higgins

lack of wetland plants in the deeper part of the wetland and substantial invasion by samphires elsewhere, even on the elevated lunette soil to the east confirms a high severity of change in salinity (North Central CMA 2016b).

An overview of the wetland characteristics is provided in Table 53.

Ecological Values and Significance

Prior to 2016, no known flora surveys have been undertaken. In early 2016, the North Central CMA undertook an IWC assessment and EVC mapping. Over 33 native flora species were recorded from the whole site, 17 of which are considered wetland species, though these are all found outside the Ramsar boundary in areas where there is some freshwater leakage through the Scotts Creek levee. The rare Spiny Lignum (*Duma horrida subsp. Horrida*) and the vulnerable Cane Grass (*Eragrostis australasica*) were recorded, as well as the poorly-known Flat-top Saltbush (*Atriplex lindleyi*) and Bluish Raspwort (*Haloragis glauca*) (North Central CMA 2016b). Only six flora species were found within the Ramsar boundary, mostly known to be salt-tolerant.

Three EVCs were mapped around Stevenson Swamp, including Intermittent Swampy Woodland, Lunette Woodland, and Riverine Chenopod Woodland, each of which are considered depleted, endangered or vulnerable respectively in Victoria (North Central CMA 2016b). There were also large areas of unknown/unclassified and unvegetated areas in the bed of the wetland, with a few scattered samphire plants. The lack of dead trees in the bed of the wetland is a likely indicator that the wetland was once too frequently inundated to support trees. In some higher elevated areas, dead eucalypt stags suggest that the area may once have been more characteristic of Intermittent Swampy Woodland.

What Stevenson Swamp could look like with more water. Photo: Ian Higgins

Fauna records are very limited for Stevenson Swamp. Seven bird species have been recorded, only one of which was considered water-dependent, the Masked Lapwing (*Vanellus miles*). None are threatened. These records are mostly from 2001. In the recent flora survey, no incidental observations of any fauna were made (North Central CMA 2016b).

Figure 22. Stevenson Swamp location and key features

Current Condition

The recent IWC assessment resulted in Stevenson Swamp being identified as severely degraded, retaining very little wetland vegetation, and receiving an IWC score of 3 or 'poor' condition. This is expected to be largely a result of the changed hydrology and associated changes in salinity levels of the wetland. The only wetland vegetation present is located where freshwater leaking from a channel or from irrigation reduces the salinity in the lakebed soil. The surrounding vegetation is also mostly saline and there has been a massive die-off of trees (North Central CMA 2016b).

Stevenson Swamp seems destined for further degradation, as the few remaining live Black Box individuals are stressed and seem unlikely to survive much longer. Aerial photography (Google 2003, 2012, 2015) shows the wetland has been dry for 10 to 11 of the thirteen years since 2003, even though its pre-European hydrological regime was 'permanent to seasonal'. In dry periods it seems that very shallow, saline watertables maintain high levels of soil salinity, preventing colonisation by vegetation other than halophytes. The approximately two years of inundation in the 2010-13 period had, by February 2015, left no detectable evidence of colonisation by wetland plants.

Stevenson Swamp. Photo: Ian Higgins

Threats

Key threats that relate to the unregulated semi-permanent wetlands are presented in Section 3.5. A particular threat to the health of the wetland stems from its altered watering regime as a result of being disconnected from the floodplain and subsequent lack of water. However, the salinity of the wetland has increased to such a level that even natural or managed flooding may be unable to flush away surface salinity or depress the saline watertable enough to allow restoration of the wetland values. This is considered a knowledge gap.

Other threats to the wetland include a changed watering regime resulting from alterations to the landscape, either from overwatering or extended dry periods as natural flood pathways have been altered or from a drying climate.

Pest plant and animals were also identified as a high threat, as well as the potential for bushfires. It was noted that some unlicensed grazing occurs on occasion at Stevenson Swamp.

Table 54. Management actions and responsibilities for Stevenson Swamp.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
		Actions to improve or protect ecological character and achieve Resource Condition Targets				
1	1, 2, 3, 5, 9, 10r, 13	Investigate the feasibility and potential benefits or impacts of restoring a connection to the floodplain and natural flow paths by 2019.	1	To be costed	North Central CMA	DELWP, GMW, PV
2	1, 3, 10r, 13	Investigate suitable canopy species for revegetation that can survive the predominantly saline conditions. Undertake revegetation of suitable canopy tree species according to wetland type and EVC benchmarks (consistent with the current/acquired EVCs) by 2020.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
3	1, 3, 10r, 13	Investigate suitable ground or understorey species for revegetation that can survive the predominantly saline conditions. Undertake revegetation of characteristic wetland vegetation species that are currently absent, including aquatic (if appropriate), submergent and emergent, and understory species, using wetland type and EVC benchmarks as a guide by 2025.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
		Actions to manage threats to ecological character				
4	1, 3, 10r	Identify areas of significant weed infestation around the wetland, including woody, non-woody and any new salt-tolerant weeds to inform a long-term pest plant control program by 2017.	Annual	Up to $10,000	PV	DELWP, Gannawarra Shire Council, North Central CMA
5	1, 3, 10r	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	$1,500/day	PV	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 10r, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 10r	Stevenson Swamp is subject to a grazing licence. See overall actions to address impacts from stock grazing across the Ramsar Site, including installing stock exclusion fencing of the wetland or particularly sensitive areas if impacted.	1	See overall action list	PV	GMW, DELWP, North Central CMA, Gannawarra Shire Council

6.7.3 Lake Bael Bael

Wetland Characteristics

Lake Bael Bael is a 647 ha temporary freshwater swamp that forms part of the Avoca Marshes in the terminal region of the Avoca floodplain (Figure 23). The Avoca River flows directly into Lake Bael Bael, which fills and spills into First Marsh, Second Marsh and Third Marsh sequentially, each wetland receiving water via overflow from the preceding marsh (Riparian Australia 2003).

The Avoca Marshes have been heavily impacted by changes to land use and associated modifications throughout the catchment, particularly the construction of levee banks for flood protection along the Avoca River and around the Marshes which have changed the distribution of floodwaters (Lakey and Hansen 1988). Prior to regulation, the Avoca Marshes were semi-permanent wetlands, periodically flooding and drying out in between. Flood waters from the Avoca River would have rarely but occasionally overflowed from Third Marsh and spilled through a number of smaller waterways, eventually ending at Lake Tutchewop and in very large floods, connecting to the Little Murray River. The advent of

Table 55. Lake Bael Bael Wetland Characteristics.

Characteristics	Description
Name	**Lake Bael Bael**
Land manager and reserve status	Parks Victoria – State Wildlife Reserve
Area (ha)	646.9 ha
Bioregion	Victoria Riverina
Water regime	Intermittent swamp that receives unregulated flows from Avoca River during large flood events, approximately two to three years in 10. The wetland can hold water for up to two years.
Water supply	Historical: – Flow from the Avoca River
	Current: – Flow from the Avoca River
Ramsar wetland category	P: seasonal/intermittent freshwater lakes (over 8 ha)
1788 wetland category (Corrick and Norman)	Permanent Open Freshwater
1994 wetland category (Corrick and Norman)	Category: Open Water Sub-category: Shallow
2013 Victorian wetland classification (DELWP 2016c)	Temporary Freshwater Swamp
Mapping ID	Corrick: 7626-482472, DELWP: 43150

Above: Lake Bael Bael

Photo: Adrian Martins

White-bellied Sea Eagle.
Photo: Adrian Martins

local irrigation systems meant that large quantities of water was extracted from the river, effectively reducing the frequency and volume of water that reached Lake Bael Bael and the Marshes beyond. Desnagging of the Avoca River assisted more water to reach the Marshes, but concerns that the Marshes were drying out and implications for waterbird feeding and breeding led to the construction of the 'sill' at the outfall of Third Marsh (Riparian Australia 2003).

The 'sill' was built in 1972 as a mechanism to extend the duration of flooding in Marshes, though it exacerbated the adverse impacts to tree condition that was already taking place throughout the wetlands as result of rising salinity levels. This rise can be attributed to a number of factors over the course of the last century, including the presence of a rising saline groundwater table below the Marshes, as well as the irrigation of adjacent lunettes and high salinity levels in this water source. The sustained inundation that occurred after the sill was built continued drawing the groundwater table closer to the surface, saturating the soil profile with saline water and subsequently resulting in an accumulation of salt in the root zone (Lakey and Nott 1988). The combination of extended waterlogging and increased salinity levels resulted in a substantial decline in tree condition (Riparian Australia 2003). Third and Second Marsh were most heavily impacted by the sill, though the decline in tree condition has extended to Lake Bael Bael.

In recognition of the rapid decline in tree condition after construction of the sill, it was progressively removed from 1988 (KBR 2011; Rakali 2014). While many trees that were already in poor health continued to decline, monitoring programs suggested that there has been some overall improvement (Riparian Australia 2003). Trees on higher elevations appeared to show a higher level of recovery than those closer to the wetland bed, a situation that remains today (Tutton 1997; Rakali 2014).

Although separated by a large sand lunette that inhibits any surface water interaction, it is thought that Lake Bael Bael is influenced by neighbouring Lake Cullen via groundwater, and vice versa. It is thought that under some conditions (i.e. water in one wetland but not the other), groundwater flow will be in one direction (i.e. from Lake Bael Bael to Lake Cullen), and with different conditions this flow will be reversed (Macumber 2003).

An overview of the wetland characteristics is provided in Table 55.

Figure 23. Lake Bael Bael location and key features

Ecological Values and Significance

In 2014, eight EVCs were mapped at Lake Bael Bael (Rakali 2014a). Of the EVCs mapped at Lake Bael Bael, one; Semi-Arid Woodland (EVC 97) is classified as endangered and three; Riverine Chenopod Woodland (EVC 103), Lignum Swampy Woodland (EVC 823) and Woorinen Mallee (824) are classified as vulnerable within the Victorian Riverina bioregion. FFG-listed Buloke vegetation communities form much of the Semi-Arid Woodland EVC (Rakali 2014a). Amongst these EVCs, the FFG-listed Buloke (*Allocasuarina luehmannii*) and Hoary Scurf-pea (*Cullen cinereum*) have been recorded at Lake Bael Bael (Rakali 2014).

Lake Bael Bael is a wetland of important ecological significance. It is primarily recognised for its large size, habitat diversity and waterbird use and breeding (Lugg et al. 1989). Lake Bael Bael has supported 58 waterbird species including the FFG listed Blue-billed Duck (*Oxyura australis*), Caspian Tern (*Hydroprogne caspia*), Gull-billed Tern (*Gelochelidon nilotica*), Eastern Great Egret (*Ardea modesta*), Freckled Duck (*Stictonetta naevosa*) and White-bellied Sea Eagle (*Haliaeetus leucogaster*).

In addition, Lake Bael Bael has also supported 71 terrestrial bird species, numerous reptiles including the endangered Lace Monitor (*Varanus varius*), turtles, and mammals such as the Echidna (*Tachyglossus aculeatus*) and White-striped Freetail Bat (*Tadarida australis*). The wetland has been known to support fish when inundated, through the only natives species to be recorded there is Freshwater Catfish (*Tandanus tandanus*).

Scar tree at Lake Bael Bael

Current Condition

In 2014, an IWC assessment was undertaken at Lake Bael Bael. The overall biota score for the wetland was 12.9 indicating poor condition, an improvement from 2009 when the overall biota score was 6 indicating very poor condition (DEPI 2014). The increase in condition is likely a result of the large-scale flooding that occurred throughout the region during 2010-11 (Rakali 2014a). The overall IWC score for Lake Bael Bael in 2014 was 6.5 indicating moderate condition.

A tree condition assessment was also conducted at Lake Bael Bael in 2014. All of the trees in the deepest section of the wetland are dead as a result of waterlogging and salinity issues. The River Red Gums and Black Box that were assessed during this study were found to range between good and poor condition. Some trees had dense crowns while others trees had sparse crowns and had lost major branches (Rakali 2014a).

Threats

Key threats that relate to the unregulated semi-permanent wetlands are presented in Section 3.5. High risk threats at Lake Bael Bael are generally focused on invasive species such as rabbits, foxes, feral cats and pigs. Invasive fauna has the potential to impact on native fauna and waterbirds through predation but in the case of rabbits, impacts can also be extended to native vegetation and soil structure through grazing and burrowing.

As Lake Bael Bael is an unregulated wetland, other very high and high threat risks are associated with altered water regimes, either from a changing climate or from modifications to land use and infrastructure. As the Avoca River itself is unregulated, there is no capacity to mitigate impacts from decreased inflows or unseasonal inflows through manipulating river flows.

Recreational activities also pose a high risk threat at Lake Bael Bael. Loss of waterbird or threatened species, loss of habitat and destruction of cultural heritage material are potential outcomes of recreational activities such as illegal hunting, camping and four wheel driving.

A potential threat to Lake Bael Bael and the Marshes, as identified by the community, is the possibility that high nutrient run-off from adjacent agricultural areas enters the wetland via floodwaters, which can contribute to excessive or toxic algal blooms, increase turbidity and reduce light penetration which in turn can impact the aquatic ecosystem. This is considered a knowledge gap at the time of writing.

Table 56. Management actions and responsibilities for Lake Bael Bael.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
		Actions to improve or protect ecological character and achieve Resource Condition Targets				
1	1, 10g	Undertake species enrichment revegetation of Semi-arid Woodland using the EVC benchmark as a guide by 2018.	5 hectares	$1,500	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
2	1, 10g	Install rabbit-proof fencing around the higher quality areas of Semi-arid Woodland EVC to enable recruitment by 2018.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
3	1, 10g	Investigate the feasibility of using kangaroo-proof fencing to protect revegetation by 2018.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, North Central CMA
4	10f, 12a	Undertake opportunistic revegetation of River Red Gum in deeper parts of the wetland.	5 hectares	$1,500	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
		Actions to manage threats to ecological character				
5	1, 3, 10f, 10g	Identify areas of significant weed infestation around the wetland, including woody, non-woody (e.g. Boxthorn, Tree Tobacco, Tamarisk, Peppercorn) and aquatic weeds (e.g. Alligator Weed, Arrowhead) to inform a long-term pest plant control program by 2017.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 10f, 10g	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 4, 10f, 10g, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 10g	Assess the need for stock exclusion fencing of the wetland or particularly sensitive areas to prevent unlicensed grazing by 2020.	1	See overall action list	PV	DELWP, North Central CMA
9	1	Investigate management options for controlling carp or mitigating carp impacts by 2025.	1	See overall action list	North Central CMA	DELWP, GMW, PV

6.7.4 First Marsh / Koorangie (Wemba Wemba language)

Wetland Characteristics

First Marsh is a 780 ha temporary freshwater lake that forms part of the Avoca Marshes. The Avoca River flows directly into Lake Bael Bael, which fills and spills into First Marsh, Second Marsh and Third Marsh sequentially, each wetland receiving water via overflow from the preceding marsh (Riparian Australia 2003).

The Avoca Marshes have been heavily impacted by changes to land use and associated modifications throughout the catchment, particularly the construction of levee banks for flood protection along the Avoca River and around the Marshes which have changed the distribution of floodwaters (Lakey and Hansen 1988). Prior to regulation, the Avoca Marshes were semi-permanent wetlands, periodically flooding and drying out in-between. Floodwaters from the Avoca River would have rarely but occasionally overflowed from Third Marsh and spilled through a number of smaller waterways, eventually ending at Lake Tutchewop and in very large floods, connecting to the Little Murray River. The advent of local irrigation systems meant that large quantities of water was extracted from the river, effectively reducing the frequency and volume of water that reached Lake Bael Bael and the Marshes beyond. Desnagging of the Avoca River assisted more water to reach the Marshes, but concerns that the Marshes were drying out and implications for waterbird feeding

Table 57. First Marsh wetland characteristics.

Characteristics	Description
Name	**First Marsh**
Land manager and reserve status	Parks Victoria – Natural Features Reserve / State Wildlife Reserve
Area (ha)	778.9 ha
Bioregion	Victoria Riverina
Water regime	Intermittent swamp that receives unregulated flows from Avoca River during large flood events, approximately 2-3 years in 10. The wetland can hold water for up to two years.
Water supply	Historical: – Flow from the Avoca River via Lake Bael Bael
	Current: – Flow from the Avoca River via Lake Bael Bael
Ramsar wetland category	P: seasonal/intermittent freshwater lakes (over 8 ha)
1788 wetland category (Corrick and Norman)	Deep Freshwater Marsh
1994 wetland category (Corrick and Norman)	Category: Open Water Sub-category: Dead Timber
2013 Victorian wetland classification (DELWP 2016c)	Permanent Freshwater Lake
Mapping ID	Corrick: 7626-480513, DELWP: 43149

Above: First Marsh
Photo: Bree Bisset

and breeding led to the construction of the 'sill' at the outfall of Third Marsh (Riparian Australia 2003).

The 'sill' was built in 1972 as a mechanism to extend the duration of flooding in Marshes, though it exacerbated the adverse impacts to tree condition that was already taking place throughout the wetlands as result of rising salinity levels. This rise can be attributed to a number of factors over the course of the last century, including the presence of a rising saline groundwater table below the Marshes, as well as the irrigation of adjacent lunettes and high salinity levels in this water source. The sustained inundation that occurred after the sill was built continued drawing the groundwater table closer to the surface, saturating the soil profile with saline water and subsequently resulting in an accumulation of salt in the root zone (Lakey and Nott 1988). The combination of extended waterlogging and increased salinity levels resulted in a substantial decline in tree condition (Riparian Australia 2003). Third and Second Marsh were most heavily impacted by the sill, though the decline in tree condition has extended to First Marsh.

In recognition of the rapid decline in tree condition after construction of the sill, it was progressively removed in 1988 (KBR 2011; Rakali 2014). While many trees that were already in poor health continued to decline, monitoring programs suggested that there has been some overall improvement (Riparian Australia 2003). Trees on higher elevations appeared to show a higher level of recovery than those closer to the wetland bed, a situation that remains today (Tutton 1997; Rakali 2014).

The full Marshes from Lake Bael Bael

Although separated by a large sand lunette that inhibits any surface water interaction, it is thought that First Marsh is influenced by neighbouring Lake Cullen via groundwater, and vice versa. It is thought that under some conditions (i.e. water in one wetland but not the other), groundwater flow will be in one direction (i.e. from First Marsh to Lake Cullen), and with different conditions this flow will be reversed (Macumber 2003).

An overview of the wetland characteristics is provided in Table 57.

Figure 24. First Marsh location and key features

Ecological Values and Significance

First Marsh is a wetland of important ecological significance. It is primarily recognised for its large size, habitat diversity and as an important colonial waterbird breeding site (Lugg et al. 1989). Eleven colonial waterbird breeding events have occurred at First Marsh between 1980 and 2005 (KBR 2011). First Marsh supports a range of bird species including the FFG-listed Eastern Great Egret (*Ardea modesta*), Freckled Duck (*Stictonetta naevosa*) and White-bellied Sea Eagle (*Haliaeetus leucogaster*).

In 2014, five EVCs were mapped at First Marsh (Rakali 2014a). Of the EVCs mapped at First Marsh, two; Riverine Chenopod Woodland (EVC 103) and Lignum Swampy Woodland (EVC 823) are classified as vulnerable within the Victorian Riverina bioregion. The nationally threatened Chariot Wheels (*Maireana cheelii*) and Slender Darling-pea (*Swainsona murrayana*) have been recorded at First Marsh as well as FFG-listed Buloke (*Allocasuarina luehmannii*), Hoary Scurf-pea (*Cullen cinereum*) and Downy Swainson Pea (*Swainsona swainsonioides*) (Rakali 2014).

Current Condition

In 2014, an IWC assessment was undertaken at First Marsh. The overall biota score for First Marsh was 8.77 indicating poor condition, an improvement from 2009 when the overall biota score was 7 indicating very poor condition (DEPI 2014). The increase in condition is likely a result of the large scale flooding that occurred throughout the region during 2010-11 (Rakali 2014a). The overall IWC score for First Marsh in 2014 was 6.5 indicating moderate condition.

A tree condition assessment was also conducted at First Marsh in 2014. In some areas of Intermittent Swampy Woodland, all of the trees are dead as a result of waterlogging and salinity issues. In other areas, tree condition ranged between good and poor condition. Some trees had dense crowns while others were sparse and had lost major branches (Rakali 2014a).

Lace Monitor

Threats

Ninety-six threats were assessed for the unregulated wetlands, including First Marsh. Key threats that relate to these wetlands are presented in Section 3.5. High risk threats at First Marsh are generally focused on invasive species such as rabbits, foxes, feral cats and pigs. Invasive fauna has the potential to impact on native fauna and waterbirds through predation but in the case of rabbits, impacts can also be extended to native vegetation and soil structure through grazing and burrowing.

As First Marsh is an unregulated wetland, other very high and high threat risks are associated with climate change and altered water regimes. The lack of infrastructure to deliver water to the wetland means that impacts associated with climate change and altered water regimes such as decreased inflows and altered timing of inflows cannot be mitigated or reduced by delivering water any other way than via the Avoca River.

First Marsh has also been subject to unlicensed grazing at times. The extent and impact of this practice is unknown, but as the potential to pose a high threat to vegetation diversity and recruitment at the wetland.

Recreational activities also pose a high risk threat at First Marsh. Loss of waterbird or threatened species, loss of habitat and destruction of cultural heritage material are potential outcomes of recreational activities such as illegal hunting, camping and four wheel driving.

A potential threat to Lake Bael Bael and the Marshes, as identified by the community, is the possibility that high nutrient run-off from adjacent agricultural areas enters the wetland via flood waters, which can contribute to excessive or toxic algal blooms, increase turbidity and reduce light penetration which in turn can impact the aquatic ecosystem. This is considered a knowledge gap at the time of writing.

Table 58. Management actions and responsibilities for First Marsh.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	10f	Assess current tree health and investigate possible impediments to growth and recovery of trees, including surveying groundwater depth and salinity levels by 2020.	1	$30,000 (across all Marshes)	PV	DELWP, North Central CMA, Research Institutions
2	10f, 12a	Undertake opportunistic revegetation of River Red Gum in deeper parts of the wetland.	5 hectares	$1,500	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
Actions to manage threats to ecological character						
3	1, 3, 10f	Identify areas of significant weed infestation around the wetland, including woody, non-woody (e.g. Boxthorn, Tree Tobacco, Tamarisk, Peppercorn) and aquatic weeds (e.g. Alligator Weed, Arrowhead) to inform a long-term pest plant control program by 2017.	Annual	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
4	1, 3, 10f	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
5	1, 3, 4, 10f, 12a, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
6	1	Assess the need for stock exclusion fencing of the wetland or particularly sensitive areas to prevent unlicensed grazing by 2020.	1	See overall action list	PV	DELWP, North Central CMA
7	1, 3	Investigate management options for controlling carp or mitigating carp impacts by 2025.	1	See overall action list	North Central CMA	DELWP, GMW, PV

6.7.5 Second Marsh / Koorangie (Wemba Wemba language)

Wetland Characteristics

Second Marsh is a 238 ha temporary freshwater swamp that forms part of the Avoca Marshes. The Avoca River flows directly into Lake Bael Bael, which fills and spills into First Marsh, Second Marsh and Third Marsh sequentially, each wetland receiving water via overflow from the preceding marsh (Figure 25; Riparian Australia 2003).

The Avoca Marshes have been heavily impacted by changes to land use and associated modifications throughout the catchment, particularly the construction of levee banks for flood protection along the Avoca River and around the Marshes which have changed the distribution of floodwaters (Lakey and Hansen 1988). Prior to regulation, the Avoca Marshes were semi-permanent wetlands, periodically flooding and drying out in between. Flood waters from the Avoca River would have rarely but occasionally overflowed from Third Marsh and spilled through a number of smaller waterways, eventually ending at Lake Tutchewop and in very large floods, connecting to the Little Murray River. The advent of local irrigation systems meant that large quantities of water was

Table 59. Second Marsh Wetland Characteristics.

Characteristics	Description
Name	**Second Marsh**
Land manager and reserve status	Parks Victoria – State Wildlife Reserve
Area (ha)	237.5 ha
Bioregion	Victoria Riverina
Water regime	Intermittent swamp that receives unregulated flows from Avoca River during large flood events, approximately 2-3 years in 10. The wetland can hold water for over 12 months.
Water supply	Historical: – Flow from the Avoca River via Lake Bael Bael and First Marsh
	Current: – Flow from the Avoca River via Lake Bael Bael and First Marsh
Ramsar wetland category	W: shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils
1788 wetland category (Corrick and Norman)	Deep Freshwater Marsh
1994 wetland category (Corrick and Norman)	Category: Deep Marsh Sub-category: Dead Timber
2013 Victorian wetland classification (DELWP 2016c)	Temporary Freshwater Swamp
Mapping ID	Corrick: 7626-483545, DELWP: 43151

Above: Lake Charm and Little Lake Charm
Photo: Michelle Maher

Bush-stone Curlew

extracted from the river, effectively reducing the frequency and volume of water that reached Lake Bael Bael and the Marshes beyond. Desnagging of the Avoca River assisted more water to reach the Marshes, but concerns that the Marshes were drying out and implications for waterbird feeding and breeding led to the construction of the 'sill' at the outfall of Third Marsh (Riparian Australia 2003).

The 'sill' was built in 1972 as a mechanism to extend the duration of flooding in Marshes, though it exacerbated the adverse impacts to tree condition that was already taking place throughout the wetlands as result of rising salinity levels. This rise can be attributed to a number of factors over the course of the last century, including the presence of a rising saline groundwater table below the Marshes, as well as the irrigation of adjacent lunettes and high salinity levels in this water source. The sustained inundation that occurred after the sill was built continued drawing the groundwater table closer to the surface, saturating the soil profile with saline water and subsequently resulting in an accumulation of salt in the root zone (Lakey and Nott 1988). The combination of extended waterlogging and increased salinity levels resulted in a substantial decline in tree condition (Riparian Australia 2003). Third and Second Marsh were most heavily impacted by the sill, though the decline in tree condition has extended to Lake Bael Bael.

In recognition of the rapid decline in tree condition after construction of the sill, particularly in Second Marsh and Third Marsh, it was progressively removed in 1988 (KBR 2011; Rakali 2014). While many trees that were already in poor health continued to decline, monitoring programs suggested that there was some overall improvement (Riparian Australia 2003). Trees on higher elevations appear to show a higher level of recovery than those closer to the wetland bed, a situation that remains today (Tutton 1997; Rakali 2014).

An overview of the wetland characteristics is provided in Table 59.

Figure 25. Second Marsh location and key features

Ecological Values and Significance

Second Marsh is a wetland of important ecological significance. It is primarily recognised for its habitat diversity and as an important colonial waterbird nesting site. 18 colonial waterbird breeding events have occurred at Second Marsh between 1980 and 2005 (KBR 2011). The site supports the breeding of Pied, Little Pied, Black and Little Black Cormorants, Australasian Darters and Yellow and Royal Spoonbills (KBR 2011). Second Marsh supports a range of threatened bird species including the FFG listed Eastern Great Egret (*Ardea modesta*), Freckled Duck (*Stictonetta naevosa*), Little Egret (*Egretta garzetta*) and White-bellied Sea Eagle (*Haliaeetus leucogaster*).

In 2014, seven EVCs were mapped at Second Marsh (Rakali 2014). Of the EVCs mapped at Second Marsh, one; Semi-Arid Woodland (EVC 97) is classified as endangered and two; Riverine Chenopod Woodland (EVC 103) and Lignum Swampy Woodland (EVC 823) are classified as vulnerable within the Victorian Riverina bioregion. FFG-listed Buloke (*Allocasuarina luehmannii*) vegetation communities form much of the Semi-Arid Woodland EVC (Rakali 2014).

Current Condition

In 2014, an IWC assessment was undertaken at Second Marsh. The overall biota score for Second Marsh was 9 indicating poor condition, an improvement from 2009 when the overall biota score was 7 indicating very poor condition (DEPI 2014). The increase in condition is likely a result of the large scale flooding that occurred throughout the region during 2010-11 (Rakali 2014). The overall IWC score for Second Marsh in 2014 was 6.4 indicating moderate condition.

A tree condition assessment was also conducted at Second Marsh in 2014. All of the trees in the central area of the marsh are dead as a result of waterlogging and salinity issues. The River Red Gums that were assessed along the fringes of the marsh during this study were found to be in poor condition. Most trees had sparse crowns and had lost major branches however there was indication of epicormic growth which can be a sign of recovery (Rakali 2014).

Evidence of rabbit damage

Threats

Ninety-six threats were assessed for the unregulated wetlands, including Second Marsh. Key threats that relate to these wetlands are presented in Section 3.5. High risk threats at Second Marsh are generally focused on invasive species such as rabbits, foxes, feral cats and pigs. Invasive fauna has the potential to impact on native fauna and waterbirds through predation but in the case of rabbits, impacts can also be extended to native vegetation and soil structure through grazing and burrowing.

As Second Marsh is an unregulated wetland, other very high and high threat risks are associated with climate change and altered water regimes. The lack of infrastructure to deliver water to the wetland means that impacts associated with climate change and altered water regimes such as decreased inflows and altered timing of inflows cannot be mitigated or reduced by delivering water any other way than via the Avoca River.

Second Marsh has also been subject to unlicensed grazing at times. The extent and impact of this practice is unknown, but as the potential to pose a high threat to vegetation diversity and recruitment at the wetland.

Recreational activities also pose a high risk threat at Second Marsh. Loss of waterbird or threatened species, loss of habitat and destruction of cultural heritage material are potential outcomes of recreational activities such as illegal hunting, camping and four wheel driving.

A potential threat to Lake Bael Bael and the Marshes, as identified by the community, is the possibility that high nutrient run-off from adjacent agricultural areas enters the wetland via flood waters, which can contribute to excessive or toxic algal blooms, increase turbidity and reduce light penetration which in turn can impact the aquatic ecosystem. This is considered a knowledge gap at the time of writing.

Table 60. Management actions and responsibilities for Second Marsh.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	1, 10f, 10g	Assess current tree health and investigate possible impediments to growth and recovery of trees, including surveying trends in groundwater depth and salinity levels by 2020.	1	$30,000 (across all Marshes)	PV	DELWP, North Central CMA, Research Institutions
2	1, 10g	Undertake species enrichment revegetation of Semi-arid Woodland using the EVC benchmark as a guide by 2018.	12 hectares	$3,600	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
3	1, 10g	Install rabbit-proof fencing around the higher quality areas of Semi-arid Woodland EVC to enable recruitment by 2018.	2.5 km	$2,500	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
4	10f, 12a	Undertake opportunistic revegetation of River Red Gum in deeper parts of the wetland.	5 hectares	$1,500	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
Actions to manage threats to ecological character						
5	1, 3, 10f, 10g	Identify areas of significant weed infestation around the wetland, including woody, non-woody (e.g. Boxthorn, Tree Tobacco, Tamarisk, Peppercorn) and aquatic weeds (e.g. Alligator Weed, Arrowhead) to inform a long-term pest plant control program by 2017.	Annual	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
6	1, 3, 10f, 10g	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
7	1, 3, 4, 10f, 10g, 12a, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
8	1, 10g	Assess the need for stock exclusion fencing of the wetland or particularly sensitive areas to prevent unlicensed grazing by 2020.	1	See overall action list	PV	DELWP, North Central CMA
9	1	Investigate management options for controlling carp or mitigating carp impacts by 2025.	1	See overall action list	North Central CMA	DELWP, GMW, PV

6.7.6 Third Marsh / Koorangie (Wemba Wemba language)

Wetland Characteristics

Third Marsh is a 1205 ha temporary freshwater swamp and the northernmost wetland of the Avoca Marshes. The Avoca River flows directly into Lake Bael Bael, which fills and spills into First Marsh, Second Marsh and Third Marsh sequentially, each wetland receiving water via overflow from the preceding marsh (Figure 26; Riparian Australia 2003). Third Marsh is also the first to recede after flood flows.

The Avoca Marshes have been heavily impacted by changes to land use and associated modifications throughout the catchment, particularly the construction of levee banks for flood protection along the Avoca River and around the Marshes which have changed the distribution of floodwaters (Lakey and Hansen 1988). Prior to regulation, the Avoca Marshes were semi-permanent wetlands, periodically flooding and drying out in between. Flood waters from the Avoca River would have rarely but occasionally overflowed from Third Marsh and spilled through a number of smaller waterways, eventually ending at Lake Tutchewop and in very large floods, connecting to the Little Murray River. The advent of

Table 61. Third Marsh Wetland Characteristics.

Characteristics	Description
Name	**Third Marsh**
Land manager and reserve status	Parks Victoria – Natural Features Reserve / State Wildlife Reserve
Area (ha)	1204.8 ha
Bioregion	Victoria Riverina
Water regime	Intermittent swamp that receives unregulated flows from Avoca River during large flood events, approximately two to three years in 10. The wetland can hold water for over 12 months.
Water supply	Historical: – Flow from the Avoca River via Lake Bael Bael, First Marsh and Second Marsh
	Current: – Flow from the Avoca River via Lake Bael Bael, First Marsh and Second Marsh
Ramsar wetland category	W: shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils
1788 wetland category (Corrick and Norman)	Deep Freshwater Marsh
1994 wetland category (Corrick and Norman)	Category: Deep Marsh Sub-category: Red Gum
2013 Victorian wetland classification (DELWP 2016c)	Temporary Saline Swamp
Mapping ID	Corrick: 7626-470566, DELWP: 43143

White-bellied Sea Eagle
Photo: Adrian Martins

Spiny Lignum (*Duma horrida*)
Photo: Ian Higgins

local irrigation systems meant that large quantities of water was extracted from the river, effectively reducing the frequency and volume of water that reached Lake Bael Bael and the Marshes beyond. Desnagging of the Avoca River assisted more water to reach the Marshes, but concerns that the Marshes were drying out and implications for waterbird feeding and breeding led to the construction of the 'sill' at the outfall of Third Marsh (Riparian Australia 2003).

The 'sill' was built on the outfall of Third Marsh in 1972 as a mechanism to extend the duration of flooding in Marshes, though it exacerbated the adverse impacts to tree condition that was already taking place throughout the wetlands as result of rising salinity levels. This rise can be attributed to a number of factors over the course of the last century, including the presence of a rising saline groundwater table below the Marshes, as well as the irrigation of adjacent lunettes and high salinity levels in this water source. The sustained inundation that occurred after the sill was built continued drawing the groundwater table closer to the surface, saturating the soil profile with saline water and subsequently resulting in an accumulation of salt in the root zone (Lakey and Nott 1988). The combination of extended waterlogging and increased salinity levels resulted in a substantial decline in tree condition (Riparian Australia 2003). Third and Second Marsh were most heavily impacted by the sill, though the decline in tree condition has extended to Lake Bael Bael.

In recognition of the rapid decline in tree condition after construction of the sill, particularly in Second Marsh and Third Marsh, it was progressively removed in 1988 (KBR 2011; Rakali 2014). While many trees that were already in poor health continued to decline, monitoring programs suggested that there was some overall improvement (Riparian Australia 2003). Trees on higher elevations appear to show a higher level of recovery than those closer to the wetland bed, a situation that remains today (Tutton 1997; Rakali 2014).

An overview of the wetland characteristics is provided in Table 61.

Figure 26. Third Marsh location and key features

Bush Stone-curlew

Ecological Values and Significance

Third Marsh is a wetland of important ecological significance. It is primarily recognised as an important colonial waterbird nesting site. Twenty-seven colonial waterbird breeding events have occurred at Third Marsh between 1980 and 2005 (KBR 2011). The site supports the breeding of Pied, Little Pied, Black and Little Black Cormorants, Australasian Darters and Yellow and Royal Spoonbills (KBR 2011).Third Marsh has supported a range of threatened bird species including FFG-listed Australian Painted Snipe (*Rostratula australis*), Bush Stone-curlew (*Burhinus grallarius*), Eastern Great Egret (*Ardea modesta*), Freckled Duck (*Stictonetta naevosa*) and Musk Duck (*Biziura lobata*).

In 2014, five EVCs were mapped at Third Marsh (Rakali 2014). Of the EVCs mapped at Third Marsh, Riverine Chenopod Woodland (EVC 103) and Lignum Swampy Woodland (EVC 823) are classified as vulnerable, and Intermittent Swampy Woodland is classified as endangered within the Victorian Riverina bioregion. Important vegetation has also been recorded at Third Marsh including EPBC-listed Chariot Wheels (*Maireana cheelii*) and Slender Darling Pea (*Swainsona murrayana*) and FFG-listed Hoary Scurf Pea (*Cullen cinereum*) and Pale Plover Daisy (*Leiocarpa leptolepis*) (Rakali 2014). The site is also recognised for its important Black Box woodland community and population of Spiny Lignum (*Duma horrida subsp. Horrida*) (KBR 2011).

Current Condition

In 2014, an IWC assessment was undertaken at Third Marsh. The overall biota score for Third Marsh was 11.6 indicating poor condition, an improvement from 2009 when the overall biota score was 6.1 indication very poor condition (DEPI 2014). The increase in condition is likely a result of the large scale flooding that occurred throughout the region during 2010-11. If the Lignum Swampy Woodland on the western side of the marsh is assessed in isolation it receives a score of 19 indicating excellent condition, the decrease in the overall score when all EVCs are assessed is due to the area of large, dead trees in the centre of the marsh (Rakali 2014). The overall IWC score for Third Marsh in 2014 was 7 indicating good condition with most sub-indices in good or excellent condition.

A tree condition assessment was also conducted at Third Marsh in 2014. All of the trees in the central area of the marsh are dead as a result of waterlogging and salinity issues. The River Red Gums that were assessed along the fringes of the marsh during this study were found to be in poor condition. Most trees had sparse crowns and had lost major branches however there was indication of epicormic growth which can be a sign of recovery (Rakali 2014). The cause of this poor health is considered a knowledge gap.

Threats

Ninety-six threats were assessed for the unregulated wetlands, including Third Marsh. Key threats that relate to these wetlands are presented in Section 3.5. High risk threats at Third Marsh are generally focused on invasive species such as rabbits, foxes, feral cats and pigs. Invasive fauna has the potential to impact on native fauna and waterbirds through predation but in the case of rabbits, impacts can also be extended to native vegetation and soil structure through grazing and burrowing.

As Third Marsh is an unregulated wetland, other very high and high threat risks are associated with climate change and altered water regimes. The lack of infrastructure to deliver water to the wetland means that impacts associated with climate change and altered water regimes such as decreased inflows and altered timing of inflows cannot be mitigated or reduced by delivering water any other way than via the Avoca River.

Recreational activities also pose a high risk threat at Third Marsh. Loss of waterbird or threatened species, loss of habitat and destruction of cultural heritage material are potential outcomes of recreational activities such as illegal hunting, camping and four wheel driving.

A potential threat to Lake Bael Bael and the Marshes, as identified by the community, is the possibility that high nutrient run-off from adjacent agricultural areas enters the wetland via flood waters, which can contribute to excessive or toxic algal blooms, increase turbidity and reduce light penetration which in turn can impact the aquatic ecosystem. This is considered a knowledge gap at the time of writing.

Table 62. Management actions and responsibilities for Third Marsh.

#	Target	Management Action	Quantity (km, ha)	Estimated cost	Lead agency	Partners
Actions to improve or protect ecological character and achieve Resource Condition Targets						
1	10f	Assess current tree health and investigate possible impediments to growth and recovery of trees, including surveying groundwater depth and salinity levels by 2020.	1	$30,000 (across all Marshes)	PV	DELWP, North Central CMA, Research Institutions
2	10f, 12a	Undertake opportunistic revegetation of River Red Gum in deeper parts of the wetland.	5 hectares	$4,500	PV	DELWP, Gannawarra Shire Council, North Central CMA, Landcare, TOs, community groups
Actions to manage threats to ecological character						
3	1, 3, 10f	Identify areas of significant weed infestation around the wetland, including woody, non-woody (e.g. Boxthorn, Tree Tobacco, Tamarisk, Peppercorn) and aquatic weeds (e.g. Alligator Weed, Arrowhead) to inform a long-term pest plant control program by 2017.	Annual	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
4	1, 3, 10f	Implement pest plant control program to reduce the extent of high threat woody and non-woody weeds as required, and aquatic weeds as identified.	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
5	1, 3, 4, 10f, 12a, 13	Undertake surveys and control programs for non-native animal species as per overall wetland program (Table 16).	To be assessed through works program.	To be assessed through works program.	PV	DELWP, Gannawarra Shire Council, North Central CMA
6	10f	Assess the need for stock exclusion fencing of the wetland or particularly sensitive areas to prevent unlicensed grazing by 2020.	1	See overall action list	PV	DELWP, North Central CMA
7	1, 3	Investigate management options for controlling carp or mitigating carp impacts by 2025.	1	See overall action list	North Central CMA	DELWP, GMW, PV

6.8 Action Plan for protecting and enhancing Aboriginal values

Table 63 shows linkages to the *Guiding principles for taking into account the cultural values of wetlands for the effective management of sites*. Many of the actions relate to sharing and strengthening cultural knowledge and traditions, with positive outcomes for the Ramsar Site.

The list of management actions in Table 64 were developed in consultation with members of Barapa Barapa and Wamba Wamba First Nations.

Table 63. Linkages to the guiding principles and outcomes for the Ramsar Site.

Action	Outcome for the Ramsar Site
Guiding Principle 3 –To safeguard the wetland-related cultural landscapes. **Guiding principle 5 – To maintain traditional sustainable self-management practices.**	
1. Traditional Owners to work collaboratively to support healthy country planning and implementation of this Action Plan.	Traditional Owners will have a strengthened connection to country and be enabled to make clear and meaningful contributions to planning and management actions for the wetlands.
Guiding principle 16 – To safeguard wetland-related oral traditions. **Guiding principle 17 – To keep traditional knowledge alive.**	
2. Develop an Intellectual Property Agreement for the Kerang Wetland Ramsar Site between stakeholders and Traditional Owners.	Traditional knowledge, culture, songs, language, stories and other information will be protected and used only in accordance with the wishes of the Traditional Owners. There are also opportunities for Aboriginal people to benefit from partnerships where the sharing of intellectual property will achieve mutual outcomes e.g. to conserve cultural heritage.
Guiding principle 2 – To link the cultural aspects of wetlands with those of water. **Guiding principle 21 – to incorporate the cultural aspects of wetlands in management planning**	
3. Engage with the Traditional Owners during project planning to ensure that cultural objectives and aspirations are incorporated e.g. seasonal watering planning, developing strategies, project planning.	Developing cultural objectives for each wetland would help to guide management planning to ensure that cultural values continue to be supported at the wetlands.
4. Traditional Owners to develop cultural objectives for each wetland that can guide their input into management plans or strategies.	
Guiding principle 12 – to protect historical structures in wetlands or closely associated with them **Guiding principle 13 – to protect and preserve wetland-related artefacts (mobile material heritage)**	
5. When on-ground works need to occur, all management agencies should seek advice from Aboriginal Victoria to ensure the protection of cultural heritage and compliance with the *Aboriginal Heritage Act, 2006*.	The protection of cultural heritage is paramount at the wetlands. Having a Traditional Owner present when undertaking on-ground works will help to mitigate potential damage to cultural heritage.
6. Undertake statutory and land manager approvals prior to undertaking any on-ground works.	
7. Undertake a program in collaboration with TOs to protect known Aboriginal cultural heritage site (e.g. fencing) if feasible.	
8. Develop and implement a program of educational activities and installation of signage to inform visitors of the appropriate behaviour and treatment of cultural sites.	
Guiding principle 1 and Guiding principle 7 – to take into account culturally appropriate treatment of gender, age and social issues.	
9. Undertake more widespread cultural heritage mapping, including gender-based mapping (i.e. women's sites, men's sites).	Strengthened and documented understanding of the cultural importance for women and men at the Kerang Wetlands, done in a gender appropriate manner.
Guiding principle 10 – to encourage research on palaeoenvironmental, palaeontological, anthropological and archaeological aspects of the wetlands.	
10. Undertake more widespread cultural heritage archaeological investigations at the Kerang Wetlands.	Strengthened and documented understanding of the historical settlement and use of the wetlands by Aboriginal people. This type of investigation may also indicate what the ecology of the wetlands may once have been (e.g. by understanding what fish were eaten, mussels, etc.).
11. Coring and carbon dating on cooking mounds (this needs to be done very carefully, on the edge of the mound and with approval from AAV)	

Action	Outcome for the Ramsar Site
Guiding principle 17 – to keep traditional knowledge alive.	
12. Develop an understanding of what plants used to be at the sites compared to what is here now and whether there would have been or still are culturally important plants present.	This may be done through mapping EVCs and IWC assessments. The outcome would be a strengthened understanding of how the wetlands supported Aboriginal people in the past and to ensure that those values are managed for.
Guiding principle 13 and 17 (stated above) Guiding principle 24 – to integrate cultural and social criteria into environmental impact assessments.	
13. Increase procurement of services and goods from Traditional Owners to support or undertake on-ground works (e.g. works crews); protection and monitoring of cultural heritage (e.g. seek advice from Traditional Owners before undertaking on-ground works); welcomes to country and other officiation.	This action is directly related to providing opportunities for the Traditional Owners to be more involved in the future management of the wetlands. These types of employment will help to fulfil other goals, such as ensuring that the needs and aspirations of the Traditional Owners are integrated and embedded in every-day practices (such as on-ground works). It will serve to protect cultural heritage, spread awareness of the cultural importance of these places, and help to maintain oral traditions.
Guiding principle 1 – to identify the cultural values and relevant associated partners.	
14. Collect oral and written stories about Aboriginal settlement and use of the wetlands, from both indigenous and non-indigenous people.	Strengthened and documented understanding of the cultural importance of the Kerang Wetlands for the Barapa and Wamba peoples in recent history and contemporary times.
15. Gather and review available literature to further develop an understanding of Barapa and Wamba history in the area.	
16. Establish a cultural health wetlands assessment team and undertake cultural health assessments of at least two wetlands per year, based on or using the Indigenous Water Assessment tool developed by Murray Lower Darling Rivers – Indigenous Nations.	
Guiding principle 6 – to incorporate cultural aspects in educational and interpretive activities in the wetlands **Guiding principle 19 – to use the arts to promote wetlands conservation and interpretation** **Guiding principle 25 – to improve wetland-related communication, education and public awareness (CEPA) in the matter of the cultural aspects of the wetlands.**	
17. Develop and undertake educational activities with secondary colleges across Barapa and Wamba country to educate students about how the Traditional Owners lived and used the wetlands and why they are still places of great cultural importance.	These actions would increase awareness, in the local community and further abroad, of the cultural and spiritual importance of the Ramsar Site for Barapa and Wamba peoples. Education may also help with the protection of cultural heritage sites by teaching identification skills and informing people of what to do if they come across a site or artefacts.
18. Incorporate dual naming, where known, of the wetlands into Ramsar documentation and signage. For interpretive signage, incorporate clan totems (Wamba – Black cockatoo, Barapa women – Nightjar Owl, Barapa men – (Freetail Bat).	
19. Develop videos that can be used as a resource to educate the local community and tourists about the cultural values of the Kerang Wetlands.	
20. Support the cultural arts as a means of sharing information and spreading awareness about the importance of the wetlands.	
Guiding principle 25 (stated above) and Guiding principle 27 – to encourage cross sectoral cooperation.	
21. Land management organisations to incorporate cross-culture training for relevant staff.	This action is aimed at facilitating an open and respectful relationship between management agencies and the Traditional Owners, so that both entities can improve their mutual understanding of each other's needs and aspirations.
22. Management agencies and Traditional Owners to meet informally on country or work with each other and share an open dialogue.	

Table 64. Actions as developed in consultation with Barapa and Wamba Traditional Owners.

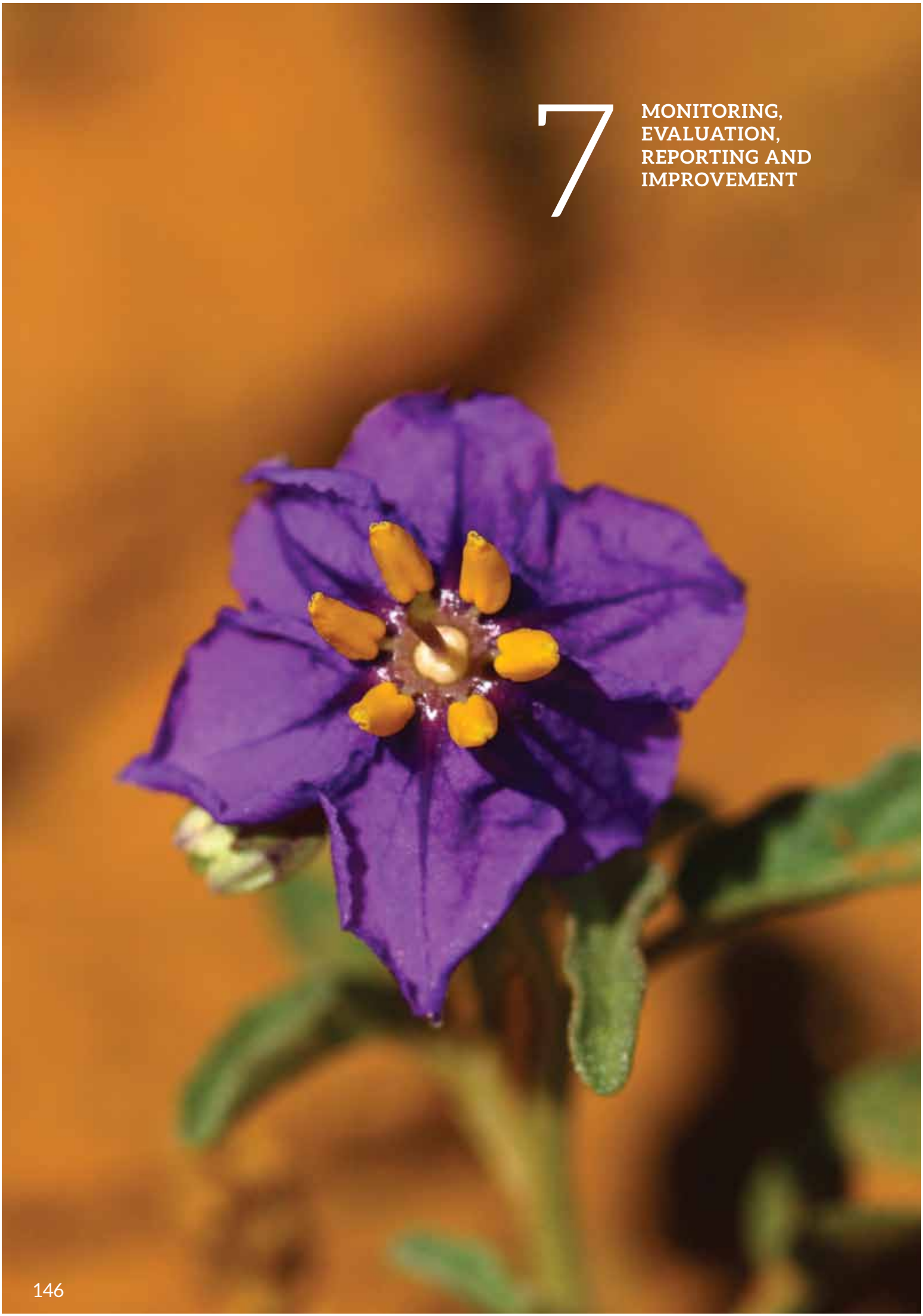
	Management Action	Quantity	Estimated cost	Lead entity
1	Traditional Owners to work collaboratively to support healthy country planning and implementation of this Action Plan.	-	-	Barapa and Wamba
2	Develop an Intellectual Property Agreement for the Kerang Wetland Ramsar Site between stakeholders and Traditional Owners.	-	To be costed.	Barapa and Wamba
3	Management agencies to engage with the Traditional Owners during project planning to ensure that cultural objectives and aspirations are incorporated e.g. seasonal watering planning, developing strategies, project planning.	20	$80,000	All
4	Traditional Owners to develop cultural objectives for each wetland that can guide the Traditional Owner's input into management plans or strategies.	23	$10,000	Barapa and Wamba
5	When on-ground works need to occur, all management agencies should seek advice from Aboriginal Victoria to ensure the protection of cultural heritage and compliance with the Aboriginal Heritage Act, 2006	As required.	-	All
6	Undertake statutory and land manager approvals prior to undertaking any on-ground works.	As required.	As required.	All
7	Undertake a program in collaboration with Traditional Owners to protect known Aboriginal cultural heritage site (e.g. fencing) if feasible.	10km (across whole site)	$45,000	PV and GMW
8	Develop and implement a program of educational activities and installation of signage to inform visitors of the appropriate behaviour and treatment of cultural sites.	16 events (seasonal)	$80,000	PV, Gannawarra Shire Council, GMW, and North Central CMA
9	Undertake more widespread cultural heritage mapping, including gender-based mapping (i.e. women's sites, men's sites).	1	$82,000	North Central CMA
10	Undertake more widespread cultural heritage archaeological investigations at the Kerang Wetlands.	1	$130,000	Aboriginal Victoria
11	Coring and carbon dating on cooking mounds (this needs to be done very carefully, on the edge of the mound and with approval from AAV)	-	To be costed.	All partners
12	Develop an understanding of what plants used to be at the sites compared to what is here now and whether there would have been or still are culturally important plants present.	-	To be costed.	All partners
13	Increase procurement of services and goods from Traditional Owners to support or undertake on-ground works (e.g. works crews); protection and monitoring of cultural heritage (e.g. seek advice from Traditional Owners before undertaking on-ground works); welcomes to country and other officiation.	To be determined in planning phases.	To be determined in planning phases.	All
14	Collect oral and written stories about Aboriginal settlement and use of the wetlands, from both indigenous and non-indigenous people.	Approx. 20 people	$6,500	Aboriginal Victoria
15	Gather and review available literature to further develop an understanding of Barapa and Wamba history in the area.	1	$13,200	Aboriginal Victoria
16	Establish a cultural health wetlands assessment team and undertake cultural health assessments of at least two wetlands per year, based on or using the Indigenous Water Assessment tool developed by Murray Lower Darling Rivers – Indigenous Nations.	2 / year	$58,000	North Central CMA
17	Develop and undertake educational activities with secondary colleges across Barapa and Wamba country to educate students about how the Traditional Owners lived and used the wetlands and why they are still places of great cultural importance.	2 / year	$24,000 in first year $4,000 / year after	North Central CMA and Gannawarra Shire Council
18	Incorporate dual naming, where known, of the wetlands into Ramsar documentation and signage. For interpretive signage, incorporate clan totems (Wamba – Black Cockatoo, Barapa women – Nightjar Owl, Barapa men – (Freetail Bat).	As developed.	As developed.	All
19	Develop videos that can be used as a resource to educate the local community and tourists about the cultural values of the Kerang Wetlands.	1	$5,000	All
20	Support the cultural arts as a means of sharing information and spreading awareness about the importance of the wetlands.	1 / year	$10,000	All
21	Land management organisations to incorporate cross-culture training for relevant staff.	Determined by each organisation	Determined by each organisation	All
22	Management agencies and Traditional Owners to meet informally on Country or work with each other and share an open dialogue.	As opportunities arise.	-	All

6.9 Action Plan for enhancing the community experience

The list of management actions in Table 65 were developed in consultation with members of the local community (see Section 1.6.3). Many of the actions relate to improving the community experience of the Ramsar Site and have linkages with the Gannawarra Shire Council Council's Strategic Tourism Plan 2015-2020.

Table 65. Actions as developed in consultation with community representatives.

	Management Action	Quantity	Estimated cost	Lead entity
1	Identify seasonally appropriate opportunities for community-based partners (e.g. Field and Game) to assist with pest animal control (i.e. foxes, rabbits, deer and pigs) through organised drives.	As required	-	GMA, GMW, PV, North Central CMA
2	Seek opportunities to partner with community-based groups (e.g. Landcare) in the delivery of on-ground works e.g. revegetation or weed control projects etc.	As developed	Funded through grants programs.	GMW, DELWP, North Central CMA, PV, Gannawarra Shire Council
3	Investigate the potential to extend or create a walking/cycling track from Town Swamp, to the Reedy Lakes and/or Lake Charm.	As developed	To be developed	Gannawarra Shire Council
4	Actively seek out partnerships with research institutions, ensuring required approvals or permits are obtained.	As developed	As developed	All
5	Support the establishment of a co-ordinating Ramsar committee comprising all relevant stakeholders, including local community members.	-	$2,000/ year	All
6	Limit vehicle access to wetlands after wet weather.	As required	-	GMW, PV, Gannawarra Shire Council
7	Develop and implement a local educational campaign, and/or signage to a) halt illegal rubbish dumping, and b) encourage visitors to take rubbish away with them.	-	To be developed	Gannawarra Shire Council, PV
8	Seek opportunities to partner with community-based groups to undertake rubbish clean-up.	As developed	As developed	Gannawarra Shire Council, PV, North Central CMA
9	Install accurate, interpretive signage around wetland describing the values of the site.	As required	$1,500/ sign	DELWP, Gannawarra Shire Council, PV, North Central CMA
10	Ensure hunters are licensed and hunting in accordance with their licence, and spread awareness of education opportunities and material in relation to waterbird identification, safety, hunting laws and appropriate behaviour.	As required	Funded through GMA	Game Management Authority



7 MONITORING, EVALUATION, REPORTING AND IMPROVEMENT

Effectively managing aquatic ecosystems requires all responsible agencies to have access to reliable information on which to base management decisions. Additionally, adaptive management at the regional level requires both regular review and learning from previous experience. This allows the responsible agencies to alter management approaches based on knowledge gained during implementation.

Figure 27 depicts the Victorian Waterway Management Strategy's eight-year adaptive management cycle. The cycle includes (DEPI, 2013a):

- **Strategy and planning** - state policy framework and targets, planning for waterway management through regional waterway strategies with priorities and regional targets
- **Implementation and monitoring** - Government and other investment in regional priorities, implementation of priority management activities, intervention monitoring and long-term resource condition assessment
- **Evaluation and reporting** - management reporting, intervention monitoring reporting, resource condition reporting, program evaluation and improvement.

Community participation and research and innovation occur across all parts of the program. This knowledge and information is crucial for ensuring effective adaptive management and informing associated monitoring, evaluation and reporting processes.

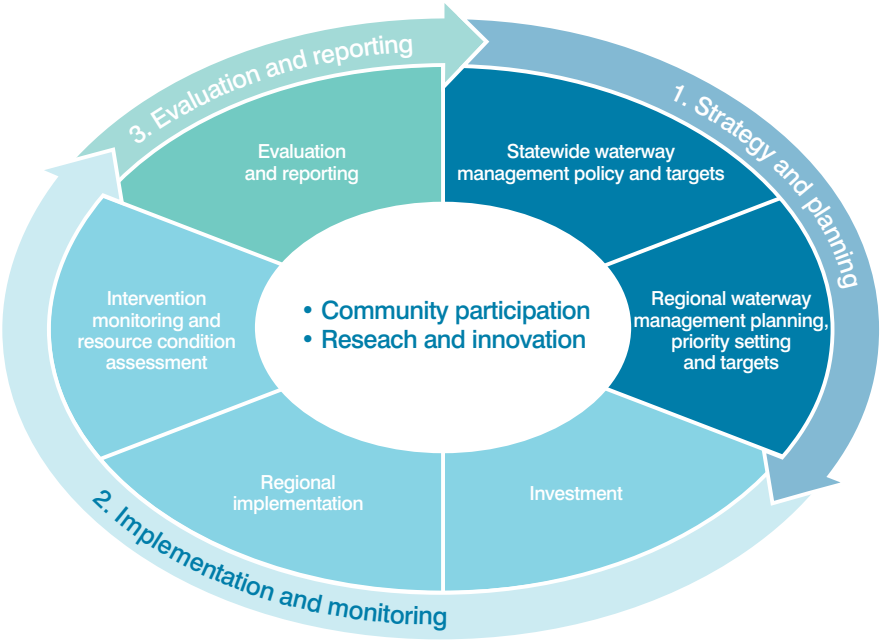


Figure 27. The eight-year adaptive management cycle of the Victorian Waterway Management Strategy

A detailed monitoring, evaluation, reporting and improvement (MERI) plan will be developed for the NCWS to support adaptive management from planning to strategy completion. It is expected that projects delivering against the NCWS will complete and utilise a similar approach. This includes the Kerang Wetlands Ramsar Action Plan, for which a detailed monitoring program will be developed to enable monitoring of the ecological character and threats to the ecological character, as presented in Section 7.1.

The MERI plan will:

- Present the program logic underpinning the NCWS
- Clarify the assumptions associated with the program logic and identify strategies to manage potential risks
- Identify the key questions for evaluation and establish processes to monitor progress within the framework of internal and statewide monitoring programs
- Clarify the communication and reporting needs and identify the processes required to support these needs
- Enable lessons learned from monitoring and evaluation to be gathered and inform improvement.

The MERI plan will be reviewed on an annual basis to ensure it remains current and relevant to informing adaptive management.

Photo previous page: Adrian Martins

7.1 Monitoring programs

Currently, there are no structured monitoring programs that occur consistently across the Kerang Wetlands Ramsar Site. The majority of assessment programs that do exist have limited funding, timelines and scope. This has implications for maintaining an up-to-date understanding of the status of the ecological character of the wetlands. This is most evident with regards to waterbird abundance. There are multiple agencies undertaking waterbird surveys each year, but these surveys are limited to season or specific wetlands rather than across the site at any given time. Therefore, it is difficult to know whether the Ramsar Site continues to fulfil Criterion 5 by regularly supporting 20,000 or more waterbirds on a regular basis.

A review of monitoring programs across Victoria's Ramsar Sites was undertaken in 2016, facilitated by DELWP. The review provided recommendations for monitoring programs at the Kerang Wetlands to assess the status of the ecological character of the site. The review informs some of the resource condition targets. A more detailed and specific monitoring program will be developed to complement this Action Plan, that will include specific methodologies to monitor progress towards resource condition targets for the CPS, threats to ecological character, and address knowledge gaps.

Table 66 provides an indication of the monitoring that is required at the Kerang Wetlands Ramsar Site to monitor critical CPS.

Table 67 provides recommendations for monitoring key threats to the site.

Table 66. Recommended monitoring for the Kerang Wetlands Ramsar Site to assess the status of ecological character, progress against RCTs and address knowledge gaps.

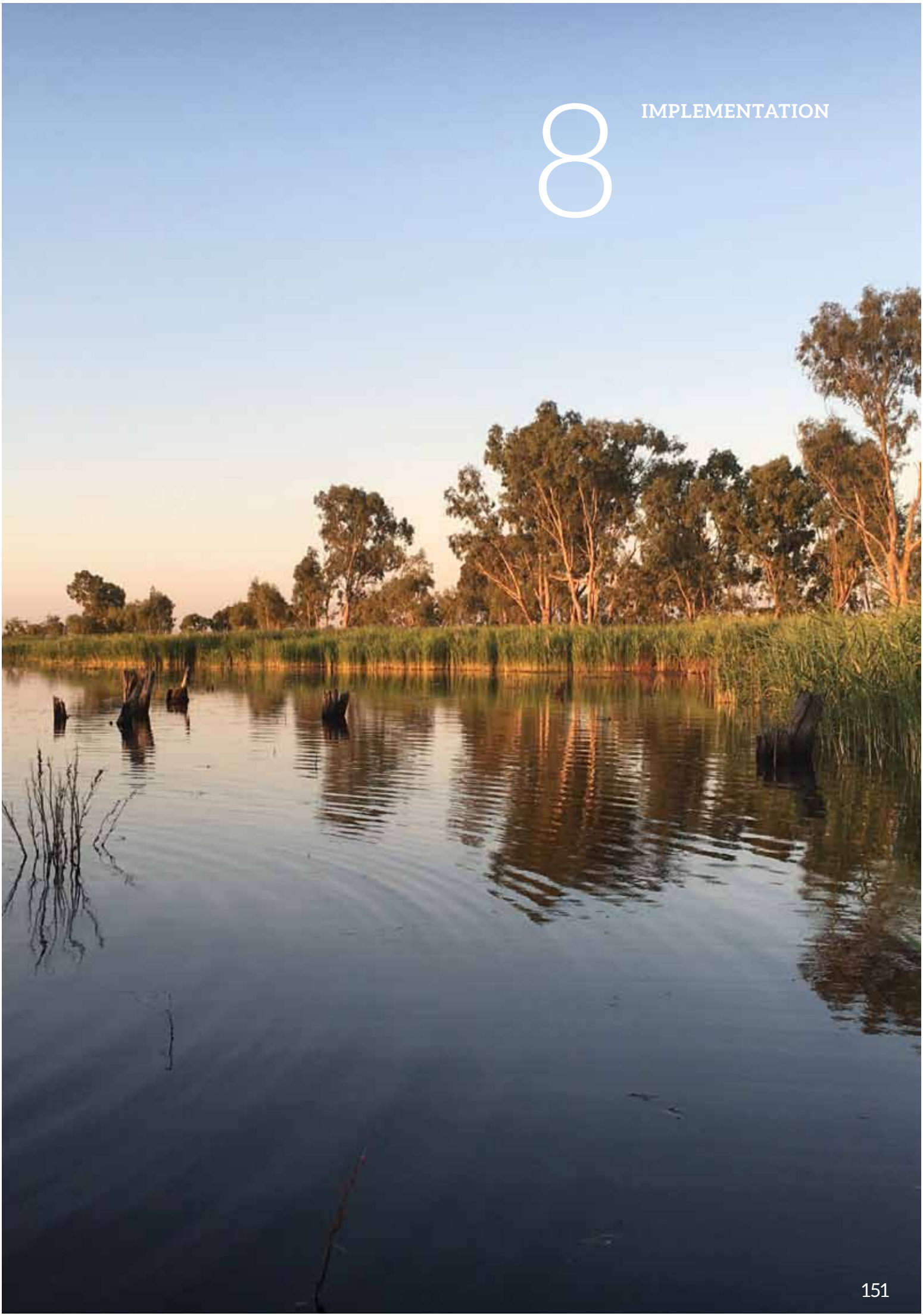
Program	Purpose	Indicator	Location	Frequency	Priority	Responsibility
Hydrology	Address knowledge gaps, confirm baselines and set LACs for those without one.	Frequency and duration of inundation	Town Swamp, Kerang Weir, Lake Tutchewop, Lake William, Lake Kelly and Little Lake Kelly.	Monthly, over several years to establish baseline, then less frequently	High	GMW
Hydrology	Assess against the LAC and RCTs	Frequency and duration of inundation	Kangaroo Lake; Racecourse Lake; Lake Char; Little Lake Charm; Reedy Lake; Middle Reedy Lake; Third Reedy Lake: Cemetery Swamp; Lake Bael Bael; Avoca Marshes; Johnson Swamp; Hird Swamp; Lake Cullen	Annual / event-based	Medium	GMW, North Central CMA
Salinity	Assess against the LAC and RCTs	EC	Kangaroo Lake; Racecourse Lake; Little Lake Charm; Reedy Lake; Middle Lake; Third Lake: Cemetery Swamp; Lake Bael Bael; Avoca Marshes; Kerang Weir Pool/ Town Swamp; Johnson Swamp; Hird Swamp	Monthly	Medium	DEDJTR, GMW, North Central CMA, PV
Salinity	Assess against the LAC and RCTs	EC	Lake Cullen	Monthly	Medium	North Central CMA, PV
Waterbird abundance	Address knowledge gaps, confirm baselines and review LAC. Assess against the LAC and RCT once established.	Species and abundance	All wetlands initially and simultaneously - could be reduced to selected wetlands once patterns of abundance are established.	Annual	High	DELWP, GMA
Waterbird diversity	Assess against the LAC and RCTs	Species richness	All wetlands - could be reduced to selected wetlands once regional species richness patterns are established.	Annual	High	DELWP, GMA

Program	Purpose	Indicator	Location	Frequency	Priority	Responsibility
Waterbird breeding: colonial nesting waterbirds	Assess against the LAC and RCTs	Successful breeding event with Australian White Ibis (*Threskiornis molucca*) and Straw-necked Ibis (*Threskiornis spinicollis*) nesting, breeding and fledging occurring	Middle Reedy Lake	Annual	Medium	DELWP, GMA, PV, GMW, North Central CMA, Birdlife Australia
Waterbird breeding CNW	Assess against the LAC and RCTs	Successful breeding event for Royal Spoonbill, Australasian Darter, Great Cormorant, Pied Cormorant, Yellow Spoonbill nesting, breeding, and fledging occurring.	Avoca Marshes	Annual	Medium	DELWP, GMA, PV, North Central CMA, Birdlife Australia
Vegetation diversity	Assess against the LAC and RCTs Supports assessment of Physical habitat	Not assessed directly for LAC	All wetlands	Establish seasonal baselines for wetlands that do not have them, then every four years. Event-based opportunities e.g. during and after flooding	High	DELWP, PV, GMW, North Central CMA
Vegetation extent	Supports assessment of physical habitat. Can be indicator of changes in hydrology.	Extent of EVCs	All wetlands	Establish baselines for wetlands that do not have them, then every four years Four years for wetlands with established baselines.	High	DELWP, PV, GMW, North Central CMA
Hydrological processes	Assess against the LAC and RCTs	Surrogate indicators: salinity and hydrology	All wetlands		Low	GMW, DEDJTR, DELWP, North Central CMA
Physical habitat for waterbird breeding	Assess against the LAC and RCTs	Surrogate indicators: salinity and hydrology	Lake Bael Bael, Avoca Marshes, Reedy Lake, Middle Reedy Lake, Third Reedy Lake, Kangaroo Lake, Racecourse Lake, Johnson Swamp, Hird Swamp, Kerang Weir, Town Swamp,	Covered by hydrology, salinity and vegetation	Medium	DELWP, PV, North Central CMA
Priority species	Assess against the LAC and RCTs	See above - may need different time for counts	Lake Tutchewop, Lake Cullen, Lake Kelly, Johnson Swamp, Hird Swamp,	Covered by waterbird abundance and diversity	High	DELWP, GMA, PV, North Central CMA, Birdlife Australia
Threatened species	Assess against the LAC and RCTs	Presence of Australasian Bittern and breeding behaviour	Johnson Swamp, Hird Swamp	Event-based e.g. Johnson or Hird Swamp inundated	High	DELWP, GMA, PV, North Central CMA
Threatened species	Assess against the LAC and RCTs	Presence of Curlew Sandpiper (*Calidris ferruginea*)	Lake Tutchewop, Lake Cullen,	Annual	Low	DELWP, GMA, PV, North Central CMA, Community
Biodiversity	Assess against the LAC and RCTs	Surrogate - salinity and hydrology	All wetlands	Covered by salinity and hydrology	Medium	DELWP, PV, North Central CMA

Table 67. Suggested assessment against key threats at the Kerang Wetlands Ramsar Site.

Program	Purpose	Indicator	Location	Frequency	Responsibility
Altered watering regime - increased frequency of inundation	Assess altered hydrology and plan mitigation measures	Frequency of inundation	All wetlands	Annual	GMW, North Central CMA
Altered watering regime or climate change - decreased frequency of inundation	Assess altered hydrology and plan mitigation measures	Frequency of inundation	All wetlands	Monthly	GMW, North Central CMA
Altered watering regime - unseasonal inflows	Assess altered hydrology and plan mitigation measures	Hydrograph	All wetlands	Monthly	GMW, North Central CMA
Water quality	Assess for ANZECC threshold levels and plan mitigation measures where possible	Salinity, dissolved oxygen, water clarity, nutrients, pH	All wetlands	Monthly Event-based for semi-permanent wetlands	DELWP, GMW, PV, North Central CMA
Invasive species - native and non-native weeds	Assess distribution, trigger for management	Extent	All wetlands	Annual	GMW, PV
Invasive species - Foxes	Assess distribution and abundance, and trigger for management.	Abundance	All wetlands	Annual	GMW, PV
Invasive species - Rabbits	Assess distribution and abundance, and trigger for management.	Abundance	All wetlands	Annual	GMW, PV
Invasive species - Pigs	Assess distribution and abundance, and trigger for management.	Abundance	All wetlands	Annual	GMW, PV
Resource use - grazing	Assess impact on wetland vegetation and nutrient levels	Vegetation extent, species richness, recruitment.	All wetlands with grazing licence	Initially to establish extent of issue; then every three years	Licence issuer (DELWP or GMW)l

8 IMPLEMENTATION



8.1 Governance

The roles and responsibilities for managing Ramsar Sites have been developed by the Australian Government (DSEWPAC 2012). Management of Ramsar Sites in Victoria is coordinated by the Victorian Government through the Department of Environment, Land, Water and Planning (DELWP). Relevant international, national and state legislation, strategies and polices are described in Section 1.4 and Appendix 2.

8.2 Partnerships

An action identified in the NCWS is to establish a coordinating committee to ensure integrated management of waterways within the Kerang region, including the Kerang Wetlands Ramsar Site. The Project Steering Committee, in combination with an existing committee already in operation, will work together to form the coordinating committee. It is envisaged that the coordinating committee will build on previous and current collaboration efforts and use the forum to:

- Develop integrated delivery approaches
- Inform annual action planning
- Support cross-agency investment opportunities
- Coordinate monitoring, evaluation of implementation, and reporting
- Review progress of the Action Plan at annual or bi-annual intervals.

Ongoing strong partnerships between management agencies, Traditional Owners, community groups and individuals are critical to the successful implementation of the Action Plan.

8.3 Resources

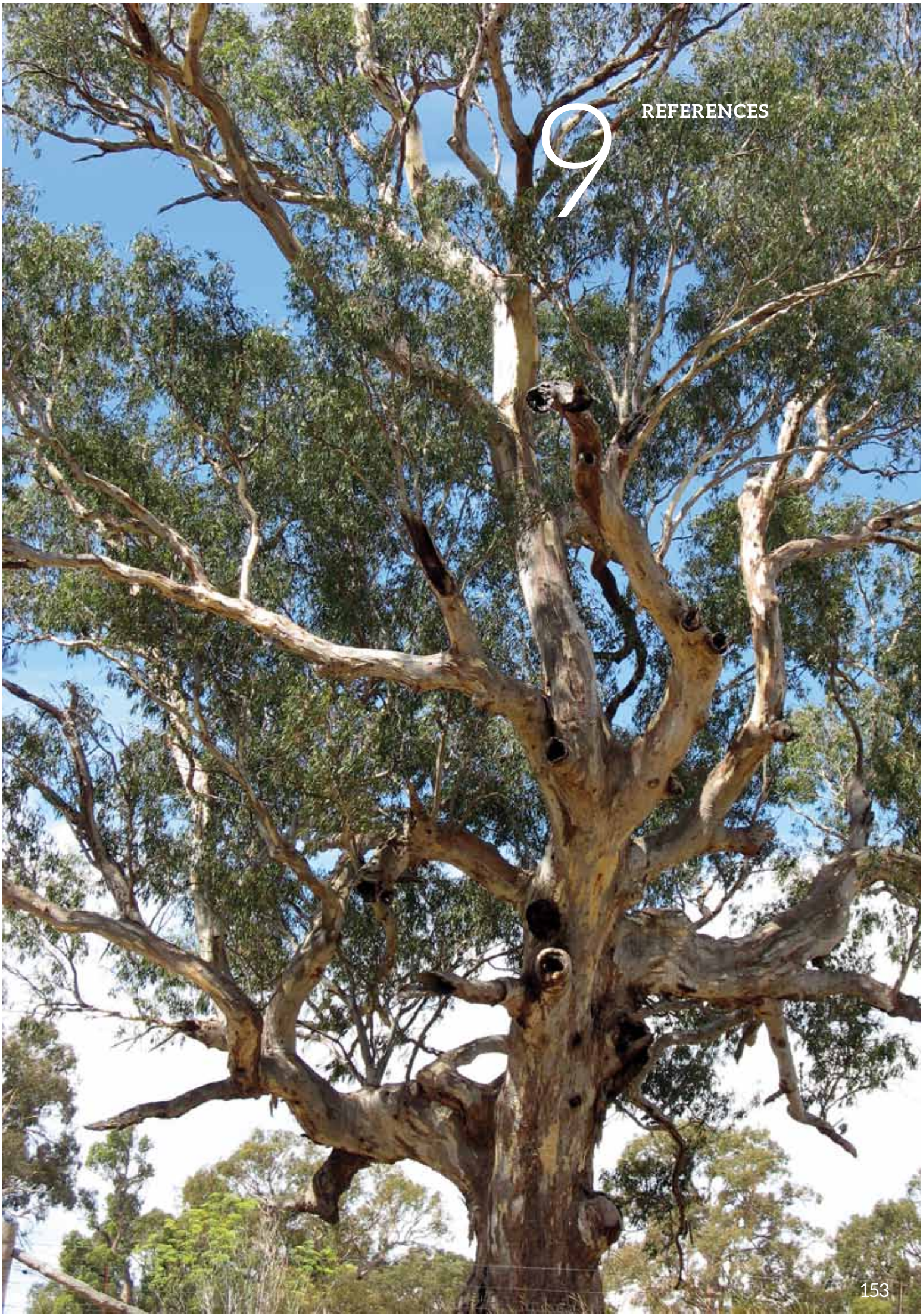
The *Kerang Wetlands Ramsar Site Action Plan* provides a clear direction and priorities for management over the next eight years. The successful implementation of the Action Plan will be influenced by available funding and strong agency and community support. Investment proposals to support actions of the Action Plan will be developed as investment opportunities arise.

As outlined in Section 6.1, assignment of lead agencies against actions in this document should not preclude other agencies or interest groups from seeking funding to undertake management activities independently, though certain approvals may be required from the lead agency and collaboration is advised.

In 2017 the North Central CMA, in conjunction with ecologists and land managers, will lead the development of a works program to identify specific locations at each wetland that require conservation, protection or rehabilitation works.

Previous page: Johnson Swamp

9 REFERENCES



ACF, 2010. *Wetlands: underpinning a robust rural economy. A briefing paper on the economic benefits of Australian wetlands: Hattah Lakes case study*. Australian Conservation Foundation, Melbourne.

Aquaterra Solutions, 2006. *Goulburn-Murray Water Barr Creek – Tutchewop Reference Committee: Independent technical review of the hydrogeological understanding of the future management options for the Tutchewop Lakes.*

Australian Ecosystems, 2012. *Wetland and Terrestrial Vegetation Condition Monitoring: Kerang Wetlands, Richardson's Lagoon and Leaghur State Park*. Report prepared for the North Central Catchment Management Authority, Australian Ecosystems, Patterson Lakes, Victoria.

Australian Geological Survey Organisation, 1997. *The Lake Tutchewop, Lake William and Lake Kelly Saline Water Disposal Basins, Murray Basin, Australia: Lithostratigraphy, hydrodynamics and hydrochemistry*.

Biosis, 2013. *Kerang Lakes fauna assessment – draft report*. Report prepared for the North Central Catchment Management Authority, Huntly, Victoria.

Bureau of Meteorology (BOM) 2015, *Climate Data Online*, viewed 14th June 2016 <http://www.bom.gov.au/climate/data/index.shtml?bookmark=136&zoom=3&lat=-37.1235&lon=145.2&layers=B00000TFFFFFFFTFFFFFFFFFFFFFFFFFFFTTT&dp=IDC10002-d>.

Butcher, R. and Hale, J., 2016. *Addendum to Ecological Character Description for the Kerang Wetlands Ramsar Site*. Report to Department of Environment, Land, Water and Planning, Melbourne, Victoria.

Cottingham, P., Butcher R., Hale J., and Brooks, S. 2015. *Glenelg Estuary and Discovery Bay Wetland Complex Ramsar Management Plan*. Report prepared for the Glenelg Hopkins Catchment Management Authority, Hamilton, Victoria.

Dedini, M 2016 *Wetland waterbird monitoring in the Kerang region*, unpublished raw data collected for North Central Catchment Management Authority, Huntly, Victoria.

Department of Environment, 2016. *National framework and guidance for describing the ecological character of Australian Ramsar wetlands*. Accessed 10th June 2016. http://www.environment.gov.au/water/wetlands/publications/national-framework-and-guidance-describing-ecological-character-australian-ramsar-wetlands

DELWP 2016a. *Ecological Vegetation Class Benchmarks*. Accessed 6th July 2016 http://www.depi.vic.gov.au/environment-and-wildlife/biodiversity/evc-benchmarks

DELWP 2016b, 'WETLAND_PRE-EUROPEAN', The State of Victoria, Department of Environment, Land, Water and Planning, viewed 7th June 2016 < http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=iwc>.

DELWP 2016c, 'WETLAND_CURRENT', The State of Victoria, Department of Environment, Land, Water and Planning, viewed 7th June 2016, < http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=iwc>.

Department of Environment and Primary Industries, 2014. *Index of Condition System database*. Accessed 14th July 2016. http://ics.water.vic.gov.au/ics/

DEPI 2013a. *Victorian Waterway Management Strategy*. Department of Environment and Primary Industries, Melbourne, Victoria.

DEPI 2013b. *Kerang Wetlands Ramsar Site boundary description*. Department of Environment and Primary Industries, Melbourne, Victoria.

DEWHA, 2010. *DRAFT Kerang Wetlands Ramsar Site: Ecological Character Description*. Report prepared by Kellogg Brown and Root for the Department of Environment, Water, Heritage and the Arts, Canberra.

DPI, 2011. GeoVic – *Explore Victoria Online Mapping Service*. Department of Primary Industries, accessed 9 February 2011 from http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=geovic.

DSE, 2005. *Game Hunting in Victoria*. Department of Sustainability and Environment, accessed 9 February 2011 from http://www.dse.vic.gov.au/CA256F310024B628/0/92592854BC5500CBCA25708F001BE02A/$File/2005+-+Information+sheet+-+where+can+I+hunt.pdf.

DSE 2004. *Kerang Wetlands Ramsar Site Strategic Management Plan*. Prepared by Parks Victoria on behalf of the Department of Sustainability and Environment, Melbourne, Victoria.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC), 2012. *Wetlands in Australia – roles and responsibilities*. Accessed 26 June 2016.

Environment Australia, 2001. *A Directory of Important Wetlands in Australia*, Third Edition. Environment Australia, Canberra

Ermaea eBirds (2016). *eBird Location Data*. Accessed between May and July 2016 http://ebird.org/ebird/australia/map/

Previous page: River Red Gum

Frood, D. and Papas, P. 2016. *A guide to water regime, salinity ranges and bioregional conservation status of Victorian wetland Ecological Vegetation Classes*. Arthur Rylah Institute for Environmental Research. Technical Report Series No. 266. Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

Gannawarra Shire Council 2015. *Strategic Tourism Plan 2015-2020*. Gannawarra Shire Council, Kerang, Victoria.

Goulburn Murray Water (GMW) 2016. *Land and On Water Management Plans*. Accessed 5 July 2016. http://www.g-mwater.com.au/recreation-tourism/lowmp

GMW 2010. *Reedy Lake – bathymetric survey*. Goulburn Murray Water. Tatura, Victoria.

Ho, S., Roberts, J., Cheers, G., and Suitor, L. 2006. *Development and application of an ecological monitoring and mapping program for targeted Kerang Lakes*. Report prepared for the North Central Catchment Management Authority, Huntly, Victoria.

Jacobs, 2016a. *Monitoring response to environmental flows in the Loddon and Campaspe Rivers*. Report prepared for North Central Catchment Management Authority, Huntly, Victoria.

Jacobs, 2016b. *Pyramid Creek fish surveys 2015/16*. Report prepared for the North Central Catchment Management Authority, Huntly, Victoria.

KBR, 2011. *Ecological Character Description for the Kerang Wetlands Ramsar Site*. Report prepared for the Department of Sustainability, Environment, Water Populations and Communities, Kellogg, Brown and Root Pty Ltd.

Lakey, R. and Hansen, W. 1988. *Hydrological and environmental impact of the sill on Third Marsh – Physical characteristics and historical background*, unpublished report prepared for the Kerang Lakes Planning Support Group.

Lakey, R. and Nott, R. 1988. *Hydrological and environmental impact of the sill on Third Marsh – Groundwater aspects*, unpublished report prepared for the Kerang Lakes Planning Support Group.

Lugg,A., Heron, S., Fleming, G., O'Donnell, T. 1989. *Conservation value of the wetlands in the Kerang Lakes area*. Report to the Kerang Lakes Area Working Group. Department of Conservation Forests and Lands, Victoria.

Macumber, P., 2003. *A review of Lake Cullen Salinity and the Cullen feasibility study*. Victoria.

Macumber, PG 2002, *A review of the hydrology of Lake Elizabeth and Lake-Groundwater interactions*, report prepared for DNRE Kerang by Sam Green and Mary Shi, Tatura.

Murray-Darling Basin Authority (MDBA), 2011. *Lake Tutchewop groundwater interaction investigations. Volume 2: Assessment*. Report prepared by Aquaterra for Goulburn Murray Water on behalf of the MDBA.

Nolan-ITU, 2001. *Cemetery Swamp feasibility study and operational guidelines*. Report prepared in association with Moore Environmental Consulting and Lloyd Environmental Consultants for the Department of Natural Resources and Environment, Melbourne, Victoria.

North Central CMA, 2016a. *Johnson Swamp Environmental Water Management Plan*. North Central Catchment Management Authority, Huntly, Victoria.

North Central CMA 2016b. *Stevenson Swamp: Vegetation survey, mapping and analysis*. North Central Catchment Management Authority, Huntly, Victoria.

North Central CMA 2014. *North Central Waterway Strategy 2014-22*. North Central Catchment Management Authority, Huntly, Victoria.

North Central CMA, 2013a. *Kerang Lakes Bypass Investigation Project: Technical Report – Little Lake Charm*. North Central Catchment Management Authority, Huntly, Victoria.

North Central CMA, 2013b. *Kerang Lakes Bypass Investigation Project: Technical Report – First Reedy Lake*. North Central Catchment Management Authority, Huntly, Victoria.

North Central CMA, 2013c. *Kerang Lakes Bypass Investigation Project: Technical Report – Middle Reedy Lake*. North Central Catchment Management Authority, Huntly, Victoria.

North Central CMA, 2013d. *Kerang Lakes Bypass Investigation Project: Technical Report – Third Reedy Lake*. North Central Catchment Management Authority, Huntly, Victoria.

North Central CMA, 2013e. *Kerang Lakes Bypass Investigation Project: Technical Report – Racecourse Lake*. North Central Catchment Management Authority, Huntly, Victoria.

North Central CMA, 2013f. *Lake Cullen Swamp Environmental Water Management Plan*. North Central Catchment Management Authority, Huntly, Victoria.

North Central CMA, 2013g. *Hird Swamp Environmental Water Management Plan*. North Central Catchment Management Authority, Huntly, Victoria.

Northern Land Systems, 2015. *Johnson Swamp Bathymetric Surveys*. Prepared for the North Central Catchment Management Authority, Northern Land Solutions, Swan Hill, Victoria.

O'Donnell, T. 1990. *Vegetation of the Wetlands in the Kerang Lakes Area*. Report prepared for the Kerang Lakes Area Working Group, Kerang, Victoria.

SKM 2001, *Wetland Watering and Operational Management Plan for McDonalds Swamp*, Sinclair Knight Merz, Victoria.

Rakali Ecological Consulting, 2015. *Ecological Response of Johnson Swamp to Environmental Watering, 2015*. Report prepared for the North Central Catchment Management Authority, Rakali Ecological Consulting, Chewton, Victoria.

Rakali Ecological Consulting, 2014a. *Kerang Ramsar and Other Significant Wetlands Monitoring Project 2014*. Report prepared for the North Central Catchment Management Authority, Rakali Ecological Consulting, Chewton, Victoria.

Rakali Ecological Consulting 2014b, *Mapping of Typha and Phragmites australis in 3 Central Murray Wetlands*, report prepared for North Central Catchment Management Authority, Huntly, Victoria.

Rakali Ecological Consulting, 2013. *Ecological Vegetation Class Assessment for the Reedy Lake system, Little Lake Charm and Racecourse Lake and surrounding areas in the Kerang Wetlands Ramsar Site*. Report prepared for the North Central Catchment Management Authority, Rakali Ecological Consulting, Huntly, Victoria.

Riparian Australia 2003. *Lower Avoca Wetlands Vegetation Condition Appraisal*, report prepared for the North Central Catchment Management Authority.

Roberts, J. and Marston, F., 2011. *Water regime for wetland and floodplain plants: a source book for the Murray-Darling Basin*. National Water Commission, Canberra.

SKM, 2001. *Johnson Swamp (West side) Watering and Operational Plan*. Report prepared for the North Central Catchment Management Authority, Sinclair Knight and Merz, Melbourne, Victoria.

Victorian Environmental Assessment Council (VEAC) 2008, *River Red Gum Forests Investigation*, Victorian Environmental Assessment Council, Melbourne.