

Nyah and Vinifera Environmental Water Management Plan



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Executive summary

Environmental Water Management Plans (EWMPs) have been developed for key sites in the Mallee region. This EWMP covers two sites, Nyah Park and Vinifera Park, which are located adjacent to each other on the Murray River Floodplain. Whilst having similar ecological objectives the two sites have different water requirements and can be operated independently with the proposed infrastructure in place.

The Nyah Park floodplain is located 30 km north of Swan Hill between Nyah and Wood Wood. It comprises 637 ha, dominated by River Red Gum forest, wetlands and Black Box woodlands at higher floodplain elevations. The main watercourse in the Park is the Parnee Malloo Creek and adjacent floodplain depressions. Nyah Park is a low-lying floodplain that would have been inundated most years at Murray River flows of 25,000 ML/d. River regulation has reduced the flood frequency and duration resulting in a decline in the condition of floodplain health.

The Vinifera Park floodplain is located 20 km north-west of Swan Hill, in the Murray Fans bioregion comprising an area of 488 ha. The floodplain runs parallel to the Murray River, and is one of the most downstream areas of the central River Red Gum forests. The floodplain includes wetland, forest and woodland areas. Under a natural flow regime, the wetlands within the Vinifera floodplain would have been flooded almost annually and frequently remained flooded throughout the year.

A high diversity of native flora has been recorded in the Nyah-Vinifera area including 6 VROT¹s listed species at Nyah Park and 12 VROTs listed species at Vinifera Park (one of these species is also listed under the FFG Act).

Threatened fauna species recorded within the Nyah-Vinifera Forest include Eastern Great Egret (*Ardea modesta*), Grey-crowned Babbler (*Pomatostomus temporalis*), Broad Shelled Turtle (*Chelodina expansa*), Regent Parrot (*Polytelis anthopeplus monarchoides*), White-bellied Sea Eagle (*Haliaeetus leucogaster*) and Growling Grass Frog (*Litoria raniformis*).

Nyah Vinifera is of importance to the Wadi Wadi people and contains numerous cultural heritage sites including scarred trees, middens, earthen ovens and burial sites.

The Nyah and Vinifera Parks are included in the Basin Plan's Sustainable Diversion Limit (SDL) Adjustment Mechanism projects aimed at improving the efficiency of water delivery to water dependant ecosystems. This is achieved through infrastructure that will target water dependant habitat and assist with inundation at lower river flows.

The infrastructure proposed for Nyah and Vinifera aims to restore the integrity and productivity of the ecosystems by increasing the frequency and duration of floodplain inundation, and will provide for up to 476 ha of inundation of water dependant habitat at Nyah and 340 ha at Vinifera (Ecological Associates 2014a).

The long term management goal for Nyah and Vinifera is:

“To restore the key species, habitat components and functions of the Nyah and Vinifera Park ecosystem by providing the hydrological environments required by indigenous plant and animal species and communities”.

To achieve this, ecological and hydrological objectives have been designed for four water regime classes at Nyah Park and five water regime classes at Vinifera Park (Ecological Associates 2014a). These have been developed to sustain various ecological components of the two parks and have

¹ Victorian Rare or Threatened species

been incorporated into minimum, optimal and maximum long-term watering regimes. The ecological objectives for both the Nyah and Vinifera parks are the same, and are outlined below:

NV1: By 2030, improve vital habitat at the Nyah Park and Vinifera Park asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.

NV2a: By 2030, protect and restore biodiversity by maintaining representative populations of small-bodied fish at the Nyah Park and Vinifera Park asset, including expected species Unspecked hardyhead - (*Craterocephalus stercusmuscarum fulvus*); Carp Gudgeon (*Hypseleotris klunzingeri*); Murray-Darling Rainbowfish (*Melanotaenia fluviatilis*); Flathead Gudgeon (*Phylipnodon grandiceps*); Australian Smelt (*Retropinna semoni*).

NV2b: By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Nyah Park and Vinifera Park asset.

NV4: By 2030, maintain nesting and recruitment of colonial waterbirds (N7, after Jaensch 2002) at the Nyah Park and Vinifera Park asset, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat.

The ecological objectives will be achieved by providing water requirements of the Nyah and Vinifera floodplains.

This Environmental Water Management Plan (EWMP) sets out the long-term objectives for the priority environmental values of two sites; Nyah Park and Vinifera Park. It will help to guide future environmental watering activities for these areas; however significant infrastructure will be required to fully implement this EWMP. The infrastructure outlined in the document is proposed only and requires further design and funding. This EWMP is not a holistic management plan for Nyah and Vinifera but is focused on environmental water management. A regional context document has been created and provides further information on the region, and complements the Mallee CMAs EWMPs and should be read in conjunction with this document (Sunraysia Environmental, 2014).

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Appendix 1 – Flora and Fauna Species List

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Acknowledgements

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1. Introduction

This Environmental Water Management Plan (EWMP) has been prepared to establish the long-term management goals for Nyah and Vinifera Parks.

The key purposes of EWMPs are to:

- Identify the long-term objectives and water requirements for the wetlands, identified as a high priority by the Mallee CMA;
- Establish links between identified ecological values and suggest appropriate environmental watering objectives supported by monitoring programs and the identification of specific knowledge gaps;
- Provide a vehicle for community consultation, including for the long-term objectives and water requirements of the wetlands;
- Inform the development of seasonal watering proposals and seasonal watering plans; and
- Inform long-term watering plans that will be developed under Murray-Darling Basin Plan requirements.

Key documents that support this Nyah Vinifera EWMP are shown in Table 1.

Table 1 - Key support documents to the Nyah Vinifera EWMP

Name	Author	Summary
Investigation of Water Management Options for the Murray River – Nyah to Robinvale	Ecological Associates 2007	<ul style="list-style-type: none"> • Identifies management units • Identifies ecological values • Develops objectives • Defines water regimes • Identifies threats • Proposes management actions
Water Management Options for the Murray River – Nyah to Robinvale, Stage II	Ecological Associates 2007	<ul style="list-style-type: none"> • Costs designs • Proposes alternative water management options • Documents environmental impacts • Documents Cultural heritage values
Mallee Waterway Strategy	Mallee CMA 2014	<ul style="list-style-type: none"> • Sets regional goals for waterway management that align with the Mallee RCSs broader objectives • Identifies high value waterways • Details strategic work programs for priority waterways • Identifies the roles and responsibilities of regional stakeholders • Establishes principles to guide the implementation
Regional Context Document for Environmental Water Management Plans; Mallee CMA Region	Sunraysia Environmental 2014	<ul style="list-style-type: none"> • Background context the region • Outlines significant wetlands and river • Sources of environmental water • Policy, legislative and planning frameworks

SDL Floodplain Watering Project Reports	Ecological Associates 2014	<ul style="list-style-type: none"> • Ecological Values • Ecological Objectives • Anticipated Ecological Benefits and Impacts • Hydrology of the Area and Environmental Water Requirements • Business Case • Risk Assessment
Concept designs	Jacobs 2014	<ul style="list-style-type: none"> • Hydrodynamic modelling • Advanced concept designs

2. Site Overview

The Mallee CMA region is located in the north-west of Victoria covering approximately 39,000 km² with an estimated regional population of 65,000. The catchment runs along the Murray River from Nyah to the South Australian border, and as far south as Birchip and Rainbow (MCMA 2014). Major towns include Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein. The region has a semi-arid climate, with an annual mean rainfall of around 250 mm and average daily temperatures (at Mildura) ranging from 32°C in summer to 15°C in winter (MCMA 2006).

The mean annual rainfall at Nyah is 303 mm with average daily temperatures (at Swan Hill) ranging from 33°C in summer to 14.7°C in winter (Bureau of Meteorology 2015).

The Mallee CMA region consists of 38% public land which is mainly national parks, reserves and large reaches of riverine and dryland state forest. The rest of the region is important for dryland farming of cereal crops and sheep; and irrigated horticulture.

In 2006 the Mallee CMA engaged consultants Ecological Associates to investigate water management options for the Murray River floodplain from Nyah to Robinvale. One of the major outcomes of these investigations was the development of a system of floodplain Management Units (WMUs). These divide the floodplain into management units in which water regimes can be managed independently of another WMUs are relatively consistent in their ecological values and land uses. The Mallee CMA has used WMUs to inform planning and development of environmental water management plans to achieve more effective management of hydrologically connected systems. In addition to this, the Mallee CMA has also used individual WMUs or groupings of WMUs to form Waterway Management Units (WMU) for planning within its Mallee Waterway Strategy (MCMA 2014). Nyah and Vinifera Parks are within the Nyah WMU (Figure 1).

The Nyah floodplain is located between 1341 and 1356 River Murray km. The neighbouring Vinifera floodplain is located between 1356 and 1367 River Murray km.

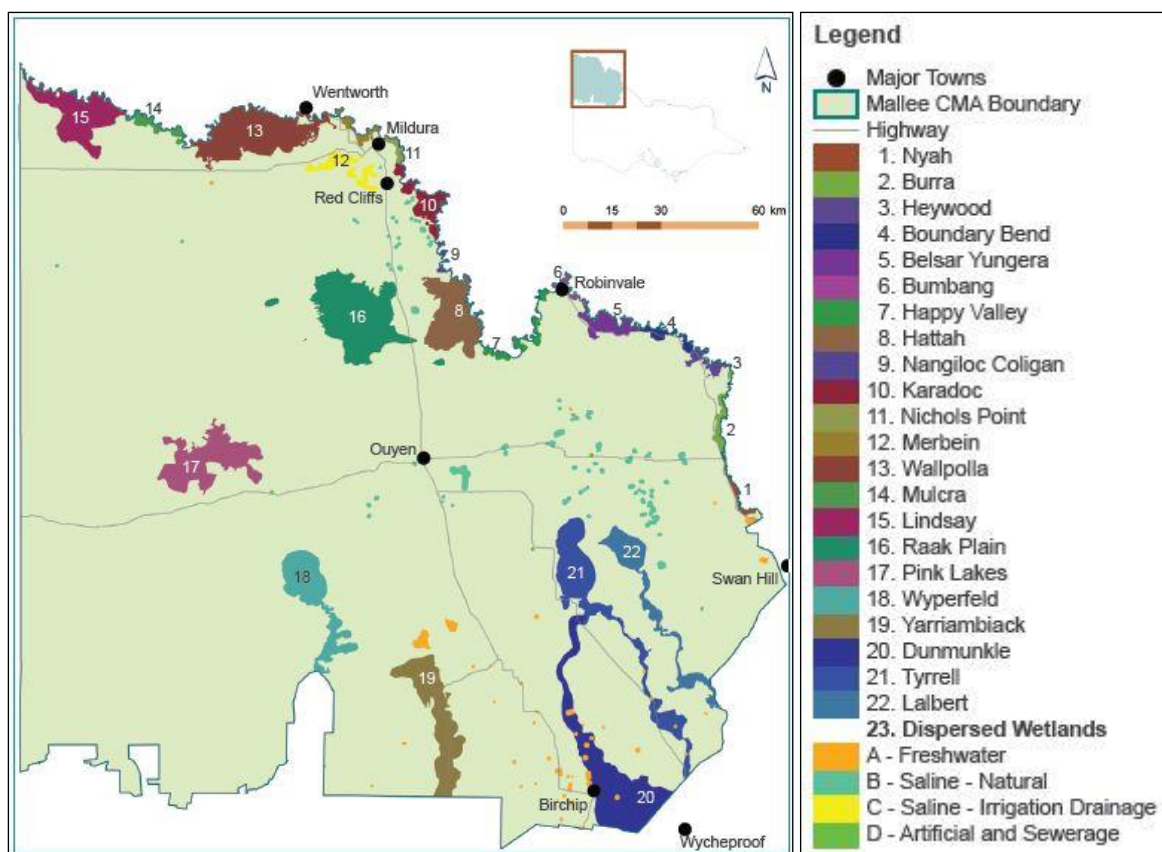


Figure 1 - Mallee Water Management Units (Mallee CMA, 2014)

2.4 Catchment Setting

Nyah and Vinifera Parks are located in the Murray Fans bioregion. The Murray Fans bioregion is characterised by a flat to gently undulating landscape on recent unconsolidated sediments with evidence of former stream channels, old river meanders and palaeochannels and broad floodplain areas associated with major river systems and prior streams (known as braided / anastomosing streams). Alluvium deposits from the Cainozoic period gave rise to the red brown earths and texture contrast soils (Dermosols, Kurosols, Chromosols and Sodosols).

Two aquifers are present in the area, the uppermost Channel Sands which is restricted to the Murray River trench, and the lower Parilla Sand which is of regional extent. Within the trench the two aquifers are locally separated by a discontinuous layer of Blanchetown Clay, allowing considerable hydraulic connection between the two layers. Regional groundwater flow is westerly around Nyah, and to the west of Nyah it has a steep westerly gradient away from the river towards the Towan Plain groundwater discharge basin.

The regional groundwater salinity in the Parilla Sand aquifer exceeds 40,000 EC near Nyah. Salinities exceeding 60,000 EC are associated with groundwater discharge zones at Towan Plain west of Nyah, and Bailey's Plains west of Piangil. A zone of less saline groundwater in the Parilla Sand aquifer parallels the river, but extends only 3 to 5 kilometres to the west. Groundwater dilution is more pronounced where greater hydraulic connection exists between the deep and shallow aquifers near the river. During the time of this study, irrigation impact on groundwater was not considered as a major concern with the existing groundwater gradient away from the river. Poor irrigation techniques could result in the displacement of large salt loads to the river however maintaining or improving current irrigation practices should prevent this occurring (MCMA 2012).

2.4 Site Descriptions

Nyah Park

Nyah Park is located north of the locality of Nyah, 30 km north of Swan Hill. The Nyah Park floodplain includes 913 ha of wetland, forest and woodland areas. The floodplain is a shallow basin aligned parallel to the River Murray. It is formed between the high ground of natural levee along the river bank in the east and the terrestrial landscape to the west. Parnee Malloo Creek is an intermittently flowing anabranch that meanders through the floodplain over a distance of 16 km. The creek departs from the River Murray near Nyah at 1353 river km and re-joins the river near Wood Wood at 1346 river km. Shallow wetland depressions adjacent to the creek are filled by water spilling from the creek and by minor effluents in the river levee (Ecological Associates 2006). See Figure 2.

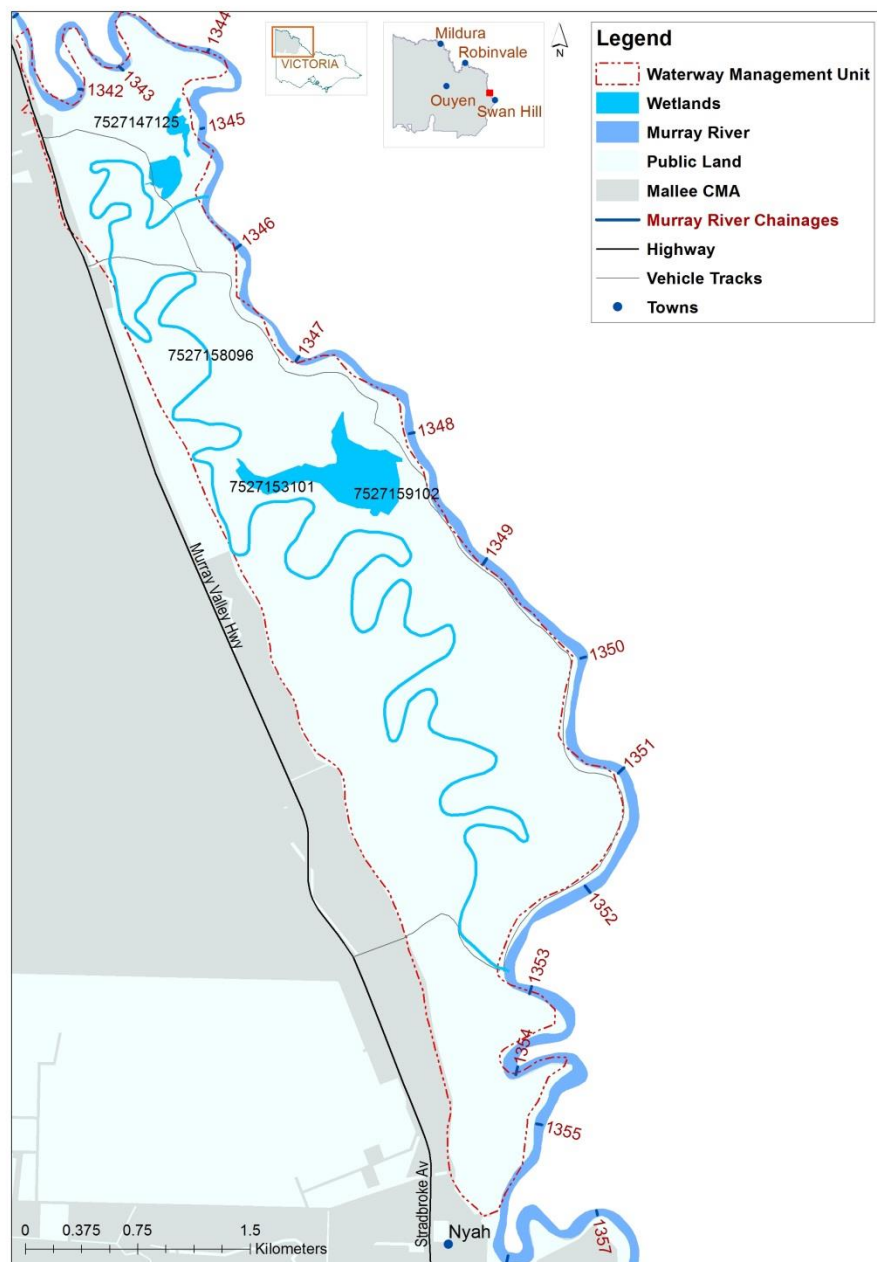


Figure 2 - Wetlands within Nyah Park

Vinifera Park

Vinifera Park is located between Nyah and Swan Hill, downstream of Nyah Park. The Vinifera floodplain spans across 638 ha and is an elongate basin aligned parallel to the River Murray. The basin is formed between the terrestrial landscape to the south and the natural levee of the river bank to the north. An artificial levee has been constructed at the eastern boundary of the Park and reduces private land flooding upstream by isolating it from the flooding in the Vinifera Park (Ecological Associates, 2014a).

The floodplain is a network of waterways, wetlands and inundation-dependent woodlands that receive water from the River Murray via Vinifera Creek. Historically the creek was an anabranch of the Murray River however modifications to the upstream end of the creek means it now functions as a separate wetland (Ecological Associates, 2014a). See Figure 3.

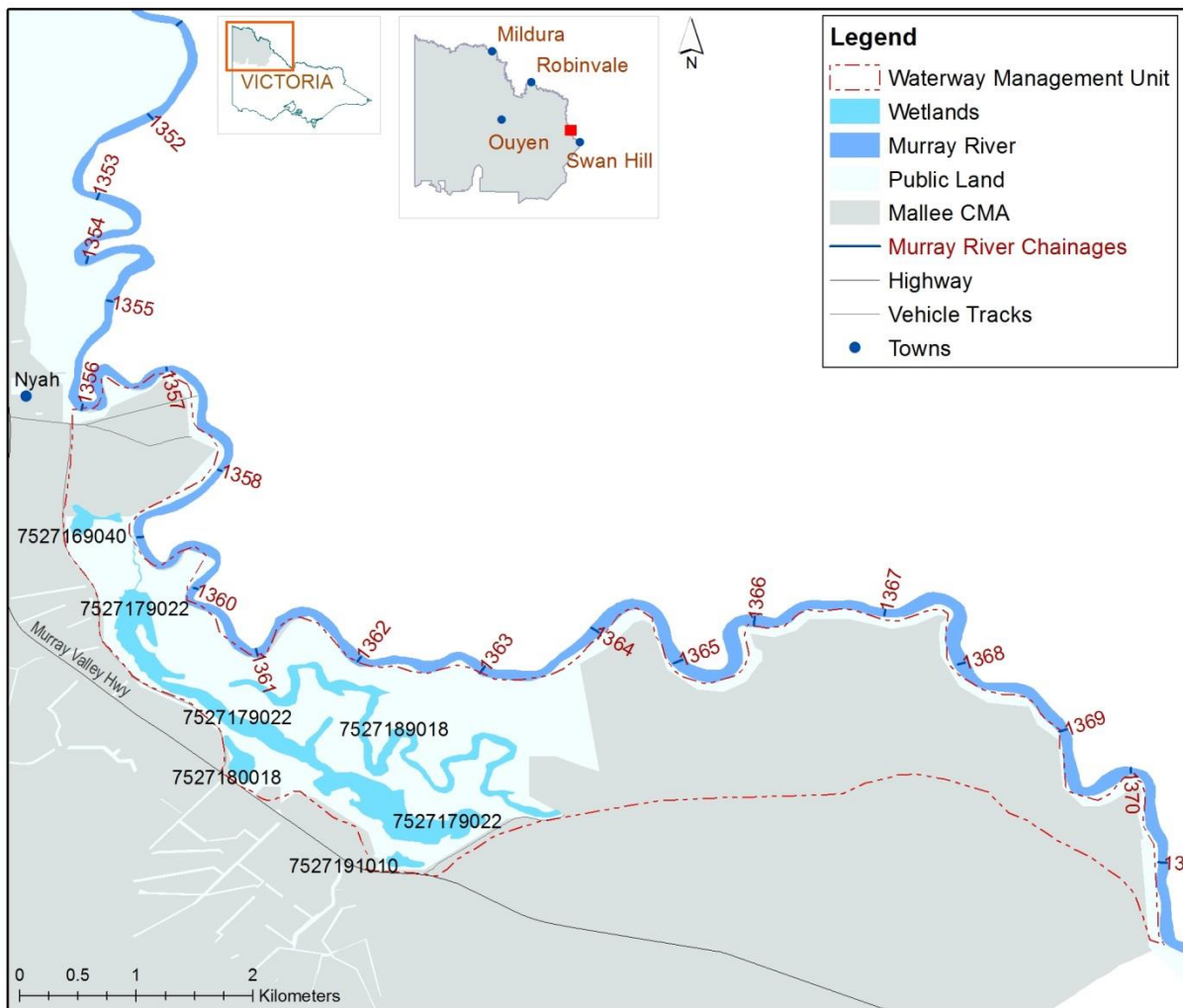


Figure 3 - Wetlands within Vinifera Park

2.2 Conceptualisation of the Site

Conceptual models of both Nyah Park (Figure 4) and Vinifera Park (Figure 5) have been developed. These models provide a visual representation of the main features and processes that are discussed throughout this document. The models highlight the changing elevation of the landscape and where significant values are present. Ecological objectives have been set to protect these values. Water regimes classes have been used to group ecological vegetation classes with common water requirements, based on their elevation in the landscape (see Table 2 and Table 3 for additional details on watering class regimes).

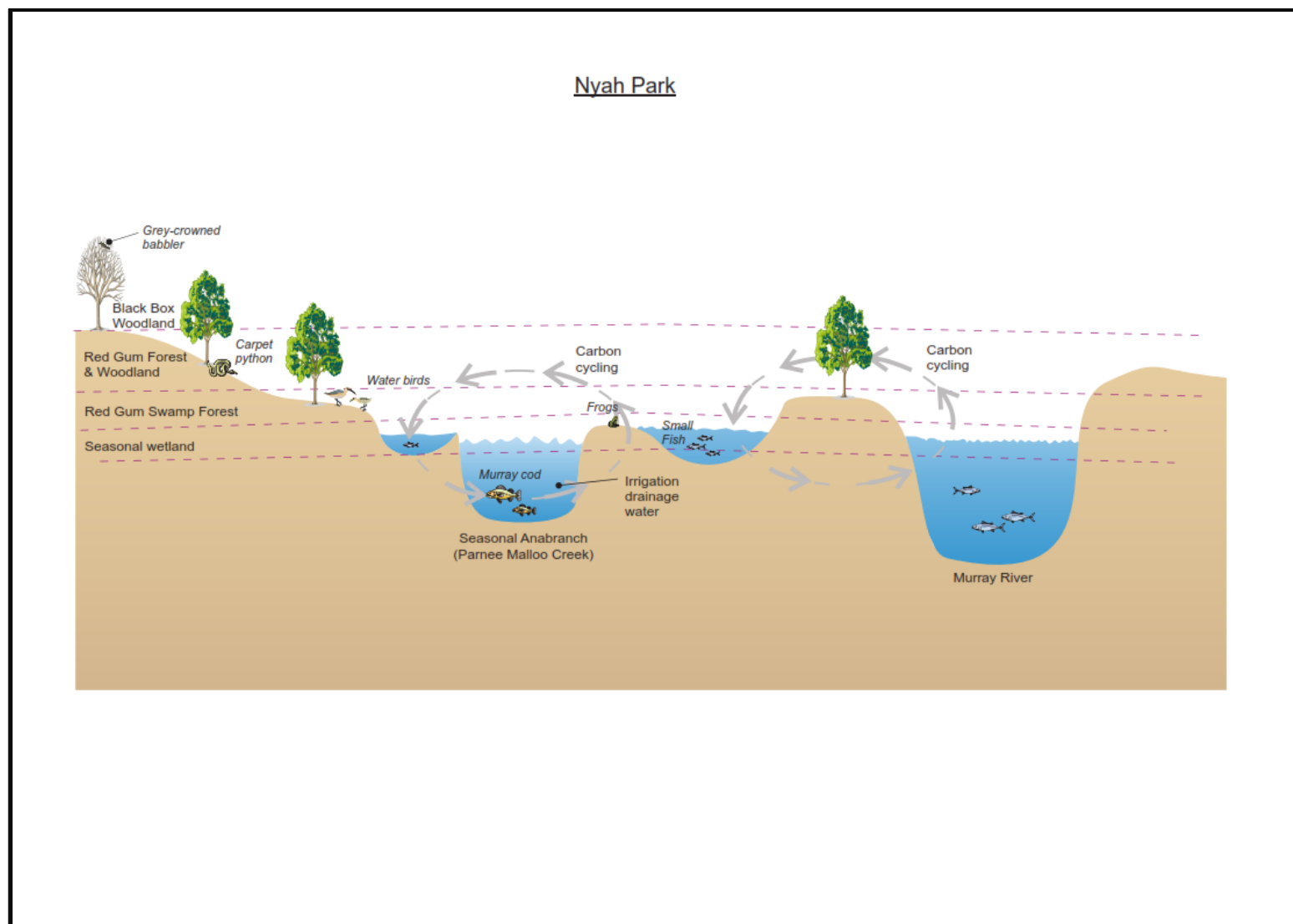


Figure 4 - Conceptual model of the Nyah landscape

Table 2 - Nyah Park Water Regime Classes and water dependant ecological values

Water Regime Class	Ecological values
Seasonal Anabranch	River Red Gum Aquatic macrophytes Murray Cod
Seasonal Wetland	River Red Gum Aquatic macrophytes Native fish Native frogs Murray Cod Habitat for waterbirds, including colonial nesting species
Red Gum Swamp Forest	River Red Gum Habitat for waterbirds, including colonial nesting species Carpet Python, Sugar Glider and Grey-crowned Babbler Organic carbon
Red Gum Forest and Woodland	River Red Gum Habitat for waterbirds, including colonial nesting species Carpet Python, Sugar Glider and Grey-crowned Babbler Organic carbon

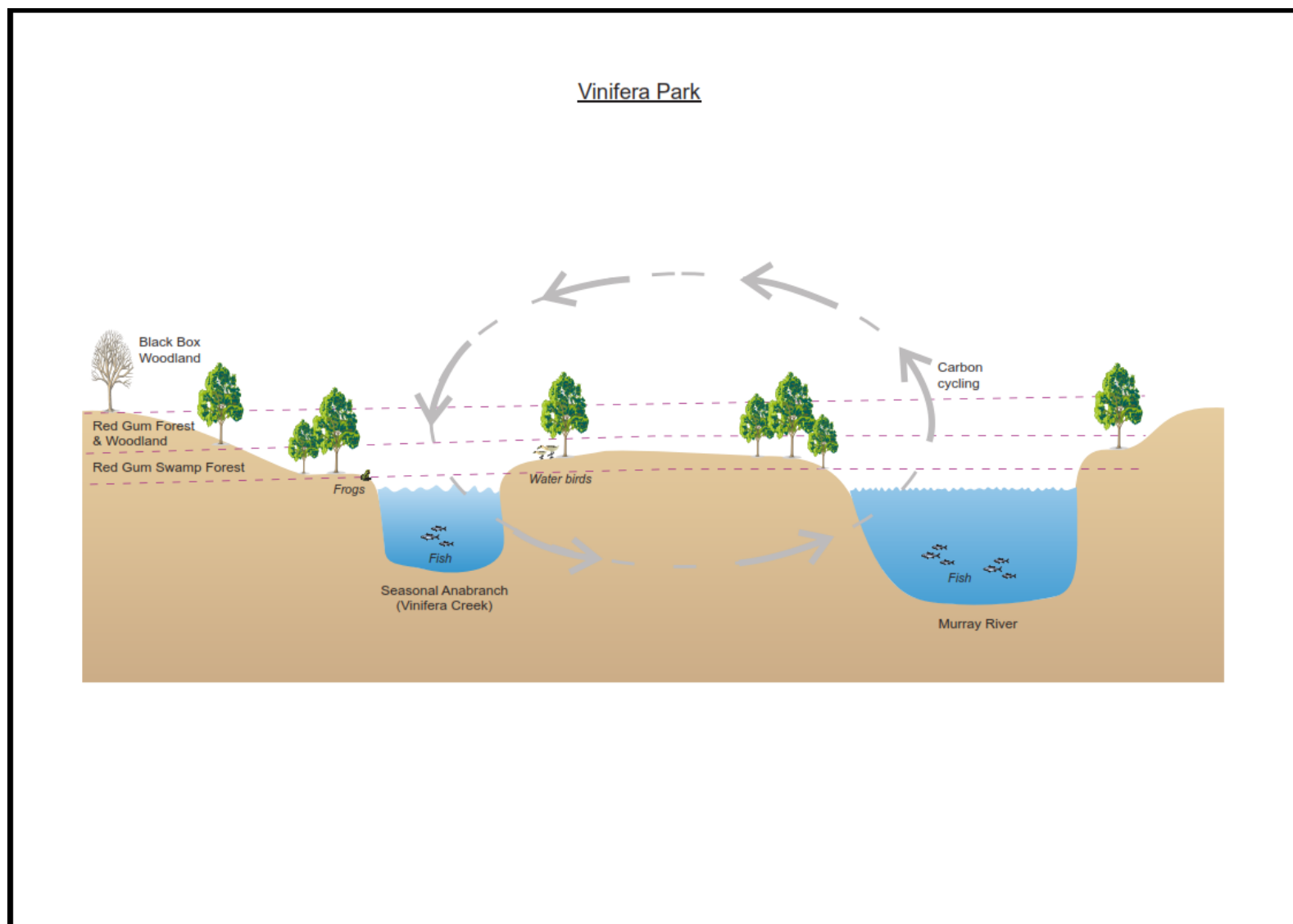


Figure 5 - Conceptual model of the Vinifera landscape

Table 3 - Vinifera Park Water Regime Classes and water dependant ecological values

Water Regime Class	Ecological values
Seasonal Wetland	River Red Gum Aquatic macrophytes Native fish Native frogs Habitat for waterbirds, including colonial nesting species
Red Gum Swamp Forest	Native fish Native frogs Habitat for waterbirds, including colonial nesting species Organic carbon
Red Gum Forest and Woodland	Native fish Native frogs Habitat for waterbirds, including colonial nesting species Carpet Python, Sugar Glider and Grey-crowned Babbler Organic carbon
Black Box Woodland	Habitat for waterbirds, including colonial nesting species Carpet Python, Sugar Glider and Grey-crowned Babbler Organic carbon

2.4 Land status and management

There are many agencies and individuals involved in managing the public and private land in the Nyah and Vinifera parks. Land management boundaries are shown in

(Nyah) and Figure 7 (Vinifera).

The Nyah and Vinifera parks have historically been managed by the Department of Environment, Land, Water and Planning and its predecessors as State Forest since the 1989 Land Conservation Council Final Recommendations (Land Conservation Council, 1989). Under recommendations from the Victorian Environmental Assessment Council River Red Gum Forests Investigation (VEAC 2008, p 67) the area has been declared a regional park with Parks Victoria as the land manager. This recommendation came into effect in July 2010. It is expected that in future, there will be co-management between the Wadi Wadi community, Parks Victoria and Department of Environment, Land, Water and Planning.

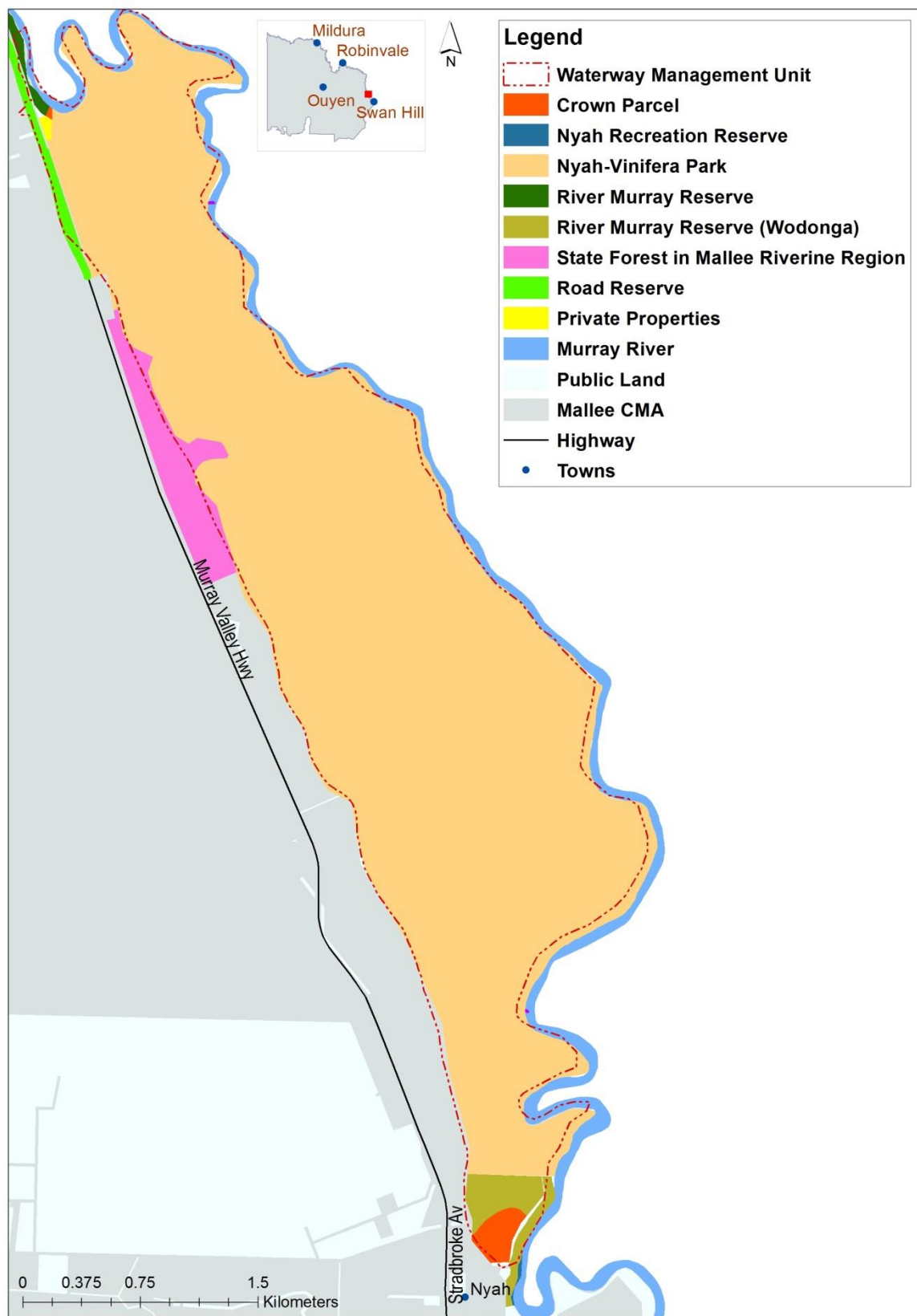


Figure 6 – Nyah Park Land Tenure

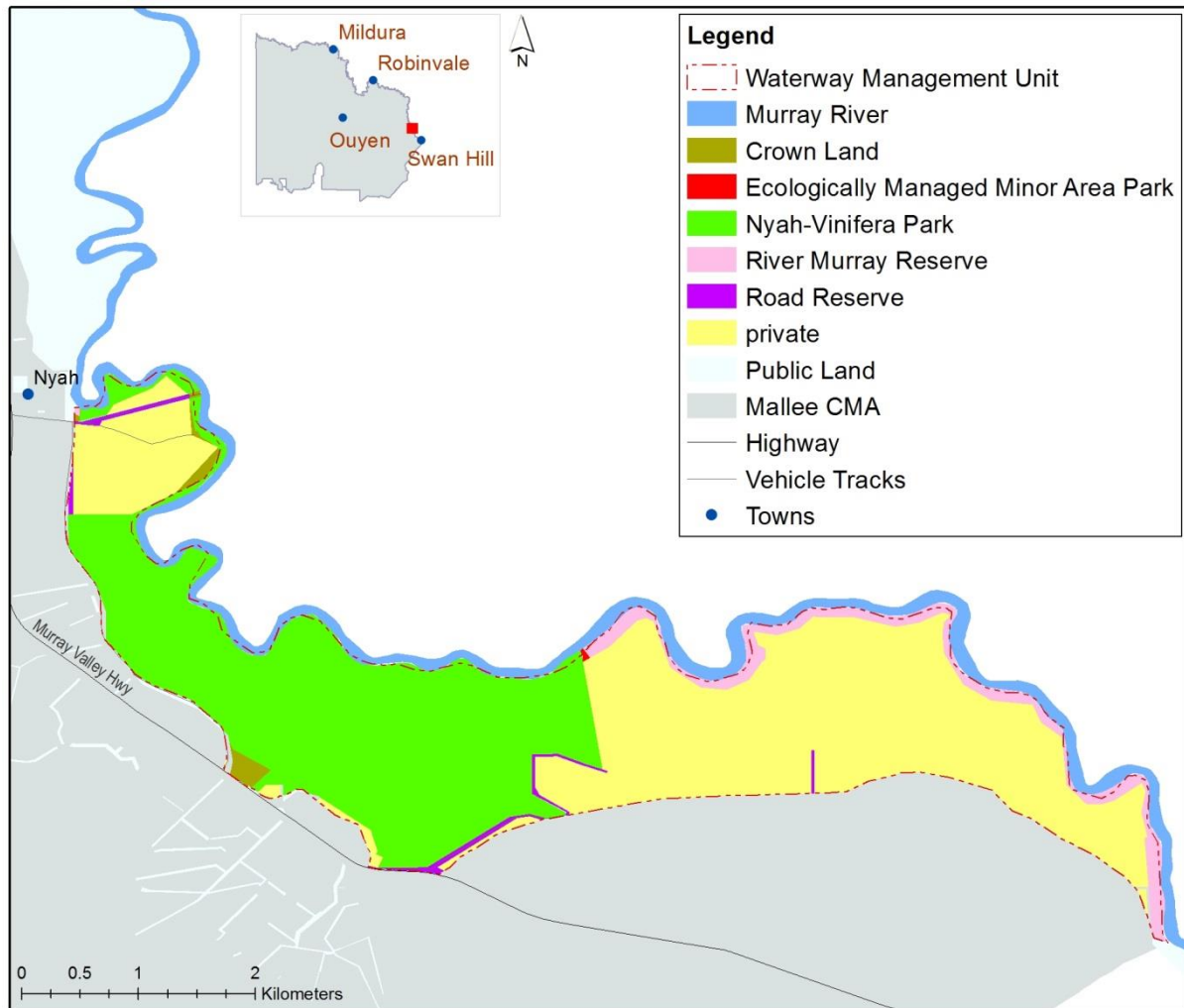


Figure 7 - Vinifera Park Land Tenure

Stakeholders associated with or interested in environmental water management outcomes for Nyah and Vinifera are listed in Table 4.

Table 4 - Stakeholders for Nyah and Vinifera

Group	Role
Parks Victoria	Land Manager. Parks Victoria is responsible for Conserving Victoria's Special Places with the aim to ensure that our valued parks, and the natural assets and cultural heritage they hold, can be enjoyed now and by future generations.
Mallee CMA	The Mallee CMA's responsibility is to ensure that natural resources in the region are managed in an integrated and ecologically sustainable way, including the regional environmental management.
Department of Environment, Land, Water and Planning	State level environmental water management planning, threatened species manager

Group	Role
Victorian Environmental Water Holder	Management of environmental water holdings since July 1 2011.
Mildura Rural City Council	Local Government. Mildura Rural City Council has a number of Water Management Programs to save water resources and improve the health of our waterways. They are responsible for disposing of storm water from Mildura into the southeast drainage basins and for recreational planning.
Aboriginal Stakeholders	Aboriginal Stakeholders. Provides assistance in planning and implementation of programs.
Local Landholders	Surrounding land users, provide assistance in planning and implementation of programs.
Friends of Nyah Forest	Local interest group
Mid Murray Field Naturalists	Flora and Fauna interest
Residents of Nyah, Vinifera, Wood Wood	Social and recreational use

2.6 Wetland characteristics

An overview of the main characteristics of the target areas in both the Nyah and Vinifera parks is outlined in Table 5 and Figure 8 and Figure 9.

Table 5 - Wetland characteristics of Nyah and Vinifera

Characteristics	Nyah	Vinifera
Mapping ID within area (numbers follow Corrick and Norman numbering system)	#7527147125 #7527153101 #7527149129 #7527158096 #7527159102 #7527184029 #7527195021	#7527179022 (Vinifera Creek Wetland) #7527169040 #7527189018 #7527191010 #75274180018
Wetland ID (current)	12583 12584	12507 12508 (Vinifera Creek) 12509 12512
Area (ha)	#7527147125 (1.77) #7527153101(4.05) #7527158096 (48.79) #7527159102 (13.96) Total =68.57 ha	#7527179022 (53.99) #7527169040 (3.73) #7527189018 (33.06) #7527191010 (2.14) #75274180018 (4.39) Total = 97.31ha
Bioregion	Murray Fans	

Characteristics	Nyah	Vinifera
Conservation status	Vulnerable, Depleted, Least Concern	
Land status	Regional Park	
Land manager	Parks Victoria	
Surrounding land use	Regional Park, broad acre dryland cropping, irrigated horticulture, rural townships	
Water supply	Natural inflows from Murray River 12,000ML/day at river gauge 409204	Natural inflows from Murray River 12,500ML/day at river gauge 409204
1788 wetland category	Deep Freshwater Marsh Shallow Freshwater Marsh	
1994 wetland category and sub-category	Deep marsh - open water shallow marsh – herb shallow marsh – lignum	Deep marsh - open water

Characteristics		Nyah	Vinifera
Current wetland categories	Aquatic system	Palustrine or lacustrine	Palustrine or lacustrine
	Salinity regime	Saline	Fresh
	Water regime	Periodically inundated- episodic	Periodically inundated- episodic Periodically inundated- seasonal or episodic (Vinifera Creek)

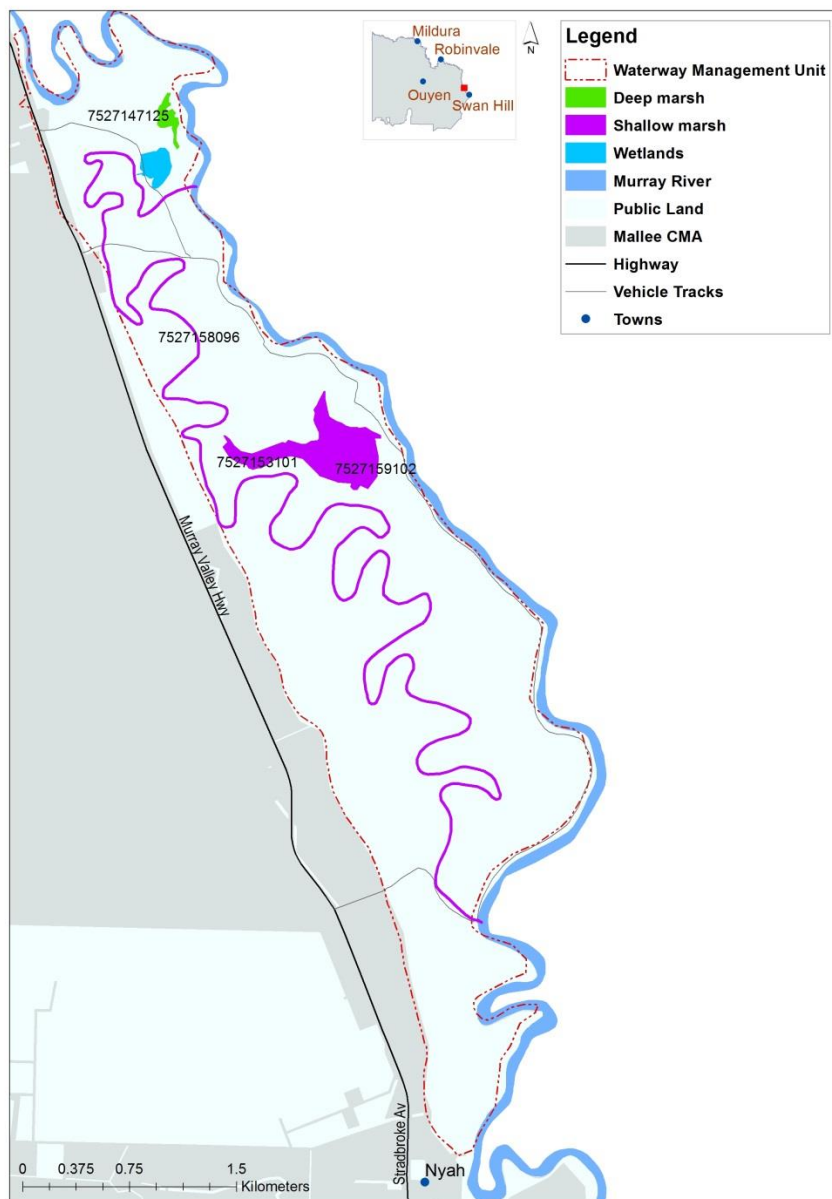


Figure 8 - Nyah Wetland Classification (Corrick and Norman)

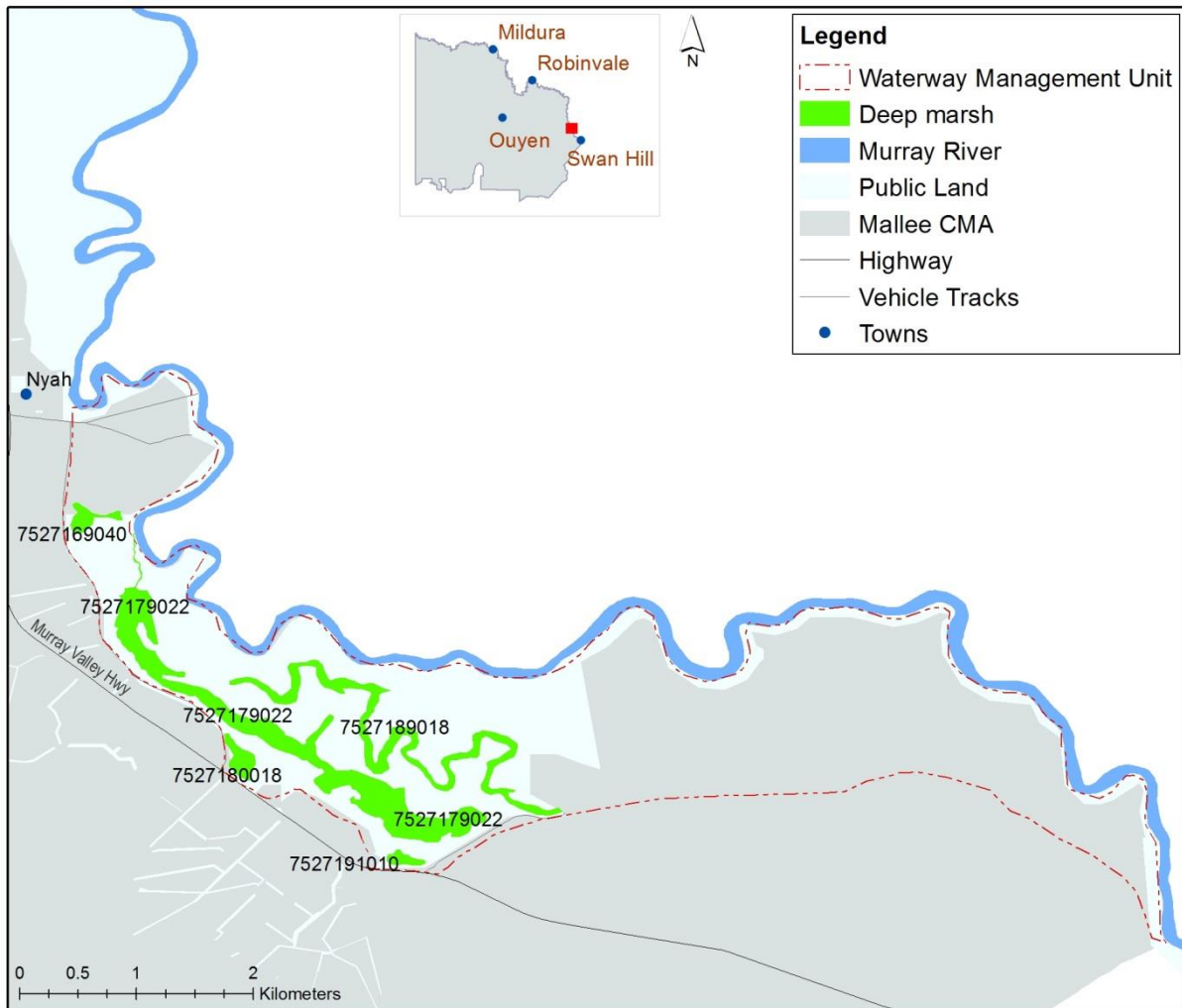


Figure 9 - Vinifera Wetland Classification (Corrick and Norman)

2.7 Management Scale

The whole of the Nyah and Vinifera Parks has a water requirement as a floodplain complex, but the focus for this plan is restricted to specific target areas within both Nyah and Vinifera Parks.

Nyah Park Target Area

The target area is based on the area that can be influenced by works proposed in the Nyah-Vinifera Sustainable Diversion Limit Business Case including track raising and regulators. These are fully detailed in section 8.2. These works will provide inundation of almost 500 hectares of inundation-dependant habitat with a water level of 63.2 m AHD (Ecological Associates 2014b). This includes the Parnee Malloo Creek, seasonal wetlands, Red Gum Swamp Forest and Red Gum Forest Woodlands (see Figure 10).

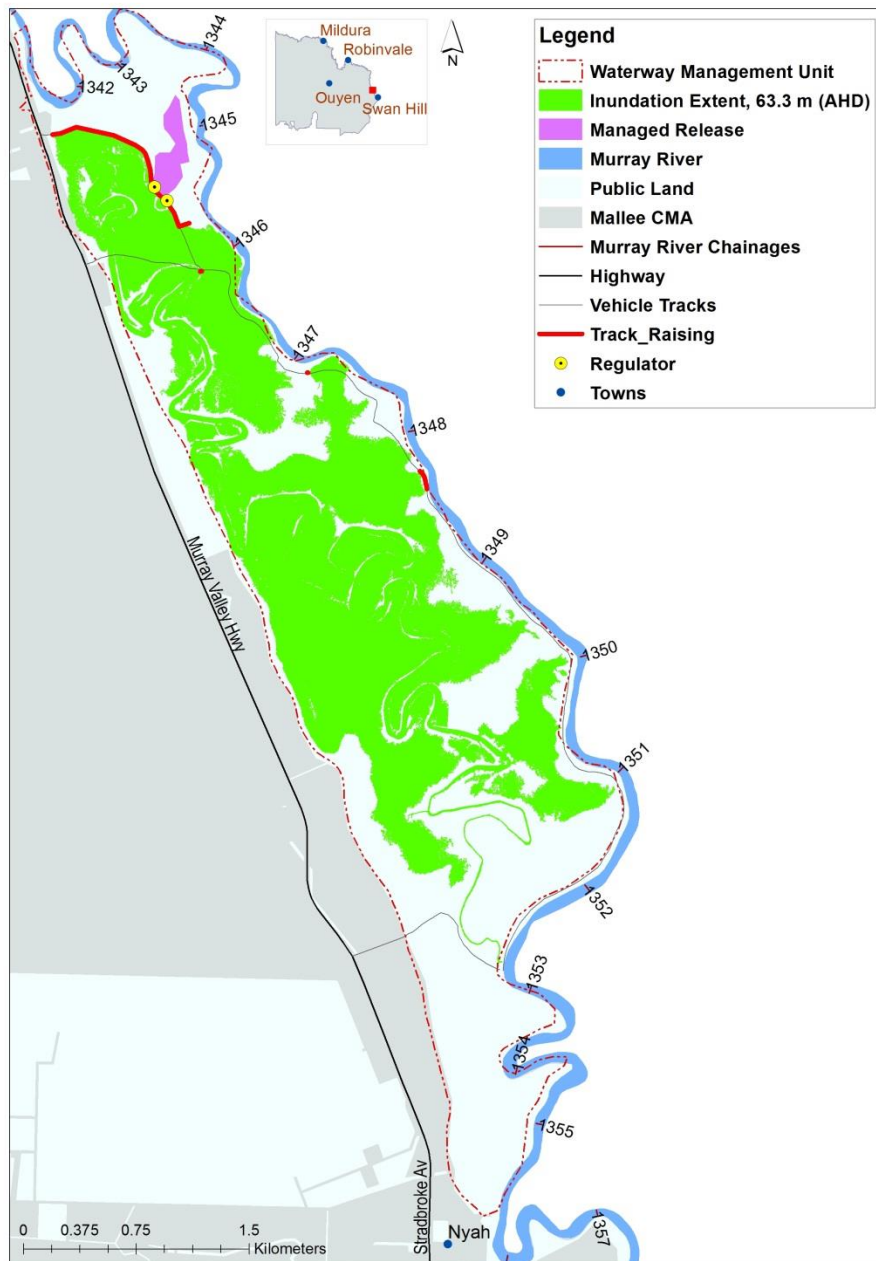


Figure 10 - Nyah target area (Inundation areas)

Vinifera Park Target Area

The target area is based on the area that can be influenced by the works proposed in the SDL Business case, which includes regulators, track raising, pipe culverts and overflow sills. These are fully detailed in section 8.2. This will provide inundation of almost 350 hectares of inundation-dependant habitat with a water level of 64.4 m AHD. This represents 55% of the total forest area and almost all of the flood dependent communities found within the forest (Ecological Associates 2014c). This includes the Vinifera Creek, seasonal wetlands, River Red Gum Swamp Forest, River Red Gum Forest Woodlands and Black Box Woodlands. See Figure 11.

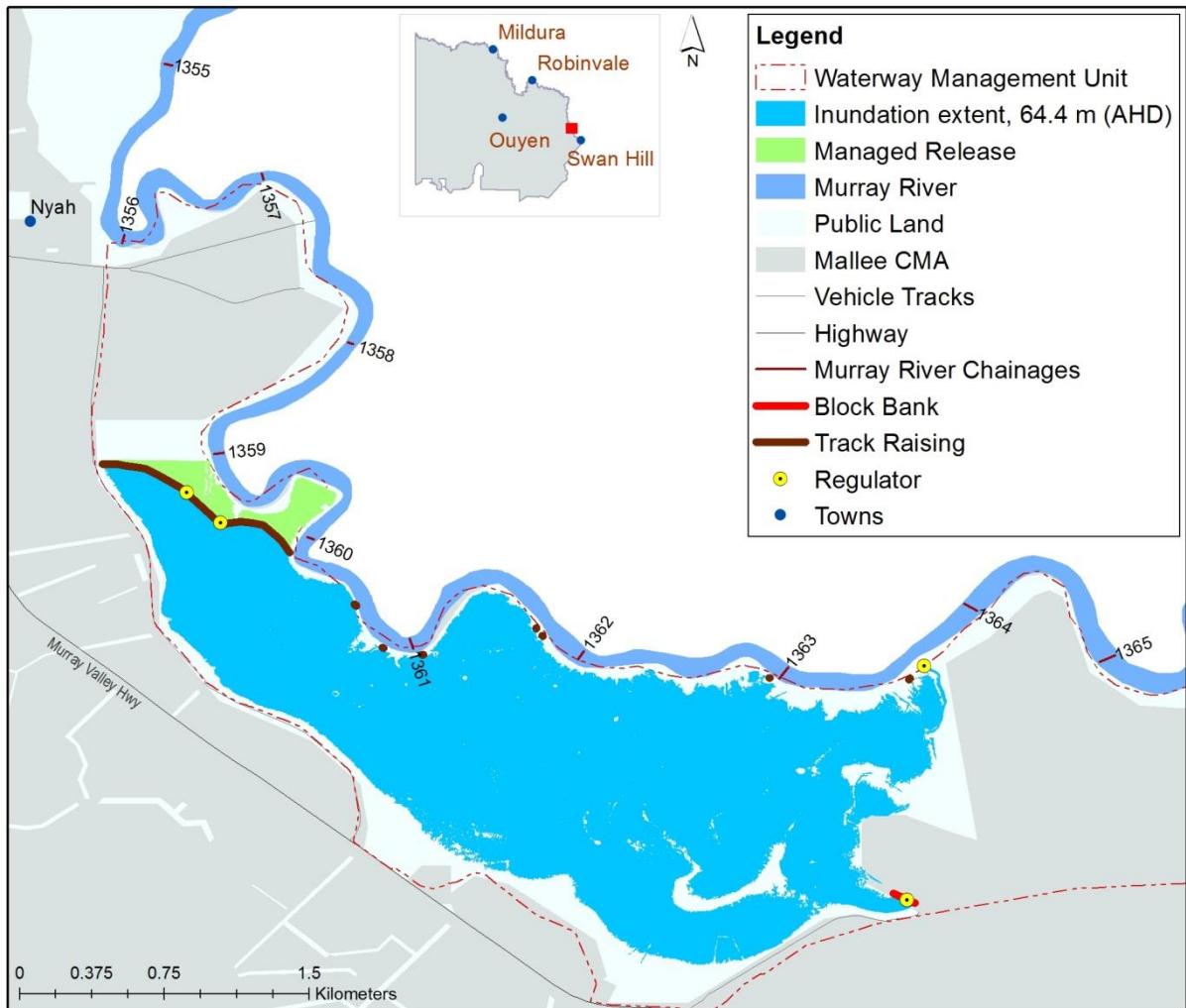


Figure 11 - Vinifera target area (Inundation areas)

2.8 Environmental Water Sources

The Environmental Water Reserve (EWR) is the legally recognised amount of water set aside to meet environmental needs. The Reserve can include minimum river flows, unregulated flows and specific environmental entitlements. Environmental entitlements can be called out of storage when needed and delivered to wetlands or streams to protect their environmental values and health.

The Victorian Minister for Environment, Climate Change and Water appoints Commissioners to Victoria's independent body for holding and managing environmental water – the Victorian Environmental Water Holder (VEWH). The VEWH is responsible for holding and managing Victoria's environmental water entitlements, and making decisions on their use.

Environmental Water for Nyah Vinifera may be sourced from the water entitlements and their agencies listed in Table 6 which is further explained in the Regional Context Document for Environmental Water Management Plans (Sunraysia Environmental 2014).

Table 6 - Summary of environmental water sources available to Nyah and Vinifera

Water Entitlement	Responsible Agency
River Murray Unregulated Flows	Murray Darling Basin Authority
Murray River Surplus Flows	
Victorian River Murray Flora and Fauna Bulk Entitlement	Victorian Environmental Water Holder
Commonwealth water	Commonwealth Environmental Water Holder
Donated Water	Victorian Environmental Water Holder

* Other sources of water may become available through water trading or changes in water entitlements.

2.9 Related Agreements, Policy, Plans and Activities

There are a range of international treaties, conventions and initiatives, as well as National and State Acts, policies and strategies that determine management of the target areas for each park. Those with particular relevance to the two parks and the management of their environmental values are listed in Table 7. For the functions and major elements of each refer to the Regional Context Document (North 2014).

Table 7 - Legislation, agreements, convention and listings relevant to the target areas within the Nyah-Vinifera WMU

Legislation, Agreement or Convention	Jurisdiction
China-Australia Migratory Bird Agreement (CAMBA)	International
<i>Environment Protection and Biodiversity Conservation Act</i> (EPBC)	National
<i>Flora and Fauna Guarantee Act</i> (FFG)	Vic State
Department of Environment, Land, Water and Planning advisory lists (DELWP)	Vic State

Nyah Vinifera is situated on the Victorian floodplain of the Murray River, which is subject to multiple investigations. These include Salinity Management Plans, environmental flow studies and Land Conservation Council reviews. An investigation into River Red Gum Health by the Victorian Environmental Assessment Council (VEAC) in 2008 resulted in Nyah and Vinifera being declared as Regional Parks in 2010.

The following plans and activities are relevant to the environmental management of Nyah and Vinifera.

Basin Plan - Sustainable Diversion Limit

The Basin Plan establishes the legal and policy framework for the use of environmental water in the Murray-Darling Basin. The Basin Plan includes a Sustainable Diversion Limit (SDL) on the amount of water that can be extracted for irrigation and other uses. The SDL is based on an assessment of the water that must be left in the system to maintain ecosystem health. An SDL adjustment mechanism has been established that will either allow equivalent environmental outcomes to be achieved with less water or increase the volume of water available for environmental use with neutral or improve socio-economic impact.

The proposed works at Nyah and Vinifera are two of several proposed by the Victorian Government as having the potential to contribute to the Basin Plan's SDL adjustment mechanism.

This view is based on the understanding that engineering works like flow control regulators, pipes and pumps can achieve similar environmental benefits to a natural flood, using a smaller volume of water to replenish greater areas. Works also allow for environmental watering in areas where system constraints prevent overbank flows and, due to the smaller volumes required, can be used to maintain critical refuge habitat during droughts.

Investigation of Water Management Options for the River Murray – Nyah to Robinvale

In 2006, Mallee CMA engaged consultants Ecological Associates to investigate water management options for the floodplain of the Murray River from Nyah to Robinvale. This investigation proposed infrastructure to enable greater inundation of the target area in Nyah Vinifera which is outlined as part of this plan.

Mallee Waterway Strategy

The Mallee Waterway Strategy applies a framework for targeting the delivery of management activities in the Mallee Region, including for Nyah and Vinifera Parks. These management activities include improving water quality, hydrology, aquatic habitat, riparian habitat and recording cultural heritage sites.

Preliminary salinity impact assessment for Mallee environmental water projects

SKM undertook a recent study on select Mallee environmental water projects which included Nyah and Vinifera (SKM 2013). This study was undertaken to identify if the proposed watering would have an impact on an area highlighted under the Basin Salinity Management Strategy (BSMS). The BSMS is implemented through a series of registers that track salinity credits and debits. Actions are identified as significant if they are assessed to change the average river salinity measurement at Morgan in South Australia by 0.1 EC or more within 30 years (Telfer, 2014).

According to SKM (2013) the largest component of the salinity impact from the proposed capital works at Nyah and Vinifera was associated with the displacement of groundwater due to diffuse recharge following inundation, but even these impacts remained insignificant.

3. Hydrology and System Operations

Wetland hydrology is the most important determinant in the establishment and maintenance of wetland types and processes. It affects the chemical and physical aspects of the wetland which in turn affects the type of flora and fauna that the wetland supports (DSE 2005). A wetland's hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (Mitsch and Gosselink, 2000 in DSE 2005). Duration, frequency and seasonality (timing) are the main components of the hydrological regime for wetlands and rivers.

The target area within the Nyah and Vinifera Parks is located downstream of the river gauge at Swan Hill (409204).

3.1 Water Management and Delivery

3.1.1 Pre-regulation

Prior to river regulation in the reach of the Murray River past Nyah and Vinifera, the floodplain experienced inundation more frequently and lasted two to three times longer. For example, flow events of 20,000 ML/day occurred on average 130 times per 100 years compared with 80 times per 100 years post regulation, and the median duration pre regulation was 130 days compared to 45 days post regulation. High flow events of 30,000 ML/day still occur on average every eight to 10 years (Ecological Associates 2014b). The wetlands within the target area of Nyah and Vinifera require flows of between 5,000 and 27,000 ML/day to commence to flow (Green and Alexander, 2006). These thresholds would have been met by these more frequent events more than once a year and stayed inundated longer pre river regulation.

The seasonal distribution of flows in this section of the Murray River shows that, despite a reduction in discharge, the river retains the same annual pattern of higher flows in Winter and Spring with lower flows in Summer and Autumn (Figure 12).

Nyah Park

Water first enters Nyah Park at the downstream end of Parnee Malloo Creek. The upstream connection of the channel is connected soon after with through-flow occurring at river discharges approaching 12,500 ML/d. As river levels continue to rise above 17,500 ML/d, water spills from Parnee Malloo Creek to adjacent wetlands. Effluents along the river bank also introduce water to wetlands, the most important of which is Green Swamp which is flooded at river levels over 20,000 ML/d. Water spreads through the forest understorey as river levels rise and at river discharges exceeding 25,000 ML/d flood water approaches the higher ground along the river levee and terrestrial boundary of the floodplain (Ecological Associates 2014b).

Vinifera Park

Vinifera Creek is the collection of watercourses and wetlands in the Vinifera floodplain. Water enters the creek from the Murray River at flows of 12,500 ML/d. At higher flows minor effluents along the river bank also contribute water to the creek.

Water spills from Vinifera Creek to the general forest floor as river flows exceed 15,000 ML/d, filling the seasonal wetlands within the Park. Most of the forest is inundated at 17,500 ML/d which would have occurred in most years for a median duration of five months. Red gum forest and black box woodland on the terrestrial fringe of the floodplain is inundated when river levels exceed 20,000 ML/d.

Most of the forest drains freely as river levels fall. However, wetlands can retain water and can remain flooded between annual inflow events (Ecological Associates 2014c).

3.1.2 Post-regulation

In this part of the Murray River, the frequency, duration and magnitude of all but the largest floods have been reduced due to effects of major storages in the Murray River and its tributaries (Thoms *et al*, 2000).

At Nyah Park, the spread of water in the Parnee Malloo Creek is currently impeded by levees from redundant irrigation infrastructure and now provides access to the forest during inundation. Two earthen banks create a water storage in the creek that is filled by water pumped from the River Murray. This was originally used by the Nyah Golf Club and is now used as a fire water supply by two landholders.

Vinifera is a low-lying floodplain area that was reliably inundated in spring under natural (without regulation) flow conditions. Water commences entering Vinifera Creek at river flows of 12,500 ML/d, inundating low lying watercourses and wetlands on the floodplain. The creek commences spilling at flows above 15,000 ML/d and by 17,500 ML/d most of the forest is flooded. Red gum and black box on the terrestrial fringe of the forest is inundated when river levels exceed 25,000 ML/d.

Key changes to the hydrology of Nyah Park and Vinifera under current (regulated) conditions:

- Median monthly flow peaks have declined under current conditions, with the greatest impacts being in the high flow months from June to January (Figure 12);
- The frequency and duration of flow peaks greater than 10,000 ML/d has declined;
- Flows of 10,000 to 15,000 ML/d, which would have occurred almost 15 times every 10 years under natural conditions, last only five weeks rather than the five month median duration under natural conditions at Nyah Park, and have almost halved at Vinifera;
- At Vinifera, the frequency and duration of 17,500 ML/d has declined by approximately 30 percent (Ecological Associates 2014c).
- At Nyah Park, the duration of events which reach the upper extent of River Red Gum forest communities (25,000 ML/d) has almost halved from 75 days to 30. The frequency of these events has also declined significantly from 10 events every 10 years to only six (Ecological Associate 2014b).

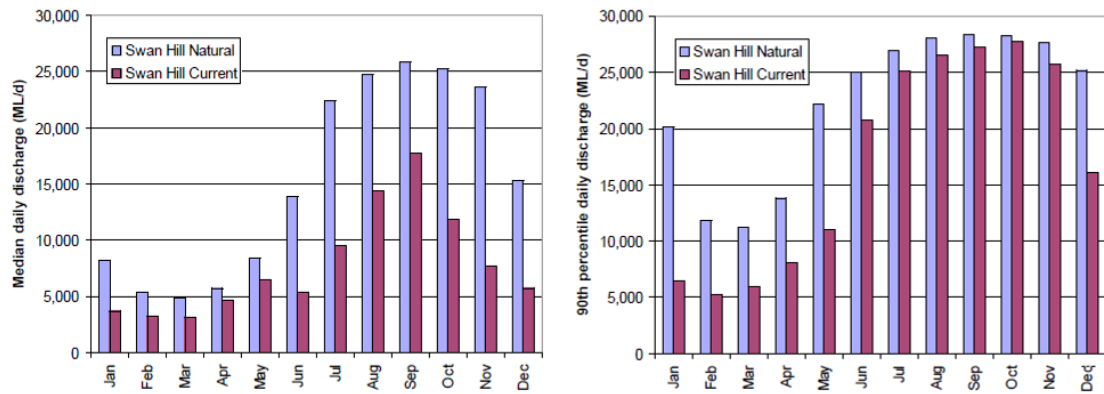


Figure 12 - Distribution of median flows and 90th percentile flows for each month in the River Murray through Nyah to Robinvale section for natural and current (benchmark) conditions. Source: derived from MDBC MSM-Bigmod 109-year data (Ecological Associates 2006)

3.1.3 Environmental watering

Environmental watering began in Nyah Park in 2005 as emergency River Red Gum watering. The water for these events was from various sources as outlined in Table 8. The initial purpose of the emergency watering program was to address the decline in River Red Gum health due to the prolonged dry conditions associated with the Millennium Drought. The watering filled two wetlands and flooded the adjacent riparian zone and was effective in improving the health of trees lining the creeks and wetlands in the target area. It had the added benefit of providing some drought refuge for waterbirds. Anecdotal evidence indicated a positive response by the River Red Gums to the watering through increased foliage vigour.

Once the trees began to respond positively to the environmental watering and dry conditions abated, the purpose of the environmental watering changed from emergency response to long term sustainability of the system.

Table 8 - A summary of recent environmental watering events in Nyah Park

Water year	Time of inflow	Inflow source	Source volume (ML)	Total volume (ML)	Area (ha) Inundated
2004/05	Autumn	Environmental water	153	153	35
2005/06	Spring	Environmental water	560	1241	110
		Environmental water	681		
	Autumn	Environmental water	500	500	110
2009/10	Autumn	Environmental water	2125.8	2125.8	165.36
2010/11	Spring	Environmental Water	161.52	161.52	
2010/11	Spring, Summer and Autumn	Natural flows	-	-	1867
2014/15	Autumn and Winter	Environmental water	1266	1266	145
2015/16	Spring	Environmental water	750	789.5	
2016/17	Spring	Natural flows	-	-	1159

2017/18	Spring	Environmental Water	1877.13	1877.13	244
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Currently environmental water can be pumped into Nyah Park from the Murray River into the creeks and held on the floodplain, covering an area of 244 ha. This requires the use of diesel pumps and temporary earth block banks to maintain the water on the floodplain and prevent the water flowing back into the river at low points (Figure 13). The extent of inundation can be increased by further infrastructure described in Section 8.2 below.



Figure 13 - Current inundation extent of Nyah Park

Vinifera did not receive environmental water during the emergency response period as the condition of the River Red Gums was of less concern.

Environmental watering began in 2015 to support the long term sustainability of the wetland, Table 9.

Table 9 A summary of recent environmental watering events in Vinifera Park

Water year	Time of inflow	Inflow source	Source volume (ML)	Total volume (ML)	Area (ha) Inundated
2010/11	Spring, Summer and Autumn	Natural flows	-	-	
2014/15	Autumn and Winter	Environmental water	500	500	65
2015/16	Spring	Environmental water	399.851	399.851	
2016/17	Spring	Natural flows	-	-	-
2017/18	Spring	Environmental Water	925.135	925.135	78

Currently environmental water can be pumped into Vinifera Park from the Murray River into the creeks and held on the floodplain, covering an area of 78 ha. This requires the use of diesel pumps, culvert blockages and temporary earth block banks to maintain the water on the floodplain and prevent the water flowing back into the river at low points (Figure 134). The extent of inundation can be increased by further infrastructure described in Section 8.2 below.



Figure 144 - Current inundation extent of Vinifera Park

4. Water Dependent Values

4.1 Environmental Values

Wetlands and waterways on the floodplain are a vital component of the landscape supporting a vast array of flora and fauna which may vary greatly with the type of wetland/waterway system. The habitat provided by vegetation communities around wetlands is essential for maintaining populations of water dependent fauna species. Other ecological functions provided by floodplain complexes include water filtration, slowing surface water flow to reduce soil erosion, flood mitigation and reducing nutrient input into waterways. Protecting the ecological functioning of wetlands ensures these vital services are maintained.

4.1.1 Listings and significance

Fauna

Nyah Park

Nyah-Vinifera consists of a series of wetlands, creeks and River Red Gum forests that provide habitat for a large range of fauna. This includes water dependent species which will benefit from the wetlands in the target area receiving water on a more regular basis (MCMA 2010).

Several fauna species common in this bioregion are at or near the downstream limit of their range in this area, including Sugar Glider (*Petaurus breviceps*) and Black Wallaby (*Wallabia bicolor*). The forests support breeding by colonial nesting waterbirds and provide habitat for woodland fauna that require dense and productive understorey (Ecological Associates 2014a).

The nationally Vulnerable (EPBC Act) Regent Parrot (*Polytelis anthopeplus monarchoides*) nest at Nyah. These birds feed in nearby mallee woodland and depend on large, healthy River Red Gum near the River Murray to provide nesting hollows (Ecological Associates 2014a).

The Endangered (FFG) Broad Shelled Turtle was found in Parnee Malloo creek, Nyah forest, in Spring 2017 by the Arthur Rylan Institute. The environmental watering program has supported permanent, deep water habitat and prey (small fish and shrimp) suitable for the freshwater turtle.

Nyah Park supports an important population of Grey-crowned Babbler (*Pomatostomus temporalis*). These birds depend on large, rough-barked trees in a forest community with a complex understorey of grasses, shrubs and timber. Flooding maintains the productivity of the ecosystem, including the insect fauna on which grey-crowned babbler depend (Ecological Associates 2014a).

Nyah Forest has a diverse microchiropteran bat fauna with ten species reported from the site. One of the species, Yellow-bellied Sheath-tailed Bat (*Saccolaimus flaviventris*), is listed under the Victorian FFG Act. The bats are largely insectivorous and depend on high levels of forest productivity to provide prey. They roost in the crevices and hollows of *Eucalyptus camaldulensis* and *E. largiflorens* trees (Ecological Associates 2014a).

Nyah Park supports threatened reptiles such as the Inland Carpet Python (*Morelia spilota metcalfei*) and Lace Monitor (*Varanus varius*). High levels of forest productivity are required to provide the birds, possums, gliders and other small vertebrate prey on which these predators depend. Refuge habitat is provided by tree hollows and logs on the forest floor (Ecological Associates 2014a).

The floodplain includes wetlands in floodplain depressions adjacent to Parnee Malloo Creek. Under a natural flow regime, these wetlands would have been flooded almost annually and frequently remained flooded throughout the year. Persistent annual flooding would have excluded trees and supported a community of marshland plants including Spiny Mudgrass. Growing Grass

Frog (*Litoria raniformis*), Murray-Darling Rainbowfish (*Melanotaenia fluviatilis*) and other aquatic species that depend on permanent aquatic habitat would have expanded from these refuges into the forest understorey during spring floods (Ecological Associates 2014a).

Nyah Park has a diverse avifauna with over 140 bird species reported from the site and the local vicinity many of which have conservation significance in Victoria or under the federal EPBC Act 1999.

Wetlands provide habitat for dabbling, diving and filter feeding ducks while fish provide prey for waterbirds such as White-bellied Sea-eagle (*Haliaeetus leucogaster*). Large wading birds such as egrets, herons and spoonbill will prey on macroinvertebrates, frogs and small fish and will make use of large woody debris and emergent macrophytes for cover.

Semi-permanent wetlands, such as Green Swamp in Nyah Park, that are surrounded by frequently flooded red gum forest provide breeding habitat for colonial nesting waterbirds.

Of special interest and responsibility are the species listed in legislation previously recorded at Nyah Park (Table **Error! Reference source not found.**10)². Many of these species are strictly water-dependent while others may rely on flood events or other characters of the water ecosystem for foraging or to trigger biological events such as breeding. A full list of all fauna previously recorded within the area is provided in Appendix 1.

Table 10 Listed fauna recorded at the Nyah Park site (Mallee CMA 2010, ARI 2013, Brown, Bryant and Horrocks 2013 in Ecological Associates 2014a)

Scientific Name	Common Name	EPBC	FFG	DELWP	Ecological Associates 2014a	ARI 2013	MCMA 2010
MAMMALS							
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail Bat		L	DD	✓		
BIRDS							
<i>Polytelis anthopeplus monarchoides</i>	Regent Parrot*	VU	L	VU			✓
<i>Lophochroa leadbeateri</i>	Major Mitchell's Cockatoo		L	VU	✓		
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	Mi	L	VU	✓		
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler*		L	EN		✓	

² NB records from databases have not been included.

Scientific Name	Common Name	EPBC	FFG	DELWP	Ecological Associates 2014a	ARI 2013	MCMA 2010
<i>Ardea modesta</i>	Eastern Great Egret	Mi	L	VU			✓
<i>Nycticorax caledonicus</i>	Nankeen Night Heron			NT	✓	✓	✓
<i>Anas rhynchotis</i>	Australasian Shoveler			VU			✓
<i>Aythya australis</i>	Hardhead			VU			✓
<i>Biziura lobata</i>	Musk Duck			VU	✓		✓
<i>Platalea regia</i>	Royal Spoonbill			NT			✓
	REPTILES						
<i>Morelia spilota mectcalfei</i>	Carpet Python*		L	EN	✓		✓
<i>Chelodina longicollis</i>	Common Long-necked Turtle			DD	✓		
<i>Chelodina expansa</i>	Broad Shelled Turtle		L	EN			
<i>Pogona barbata</i>	Eastern Bearded Dragon			VU	✓		
<i>Varanus varius</i>	Lace Monitor			EN	✓		
	FROGS						
<i>Litoria raniformis</i>	Growling Grass Frog	VU	L	EN			✓
	INVERTEBRATES						
<i>Notopala sublineata</i>	River Snail		L	CR			✓

LegendEPBC status: Vulnerable, MigratoryFFG status: Listed as threatened

DELWP status: CRitically endangered, Endangered, Vulnerable, Near Threatened, Data Deficient,

*Species are included as water dependent due to habitat requirements

These species are considered water dependent (or at least dependent on habitat that is water dependent) because they forage or nest in or over water, or require flooding to trigger breeding and fledging. The list includes the Regent Parrot which is indirectly dependent on water as they require riparian trees for nesting habitat.

The floodplain includes wetlands along Vinifera Creek. Under a natural flow regime, these wetlands would have been flooded almost annually and frequently remained flooded throughout the year. Persistent annual flooding would have excluded trees and supported a community of marshland plants including Spiny Mudgrass, frogs, small fish and other aquatic species that depend on permanent aquatic habitat would have expanded from these refuges into the forest understorey during floods (Ecological Associates 2014a).

Wetlands provide habitat for dabbling, diving and filter feeding ducks while fish provide prey for waterbirds such as White-bellied Sea-eagle. Large wading birds such as egrets, herons and spoonbill will prey on macroinvertebrates, frogs and small fish and will make use of large woody debris and emergent macrophytes for cover (Ecological Associates 2014a).

Seasonally flooded wetlands, that are surrounded by frequently flooded red gum forest provide breeding habitat for colonial nesting waterbirds. Vinifera is known as a breeding area the colonial nesting waterbirds cormorant and Australasian Darter (*Anhinga novaehollandiae*) (Ecological Associates 2006) and may also support breeding by Royal Spoonbill (*Platalea regia*) and Nankeen Night-heron (*Nycticorax caledonicus*) (Ecological Associates 2014a).

While not reported from Vinifera Park, the floodplain potentially provides habitat for Regent Parrot (EPBC vulnerable, DEPI vulnerable, FFG) which feeds in the mallee and depends on tree hollows provided on the floodplain.

Vinifera Forest has a diverse microchiropteran bat fauna with eleven species reported from the site (**Error! Reference source not found.**). The bats are largely insectivorous and depend on high levels of forest productivity to provide prey. They roost in the crevices and hollows of *Eucalyptus camaldulensis* and *E. largiflorens* trees (Ecological Associates 2014a).

The forest provides a variety of complex habitats in understorey vegetation, litter, woody debris, shrubby vegetation tree bark, crevices and hollows. Flooding maintains the structure of these habitat components and high levels of productivity which provide food for reptiles and amphibians in the form of vegetation, invertebrates and small birds and mammals (Ecological Associates 2014a).

Vinifera is a low-lying floodplain area that is reliably inundated in spring by elevated river flows. Under a restored water regime, the wetland and flooded forest areas would provide reliable refuge and breeding habitat for aquatic fauna and waterbirds.

Of special interest and responsibility are the species listed in legislation previously recorded at Vinifera Park (Table 11**Error! Reference source not found.**)³. Many of these species are strictly water dependent others may rely on flood events or other characters of the water ecosystem for foraging or to trigger biological events such as breeding. A full list of all fauna previously recorded within the WMU is provided in Appendix 1.

³ NB records from databases have not been included.

Table 11 Listed fauna recorded at the Vinifera Park site (Mallee CMA 2010, ARI 2013, Brown, Bryant and Horrocks 2013 in Ecological Associates 2014a)

Scientific Name	Common Name	EPBC	FFG	DSE	Ecological Associates 2014a	ARI 2013	MCMA 2010
MAMMAL							
<i>Scotorepens greyii</i>	Little Broad-nosed Bat			NT	✓	✓	
BIRD							
<i>Ardea modesta (=alba)</i>	Eastern Great Egret	Mi	L	VU			✓
<i>Polytelis anthopeplus</i>	Regent Parrot*	VU	L	VU			✓
<i>Cacatua leadbeateri</i>	Major Mitchell's Cockatoo*		L	VU	✓		
<i>Nycticorax caledonicus</i>	Nankeen Night Heron			NT	✓		✓
<i>Anas rhynchotis</i>	Australasian Shoveler			VU		✓	✓
<i>Aythya australis</i>	Hardhead			VU		✓	✓
<i>Biziura lobata</i>	Musk Duck			VU			✓
<i>Platalea regia</i>	Royal Spoonbill			NT			✓
REPTILE							
<i>Morelia spilota metcalfei</i>	Carpet Python*		L	EN			✓
FROG							
<i>Litoria raniformis</i>	Growling Grass Frog	VU	L	EN			✓
INVERTEBRATE							
<i>Notopala sublineata</i>	River Snail		L	CR			✓

Legend**EPBC status:** Vulnerable, Migratory**FFG status:** Listed as threatened**DELWP status:** Critically endangered, Endangered, Vulnerable, Near Threatened, Data Deficient,

*Species are included as water dependent due to habitat requirements

*Species are included as water dependent due to habitat requirements

These species are considered water dependent (or at least dependent on habitat that is water dependent) because they forage or nest in or over water, or require flooding to trigger breeding and fledging. The list includes the Regent Parrot which is indirectly dependent on water as they require riparian trees for nesting habitat.

Fish and Crayfish

The same ten native fish species and one crayfish species (Nyah Park only) are encountered regularly in the River Murray near Nyah Park and near Vinifera Park and could be expected to at least occasionally occur within floodplain wetlands. Wetlands and flooded forest provide habitat for a range of small fish that benefit from submerged aquatic vegetation, woody debris and plant, biofilm and invertebrate food sources (Ecological Associates 2014a).

The following table (Table 12 **Error! Reference source not found.**) identifies the native fish expected to occur at both Nyah Park and Vinifera Park (Ecological Associates 2014a).

Table 12 Native fish expected to occur at Nyah Park and Vinifera Park

Scientific Name	Common Name	Conservation Status		
		EPBC	FFG	DELWP
FISH				
<i>Bidyanus bidyanus</i>	Silver Perch		L	V
<i>Craterocephalus stercusmuscarum fulvus</i>	Fly-specked Hardyhead			
<i>Hypseleotris klunzingeri</i>	Carp Gudgeon			
<i>Maccullochella peelii peelii</i>	Murray Cod	V	L	V
<i>Macquaria ambigua</i>	Golden Perch		I	NT
<i>Melanotaenia fluviatilis</i>	Murray-Darling Rainbowfish		L	V
<i>Nematalosa erebi</i>	Bony Herring			
<i>Phyllipnodon grandiceps</i>	Flathead Gudgeon			
<i>Retropinna semoni</i>	Australian Smelt			
<i>Tandanus tandanus</i>	Freshwater Catfish		L	E
CRAYFISH				
<i>Euastacus armatus*</i>	River Murray Crayfish		L	NT

Legend

*Nyah Park only

EPBC status: Vulnerable,

FFG status: Listed as threatened, Ineligible for listing

DELWP status: Endangered, Vulnerable, Near Threatened

Nyah Park

Seasonal fast-flowing habitat in Parnee Malloo Creek will provide habitat for large-bodied channel specialists, specifically Murray Cod, Golden Perch and Silver Perch. The restoration of wetland habitat would potentially support resident populations include Murray-Darling Rainbowfish, Carp Gudgeon, Flathead Gudgeon, Australian Smelt and River Murray Crayfish which would promote the ecological objectives of water management at this Park.

Vinifera Park

The large channel-specialist fish species of Murray Cod, Silver Perch and Golden Perch are unlikely to use the floodplain to a significant degree. The restoration of wetland habitat would potentially support resident populations of Murray-Darling Rainbowfish, Carp Gudgeon, Flathead Gudgeon and Australian Smelt which would support the ecological objectives for this site.

Frogs

One of the key ecological objectives of the project is to restore resident populations of frogs at Nyah and Vinifera Parks. Like most flood dependent species, frogs respond to the timing, duration and frequency of flooding, with the timing of inundation being the most significant factor. Close proximity to permanent waterbodies and drought refuges is also important for frogs. Aquatic vegetation complexity is important for many species, particularly at tadpole stage, and can drive occupancy patterns and recruitment success (Tarr & Babbitt 2002, cited in Rogers & Ralph 2011).

Frogs are considered to be good indicators of environmental health and may act as 'sentinel' species for secondary salinisation (DSE 2006). A study by the Arthur Rylah Institute (2006) found that salinity levels up to 3000 EC did not limit amphibian occupancy but amphibian diversity declined significantly between 3000 and 6000 EC.

Inundation of wetlands will provide terrestrial frogs with abundant aquatic invertebrates and flying insects, a substrate for eggs and shelter from predators.

Nyah Park supports six frog species (Table 13 **Error! Reference source not found.**).

Table 13 Frogs recorded at Nyah Park

Scientific Name	Common Name	EPBC	FFG	DSE	Ecological Associates 2014a	ARI 2013	MCMA 2010
<i>Litoria raniformis</i>	Growling Grass Frog	VU	L	EN			✓
<i>Litoria peronii</i>	Peron's Tree Frog				✓	✓	
<i>Crinia parinsignifera</i>	Plains Froglet				✓	✓	
<i>Crinia signifera</i>	Common Froglet				✓		
<i>Limnodynastes dumerilii</i>	Southern Bullfrog				✓	✓	
<i>Limnodynastes tasmaniensis</i>	Spotted Marsh Frog				✓	✓	

Vinifera Park supports four frog species (Table 14 **Error! Reference source not found.**).

Table 14 Frogs recorded at Vinifera Park

Scientific Name	Common Name	EPBC	FFG	DSE	Ecological Associates 2014a	ARI 2013	MCMA 2010
<i>Litoria raniformis</i>	Growling Grass Frog	VU	L	EN			✓
<i>Litoria peronii</i>	Peron's Tree Frog				✓	✓	
<i>Limnodynastes dumerilii</i>	Southern Bullfrog				✓	✓	
<i>Limnodynastes tasmaniensis</i>	Spotted Marsh Frog				✓	✓	

The wetlands are a refuge habitat for frogs such as Southern Bullfrog and Spotted Marsh Frog. Reliable flooding in the wetlands maintains the population, which expands to flooded red gum understorey during floods.

Waterbirds

Nyah

Semi-permanent wetlands, such as Green Swamp in Nyah Park, that are surrounded by frequently flooded red gum forest provide breeding habitat for colonial nesting waterbirds.

Vinifera

Vinifera is known as a breeding area the colonial nesting waterbirds cormorant and Australasian Darter (Ecological Associates 2006) and may also support breeding by Royal Spoonbill and Nankeen Heron.

Australia's waterbirds are often nomadic and take advantage of highly variable and often temporary aquatic resources. The distribution of temporary habitat patches throughout the landscape may facilitate movement and exploitation of available resources for waterbirds (Roshier *et al.* 2001). The provision of environmental water to wetlands is one method of creating such habitat patches for waterbirds, allowing them to move between suitable habitat to survive and reproduce (MDBA 2009). Taft *et al.* (2002, cited in MDBA 2009) states that wetland management which increases the diversity of available habitat types such as variable water depths, mud flats, inundated vegetation and deep water areas have the greatest abundance and diversity of waterbirds. For this reason drawdown patterns are important as they change habitat types and influence waterbird presence (MDBA 2009). Exposed mud flats and fringing vegetation provide ideal feeding grounds for wading birds upon drawdown (DEWNR 2012).

Nankeen Night Herons utilise shallow water for foraging and breed in colonies building stick nests over water (Pizzey and Knight 2007). They are nomadic in response to rainfall and flooding of suitable habitat. Breeding usually occurs from September to February. Nankeen Night Herons have a minimum lag time to breeding of three months from flood, and breeding success is significantly enhanced by longer durations of inundation, up to 12 months (Rogers & Ralph, 2011).

Great Egrets breed on a stick platforms built over water, usually between November and February (Pizzey & Knight 2007). They have a preference for permanent water sites, and forage in water up to 30 cm deep (Rogers & Ralph 2011). Fish are a significant part of the diet (Rogers & Ralph 2011). Nests are built in the forks of trees over water, in colonies (which can be of mixed species). Long lag times for breeding have been recorded, though this may be variable depending on whether flooding occurs during the optimal breeding season of November to May or whether it occurs outside of the main breeding season (in which case the lag period is longer) (Rogers & Ralph 2011). Minimum flood duration needs to be six to seven months to support breeding (Rogers & Ralph 2011).

Vegetation communities

Information on the Ecological Vegetation Classes (EVCs) present at Nyah and Vinifera was compiled from field surveys undertaken by Australian Ecosystems (2012) and GHD (2013). The Nyah and Vinifera Parks are within the Murray Fans Bioregion, and the conservation status of the thirteen EVCs identified during field surveys are outlined in Table 15 **Error! Reference source not found.**

The EVCs present within the Nyah and Vinifera Parks are shown in Figure 155 (Nyah) and Figure 166 (Vinifera).

Table 15 Conservation status of EVCs present at Nyah-Vinifera (Australian Ecosystems 2012, Mallee CMA 2015)

EVC no.	EVC name	Conservation Status	Area (Ha) based on DELWP modelled mapping
103	Riverine Chenopod Woodland	Endangered	No data
308	Aquatic Sedgeland	Endangered*	No data
295	Riverine Grassy Woodland	Vulnerable	3.1
819	Spike-sedge Wetland	Vulnerable	15.1
106	Grassy Riverine Forest	Depleted	11.5
810	Floodway Pond Herbland	Depleted	6.7
811	Grassy Riverine Forest/Floodway Pond Herbland Complex	Depleted	0
812	Grassy Riverine Forest/Riverine Swamp Forest Complex	Depleted	178.5
814	Riverine Swamp Forest	Depleted	126.4
816	Sedgy Riverine Forest	Depleted	44.6
817	Sedgy Riverine Forest/ Riverine Swamp Forest Complex	Depleted	79.6
945	Floodway Pond Herbland/Riverine Swamp Forest Complex	Depleted	No data
821	Tall Marsh	Least Concern	No data

*EVC that is not recognised within the Murray Fans Bioregion, indicating that the conservation status is likely to be Endangered (Australian Ecosystems 2012).

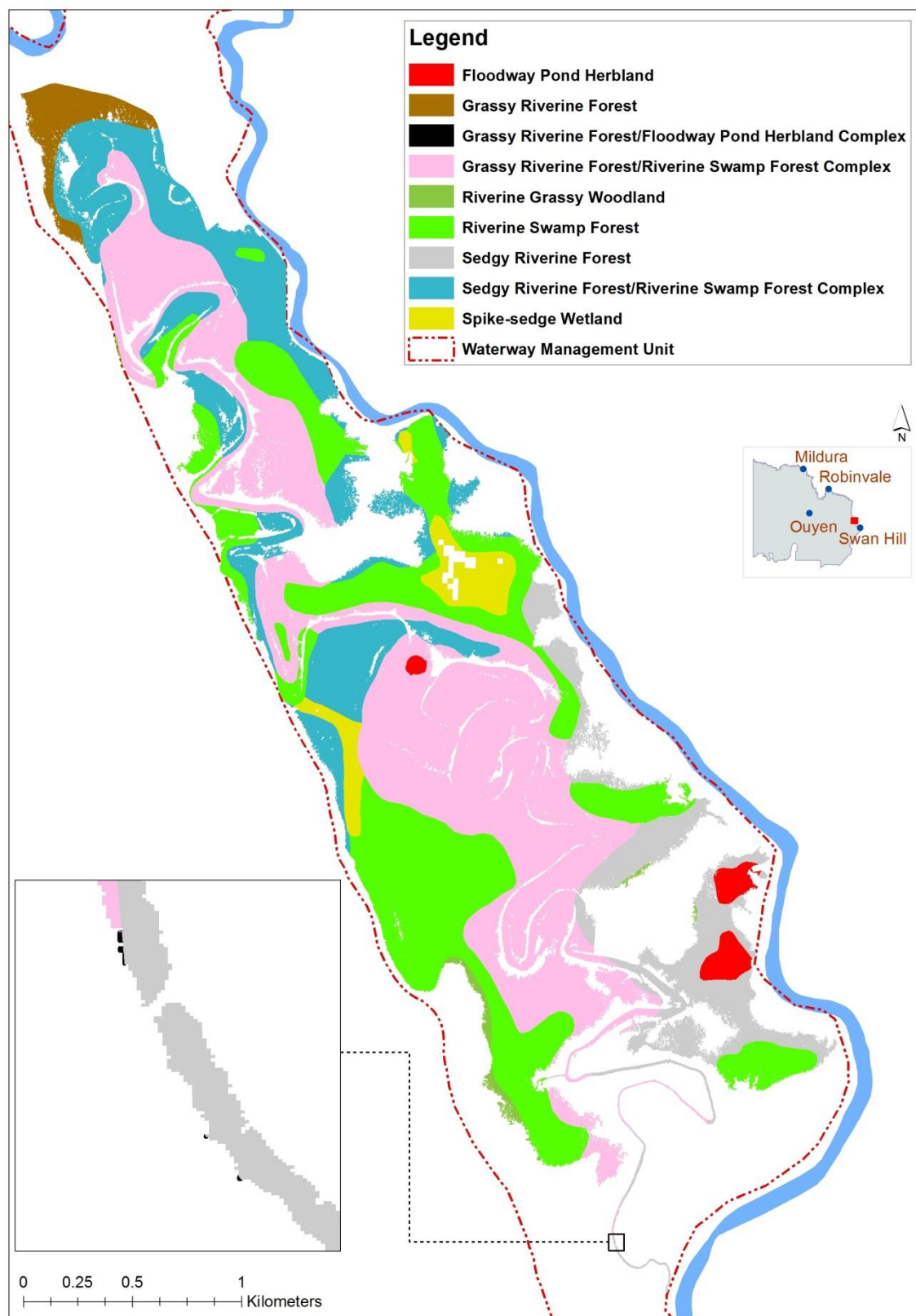


Figure 155 - Ecological Vegetation Classes (EVCs) present within Nyah Park

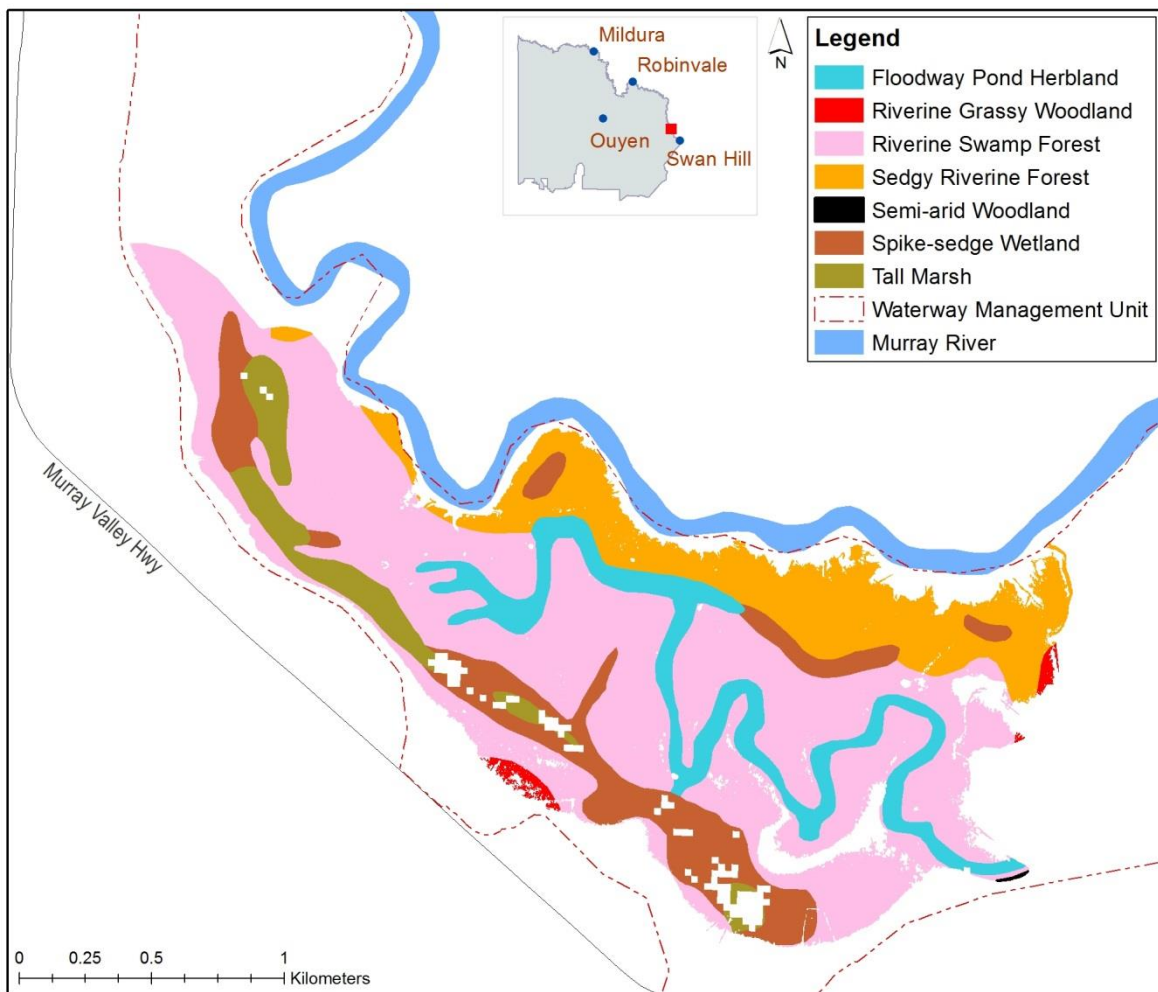


Figure 166 - Ecological Vegetation Classes (EVCs) present within Vinifera Park

Flora

A full list of flora recorded at the Nyah-Vinifera WMU can be found in Appendix 1. Threatened flora species have been recorded during surveys within the WMU: six VROT listed species have been recorded at Nyah Park (see Table 16) and 12 VROT listed species have been recorded at Vinifera Park (one of these species is also listed under the FFG Act) (see 7).

The majority of the listed species (Table 17) occur in EVC's dominated by Lignum, Black Box and River Red Gum and management will be directed towards these species, whose water requirements are well known.

Table 16 Listed flora species recorded at Nyah Park (Australian Ecosystems 2014b)

Scientific name	Common name	Conservation status		
		EPBC	FFG	DELWP
<i>Cardamine moirensis</i>	Riverina Bitter-cress			R
<i>Cuscuta australis</i>	Australian Dodder			R
<i>Dianella porracea</i>	Riverine Flax-lily			V
<i>Glossostigma drummondii</i>	Desert Mud-mat			PK
<i>Senecio campylocarous</i>	Floodplain Fireweed			PK
<i>Senecio cunninghamii</i> var. <i>cunninghamii</i>	Branching Groundsel			R

EPBC status: EXtinct, CRitically endangered, ENdangered, Vulnerable, Conservation Dependent, Not Listed
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DELWP status: presumed EXtinct, Regionally EXtinct, EXtinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

Table 17 Listed water dependent flora species recorded at Vinifera Park (Australian Ecosystems 2014b)

Scientific name	Common name	Conservation status		
		EPBC	FFG	DELWP
<i>Asperula gemella</i>	Twin-leaf Bedstraw			R
<i>Cardamine moirensis</i>	Riverina Bitter-cress			R
<i>Cuscuta australis</i>	Australian Dodder			R
<i>Cynodon dactylon</i> var. <i>dactylon</i>	Native Couch			V
<i>Cyperus pygmaeus</i>	Dwarf Flat-sedge			V

Scientific name	Common name	Conservation status		
		EPBC	FFG	DELWP
<i>Glossostigma drummondii</i>	Desert Mud-mat			PK
<i>Nymphoides crenata</i>	Wavy Marshwort		L	V
<i>Ranunculus pumilio</i> var. <i>politus</i>	Ferny Small-flower Buttercup			PK
<i>Ranunculus undosus</i>	Swamp Buttercup			V
<i>Rorippa eustylis</i>	Dwarf Bittercress			V
<i>Rutidosia helichrysoides</i>	Grey Wrinklewort			E
<i>Senecio cunninghamii</i> var. <i>cunninghamii</i>	Branching Groundsel			R

EPBC status: EXtinct, CRitically endangered, ENdangered, Vulnerable, Conservation Dependent, Not Listed

FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing

DELWP status: presumed EXtinct, Regionally EXtinct, EXtinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

4.1.2 Wetland depletion and rarity

It has been possible to estimate the depletion of wetland types across the state using the primary category only, based on a comparison of wetland extent between the 1788 and 1994 wetland layers. Comparison between the wetland layers has demonstrated the impact of European settlement and development on Victoria's wetlands. This has been severe, with approximately one third of the states wetlands being lost since European settlement; many of those remaining are threatened by continuing degradation from salinity, drainage and agricultural practices (ANCA 1996).

Nyah and Vinifera Parks contain eleven wetlands. Seven have been classified using the Corrick-Norman wetland classification system as deep freshwater marsh and four as shallow freshwater marsh (Table 18 **Error! Reference source not found.**). There has been very little decrease in the area of these two wetland types in the Murray Fans Bioregion, however both types of wetlands have decreased in area quite substantially in Victoria and in the Mallee CMA region since 1788, with deep freshwater marsh and shallow freshwater marsh being the second and third most depleted categories respectively in the Mallee CMA region (Mallee CMA, Mallee Wetland Strategy, 2006). This makes them significant in terms of representativeness.

Table 18 Changes in area of the wetlands by Corrick classification

Category	No of Wetlands in target area	Total area (ha)	Decrease in wetland area from 1788 to 1994		
			% Change in area in Victoria	% Change in area in Mallee CMA	% Change in Murray Fans
Deep freshwater marsh	7	147.87	70	45	6
Shallow freshwater marsh	4	22.4	60	6	10

*Source: DELWP Biodiversity interactive maps (<http://www.depi.vic.gov.au/environment-and-wildlife/biodiversity/biodiversity-interactive-map>)

4.1.3 Ecosystem functions

Wetlands and waterways on the floodplain are a vital component of the landscape which support a vast array of flora and fauna which may vary greatly with the type of wetland/waterway system. The habitat provided by vegetation communities around wetlands is essential for maintaining populations of water dependent fauna species. Other ecological functions provided by floodplain complexes include water filtration, slowing surface water flow to reduce soil erosion, flood mitigation and reducing nutrient input into waterways. Protecting the ecological functioning of wetlands ensures these vital services are maintained.

Wetland ecosystems support distinctive communities of plants and animals and provide numerous ecosystem services to the community (DSE 2005). Floodplain wetlands perform important functions necessary to maintain the hydrological, physical and ecological health of river systems. These ecosystem functions include:

- Enhancing water quality through filtering sediments and re-using nutrients;
- Absorbing and releasing floodwaters;
- Providing organic material to rivers to maintain riverine food chains; and
- Providing feeding, breeding and drought refuge sites for an array of flora and fauna, especially waterbirds and fish.

The target area within this WMU contains a floodplain wetland complex of eleven wetlands which are categorised as deep freshwater marsh or shallow freshwater marsh. Altered water regimes in the target area due to river regulation and dry conditions have seen a decrease in the frequency of inundation in these floodplain wetlands and therefore a decrease in the ability for these wetlands to perform these valuable ecosystem functions.

4.2 Social

4.2.1 Cultural Value

The Mallee has been occupied for thousands of generations by Indigenous people with human activity dated as far back as 23,400 years ago. The region's rich and diverse Indigenous heritage has been formed through the historical and spiritual significance of sites associated with this habitation; together with the strong connection traditional owners continue to have with the Mallee's natural landscapes.

Given the semi-arid climate of the region, ready access to more permanent water has been a major determinant of human habitation, and as such the highest density of identified Indigenous cultural heritage site are located around or close to areas of freshwater sources.

Within the Mallee CMA region, the Murray River and its associated waterways were important habitation areas for multiple Indigenous groups, containing many places of spiritual significance. The high number of Indigenous cultural heritage sites throughout the Murray floodplain is unique in Victoria, for both concentration and diversity. They include large numbers of burial, middens and hunting sites.

In the south of the region, waterways were focal points for the region's Traditional Owners, with many lakes being the site for large gatherings of several social clan groups that afforded trade and cultural exchanges.

Waterways also play a large role in the region's more recent non-Indigenous heritage due to the historical infrastructure (e.g. buildings, irrigation and river navigation structures) they often contain. These places provide links to early industries and settlements and play a key part in the region's identity.

4.2.2 Cultural Heritage

The floodplain of the Murray River has significant cultural heritage values for the local indigenous communities. It is well recognised as a traditional meeting place providing water, food and materials for medicines, shelter, clothing and tools. The area contains numerous scar trees, middens, mounds, burial sites, surface scatters and other artefacts.

There is no Registered Aboriginal Party (RAP) appointed for the area. There are no RAP applicants for the area. Wamba Wamba Barapa Barapa and Wadi Wadi Peoples Native Title Group (WWBBWW) is the Aboriginal group relevant to the Nyah-Vinifera Park and the Murray River Reserve activity area (Bell et al. 2014).

A search of the Victorian Aboriginal Heritage Register (VAHR) (Bell et al 2014) in relation to any archaeological investigations previously undertaken within the vicinity of the activity areas, indicate that a number of investigations have been carried out in the region including both regional and more site specific studies. The majority of Nyah Forest has been surveyed for Aboriginal archaeological sites although this has not continued into Vinifera Forest. The most extensive and intensive studies were those carried out by the Victoria Archaeological Survey as part of their summer field school programs.

Nyah and Vinifera forests are important cultural sites for the local indigenous people and there are numerous burial sites, middens, and scarred trees throughout the park (Department of Planning and Community Development website: Maps of Areas of Cultural Heritage Significance in Victoria). The area is subject to a Native Title Claim by the Wamba Wamba, Barapa Barapa and Wadi Wadi people which takes in parcels of land from Nyah to Boundary Bend. Earthen ovens and middens are listed on the Register of the National Estate and some cultural sites have been documented and records are held by Aboriginal Affairs Victoria. As is the case for most of the Murray River floodplain and beyond, it is recognised that waterways and floodplains are highly significant for the indigenous culture but the true extent of the number and types of sites present is still unknown.

The Wadi Wadi people have a strong connection to the area and make use of the natural resources within the forest for bush medicine, basket weaving and other cultural activities. The opportunity of co-management of the park by Parks Victoria and the Indigenous community opens up the possibility for the younger members of the community to gain valuable knowledge, skills, training and employment.

European heritage reflects the pioneering history of the area. These forests have had many uses since European settlement including grazing, rice growing, charcoal burning, forestry and local firewood collection. The area is popular for bird watching and water related activities such as camping, fishing and picnics.

The Friends of Vinifera and Nyah Forests became incorporated in 1996 to promote and enhance the cultural and environmental values of the forests and to encourage community participation under their management (Mallee CMA 2006). Friends of Nyah Vinifera and Friends of the Earth (FoE) are community stakeholder groups with an interest in activity within the area (Bell et al 2014).

4.2.3 Recreation

The region is popular for camping, fishing, boating, four wheel driving, trail bike riding, horse riding and walking and these uses will continue in the park. Vinifera forest was popular for duck hunting when the creek is running but this activity will not continue in the Nyah Vinifera Park.

The Nyah District Pony Club is currently licensed to use 13 hectares of Vinifera forest for equestrian activities and this activity will be allowed to continue (VEAC, 2008).

4.3 Economic

The Nyah-Vinifera Park has been used for grazing and fire wood collection in the past. However due to community opposition no coupe has been cut and domestic firewood has been sourced from elsewhere. Cattle grazing (agistment) was removed from Vinifera State Forest after it was changed to Vinifera River Reserve with the 1989 Land Conservation Council Final Recommendations (Land Conservation Council, 1989). Cattle agistment in the Nyah Park was halted in 1998 after attempts to protect cultural sites were not effective in preventing damage to the Aboriginal cultural sites. Domestic firewood collection and grazing are not permitted uses in the recommended park. There is an apiary site in each of Nyah and Vinifera Parks that will be continued (VEAC, 2008).

4.4 Significance

The environmental, social and economic values of the Nyah and Vinifera Parks outlined in preceding sections indicate that this site is significant to the local communities and is important in maintaining the functioning of the river system and the sustainability of the riparian and floodplain ecosystems.

The riparian and floodplain communities of Nyah and Vinifera are important to the functioning and sustainability of the River Murray system and as such should be protected.

The wetlands within the Nyah and Vinifera Parks are classified as regionally important wetlands and Parne-Malloo Creek and Green Swamp within the Nyah Park are included in the Register of National Estate (MCMA 2012). Furthermore, Nyah Park is at the western extent of the central River Red Gum forests, in the Murray Fans bioregion. It is an example of a an ecological community where the semi-arid Mallee landscape connects to the Murray River and its floodplain. The Park provides a corridor for fauna to move between the riverine and floodplain environments.

The area is rich in biodiversity, essential as habitat to native species and a refuge for listed flora and fauna species. The social and cultural values are important to local communities of the area. The values contained within Nyah and Vinifera and specifically the target area for this plan makes this area a priority for protection and enhancement through environmental water management. Of particular significance are the River Red Gum communities which line the temporary wetlands and creeks throughout the target area. These iconic trees form the basis for the functioning ecological system and are the primary focus of this plan.

5. Ecological Condition and Threats

5.1 Past condition

Nyah-Vinifera Index of Wetland Condition Assessment: 2009

The condition of two of the eleven wetlands within the Nyah Vinifera WMU was assessed in 2009 using the Index of Wetland Condition (IWC) method (see Appendix 3 for details on IWC method and the results of the assessment). The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions. The overall IWC score for both wetlands assessed in this WMU in December 2009 was 6 out of 10, which is considered to be a moderate level of condition (**Error! Reference source not found.**).

The hydrology and biota sub-indices were considered to be in very poor and poor condition respectively. Hydrology was considered to be very poor due to a lack of water reaching the wetlands in more than a decade due to river regulation, dry conditions and being beyond the extent of recent environmental water events. These altered conditions were in turn reflected in the poor biota score which indicated a lack of diversity and abundance of the species expected to be present in the EVC for the wetland.

Management intervention had already begun in the Nyah Vinifera WMU with environmental watering events between 2005 and 2016 as outlined in Section 2.8. Photographic (see Figure 177) and anecdotal evidence indicated an increase in River Red Gum canopy health following these watering events. If this intervention is not continued the benefits from these watering events such as River Red Gum recovery may not be sustained and the floodplain will continue to become drier, resulting in reduced productivity, less carbon flux, and reduced ecosystem functionality. Due to river regulation, flooding alone may not be enough to sustain these communities.



Figure 177 - River Red Gum communities at Nyah Park, pre and post environmental watering.

5.1 Current condition and trajectory

Nyah and Vinifera are relatively intact, however the condition of wetlands within the area of focus will continue to decline without regular and well planned environmental watering targeting appropriate objectives.

The loss of seasonal wetland habitat from Vinifera Park reflects a reduction in the duration of spring flow peaks. River Red Gums have colonised former wetlands as high river levels now only inundate

wetlands briefly. The shorter duration of floods means that aquatic marshland vegetation is no longer supported and the understorey has become dominated by seasonal floodplain herbs and grasses (Cook 2012). The associated decline of wetland habitat has meant that the floodplain only provides opportunistic habitat for aquatic fauna when water is available. Further encroachment by trees has excluded waterbirds that depend on open water.

The altered water regime is considered the major threat for the target area and is the primary factor behind the development of this environmental water management plan.

5.3 Water related threats

Threats to the water dependent values at the sites are the result of such factors as human intervention and climate variability. Some of the threats which may have an impact on the Nyah and Vinifera include:

- Changed water regime;
- Loss or reduction of wetland connectivity;
- Water quality; and
- Introduction/increase of exotic flora and fauna.

River Regulation

The regulation of the Murray River has seen the water regime through the Nyah Vinifera WMU altered. Flow events of the appropriate magnitude required to promote flows into creeks and wetlands of the floodplain occur less frequently and when they do, they are of a shorter duration than preferred. This combined with dry conditions over the last decade affects the vigor of the vegetation and places trees under stress, affecting the productivity and functioning of the floodplain ecosystem.

The wetlands present in the target area of the WMU are classified as deep freshwater marsh and shallow freshwater marsh (Table 5). Both types of wetlands have decreased in area in Victoria and the Mallee CMA region since 1788 with deep freshwater marsh and shallow freshwater marsh being the second and third most depleted categories respectively in the Mallee CMA region (Mallee Wetland Strategy). Reduction in wetland area and loss of wetland connectivity threaten the vegetation communities surrounding the wetlands and therefore the fauna communities which inhabit the target area are also threatened.

Irrigation Impacts

Nyah

The Nyah Irrigation District Drain No. 1 discharges water directly in the Parnee Malloo Creek. Monitoring of drainage water showed that saline water (1532 EC) was entering the Creek, which evaporated within the first 3 km of the creek bed. Regular flooding (every four out of five years) stopped the salt from accumulating however, the drain blocked with cumbungi and caused localised salinity and waterlogging effects.

A lack of defined drains along the Northern Extension to the Nyah Irrigation District (about 25 irrigators) allows drainage water to pond along the boundary of the Nyah forest and freehold. This caused water logging and excess surface salinity that encourages the growth of pest plants to the area, e.g. sea barley grass and spiny rush.

Vinifera

Along with floodwater and rainfall wetland #7527179022 receives irrigation drainage water from eight open drains that vary in length (from 100 m to 500 m), 20 ha of which remain permanently inundated. The permanent inundation is likely to have reduced the species diversity but thought to have provided good drought relief for waterbirds. There has been no significant drainage going into this area for almost 10 years due to conversion to more efficient irrigation methods in the area, e.g. flood to drip irrigation (EWMP 2012; EA 2006).

The drains are prone to blocking with excessive cumbungi growth causing local waterlogging and soil salinity build-up. The waterlogging caused by the blocked drains results in growth of pest plants and decline in health of River Red Gums.

Historically irrigation and other drainage water have been a consideration for water quality issues. Drains from adjoining freehold land enter along the western boundary of the southern end of Nyah forest. Changed irrigation practices (flood to drip) in surrounding horticultural land and dry conditions have drastically reduced the run off into the target area (MCMA 2012).

Pest Plants

Agricultural and other weeds are an ongoing threat and management issue along the Murray River floodplain. These may pose a threat when water is applied. Of concern to local communities is the increase in occurrence of *Exocarpus strictus* (Pale-fruit ballart), a root parasite, that has proliferated through the forest over the past 14 years. Sinclair (2004) recommended the restoration of winter floods as a means of increasing River Red Gum health and incidentally achieving limited reduction in the vigour of *Exocarpus strictus*.

6. Management Objective

Ecological objectives were revised in 2014 by Ecological Associates for the purpose of preparing a business case for the sites under the Basin Plan SDL Offset project. The two sites share the same management goal and almost the same ecological objectives, given their close proximity to each other.

6.1 Management Goal

The environmental water management goal for Nyah and Vinifera over the next 5-10 years is:

“to restore the key species, habitat components and functions of the Nyah and Vinifera Parks ecosystem by providing the hydrological environments required by indigenous plant and animal species and communities”.

6.2 Environmental Objectives

Environmental objectives represent the desired environmental outcomes of the site based on the management goal, above, as well as the key values outlined in the Water Dependent Values section. It is intended that EWMP objectives will be described in terms of the primary environmental outcomes, in most cases ecological attributes. The focus of the objectives should be on the final ecological outcomes and not the drivers per se.

During 2020, the environmental objectives (formally ecological objectives) undertook a refinement process with the intent of improving the specificity and measurability of the objectives through the development of targets, and to improve line of sight to the Basin Plan. While the process attempted to maintain the intent and integrity of the original objectives, it provided an opportunity to reassess the suitability of these objectives for the asset. The rationalisation, assessment of SMARTness, mapping to Basin Plan and update of each objective for Nyah and Vinifera can be found in Section 5.20.1 of Butcher et al. (2020).

6.2.1 Alignment to Murray-Darling Basin Plan

The primary environmental outcome of the Basin Plan is the protection and restoration of water-dependent ecosystems and ecosystem functions in the Murray-Darling Basin, with strengthened resilience to a changing climate. The MDBA is required to measure progress towards achieving the objectives of the Environmental Watering Plan (EWP) (Chapter 8 of the Basin Plan) by using the targets in Schedule 7 and having regard to the long-term average sustainable diversion limits, ecological objectives and ecological targets. These are set out in Long-Term Watering Plan's (LTWP), the Basin-wide Environmental Watering Strategy (BWS) and annual Basin environmental watering priorities.

6.2.2 Mapping of Environmental objectives to high level planning documents

As well as alignment with Basin Plan, the objectives have alignment with Basin-wide environmental Watering Strategy objectives and State level Long-term Watering Plan objectives. Table 19 maps the current EWMP objectives against these objectives to provide a line of sight.

Table 19 Mapping updated Nyah and Vinifera EWMP objectives to Basin Plan Environmental Watering Plan (EWP) objectives, Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) quantified environmental expected outcomes (QEEO) (MDBA 2019), and Long-term Watering Plan (LTWP) Victorian Murray objective (DELWP 2015).

EWMP objectives	Basin Plan EWP objective	Relevant Schedule 7 target	Relevant BWS QEEO	LTWP objective
NV1	8.05,3(b) 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species Diversity of native water dependent vegetation	B2.11	
NV2a	8.05,3(b)	Condition of priority asset - prevention of decline in native biota	B4.5	LTWPMV15
NV2b	8.05,3(b) 8.05,3(a)	Condition of priority asset - prevention of decline in native biota Condition of priority asset – supports EPBC listed species Recruitment and populations of other native water-dependent biota	None specified	LTWPVM19 LTWPVM20
NV4	8.06,6(b)	Recruitment and populations of native water-dependent birds	B3.3	LTWPVM10

6.2.3 Environmental objectives and targets

While every attempt has been made to make the following objectives and targets as complete as possible, there still remains gaps as critical information is not currently available. As such, baselines are not able to be set at this time. In the interests of moving forward, the objectives and targets have been written in a way (i.e. **red highlighted text**) that allows this information to be included at a later stage as this information becomes available.

Table 20 Updated ecological objectives for Nyah and Vinifera

Environmental objective	Target
NV1: By 2030, improve vital habitat at the Nyah Park and Vinifera Park asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.	By 2030, increase diversity of native of macrophytes at the Nyah Park and Vinifera Park asset with ≥ 4 species from each of the following Water Regime Indicator Groups present in 80% of years: <ul style="list-style-type: none"> Aquatic (obligate submerged) (Aos) (no species recorded) Aquatic (submerged to partially emergent) (Ase) (Northern Water-ribbons <i>Cycnogeton multifructum</i>, Common Water-ribbons <i>Cycnogeton procerum</i> s.s., Star Fruit <i>Damasonium minus</i>, Waterwort <i>Elatine gratioloides</i>, Swamp Lily <i>Ottelia ovalifolia</i> subsp. <i>ovalifolia</i>) Aquatic graminoids (persistent) (Agp) (Tall Spike-sedge <i>Eleocharis sphacelate</i>, Giant Rush <i>Juncus ingens</i>, Common Reed <i>Phragmites australis</i>, Narrow-leaf Cumbungi <i>Typha domingensis</i>, Broad-leaf Cumbungi <i>Typha orientalis</i>) Aquatic to semi-aquatic (persistent) (Asp) (Swamp Crassula <i>Crassula helmsii</i>, Common Blown-grass <i>Lachnagrostis filiformis</i> s.l., Clove-strip <i>Ludwigia peploides</i> subsp. <i>montevideensis</i>, Narrow-leaf Nardoo

	<p><i>Marsilea costulifera</i>, Common Nardoo <i>Marsilea drummondii</i>, Spiny Mud-grass <i>Pseudoraphis spinescens</i>)</p> <ul style="list-style-type: none"> Seasonally immersed – low growing (Slg) (Lesser Joyweed <i>Alternanthera denticulata</i> s.s., Twin-leaf Bedstraw <i>Asperula gemelli</i>, Marsh Club-sedge <i>Bolboschoenus medianus</i>, Tufted Burr-daisy <i>Calotis scapigera</i>, Rosinweed <i>Cressa australis</i>, Native Couch <i>Cynodon dactylon</i> var. <i>pulchellus</i>, Common Spike-sedge <i>Eleocharis acuta</i>, Small Spike-sedge <i>Eleocharis pusilla</i>, Southern Liquorice <i>Glycyrrhiza acanthocarpa</i>, Rough Raspwort <i>Haloragis aspera</i>, Joint-leaf Rush <i>Juncus holoschoenus</i>, Poison Pratia <i>Lobelia concolor</i>, Creeping Knotweed <i>Persicaria prostrata</i>, Narrow-leaf Dock <i>Rumex tenax</i>, Tall Fireweed <i>Senecio runcinifolius</i>, Swamp Starwort <i>Stellaria angustifolia</i> subsp. <i>angustifolia</i>, Blue Rod <i>Stemodia florulenta</i>, River Bluebell <i>Wahlenbergia fluminalis</i>). Seasonally inundated – emergent non woody (Sen) (Common Swamp Wallaby-grass <i>Amphibromus nervosus</i>, Tall Sedge <i>Carex appressa</i>, Poong'ort <i>Carex tereticaulis</i>, Spiny Flat-sedge <i>Cyperus gymnocaulos</i>, Southern Cane-grass <i>Eragrostis infecunda</i>, Hollow Rush <i>Juncus amabilis</i>, Tussock Rush <i>Juncus aridicola</i>, Gold Rush <i>Juncus flavidus</i>, Warrego Summer-grass <i>Paspalidium jubiflorum</i>)
<p>NV2a: By 2030, protect and restore biodiversity by maintaining representative populations of small-bodied fish at the Nyah Park and Vinifera Park asset, including expected species Unspecked hardyhead - (<i>Craterocephalus stercusmuscarum fulvus</i>); Carp Gudgeon (<i>Hypseleotris klunzingeri</i>); Murray-Darling Rainbowfish (<i>Melanotaenia fluviatilis</i>); Flathead Gudgeon (<i>Phyllipnodon grandiceps</i>); Australian Smelt (<i>Retropinna semoni</i>).</p>	<p>By 2030, maintain self-sustaining populations of Unspecked hardyhead - (<i>Craterocephalus stercusmuscarum fulvus</i>); Carp Gudgeon (<i>Hypseleotris klunzingeri</i>); Murray-Darling Rainbowfish (<i>Melanotaenia fluviatilis</i>); Flathead Gudgeon (<i>Phyllipnodon grandiceps</i>); Australian Smelt (<i>Retropinna semoni</i>) at the Nyah Park and Vinifera Park asset. Measured as:</p> <ul style="list-style-type: none"> Adults or YoY for each species recorded in 8 out of 10 years
<p>NV2b: By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Nyah Park and Vinifera Park asset.</p>	<p>By 2030, maintain self-sustaining populations of frogs at the Nyah Park and Vinifera Park asset including:</p> <ul style="list-style-type: none"> Spotted Marsh Frog (<i>Limnodynastes tasmaniensis</i>), Eastern Banjo Frog (<i>Limnodynastes dumerilii</i>), Perons Tree Frog (<i>Litoria peronii</i>), Plains Froglet (<i>Crinia parinsignifera</i>), and Common Froglet (<i>Crinia signifera</i>) in 80% of years. Growling Grass Frog (<i>Litoria raniformis</i>) at Nyah Park in 70% of years
<p>NV4: By 2030, maintain nesting and recruitment of colonial waterbirds (N7, after Jaensch 2002) at the Nyah Park and Vinifera Park asset, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat</p>	<p>There is a lack of data on species that breed at the site. The expectation is that the list of species commonly nesting at Nyah-Vinifera will be confirmed over time.</p> <p>By 2030, at least two of the following species to be recorded as nesting and/or breeding at the Nyah Park and Vinifera Park asset in 50% of years in which nesting/breeding conditions are suitable over the 10 year period:</p>

	<ul style="list-style-type: none"> Representative N7 species include: Australasian Darter (<i>Anhinga novaehollandiae</i>), Great Egret (<i>Ardea modesta</i>), Royal Spoonbill (<i>Platalea regia</i>), Nankeen Night-heron (<i>Nycticorax caledonicus</i>)
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6.3 Hydrological Objectives

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives at this site. Ecological Associates (2014b) identified water regime classes as a way of grouping EVCs with common water requirements. Watering each of these water regime classes will contribute to the achievement ecological objectives as summarised in Table 21 **Error! Reference source not found.**and Table 22. The hydrological requirements of the water regime classes that will address the ecological objectives are presented in Table 23 (Nyah) and Table 23**Error! Reference source not found.** (Vinifera).

Table 21 Water Regime Classes and ecological objectives for Nyah Park

Water Regime Class	EVC/location	Area	Ecological Objectives
Seasonal Anabranch	Parnee Malloo Creek mapped by Murray Wetlands Working Group "Wetlands54"	58	Provide seasonal feeding and reproductive opportunities for riverine fish species Restore the structure of wetland plant communities
Seasonal Wetland	819 Spike-sedge Wetlands 810 Floodway Pond Herbland	45	Restore resident populations of frogs and small fish Provide seasonal feeding and reproductive opportunities for riverine fish species Restore the structure of wetland plant communities Provide reliable breeding habitat for waterbirds, including colonial nesting species
Red Gum Swamp Forest	814 Riverine Swamp Forest	168	Provide reliable breeding habitat for waterbirds, including colonial nesting species Restore floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler Contribute to the carbon requirements of the River Murray channel ecosystem
Red Gum Forest and Woodland	106 Grassy Riverine Forest 811 Grassy Riverine Forest / Floodway Pond Herbland Complex 812 Grassy Riverine Forest / Riverine Swamp Forest Complex 816 Sedgy Riverine Forest 817 Sedgy Riverine Forest / Riverine Swamp Forest Complex	576	Provide reliable breeding habitat for waterbirds, including colonial nesting species Restore floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler Contribute to the carbon requirements of the River Murray channel ecosystem

Table 22 Water Regime Classes and ecological objectives for Vinifera Park

Water Regime Class	EVCs	Area	Ecological Objectives
Seasonal Wetland	819 Spike-sedge Wetlands 821 Tall Marsh 810 Floodway Pond Herbland	98	Restore the structure of wetland plant communities Restore resident populations of frogs and small fish Providing seasonal feeding and reproductive opportunities for riverine fish species Provide reliable breeding habitat for waterbirds, including colonial nesting species
Red Gum Swamp Forest	814 Riverine Swamp Forest	277	Restore the structure of wetland plant communities Restore resident populations of frogs and small fish Provide reliable breeding habitat for waterbirds, including colonial nesting species Contribute to the carbon requirements of the River Murray channel ecosystem
Red Gum Forest and Woodland	106 Grassy Riverine Forest 811 Grassy Riverine Forest/ Floodway Pond Herbland Complex 816 Sedgy Riverine Forest	161	Restore the structure of wetland plant communities Restore resident populations of frogs and small fish Provide reliable breeding habitat for waterbirds, including colonial nesting species Contribute to the carbon requirements of the River Murray channel ecosystem
Black Box Woodland	295 Riverine Grassy Woodland 103 Riverine Chenopod Woodland	94	Provide reliable breeding habitat for waterbirds, including colonial nesting species Contribute to the carbon requirements of the River Murray channel ecosystem Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler

Table 23 Hydrological objectives for Nyah

Water regime Class	Ecological Objective	Mean frequency of evens (Number per 10 years)			Tolerable interval between events (years)		Duration of Ponding (months)			Preferred timing of inflows
		Min	Opt	Max	Min	Max	Min	Opt	Max	
Seasonal Anabranh	1,3	10	10	10	0	0	NA	NA	NA	Spring/early Summer
Seasonal Wetland	1, 2, 3, 4	8	9	9	1	1	9	10	12	Spring/Summer Wetland depth to be less than 50% of retention level in May 5 years in 10
Red Gum Swamp Forest	4,5,6	7	9	10	1	3	5	6	7	Spring/Summer

Red Gum Forest and Woodland	4,5,6	7	8	9	1	3	1	1.5	3	Spring/Summer
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1. Restore the structure of wetland plant communities
2. Restore resident populations of frogs and small fish
3. Providing seasonal feeding and reproductive opportunities for riverine fish species
4. Provide reliable breeding habitat for waterbirds, including colonial nesting species
5. Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler
6. Contribute to the carbon requirements of the River Murray channel ecosystem

Table 24 Hydrological objectives for Vinifera

Water regime Class	Ecological Objective	Mean frequency of events (Number per 10 years)			Tolerable interval between events (years)		Duration of Ponding (months)			Preferred timing of inflows
		Min	Opt	Max	Min	Max	Min	Opt	Max	
Seasonal Wetland	1, 2, 3, 4	8	9	9	1	1	6	7-8	9	Spring/Summer
Red Gum Swamp Forest	1, 2, 4, 6	7	9	10	1	1	5	6	7	Spring/Summer

Red Gum Forest and Woodland	1, 2, 4, 6	7	9	10	1	1	2	4	6	Spring/Summer
Black Box Woodland	4, 5, 6	6	8	9	2	2	1	1.5	2	Spring/Summer

1. Restore the structure of wetland plant communities
2. Restore resident populations of frogs and small fish
3. Providing seasonal feeding and reproductive opportunities for riverine fish species
4. Provide reliable breeding habitat for waterbirds, including colonial nesting species
5. Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler
6. Contribute to the carbon requirements of the River Murray channel ecosystem

6.4 Watering regime

The wetland watering regime has been derived from the ecological and hydrological objectives. To allow for adaptive and integrated management, the watering regime is framed using the seasonally adaptive approach. This means that a watering regime is identified for optimal conditions, as well as the maximum and minimum tolerable watering scenarios. The minimum watering regime is likely to be provided in drought or dry years, the optimum watering regime in average conditions and the maximum watering regime in wet or flood years.

The optimal, minimum and maximum watering regimes are described below. Due to the inter-annual variability of these estimates (particularly the climatic conditions), determination of the predicted volume requirements in any given year will need to be undertaken by the environmental water manager when watering is planned.

Table 25 Target water regime in response to climatic conditions

	Dry/drought	Median	Wet
Nyah	Seasonal Anabranh Seasonal Wetland	Seasonal Anabranh Seasonal Wetland Red Gum Swamp Forest	Seasonal Anabranh Seasonal Wetland Red Gum Swamp Forest Red Gum Forest and Woodland
Vinifera	Seasonal Wetland	Seasonal Wetland Red Gum Swamp Forest	Seasonal Wetland Red Gum Swamp Forest Red Gum Forest and Woodland Black Box Woodland

7. MANAGING RISKS TO ACHIEVE OBJECTIVES

A detailed risk assessment was undertaken as part of the SDL Business Case Offset Project (Newell et al 2014). This included risks during construction and operation of the proposed infrastructure. Risks were classified as very high, high, moderate, or low dependent on the likelihood and consequence of them occurring. The complete risk assessment is in Appendix 4. Items that relate to the proposed water regime and deemed very high risk are summarised in Table 26.**Error! Reference source not found.**

Prior to delivering environmental water in any given season, these risks will be further refined as part of the Seasonal Watering Proposal and Environmental Water Delivery Plan process. These documents will provide a greater level of risk analysis and mitigation measures according to conditions observed closer to the proposed delivery (i.e. operational risks). The documents will also include detailed consideration of the impact of proposed mitigation measures on the likelihood and consequence of the risk occurring (residual risk) as this may change according to catchment conditions and operations closer to the proposed delivery. They will clearly outline roles and responsibilities regarding risk management.

Table 26 Risks associated with hydrological objectives for Nyah and Vinifer

Threat	Likelihood	Consequence	Risk – H, M, L (likelihood x consequence)	Management Measure	Residual Risk
Enhancing carp recruitment conditions	Certain	Severe	V high	Promote native fish to balance impacts of increased carp. Drying sequence should aim to maximise impacts to carp and minimise impacts on native (if this is possible). Research required. PV Management Plan.	Moderate
Changed flow regime favouring high risk weed species	Certain	Severe	V high	Time water manipulations to drown seedlings, minimise growth and germination, seed set etc; promote native species. Problem species and severity not fully known - monitor and manage adaptively.	Low
Removal of habitat for recently established threatened species which resulted/adapted from historic regulation practices	Likely	Severe	High	Operating plans/rules/strategies Monitoring/reporting to adaptively manage Confirming flow regime requirements through modelling – target species. Clearly define ecological outcomes (seasonal plans, long term objectives etc)	Low
Germination of river red gum in watercourses	Certain	Moderate	High	Operational strategies to drown seedlings Operations to vary water levels each season, each year Hydraulic model to determine where strand lines will be and how extensive issue might occur Timing and duration (avoid seed drop time) Last resort remove them.	Low

Threat	Likelihood	Consequence	Risk – H, M, L (likelihood x consequence)	Management Measure	Residual Risk
Episodic reduction in hydrodynamic diversity	Likely	Severe	High	Design & operation Operating strategy Monitor flow dependent fauna – adaptive management Manage expectations in stakeholder groups.	Moderate
Blackwater events result from waterings	Likely	Severe	High	Plan flooding with regard to quality of incoming water including Darling water Monitor antecedent floodplain conditions (organic matter loads) Take account seasonal conditions (e.g. blackwater, algae). Have rules in place to manage risks. Manage through-flow to help manage risk. Monitor risk factors (DO, temp) and manage flooding event to minimise risk. Disposing of blackwater – can manage outflow rates to wait for dilution flow. Water can be disposed within the site (pump to higher wetlands) Flood frequency – prevent high organic load build. Manage community expectations.	Moderate

Threat	Likelihood	Consequence	Risk – H, M, L (likelihood x consequence)	Management Measure	Residual Risk
Low DO levels	Likely	Severe	High	Plan flooding with regard to quality of incoming water including Darling water Monitor antecedent floodplain conditions (organic matter loads) Take account seasonal conditions (e.g. blackwater, algae). Have rules in place to manage risks. Manage through-flow to help manage risk. Monitor risk factors (DO, temp) and manage flooding event to minimise risk. Disposing of blackwater – can manage outflow rates to wait for dilution flow. Water can be disposed within the site (pump to higher wetlands) Flood frequency – prevent high organic load build. Manage community expectations.	Low
Inability to discharge poor quality water	Likely	Severe	High	Dilution flows Good relationships Local disposal	Low
Increase in native and non-native pest mammals (kangaroos, rabbits, pig)	Likely	Severe	High	Monitor and “control” Implement existing management strategy. Support partner agencies to seek complementary funding	Low
Loss of artefacts via Inundation	Possible	Severe	High	Ongoing inspection and management O&M Ongoing stakeholder liaison (early and often)	Low

8. Environmental Water Delivery Infrastructure

8.1 Constraints

The current constraints to achieving the ecological objectives at Nyah and Vinifera Parks are the current River Murray operations reducing the frequency and duration of inundation and redundant irrigation infrastructure creating blockages in the creek lines.

The proposed infrastructure is designed to increase the frequency and duration of inundation within current river Murray operations.

8.2 Infrastructure recommendations

Nyah Park

The infrastructure proposed in the Nyah Floodplain SDL Business Case (Ecological Associates 2014b) are four regulators, three on the downstream end of Parnee Malloo Creek and one on the upstream end. To contain water within the forest it is necessary to raise 1,648 m of low level track to form a levee at the downstream end of the forest.

Decommissioning of former irrigation infrastructure including two blockages and an overflow bypass on Parnee Mallee Creek will also be undertaken. Details of these works are provided in Table 27 **Error! Reference source not found..**

These works will be able to provide water to 488 ha of inundation dependant habitat, which is 53% of the total forest area and almost all of the water dependant communities at the site (Ecological Associates 2014b).

The works will replicate Murray River flows of 25,000 ML/d and inundate up to 63.2 m AHD. The works will allow natural river flows in and in the absence of suitable river flows, temporary pumping will be used to provide water from the Murray River to the floodplain.

Table 27 Nyah Infrastructure works (Jacobs, 2014, in Ecological Associates 2014b)

Structure	Description
Main track raising and overflow sills	<p>A section of the main track at the northern end of the floodplain will be raised in order to retain water to 63.2 m AHD. The track raising will incorporate regulators N1a, N1b, N2 and 3 overflow sills.</p> <p>Existing track alignment to be raised over a length of 1,308 m and will include 300 mm freeboard and 150 mm crest allowance. Overflow sills 1 and 3 will each be 100 m long; overflow sill 2 will be 65 m long.</p>
N1a and N1b	<p>Enables water to be held up to 63.2 m AHD and released as required.</p> <p>Two regulators, each consisting of 3 box culverts, each with single sluice gates and access provision.</p>

Structure	Description
N2	<p>The main regulator and outlet point for the floodplain, N2 will be used to hold water to 63.2 m AHD and control return flows.</p> <p>Regulator consists of 8 box culverts, all with split leaf gates and access provision.</p>
Drop Structure	<p>Situated downstream of N2, the drop structure is necessary to protect banks against erosion upon release of impounded water. The structure will establish a tailwater at the regulator sufficient to prevent sweep out of the hydraulic jump and provide a plunge pool for downstream fish passage.</p> <p>Consists of sheet piles and rock beaching.</p>
N5	<p>Replacement structure for an existing pipe culvert of correct size but unreliable quality, at the southern end of the Parnee Malloo Creek. This structure will prevent impounded water draining back to the River Murray.</p> <p>1,200 mm diameter reinforced concrete pipe with manually actuated penstock gate and access provision.</p>
Raised track sections and overflow sills (4, 5, 6, 7, 8)	<p>Small sections of additional track raising and overflow sill works, to contain water on the floodplain and provide inflow and outflow path for natural flood events. Approximately 340 m of track raising is proposed at five locations, incorporating overflow sills at each.</p>
N4	<p>Decommissioning of redundant irrigation infrastructure including blockages in the creek and a bypass pipeline.</p>

Vinifera Park

The infrastructure proposed in the Vinifera Floodplain SDL Business Case (Ecological Associates 2014c) are two box regulators (V1 and V2) and a stop bank (levee) with overflow sills near the northern (downstream) end of the floodplain. Details of these works are provided in Table 28 **Error! Reference source not found..**

The regulators will be located in a stop bank (levee) to allow through-flow in the creek and to retain water at a level of up to 64.4 m AHD, replicating a 20,000 ML/d flow event through natural river flows or pumping. The works will inundate up to 350 ha.

Table 28 Vinifera Infrastructure works (Jacobs, 2014, in Ecological Associates 2014c)

Works	Description
V1 – Regulator	<p>New ten bay regulator to retain water within Vinifera Creek allowing release of gravity controlled water to the very north-western tip of the Vinifera floodplain.</p> <p>10 box culverts, four with dual leaf combination gates and 6 with single leaf gates.</p>
V2 – Regulator	<p>New four bay regulator allowing the release of water into the bend directly adjacent to the River Murray in the northern section of the Vinifera floodplain.</p> <p>Four box culverts with split leaf combination gates</p>
Main Levee	<p>1087 m long raised track, to a maximum height of 1700 mm, incorporating 2 x 70 m long overflow sills.</p>
Drop structure	<p>Rock structure to minimise erosion risk associated with the return of the impounded water to the River Murray.</p>
V3 – Pipe culvert	<p>New pipe culvert regulator on Vinifera creek to pass both local drainage and overland flows in large events.</p> <p>1,200 mm diameter concrete pipe with penstock gate.</p>
V4 – Pipe culvert	<p>New pipe culvert to allow inflows from the River Murray and prevent backflow to the River Murray when retaining water on the floodplain during a watering event.</p> <p>1,200 mm diameter concrete pipe with penstock gate.</p>
Raised track sections and overflow sills	<p>Seven overflow sill works, to contain water on the floodplain. The location of overflow sills to align with existing roads where possible, to reduce environmental and cultural heritage impacts.</p> <p>Raise short sections (< 200 m in total) of the natural river levee at some sites.</p>

Table 29 Estimates of watering possibilities in Nyah Vinifera WMU

	Area able to be inundated (ha)			Volume (ML)		
	Nyah	Vinifera	Total	Nyah	Vinifera	Total
Current arrangements	165.36	36.81	202.17	2,125	179	2,304
With proposed infrastructure	488	350	838	2,797	2,743	5,540

9. Demonstrating Outcomes

9.1 Monitoring priorities at the site

Ecological Associates (2014a) established ecological targets to measure progress towards ecological objectives. The targets compare a baseline to the state of the site after the proposed water regimes have been applied. A baseline will need to be established for each parameter at both sites. It is not expected that outcomes will be achieved until several years after the water regime has been in place.

In some cases existing monitoring programs can be used or adapted to monitor the achievement of ecological objectives including TLM monitoring for fish and waterbirds (Henderson, *et al.* 2013) and MDBA tree health monitoring (Cunningham, *et al.* 2011). A method to evaluate the export of carbon to the floodplain needs to be developed.

The monitoring requirements to demonstrate progress towards ecological objectives for both Nyah and Vinifera are the same.

Table 30 Ecological objective outcome monitoring recommendations

Ecological Objective	Target	Monitoring Recommendation
Restoring the vegetation structure of wetland plant communities	<p>The projected red gum canopy cover in seasonal wetlands decreases by 50% from 2015 levels by 2030</p> <p>The projected aquatic macrophyte plant cover in December in seasonal wetlands exceeds 50% by 2030.</p>	<p>Cunningham (2011) tree health monitoring</p> <p>Nicol and Weedon (2006) approach to monitoring littoral and aquatic vegetation</p>
Re-establishing resident populations of frogs and vegetation-dependent fish	<p>At least four native fish species are present in seasonal wetlands every spring between 2025 and 2035.</p> <p>At least three frog species are present in seasonal wetlands every spring between 2025 and 2035</p>	<p>Fish</p> <p>TLM monitoring (Henderson, <i>et al.</i> 2013)</p> <p>Frogs</p> <p>Song meters</p> <p>Active search - nocturnal</p>
Providing seasonal feeding and reproductive opportunities for channel-dependent fish species	No target set in Ecological Associates 2014	<p>Fish</p> <p>TLM monitoring (Henderson, <i>et al.</i> 2013)</p>

Ecological Objective	Target	Monitoring Recommendation
Providing reliable breeding habitat for waterbirds, including colonial nesting species	Any species of waterfowl, crane, rail, waterhen or coot breeds every year between 2025 and 2035 at Vinifera Park. Cormorants and / or nankeen night heron breed at Nyah Park on at least six occasions between 2025 and 2035	Waterbird surveys – conducted pre, during and post inundation as water levels change GIS mapping to monitor water levels – i.e. waterbird habitat availability.
Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler	All red gum and black box stands within the project area achieve a health score of moderate or better under Cunningham (2011) tree health monitoring for all years between 2025 and 2035. Total bat abundance increases by 25% from 2015 levels by 2030	Habitat Cunningham (2011) tree health monitoring Bats – Harp traps, Anabat Carpet Python – Nocturnal spotlight transects Sugar Glider – Nocturnal spotlight transects Grey-crowned Babbler – 20min/2ha bird census and call playback
Contributing to the organic carbon requirements of the River Murray channel ecosystem	The average annual carbon load (dissolved and particulate) to the River Murray for the period 2025 to 2035 is double 2015 to 2020 levels.	Dissolved and particulate organic matter concentrations in water draining from floodplain

10. CONSULTATION

This Plan was developed in collaboration with key stakeholders namely Parks Victoria, the Department of Environment, Land, Water and Planning, Lower Murray Water and local interest groups.

Table 31 Consultation Process for development of Nyah and Vinifera Environmental Water Management Plan

Meeting date	Stakeholders	Details
May 2014	Parks Victoria	Initial discussion to introduce concept of plan and discuss the issue of feral pigs in the area.
May 2016	Parks Victoria	Presentation of plan.
June 2016	Department of Environment Land Water and Planning	Presentation of plan.
May 2014 & June 2016	Lower Murray Water	Discussion on drainage disposal to the wetlands creating habitat for feral pigs and management actions going forward. Presentation of plan.
June 2016	Murray Lower Darling Rivers Indigenous Nations	Presentation of plan.
June 2016	Mid-Murray Field Naturalists	Presentation of plan.
May 2016	Community – Swan Hill College	Presentation of plan.

11. Knowledge Gaps and Recommendations

This plan is based on the best information at the time of writing. In some cases this information is scarce or outdated. Further investigation and information collection will continue and the results of this further work will continue to build a better picture of the site and add rigor to future planning. Some areas where further knowledge would be beneficial are outlined in Table 30Table 32**Error! Reference source not found..**

Table 32 Knowledge gaps and recommendations for the target area

Knowledge and data gaps	Action recommended	Priority
Role of wetland on fish breeding and population	Monitoring of fish population	2
Accurate depth and volumes for the wetland	Install depth gauges and bathymetric survey	2
Nesting habits of birds at the site	Data collection and monitoring	2
Bat, Carpet Python, Sugar Glider and Grey-crowned Babbler populations and response to environmental watering	Data collection and monitoring	2
Impacts of climate variability	Data collection and monitoring	3
Monitoring method for carbon export to the Murray River	Method and data collection	1

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13. Abbreviations and Acronyms

CAMBA	China-Australia Migratory Bird Agreement
CMA	Catchment Management Authority
DELWP	Department of Environment, Land, Water and Planning
DEPI	Department of Environment and Primary Industries (now DEWLP)
DSE	Department of Sustainability and Environment (now DELWP)
EVC	Ecological Vegetation Class
EPBC	Environment Protection and Biodiversity Conservation Act
EWMP	Environmental Water Management Plan
EWH	Environmental Water Holder
EWB	Environmental Water Reserve
FFG	Flora and Fauna Guarantee Act
FSL	Full Supply Level
WMU	Floodplain Management Unit
IWC	Index of Wetland Condition
JAMBA	Japan-Australia Migratory Bird Agreement
MCMA	Mallee Catchment Management Authority
MDBA	Murray-Darling Basin Authority (formally Murray-Darling Basin Commission, MDBC)
Ramsar	Global treaty adopted in the Iranian city of Ramsar in 1971 that focuses on the conservation of internationally important wetlands
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RRG	River Red Gum
SDL	Sustainable Diversion Limit
TLM	The Living Murray Initiative
TSL	Targeted Supply Level
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway management Strategy
WMU	Waterway Management Unit

Appendix 1 – Flora and Fauna Species List

Flora and Fauna Species List

Flora Species List

Scientific Name	Common Name	Classification	Source of information			
			2010 EWMP (both sites)	AE 2012 (both sites)	2013 GHD survey	
					Nyah	Vinifera
Native Species						
<i>Acacia hakeoides</i>	Hakea Wattle	P	Y			
<i>Acacia ligulata</i>	Small Cooba	P	Y			
<i>Acacia loderi</i>	Nealie	v, P	Y			
<i>Acacia melvillei</i>	Yarran	v, P	Y			
<i>Acacia oswaldii</i>	Umbrella Wattle		Y			
<i>Acacia</i> spp.	Wattle		Y			
<i>Acacia stenophylla</i>	Eumong	P	Y			
<i>Alternanthera prostrata</i> s.l.	Lesser Joyweed		Y	Y	Y (<i>A. denticulata</i>)	Y
<i>Amphibromus nervosus</i>	Common Swamp Wallaby-grass		Y			
<i>Amyema miquelii</i>	Box Mistletoe		Y			
<i>Asteraceae</i> spp.	Composite	P	Y			
<i>Atriplex acutibractea</i> subsp. <i>karoniensis</i>	Pointed Saltbush	r	Y			
<i>Atriplex leptocarpa</i>	Slender-fruit Saltbush		Y		Y	Y
<i>Atriplex semibaccata</i>	Berry Saltbush		Y	Y	Y	Y
<i>Atriplex suberecta</i>	Sprawling Saltbush		Y	Y		
<i>Austrostipa elegantissima</i>	Feather Spear-grass		Y			
<i>Austrostipa scabra</i> subsp. <i>prostrata</i>	Rough Spear-grass		Y	Y		
<i>Austrostipa</i> spp.	Spear Grass		Y			
<i>Azolla filiculoides</i>	Pacific Azolla		Y			Y
<i>Azolla</i> spp.	Azolla		Y			
<i>Beyeria opaca</i>	Dark Turpentine-bush		Y			
<i>Billardiera cymosa</i> s.l.	Sweet Apple-berry		Y			
<i>Bolboschoenus medianus</i>	Marsh Club-sedge		Y	Y		Y
<i>Brachychiton populneus</i> subsp. <i>populneus</i>	Kurrajong		Y			
<i>Brachyscome basaltica</i> var. <i>gracilis</i>	Woodland Swamp-daisy	P	Y	Y	Y	
<i>Brachyscome ciliaris</i>	Variable Daisy	P	Y			
<i>Brachyscome lineariloba</i>	Hard-head Daisy	P	Y			
<i>Calandrinia eremaea</i>	Small Purslane		Y			
<i>Callistemon rugulosus</i>	Scarlet Bottlebrush		Y			
<i>Callitris gracilis</i> subsp. <i>murrayensis</i>	Slender Cypress-pine		Y			
<i>Calotis scapigera</i>	Tufted Burr-daisy		Y			
<i>Cardamine moirensis</i>	Riverina Bitter-cress	r	Y	Y	Y	
<i>Carex appressa</i>	Tall Sedge		Y			
<i>Carex tereticaulis</i>	Poong'ort		Y			
<i>Carpobrotus modestus</i>	Inland Pigface		Y			
<i>Cassytha melantha</i>	Coarse Dodder-laurel		Y			
<i>Centipeda cunninghamii</i>	Common Sneezeweed	P	Y	Y	Y	Y
<i>Centipeda minima</i> s.l.	Spreading Sneezeweed	P	Y			
<i>Centipeda minima</i> subsp. <i>minima</i> s.s.	Spreading Sneezeweed	P	Y			
<i>Chenopodium curvispicatum</i>	Cottony Saltbush		Y			
<i>Chenopodium desertorum</i>	Frosted Goosefoot		Y			
<i>Chenopodium desertorum</i> subsp. <i>microphyllum</i>	Small-leaf Goosefoot		Y			
<i>Chenopodium nitriaceum</i>	Nitre Goosefoot		Y			
<i>Chloris prostrata</i>	Windmill Grass		Y	Y (<i>C. truncata</i>)		
<i>Clematis microphylla</i> s.l.	Small-leaved Clematis		Y			
<i>Convolvulus remotus</i>	Grassy Bindweed			Y		
<i>Crassula colorata</i>	Dense Crassula		Y			
<i>Crassula helmsii</i>	Swamp Crassula		Y			Y
<i>Crassula sieberiana</i> s.l.	Sieber Crassula		Y			
<i>Cressa australis</i>	Rosinweed			Y		
<i>Cuscuta australis</i>	Australian Dodder	k		Y	Y	
<i>Cynodon dactylon</i>	Couch		Y			
<i>Cynodon dactylon</i> var. <i>pulchellus</i>	Native Couch	v	Y		Y	
<i>Cyperus difformis</i>	Variable Flat-sedge			Y		
<i>Cyperus exaltatus</i>	Tall Flat-sedge		Y	Y	Y	

Scientific Name	Common Name	Classification	Source of information			
			2010 EWMP (both sites)	AE 2012 (both sites)	2013 GHD survey	
					Nyah	Vinifera
<i>Cyperus gymnocaulos</i>	Spiny Flat-sedge		Y			
<i>Cyperus pygmaeus</i>	Dwarf Flat-sedge	v	Y			
<i>Damasonium minus</i>	Star Fruit		Y			
<i>Daucus glochidiatus</i>	Australian Carrot		Y			
<i>Dianella porracea</i>	Riverine Flax-lily	v			Y	
<i>Dianella prostrata</i> s.l.	Black-anther Flax-lily		Y			
<i>Dianella</i> sp. aff. <i>prostrata</i> (North-west Victoria)	Stiff Flax-lily		Y			
<i>Dichondra repens</i>	Kidney-weed		Y			
<i>Dodonaea prostrata</i>	Sticky Hop-bush		Y			
<i>Dodonaea prostrata</i> subsp. <i>angustissima</i>	Slender Hop-bush		Y			
<i>Dysphania pumilio</i>	Clammy Goosefoot		Y	Y	Y	
<i>Eclipta platyglossa</i>	Yellow Twin-heads		Y	Y		Y
<i>Einadia nutans</i> subsp. <i>nutans</i>	Nodding Saltbush		Y	Y	Y	
<i>Elatine gratioloides</i>	Waterwort		Y			Y
<i>Eleocharis acuta</i>	Common Spike-sedge		Y	Y	Y	Y
<i>Eleocharis pusilla</i>	Small Spike-sedge		Y			
<i>Eleocharis sphacelata</i>	Tall Spike-sedge		Y			
<i>Enchylaena prostrata</i> var. <i>prostrata</i>	Ruby Saltbush		Y	Y	Y (<i>E. tomentosa</i>)	Y
<i>Enteropogon acicularis</i>	Spider Grass		Y			
<i>Ephemerum cristatum</i>	Earth Moss		Y			
<i>Epilobium billardierianum</i> subsp. <i>cinereum</i>	Grey Willow-herb		Y			
<i>Eragrostis infecunda</i>	Southern Cane Grass			Y		
<i>Eragrostis</i> spp.	Love Grass		Y			
<i>Eucalyptus calycogona</i>	Red Mallee		Y			
<i>Eucalyptus camaldulensis</i>	River Red-gum		Y	Y	Y	Y
<i>Eucalyptus dumosa</i>	Dumosa Mallee		Y			
<i>Eucalyptus gracilis</i>	Yorrell		Y			
<i>Eucalyptus largiflorens</i>	Black Box		Y		Y	
<i>Eucalyptus leptophylla</i>	Slender-leaf Mallee		Y			
<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>	Oil Mallee		Y			
<i>Eucalyptus socialis</i> subsp. <i>socialis</i>	Grey Mallee		Y			
<i>Euchiton sphaericus</i>	Annual Cudweed		Y			
<i>Euphorbia drummondii</i>	Flat Spurge				Y	Y
<i>Euphorbia drummondii</i>	Flat Spurge		Y	Y		
<i>Exocarpos aphyllus</i>	Leafless Ballart		Y	Y		
<i>Exocarpos sparteus</i>	Broom Ballart				Y	
<i>Exocarpos strictus</i>	Pale-fruit Ballart		Y		Y	
<i>Gemmabryum pachythecum</i>	Acorn-fruited Thread-moss		Y			
<i>Geranium retrorsum</i> s.s.	Grassland Crane's-bill		Y			
<i>Glinus lotoides</i>	Hairy Carpet-weed		Y	Y	Y	
<i>Glinus oppositifolius</i>	Slender Carpet-weed				Y	
<i>Glossostigma drummondii</i>	Desert Mud-mat	k				
<i>Glycyrrhiza acanthocarpa</i>	Southern Liquorice		Y			
<i>Gnaphalium polycaulon</i>	Indian Cudweed	P				Y
<i>Grevillea huegelii</i>	Comb Grevillea		Y			
<i>Haloragis aspera</i>	Rough Raspwort		Y			
<i>Helichrysum leucopsidium</i>	Satin Everlasting	P	Y			
<i>Helichrysum luteoalbum</i>	Jersey Cudweed	P	Y	Y		
<i>Juncus amabilis</i>	Hollow Rush			Y		
<i>Juncus aridicola</i>	Tussock Rush					Y
<i>Juncus bufonius</i>	Toad Rush		Y	Y		
<i>Juncus flavidus</i>	Gold Rush		Y			
<i>Juncus holoschoenus</i>	Joint-leaf Rush		Y			
<i>Juncus ingens</i>	Giant Rush		Y			
<i>Juncus subsecundus</i>	Finger Rush		Y			
<i>Lachnagrostis filiformis</i>	Common Blown-grass		Y	Y	Y	Y
<i>Lachnagrostis filiformis</i> var. 1	Common Blown-grass		Y			
<i>Landoltia punctata</i>	Thin Duckweed		Y			

Scientific Name	Common Name	Classification	Source of information			
			2010 EWMP (both sites)	AE 2012 (both sites)	2013 GHD survey	
					Nyah	Vinifera
<i>Limosella australis</i>	Austral Mudwort		Y			Y
<i>Limosella curdieana</i>	Large Mudwort		Y			
<i>Lobelia concolor</i>	Poison Pratia		Y		Y	Y
<i>Lomandra effusa</i>	Scented Mat-rush		Y			
<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	Clove-strip		Y	Y	Y	Y
<i>Lythrum hyssopifolia</i>	Small Loosestrife		Y	Y	Y	
<i>Maireana brevifolia</i>	Short-leaf Bluebush		Y			
<i>Maireana decalvans</i>	Black Cotton-bush		Y	Y		
<i>Marsilea costulifera</i>	Narrow-leaf Nardoo		Y			
<i>Marsilea drummondii</i>	Common Nardoo		Y		Y	Y
<i>Mentha australis</i>	River Mint		Y			
<i>Minuria leptophylla</i>	Minnie Daisy	P	Y			
<i>Morgania glabra</i> spp. agg.	Blue Rod		Y			
<i>Muellerina eucalyptoides</i>	Creeping Mistletoe		Y			
<i>Myoporum montanum</i>	Waterbush	r	Y			
<i>Myoporum platycarpum</i>	Sugarwood		Y			
<i>Myosurus australis</i>	Mousetail				Y	
<i>Myriophyllum</i> spp.	Water-milfoil		Y			
<i>Nymphoides crenata</i>	Wavy Marshwort	v, L	Y			
<i>Olearia muelleri</i>	Mueller Daisy-bush	P	Y			
<i>Olearia pimeleoides</i>	Pimelea Daisy-bush	P	Y			
<i>Ottelia ovalifolia</i> subsp. <i>ovalifolia</i>	Swamp Lily		Y			
<i>Oxalis perennans</i>	Grassland Wood-sorrel		Y	Y	Y	
<i>Panicum effusum</i>	Hairy Panic		Y			
<i>Panicum</i> spp.	Panic		Y			
<i>Paspalidium jubiflorum</i>	Warrego Summer-grass		Y	Y	Y	
<i>Pelargonium australe</i>	Austral Stork's-bill		Y			
<i>Persicaria lapathifolia</i>	Pale Knotweed		Y			Y
<i>Persicaria prostrata</i>	Creeping Knotweed		Y	Y	Y	Y
<i>Phascum robustum</i> var. <i>crassinervium</i>	Ball Moss		Y			
<i>Phragmites australis</i>	Common Reed		Y			
<i>Picris angustifolia</i>	Native Picris	P	Y			
<i>Picris</i> spp.	Picris	P	Y			
<i>Picris squarrosa</i>	Squat Picris	P	Y			
<i>Pimelea microcephala</i> subsp. <i>microcephala</i>	Mallee Rice-flower		Y		Y	
<i>Pittosporum angustifolium</i>	Weeping Pittosporum		Y			
<i>Polygonum plebeium</i>	Small Knotweed		Y	Y	Y	
<i>Potamogeton pectinatus</i>	Fennel Pondweed		Y			
<i>Potamogeton tricarlinatus</i> s.l.	Floating Pondweed		Y			
<i>Pseudoraphis spinescens</i>	Spiny Mud-grass		Y			
<i>Ptilotus seminudus</i>	Rabbit Tails		Y			
<i>Ranunculus inundatus</i>	River Buttercup		Y			
<i>Ranunculus pumilio</i>	Ferny Small-flower Buttercup		Y			
<i>Ranunculus pumilio</i> var. <i>pumilio</i>	Ferny Small-flower Buttercup		Y		Y	
<i>Ranunculus</i> spp.	Buttercup		Y			
<i>Ranunculus undosus</i>	Swamp Buttercup	v	Y			
<i>Rhagodia spinescens</i>	Hedge Saltbush		Y	Y	Y	Y
<i>Rumex crystallinus</i> s.l.	Glistening Dock		Y	Y		
<i>Rumex prostrata</i>	Slender Dock		Y		Y (<i>R. brownii</i>)	Y
<i>Rumex tenax</i>	Narrow-leaf Dock			Y	Y	Y
<i>Rytidosperma caespitosa</i>	Common Wallaby-grass		Y			
<i>Rytidosperma setacea</i>	Bristly Wallaby-grass		Y			
<i>Rytidosperma setacea</i> var. <i>setacea</i>	Bristly Wallaby-grass		Y			
<i>Rytidosperma setaceum</i> var. <i>setaceum</i>	Bristly Wallaby-grass			Y		
<i>Rytidosperma</i> spp.	Wallaby Grass		Y			
<i>Salsola tragus</i> subsp. <i>tragus</i>	Prickly Saltwort			Y		
<i>Santalum murrayanum</i>	Bitter Quandong		Y			
<i>Sarcozona praecox</i>	Sarcozona	r			Y	

Scientific Name	Common Name	Classification	Source of information			
			2010 EWMP (both sites)	AE 2012 (both sites)	2013 GHD survey	
					Nyah	Vinifera
<i>Sclerolaena diacantha</i>	Grey Copperburr		Y			
<i>Sclerolaena muricata</i>	Black Roly-poly		Y			
<i>Sclerolaena muricata</i> var. <i>villosa</i>	Grey Roly-poly			Y	Y	
<i>Sclerolaena tricuspid</i>	Streaked Copperburr			Y		
<i>Senecio cunninghamii</i> var. <i>cunninghamii</i>	Branching Groundsel	r, P	Y	Y		Y
<i>Senecio quadridentatus</i>	Cotton Fireweed	P	Y	Y	Y	Y
<i>Senecio runcinifolius</i>	Tall Fireweed	P	Y	Y		Y
<i>Senna form taxon 'coriacea'</i>	Broad-leaf Desert Cassia		Y			
<i>Senna form taxon 'filifolia'</i>	Fine-leaf Desert Cassia		Y			
<i>Senna form taxon 'zygophylla'</i>	Narrow-leaf Desert Cassia		Y			
<i>Sida corrugata</i>	Variable Sida				Y	
<i>Spergularia</i> sp. 3	Salt Sea-spurrey		Y	Y		
<i>Sphaeromorphaea australis</i>	Spreading Nut-heads	P	Y			
<i>Sporobolus caroli</i>	Yakka Grass	r		Y		
<i>Stellaria angustifolia</i>	Swamp Starwort		Y			
<i>Stellaria prostrata</i>	Matted Starwort		Y		Y (<i>S. caespitosa</i>)	
<i>Stelligera endecaspinis</i>	Star Bluebush			Y		
<i>Templetonia sulcata</i>	Flat Templetonia		Y			
<i>Tetragonia eremaea</i> s.l.	Desert Spinach		Y			
<i>Triglochin multifructa</i>	Northern Water-ribbons		Y	Y		
<i>Triglochin procera</i> s.l.	Water Ribbons		Y			Y
<i>Triglochin procera</i> s.s.	Common Water-ribbons		Y			
<i>Triodia scariosa</i>	Porcupine Grass		Y			
<i>Typha domingensis</i>	Narrow-leaf Cumbungi		Y		Y	
<i>Typha orientalis</i>	Broad-leaf Cumbungi		Y			
<i>Typha</i> spp.	Bulrush		Y			
<i>Vittadinia cuneata</i>	Fuzzy New Holland Daisy	P	Y	Y	Y	Y
<i>Vittadinia dissecta</i> s.l.	Dissected New Holland Daisy	P	Y		Y	
<i>Vittadinia gracilis</i>	Woolly New Holland Daisy	P	Y			
<i>Vittadinia</i> spp.	New Holland Daisy	P	Y			
<i>Wahlenbergia fluminalis</i>	River Bluebell		Y	Y	Y	Y
<i>Westringia rigida</i>	Stiff Westringia		Y			
<i>Xerochrysum bracteatum</i>	Golden Everlasting	P	Y			
<i>Zygophyllum apiculatum</i>	Pointed Twin-leaf		Y		Y	
<i>Zygophyllum aurantiacum</i> subsp. <i>aurantiacum</i>	Shrubby Twin-leaf		Y			
Introduced Species						
<i>Acacia saligna</i>	Golden Wreath Wattle		Y			
<i>Acetosella vulgaris</i>	Sheep Sorrel		Y			
<i>Asparagus asparagoides</i>	Bridal Creeper	R, WoNS	Y			
<i>Asparagus officinalis</i>	Asparagus		Y	Y	Y	Y
<i>Aster subulatus</i>	Aster-weed		Y	Y	Y	Y
<i>Atriplex prostrata</i>	Hastate Orache		Y	Y		
<i>Avena fatua</i>	Wild Oat		Y			
<i>Avena</i> spp.	Oat		Y			
<i>Brassica tournefortii</i>	Mediterranean Turnip		Y		Y	Y
<i>Bromus catharticus</i>	Prairie Grass		Y			
<i>Bromus diandrus</i>	Great Brome		Y		Y	Y
<i>Bromus lanceolatus</i>	Mediterranean Brome		Y			
<i>Bromus rubens</i>	Red Brome		Y			
<i>Carduus tenuiflorus</i>	Winged Slender-thistle	R, WoNS			Y	
<i>Centaurea melitensis</i>	Malta Thistle		Y		Y	
<i>Chenopodium album</i>	Fat Hen		Y			
<i>Chloris gayana</i>	Rhodes Grass		Y			
<i>Chloris virgata</i>	Feather Windmill Grass		Y			
<i>Chondrilla juncea</i>	Skeleton Weed		Y			
<i>Cichorium intybus</i>	Chicory		Y			
<i>Cirsium vulgare</i>	Spear Thistle	R, WoNS	Y	Y	Y	Y
<i>Conyza bonariensis</i>	Flaxleaf Fleabane		Y	Y	Y	Y

Scientific Name	Common Name	Classification	Source of information			
			2010 EWMP (both sites)	AE 2012 (both sites)	2013 GHD survey	
					Nyah	Vinifera
<i>Cotula coronopifolia</i>	Water Buttons		Y			
<i>Cotyledon orbiculata</i>	Pig's Ear		Y			
<i>Cynodon dactylon</i> var. <i>dactylon</i>	Couch		Y			
<i>Cyperus eragrostis</i>	Drain Flat-sedge		Y			Y
<i>Dittrichia graveolens</i>	Stinkwort	R	Y			
<i>Echium plantagineum</i>	Paterson's Curse	R			Y	
<i>Ehrharta longiflora</i>	Annual Veldt-grass		Y			
<i>Fumaria bastardii</i>	Bastard's Fumitory				Y	Y
<i>Fumaria capreolata</i>	White Fumitory		Y			
<i>Gomphocarpus fruticosus</i> subsp. <i>fruticosus</i>	Swan Plant		Y			
<i>Heliotropium supinum</i>	Creeping Heliotrope		Y	Y	Y	Y
<i>Helminthotheca echioides</i>	Ox-tongue		Y			Y
<i>Hordeum marinum</i>	Sea Barley-grass		Y			
<i>Hordeum murinum</i> s.l.	Barley-grass		Y			
<i>Hypochaeris glabra</i>	Smooth Cat's-ear		Y			
<i>Hypochaeris radicata</i>	Flatweed		Y			
<i>Lactuca saligna</i>	Willow-leaf Lettuce		Y			
<i>Lactuca serriola</i>	Prickly Lettuce		Y	Y	Y	Y
<i>Leontodon taraxacoides</i> subsp. <i>taraxacoides</i>	Hairy Hawkbit		Y			
<i>Lepidium africanum</i>	Common Peppergrass		Y		Y	Y
<i>Lolium rigidum</i>	Wimmera Rye-grass		Y			Y
<i>Lycium ferocissimum</i>	African Box-thorn	C, WoNS	Y			
<i>Lysimachia arvensis</i>	Pimpernel		Y		Y	
<i>Marrubium vulgare</i>	Horehound	R	Y		Y	
<i>Medicago minima</i>	Little Medic		Y			
<i>Medicago polymorpha</i>	Burr Medic		Y	Y		Y
<i>Melilotus indicus</i>	Sweet Melilot				Y	
<i>Opuntia</i> spp.	Prickly Pear	C, WoNS	Y			
<i>Paspalum dilatatum</i>	Paspalum		Y			
<i>Paspalum distichum</i>	Water Couch		Y	Y		Y
<i>Petrorhagia dubia</i>	Velvety Pink				Y	
<i>Phyla canescens</i>	Fog-fruit		Y	Y	Y	Y
<i>Plantago lanceolata</i>	Ribwort		Y	Y		Y
<i>Polygonum aviculare</i> s.s.	Hogweed		Y	Y		Y
<i>Polypogon monspeliensis</i>	Annual Beard-grass		Y			
<i>Ranunculus muricatus</i>	Sharp Buttercup		Y			
<i>Ranunculus sceleratus</i> subsp. <i>sceleratus</i>	Celery Buttercup		Y	Y		
<i>Reichardia tingitana</i>	False Sow-thistle		Y			
<i>Reseda luteola</i>	Weld		Y			
<i>Rhaponticum repens</i>	Creeping Knapweed		Y			
<i>Rorippa palustris</i>	Marsh Yellow-cress		Y	Y		
<i>Rostraria cristata</i>	Annual Cat's-tail		Y			
<i>Rumex crispus</i>	Curled Dock		Y			
<i>Salvia verbenaca</i>	Wild Sage		Y			
<i>Schismus barbatus</i>	Arabian Grass		Y			
<i>Scorzonera laciniata</i>	Scorzonera		Y			
<i>Sida rhombifolia</i>	Paddy's Lucerne		Y			
<i>Silene apetala</i> var. <i>apetala</i>	Mallee Catchfly		Y			
<i>Solanum nigrum</i> sensu <i>Willis</i> (1972)	Black Nightshade		Y	Y	Y	
<i>Sonchus asper</i> s.l.	Rough Sow-thistle		Y	Y	Y	
<i>Sonchus asper</i> subsp. <i>glaucescens</i>	Blue Sow-thistle		Y			
<i>Sonchus oleraceus</i>	Common Sow-thistle		Y	Y	Y	
<i>Sorghum halepense</i>	Johnson Grass		Y			
<i>Stellaria media</i>	Chickweed		Y			
<i>Trifolium fragiferum</i> var. <i>fragiferum</i>	Strawberry Clover		Y			
<i>Trifolium glomeratum</i>	Cluster Clover		Y			
<i>Trifolium</i> spp.	Clover		Y			
<i>Trifolium campestre</i> var. <i>campestre</i>	Hop Clover				Y	

Scientific Name	Common Name	Classification	Source of information			
			2010 EWMP (both sites)	AE 2012 (both sites)	2013 GHD survey	
					Nyah	Vinifera
<i>Vicia sativa</i>	Common Vetch				Y	
<i>Vulpia bromoides</i>	Squirrel-tail Fescue		Y	Y	Y	
<i>Xanthium spinosum</i>	Bathurst Burr	R	Y			
<i>Xanthium strumarium</i> spp. agg.	Noogoora Burr species aggregate	C	Y			

Key:

r Listed as rare under VROT's list
 k Listed as poorly known under VROT's list
 P Listed as protected under FFG Act
 C Listed as Regionally Controlled under CaLP Act within the Mallee CMA
 R Listed as Restricted under the CaLP Act within the Mallee CMA
 WoNS Weed of National Significance

Fauna Species List

Scientific Name	Common Name	Classification	Type	Source of information						
Native Species				2010 EWMP (both sites)	2013 GHD survey		ARI 2013 Survey		2014 Ecological SDL	
					Nyah	Vinifera	Nyah	Vinifera	Nyah	Vinifera
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill		B		Y		Y			
<i>Acanthiza reguloides</i>	Buff-rumped Thornbill		B		Y		Y			
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill		B	Y			Y			
<i>Accipiter fasciatus</i>	Brown Goshawk		B	Y	Y		y			
<i>Accipiter (Paraspizias) cirrocephalus</i>	Collared Sparrowhawk		B		Y		y			
<i>Accipiter novaehollandiae</i>	Grey Goshawk		B	Y						
<i>Acrocephalus stentoreus</i>	Clamorous Reed Warbler		B	Y						
<i>Alisterus scapularis</i>	Australian King-Parrot		B	Y						
<i>Anas gracilis</i>	Grey Teal		B	Y		Y				
<i>Anas rhynchotis</i>	Australasian Shoveler	v	B			Y				
<i>Anas superciliosa</i>	Pacific Black Duck		B	Y		Y				
<i>Anhinga melanogaster</i>	Darter		B			Y				
<i>Anthochaera carunculata</i>	Red Wattlebird		B	Y						
<i>Aquila audax</i>	Wedge-tailed Eagle		B	Y						
<i>Ardea modesta</i>	Eastern Great Egret		B	Y						
<i>Ardea pacifica</i>	White-necked Heron		B	Y						
<i>Artamus cyanopterus</i>	Dusky Woodswallow		B	Y						
<i>Artamus personatus</i>	Masked Woodswallow		B		Y		Y			
<i>Artamus superciliosus</i>	White-browed Woodswallow		B		Y		Y			
<i>Aythya australis</i>	Hardhead		B	Y						
<i>Biziura lobata</i>	Musk Duck		B	Y						
<i>Cacatua galerita</i>	Sulphur-crested Cockatoo		B		Y		y			
<i>Lophochroa leadbeateri</i>	Major Mitchell's Cockatoo	v, L	B						Y	Y
<i>Cacatua sanguinea</i>	Little Corella		B		Y					
<i>Chalinolobus gouldi</i>	Gould's Wattled Bat		M		Y	Y	y	y	Y	Y
<i>Chalinolobus morio</i>	Chocolate Wattled Bat		M		Y	Y	y	y	Y	Y
<i>Chelodina longicollis</i>	Common Long-necked Turtle	dd	R						Y	
<i>Chenonetta jubata</i>	Australian Wood Duck		B	Y		Y				
<i>Christinus marmoratus</i>	Marbled Gecko		R	Y					Y	
<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo		B	Y						
<i>Cincloramphus mathewsi</i>	Rufous Songlark		B	Y						
<i>Climacteris picumnus</i>	Brown Treecreeper		B				Y			
<i>Colluricincla harmonica</i>	Grey Shrike-thrush		B		Y	Y	Y			
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike		B	Y	Y	Y	Y	Y		
<i>Corcorax melanorhamphos</i>	White-winged Chough		B	Y	Y	Y	Y	Y		
<i>Corvus coronoides</i>	Australian Raven		B	Y	Y	Y	Y	Y		
<i>Corvus mellori</i>	Little Raven		B	Y				Y		
<i>Cracticus nigrogularis</i>	Pied Butcherbird		B	Y	Y	Y	Y	Y		
<i>Crinia parsignifera</i>	Plains Froglet		R		Y				Y	
<i>Crinia signifera</i>	Common froglet		R						Y	
<i>Cryptoblepharus carnabyi</i>	Carnaby's Wall Skink		R	Y	Y	Y	Y		Y	Y
<i>Cygnus atratus</i>	Black Swan		B	Y						
<i>Daphoenositta chrysoptera</i>	Varied Sittella		B		Y		Y			
<i>Dacelo novaeguineae</i>	Laughing Kookaburra		B	Y	Y	Y				y
<i>Delma inomata</i>	Olive Legless Lizard		R			Y		Y		Y
<i>Dicaeum hirundinaceum</i>	Mistletoebird		B	Y						
<i>Egretta novaehollandiae</i>	White-faced Heron		B	Y		Y				
<i>Elsayornis melanops</i>	Black-fronted Dotterel		B	Y						
<i>Entomyzon cyanotis</i>	Blue-faced Honeyeater		B	Y		Y		Y		

Scientific Name	Common Name	Classification	Type	Source of information						
Native Species				2010 EWMP (both sites)	2013 GHD survey		ARI 2013 Survey		2014 Ecological SDL	
					Nyah	Vinifera	Nyah	Vinifera	Nyah	Vinifera
<i>Eolophus roseicapilla</i>	Galah		B	Y	Y	Y	y	y		
<i>Falco berigora</i>	Brown Falcon		B	Y						
<i>Falco cenchroides</i>	Nankeen Kestrel		B	Y	Y		y			
<i>Fulica atra</i>	Eurasian Coot		B	Y						
<i>Gallinula tenebrosa</i>	Dusky Moorhen		B	Y						
<i>Gallinula ventralis</i>	Black-tailed Native-hen		B	Y						
<i>Gerygone fusca</i>	Western Gerygone		B		Y		Y			
<i>Geopelia striata</i>	Peaceful Dove		B	Y	Y	Y				
<i>Grallina cyanoleuca</i>	Magpie-lark		B	Y	Y	Y	Y	Y		
<i>Gymnorhina tibicen</i>	Australian Magpie		B	Y	Y	Y	Y	Y		
<i>Haliaeetus (Pontoaetus) leucogaster</i>	White-bellied Sea-eagle	v, L	B						Y	
<i>Haliastur sphenurus</i>	Whistling Kite		B	Y		Y				
<i>Hirundo neoxena</i>	Welcome Swallow		B	Y						
<i>Hirundo nigricans</i>	Tree Martin		B	Y	Y					
<i>Hydromus chrysogaster</i>	Water Rat		M						Y	
<i>Lalage (Lalage) sueurii</i>	White-winged Triller		B		Y		Y			
<i>Lampropholis guichenoti</i>	Garden Skink		R		Y	Y	Y	Y	Y	Y
<i>Lerista punctatovittata</i>	Spotted Burrowing Skink		R	Y						
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater		B	Y	Y	Y	Y	Y		
<i>Lichenostomus virescens</i>	Singing Honeyeater		B	Y						
<i>Limnodynastes dumerilii</i>	Southern Bullfrog		A	Y	Y	Y	Y	Y	Y	Y
<i>Limnodynastes tasmaniensis</i>	Spotted Marsh Frog		A	Y	Y	Y	Y	Y	Y	Y
<i>Litoria peronii</i>	Peron's Tree Frog		A	Y	Y			Y	Y	Y
<i>Litoria raniformis</i>	Growling Grass Frog		A	Y						
<i>Macropus giganteus</i>	Eastern Grey Kangaroo		M			Y	Y	Y	Y	Y
<i>Malacorhynchus membranaceus</i>	Pink-eared Duck		B	Y						
<i>Malurus cyaneus</i>	Superb Fairy-wren		B	Y	Y		Y			
<i>Manorina melanocephala</i>	Noisy Miner		B	Y	Y	Y	Y	Y		
<i>Menetia greyii</i>	Grey's Skink		R						Y	
<i>Merops ornatus</i>	Rainbow Bee-eater		B	Y		Y				
<i>Microcarbo melanoleucos</i>	Little Pied Cormorant		B	Y						
<i>Morelia spilota mectalei</i>	Carpet Python	e, L	R	Y					Y	
<i>Morethia boulengeri</i>	Boulenger's Skink		R	Y	Y	Y	Y	Y	Y	Y
<i>Mormopterus sp. 2</i>	Eastern Freetail Bat		M		Y	Y	y	y	Y	Y
<i>Mormopterus sp. 4</i>	Southern Freetail Bat		M		Y	Y	y	y	Y	Y
<i>Myiagra inquieta</i>	Restless Flycatcher		B			Y		Y		
<i>Ninox novaeseelandiae</i>	Southern Boobook		B		Y	Y	Y	Y		
<i>Northiella haematogaster</i>	Blue Bonnet		B	Y						
<i>Notopala sublineata</i>	River Snail		I	Y						
<i>Nycticorax caledonicus</i>	Nankeen Night Heron	nt	B	Y					Y	Y
<i>Nymphicus hollandicus</i>	Cockatiel		B	Y						
<i>Ocyphaps lophotes</i>	Crested Pigeon		B	Y		Y		y		
<i>Pachycephala rufiventris</i>	Rufous Whistler		B	Y	Y	Y	Y			
<i>Pardalotus striatus</i>	Striated Pardalote		B	Y	Y	Y	Y	Y		
<i>Pelecanus conspicillatus</i>	Australian Pelican		B	Y	Y	Y	y			
<i>Petrochelidon nigricans</i>	Tree Martin		B				Y			
<i>Petroica goodenovii</i>	Red-capped Robin		B	Y	Y		Y			
<i>Phalacrocorax carbo</i>	Great Cormorant		B	Y		Y				
<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant		B			Y				
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant		B	Y		Y				
<i>Phaps chalcoptera</i>	Common Bronzewing		B	Y	Y	Y	y			
<i>Philemon citreogularis</i>	Little Friarbird		B	Y	Y	Y	Y	Y		
<i>Platalea flavipes</i>	Yellow-billed Spoonbill		B	Y		Y				
<i>Platalea regia</i>	Royal Spoonbill		B	Y						
<i>Platycercus elegans elegans</i>	Crimson Rosella		B	Y						

Scientific Name	Common Name	Classification	Type	Source of information						
Native Species				2010 EWMP (both sites)	2013 GHD survey		ARI 2013 Survey		2014 Ecological SDL	
					Nyah	Vinifera	Nyah	Vinifera	Nyah	Vinifera
<i>Platycercus elegans flaveolus</i>	Yellow Rosella		B	Y	Y	Y	y	y		
<i>Platycercus eximius</i>	Eastern Rosella		B	Y				y		
<i>Podargus strigoides</i>	Tawny Frogmouth		B		Y	Y	Y	Y		
<i>Poliocephalus poliocephalus</i>	Hoary-headed Grebe		B			Y				
<i>Polytelis anthopeplus</i>	Regent Parrot	v, L, VU	B	Y						
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler		B	Y						
<i>Porzana tabuensis</i>	Spotless Crane		B	Y						
<i>Psephotus haematonotus</i>	Red-rumped Parrot		B	Y	Y	Y	y	y		
<i>Pseudonaja textilis</i>	Eastern Brown Snake		R			Y		Y	Y	Y
<i>Rhipidura albiscarpa</i>	Grey Fantail		B	Y						
<i>Rhipidura leucophrys</i>	Willie Wagtail		B	Y	Y	Y	Y	Y		
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tailed Bat	dd, L	M		Y		y		Y	
<i>Scotorepens balstoni</i>	Inland broad-nosed Bat		M			Y		y		Y
<i>Scotorepens greyii</i>	Little Broad-nosed Bat	NT	M			Y		y		Y
<i>Simoselaps australis</i>	Coral Snake		R	Y						
<i>Smicromys brevirostris</i>	Weebill		B	Y	Y	Y	Y	Y		
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe		B			Y				
<i>Tachyglossus aculeatus</i>	Short-beaked Echidna		M						Y	
<i>Tadarida australis</i>	White-striped Freetail Bat		M		Y	Y	y	y		Y
<i>Taeniopygia guttata</i>	Zebra Finch		B	Y						
<i>Threskiornis molucca</i>	Australian White Ibis		B	Y		Y				
<i>Threskiornis spinicollis</i>	Straw-necked Ibis		B	Y						
<i>Todiramphus sanctus</i>	Sacred Kingfisher		B	Y	Y	Y			y	y
<i>Trichosurus vulpecula</i>	Common Brushtail Possum		M		Y	Y	Y	Y	Y	Y
<i>Turnix varia</i>	Painted Button-quail		B	Y						
<i>Tyto alba</i>	Barn Owl						Y	Y		
<i>Tyto javanica</i>	Eastern Barn Owl		B		Y	Y				
<i>Varanus varius</i>	Lace Monitor		R						Y	
<i>Vespadelus darlingtoni</i>	Large Forest Bat		M		Y	Y	y	y	Y	Y
<i>Vespadelus regulus</i>	Southern Forest Bat		M		Y	Y	y	y	Y	Y
<i>Vespadelus vulturnus</i>	Little Forest Bat		M		Y	Y	y	y	Y	Y
<i>Wallabia bicolor</i>	Black Wallaby		M	Y		Y	Y	Y	Y	Y
<i>Zosterops lateralis</i>	Silvereye		B	Y	Y		Y			
Introduced Species										
<i>Anas platyrhynchos</i>	Northern Mallard		B	Y						
<i>Lepus europaeus</i>	European Hare							Y		
<i>Oryctolagus cuniculus</i>	European Rabbit		M		Y		Y			
<i>Passer domesticus</i>	House Sparrow		B	Y						
<i>Sturnus vulgaris</i>	Common Starling		B	Y						
<i>Turdus merula</i>	Common Blackbird		B	Y						
<i>Vulpes vulpes</i>	Red Fox		M	Y		Y	Y	Y		

Appendix 2 - Recent watering history

The table below summarises the recent environmental watering history in the target area. Environmental watering has only occurred in the Nyah section of the WMU.

This appendix will be updated seasonally.

Water year	Time of inflow	Inflow source	Source volume (ML)	Total volume (ML)	Cost of delivery (\$)	Area (ha) Inundated	Comments
2004/05	Autumn	Donated water	153	153	\$30 -45/ML*	35	
2005/06	Spring	EWR	560	1241		110	
		RMUF	681				
	Autumn	EWR	500	500		110	
2009/10	Autumn	EWR	2125.8	2125.8		165.36	

*the cost of delivery is dependent on factors such as fuel prices, river heights, site access, type of pump required, volume to be pumped etc



Pumping at Nyah, April 2010



Nyah Forest photo point #3 April 8 2010

Appendix 3 - Index of Wetland Condition Assessment

Background

The condition of the Nyah Vinifera WMU was assessed in 2009 using the Index of Wetland Condition (IWC) method. The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions. The condition of two of the eleven wetlands within the target area of the Nyah Vinifera WMU (see map below) was assessed in December 2009.

The IWC has five sub-indices based on the catchment of the wetland and its fundamental characteristics: physical form, hydrology, water properties, soils and biota. Each sub-index is given a score between 0 and 20 based on the assessment of a number of measures. The overall IWC score is not a simple summation of the sub-index scores. A formula is used that weights each sub-index according to the contribution it makes to the overall condition of the wetland. The wetland hydrology sub-index for example contributes more to the overall score than the soils sub-index.

Methods

Sub-indices

The table below shows what is measured for each of the six sub-indices and how each sub-index is scored. The sections below describe this in greater detail. Further information can be found on the IWC website (www.dse.vic.gov.au/iwc).

IWC sub-indices and measures

Sub-index	What is measured	How it is scored
Wetland catchment	The intensity of the land use within 250 metres of the wetland	The more intensive the land use the lower the score
	The width of the native vegetation surrounding the wetland and whether it is a continuous zone or fragmented	The wider the zone and more continuous the zone, the higher the score
Physical form	Whether the size of the wetland has been reduced from its estimated pre-European settlement size	A reduction in area results in a lowering of the score
	The percentage of the wetland bed which has been excavated or filled	The greater the percentage of wetland bed modified, the lower the score
Hydrology	Whether the wetland's water regime (i.e. the timing, frequency of filling and duration of flooding) has been changed by human activities	The more severe the impacts on the water regime, the lower the score
Water properties	Whether activities and impacts such as grazing and fertilizer run-off that would lead to an input of nutrients to the wetland are present	The more activities present, the lower the score
	Whether the wetland has become more saline or in the case of a naturally salty wetland, whether it has become more fresh	An increase in salinity for a fresh wetland lowers the score or a decrease in salinity of a naturally salty wetland lowers the score

Sub-index	What is measured	How it is scored
Soils	The percentage and severity of wetland soil disturbance from human, feral animals or stock activities	The more soil disturbance and the more severe it is, the lower the score
Biota	The diversity, health and weediness of the native wetland vegetation	The lower the diversity and poorer health of native wetland vegetation, the lower the score
		The increased degree of weediness in the native wetland vegetation, the lower the score

Scoring method

Each subindex is given a score between 0 and 20 based on the assessment of a number of measures as outline above. Weightings are then applied to the scores as tabulated below. The maximum possible total score for a wetland is 38.4. For ease of reporting, all scores are normalised to an integer score out of 10 (i.e. divide the total score by 38.4, multiply by 10 and round to the nearest whole number).

IWC sub-index	Weight
Biota	0.73
Wetland catchment	0.26
Water properties	0.47
Hydrology	0.31
Physical form	0.08
Soils	0.07

Five wetland condition categories have been assigned to the sub-index scores and total IWC scores as tabulated over page. The five category approach is consistent with the number of categories used in other condition indices such as the Index of Stream Condition. Biota sub-index score categories were determined by expert opinion and differ to those of the other sub-indices.

Non-biota sub-index score range	Biota sub-index score range	Total score range	Wetland condition category
0-4	0-8	0-2	Very poor
5-8	9-13	3-4	Poor
9-12	14-16	5-6	Moderate
13-16	17-18	7-8	Good
16-20	19-20	9-10	Excellent
N/A	N/A	N/A	Insufficient data

Results

The overall IWC score for both wetlands assessed in this WMU in December 2009 was six out of 10, which is considered to be moderate (see table below)

IWC sub-index and overall score for two wetlands in the target area

IWC sub-index	Wetland #7527147125		Wetland #7527153101	
	Score /20	Category	Score /20	Category
Wetland catchment	18	Excellent	18	Excellent
Physical form	20	Excellent	20	Excellent
Hydrology	0	Very poor	0	Very poor
Water properties	17	Excellent	17	Excellent
Soils	19.8	Excellent	19.8	Excellent
Biota	11.4	Poor	8.4	Poor
Overall IWC score	6 / 10	Moderate	6 / 10	Moderate

**Department of
Sustainability and
Environment**



- Biodiversity Interactive Map A4 Landscape**
- (c) The State of Indiana Department of Sustainability and Environment 2011
- Product

Map Scale 1:39,449

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