

Local Land Services



Murray Regional Natural Resource Management Strategy

2023-2028

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Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing May 2023. However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of Local Land Services or the user's independent adviser.

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Acknowledgement of Country

Murray Local Land Services (Murray LLS) acknowledges the traditional owners of the lands across which we work. We recognise the primacy of their role in cultural heritage, cultural economy, cultural knowledge, and the continuing connection of first nations people to country.

The Murray region spans the traditional lands of the Wiradjuri, Wolgalu, Ngarigo, Bangarang, Yorta Yorta, Barapa Barapa, Wamba Wamba, Nari Nari, Wadi Wadi and Mari Mari people.

We pay our respects to elders past, present and emerging across these lands, and celebrate Aboriginal culture as a living and dynamic creation that provides a strong foundation to generate a brighter future.

We are committed to reconciliation, closing the gap, and engaging with First Nations people as the custodians who sustainably managed this land for tens of thousands of years. In our planning, we aim to consider how our proposed activities could affect traditional owner rights in relation to their lands and waters. Our commitments are formalised in the Local Strategic Plan and the Local Land Services Aboriginal Engagement Strategy.

We look forward to ongoing partnerships with our local first nations people across all sectors of our organisation.



Introduction

This strategy provides an overview of the development and implementation of Murray LLS's Natural Resource Management (NRM) activities as part of the organisation's Landscape Management Strategy. Projects detailed in this strategy are collated on an annual basis to contribute Murray LLS's Annual Business Plan.

The location of this strategy is highlighted in yellow in Figure 1.

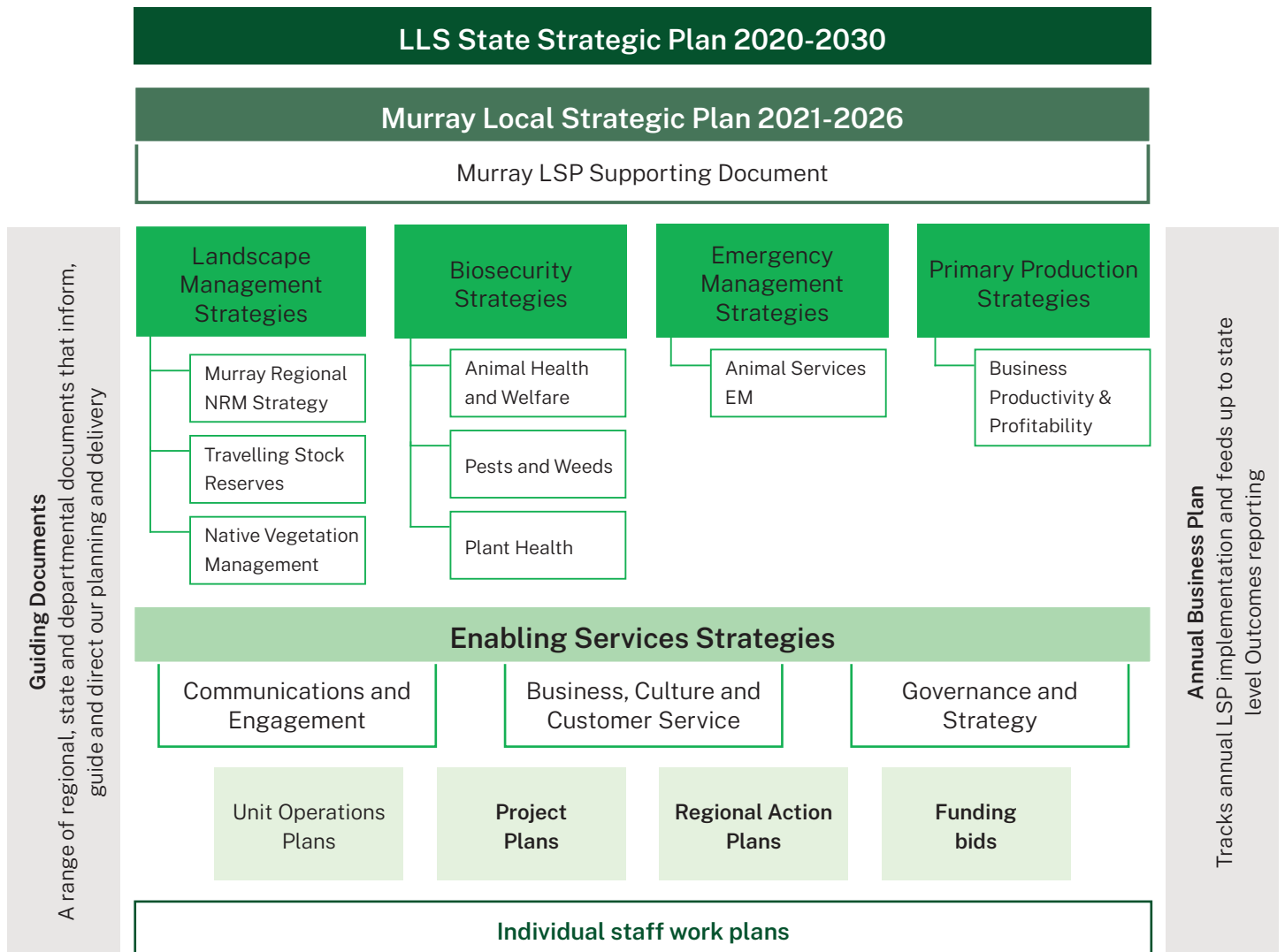


Figure 1. Murray LLS's Planning Framework

Purpose

The purpose of this strategy is to:

1. Identify priority activities to protect the natural values of the Murray region
2. Provide a link of priority activities to the Australian Government's matters of national environmental significance
3. Provide strategic and practical guidance to Murray LLS in the implementation of its regional NRM program.

How We Developed This Strategy

This strategy was developed by analysing survey data, mapping data and condition assessments in addition to undertaking modelling exercises. Murray LLS reviewed previous plans and strategies and obtained expert opinions. Murray LLS also identified emerging trends, risks, and opportunities, and assessed stakeholder needs to identify priority projects over the next 5 years.

The Murray region

The Murray region spans more than 4.2 million ha of public and private land, bounded to the south by the Murray River and ranging from steep alpine slopes in the east to vast native grasslands, rangelands, and riverine floodplains in the west.

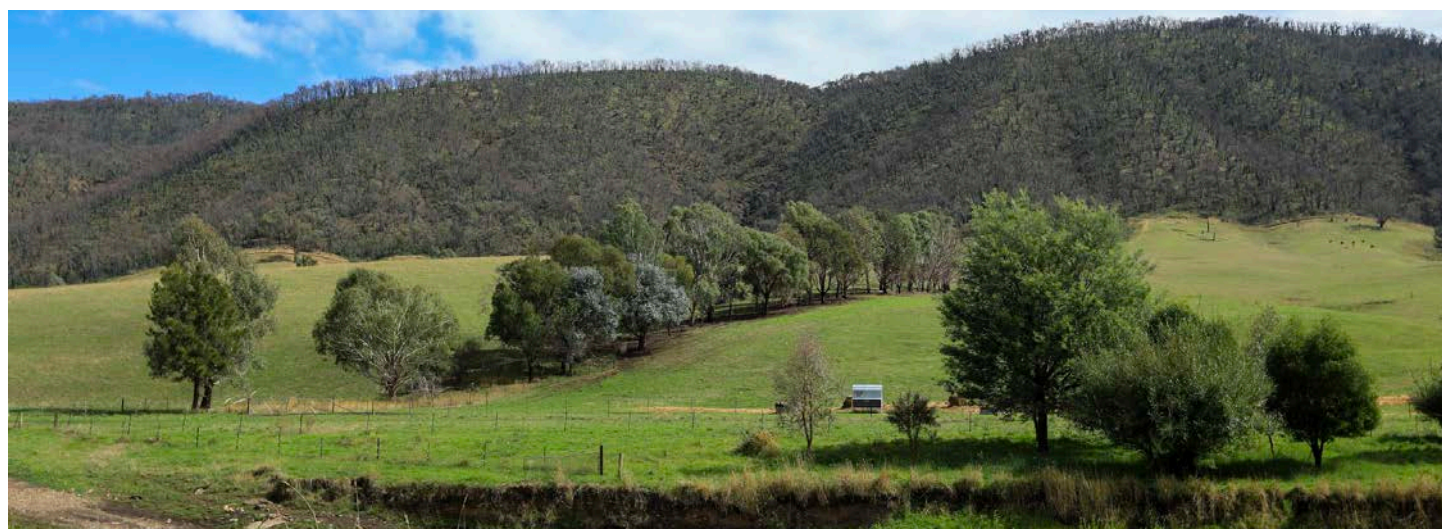
The region has nationally significant wetlands including Kosciuszko National Park, the Murray River, and the Central Murray Red Gum forests. The region also has approximately 380,000 ha of national parks and reserves, 140,000 ha of state forests and 55,000 ha of travelling stock reserves.

Much of the region's multi-billion-dollar economy depends on continuing access to healthy natural resources as around 80% of land in the region is used for agriculture and one-third of residents are directly involved in agricultural production (Figure 3).

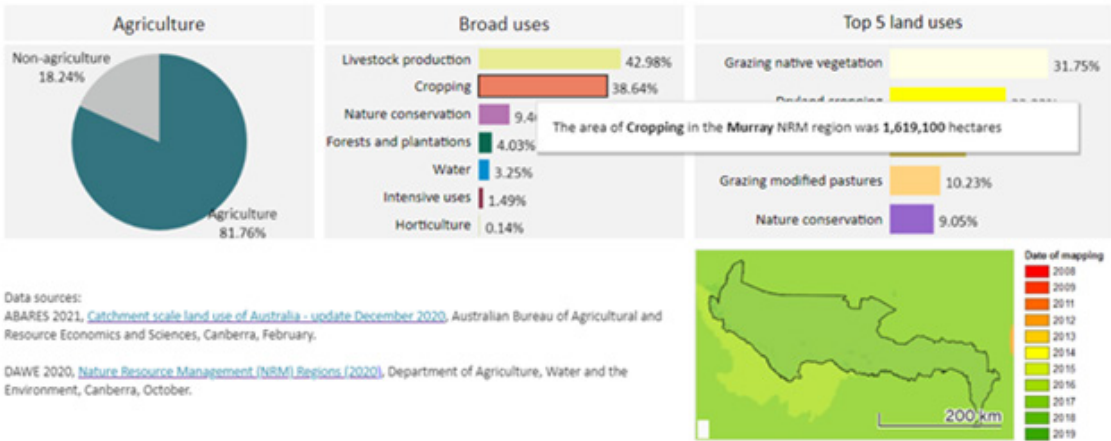
High quality land and water resources support diverse agricultural enterprises, including cropping, grazing, horticulture, forestry, and dairying.



Figure 2. Map of the Murray region.



			Area (ha)	Share
Agriculture	Livestock production	Grazing native vegetation	1,330,108	31.75%
		Grazing modified pastures	428,521	10.23%
		Land in transition	508	0.01%
		Irrigated pastures	38,764	0.93%
		Intensive animal production	2,703	0.06%
	Cropping	Dryland cropping	973,206	23.23%
		Irrigated cropping	645,895	15.42%
	Horticulture	Dryland horticulture	463	0.01%
		Irrigated horticulture	5,432	0.13%
		Intensive plant production	64	0.00%
Non-agriculture	Nature conservation	Nature conservation	379,087	9.05%
		Other protected areas including indigenous uses	15,035	0.36%
		Minimal use	2,388	0.06%
	Forests and plantations	Production native forests	131,106	3.13%
		Plantation forests (commercial and other)	37,879	0.90%
	Intensive uses	Urban intensive uses	40,997	0.98%
		Rural residential and farm infrastructure	18,958	0.45%
		Mining and waste	2,346	0.06%
	Water	Water	136,244	3.25%
	Grand Total			4,189,702



Data sources:
 ABARES 2021, [Catchment scale land use of Australia – update December 2020](#), Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, February.
 DAWE 2020, [Nature Resource Management \(NRM\) Regions \(2020\)](#), Department of Agriculture, Water and the Environment, Canberra, October.

Figure 3. Murray Region Land Use Summary.

The region’s population of approximately 107,000 people is concentrated along the Murray, Edward, and Billabong-Yanco River systems in towns such as Albury, Corowa, Deniliquin, Holbrook, Jerilderie, Moama, and Tocumwal.

Our communities have been challenged over the past decade with changes to demographics, land use, climate, and water availability. These challenges present the risks and opportunities on which this strategy is based.

Traditional Country of the Murray region

The Murray region is steeped in first nation’s history and culture, encompassing many important cultural locations. There is a collaborative approach to land management, utilising the skills and experience of first nations people to maintain cultural knowledge and traditional practices.

Traditional custodians and their descendants have managed the environment for thousands of years and first nations people possess immeasurable knowledge and experience in relation to country. Their spirituality is embedded in the landscape and a connective thread binds them to all that exists naturally.

Climate and climate change in the Murray region

The Murray region's climate ranges from cool temperatures in the east to semi-arid in the west, with high temperatures and evaporation rates that exceed rainfall. Our long-term annual average rainfall ranges from 1,600 mm in the Alps to 700 mm at Albury, and 323 mm west of Moulamein.

As a result of climate change, climate modelling predicts that average temperatures are expected to increase in all seasons with more hot days and heat waves (Figure 4). These changes are likely to result in harsher fire conditions.

A decrease in rainfall, particularly in winter and spring, is projected in addition to fewer frosts. Climate modelling also predicts an increase in extreme rainfall events. (Figure 5).

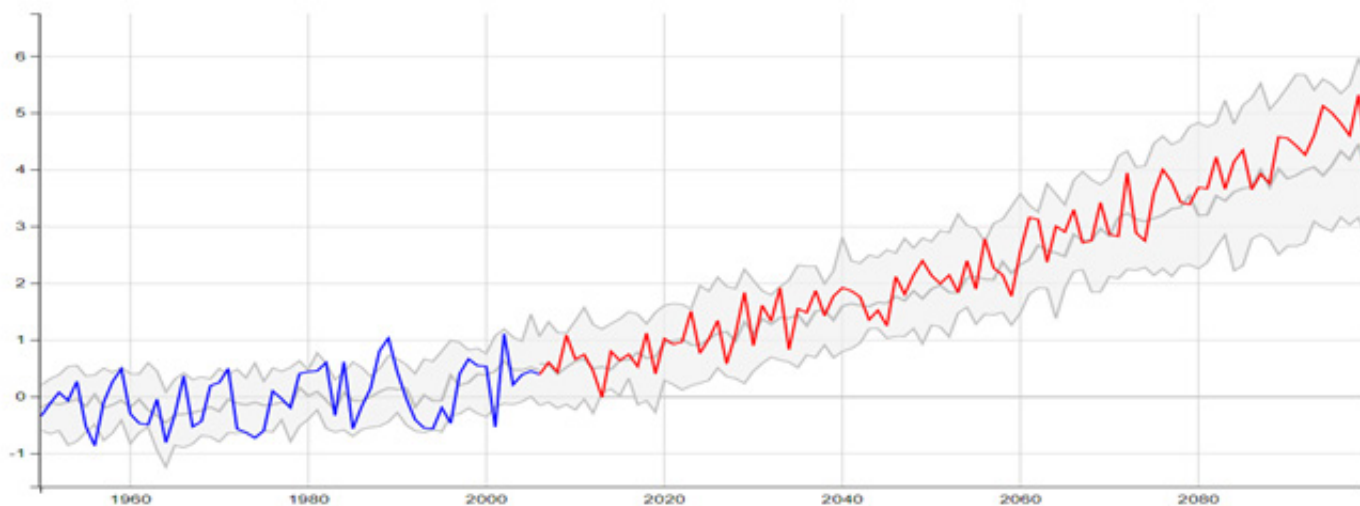


Figure 4. Modelled Temperature Changes in the Murray Region Over Time (CSIRO 2022).

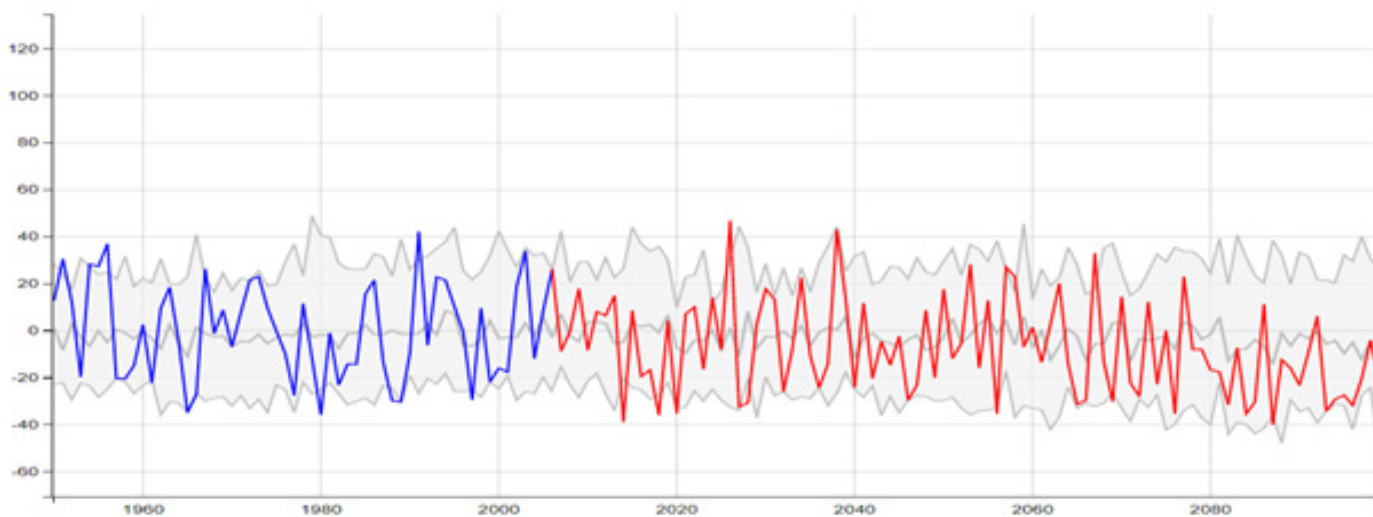


Figure 5. Modelled Rainfall Changes for the Murray Region over time (CSIRO 2022)

Natural asset descriptions and threats

This section details what the science tells us about the condition of natural assets and resources across the Murray Region and identifies threats.

This information is aligned with Murray LLS's NRM Framework, which divides natural assets and resources into 4 categories:

- Terrestrial ecosystems
- Aquatic ecosystems
- Soils and land
- Significant species.

Table 1. Murray Region IBRA Bioregions.

Bioregion	Hectares of IBRA bioregion in Murray Region	% of Murray Region comprised of each IBRA bioregion	% of IBRA bioregion reserved in the Murray Region	% of IBRA bioregion reserved in NSW
Australian Alps	108,423	3	84	82
South Eastern Highlands	153,706	4	48	12
NSW South Western Slopes	1,006,344	29	5	2
Riverina	2,194,443	62	3	4
Murray Darling Depression	70,265	2	<1	6

Biogeographic diversity in the Murray region

Over geological timescales, the variations in climate, soil type and physical features across the Murray Region provide an incredibly varied canvas for the development of ecological diversity. Landscapes of the region range from alpine to semi-arid and include 5 of the 89 interim Biogeographic Regionalisation for Australia IBRA bioregions recognised across Australia and 7 sub-regions.

Murray regions IBRA subregions

- South Olary Plain
- Murrumbidgee
- Murray Fans
- Inland Slopes
- Lower Slopes
- Bondo
- Snowy Mountains



Terrestrial ecosystems

Native vegetation of the Murray region

The Murray region supports a range of ecosystems, ecological communities, and vegetation types.

These include:

- Alpine fjaeldmarks
- Heathlands and herbfields in the east
- Semi-arid woodlands and shrublands in the west
- Grassy woodlands, floodplain woodlands, natural grasslands, and freshwater and forested wetlands (Figure 6).

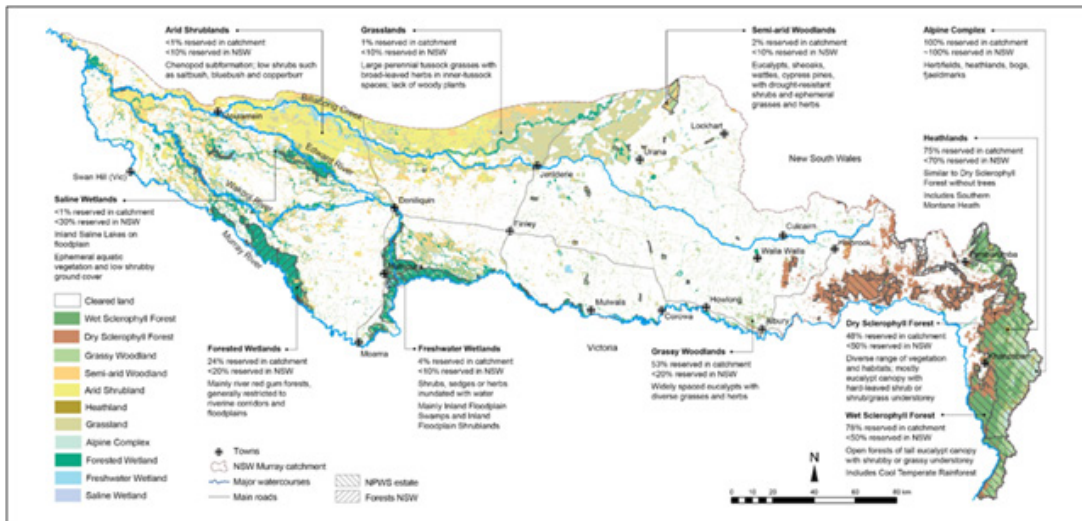


Figure 6. Murray Region Native Vegetation Formations

The condition of these vegetation communities varies substantially (Figure 7). At the landscape scale, high quality patches are restricted to public land reserves managed for conservation outcomes. High-condition parcels occur at the local scale, particularly in the upper, central north and west of the region. These locations require ongoing surveillance to manage emerging risks.

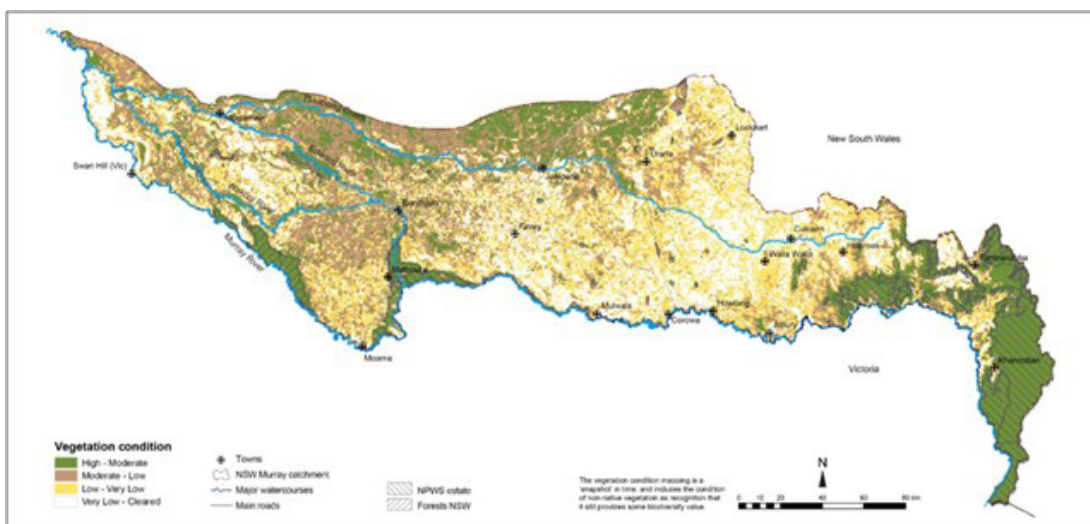


Figure 7. Murray Region Vegetation Condition

Many areas need repair to prevent further declines in vegetation communities and loss of species. Priority areas are primarily in the over-cleared landscapes that were formerly Grassy Woodlands. These areas require revegetation through replanting and promotion of natural regeneration, strategic grazing, and weed and pest management to improve the extent and condition of native vegetation for biodiversity.

Native vegetation communities have been extensively cleared for agricultural production and some are now listed as endangered (Figure 8).

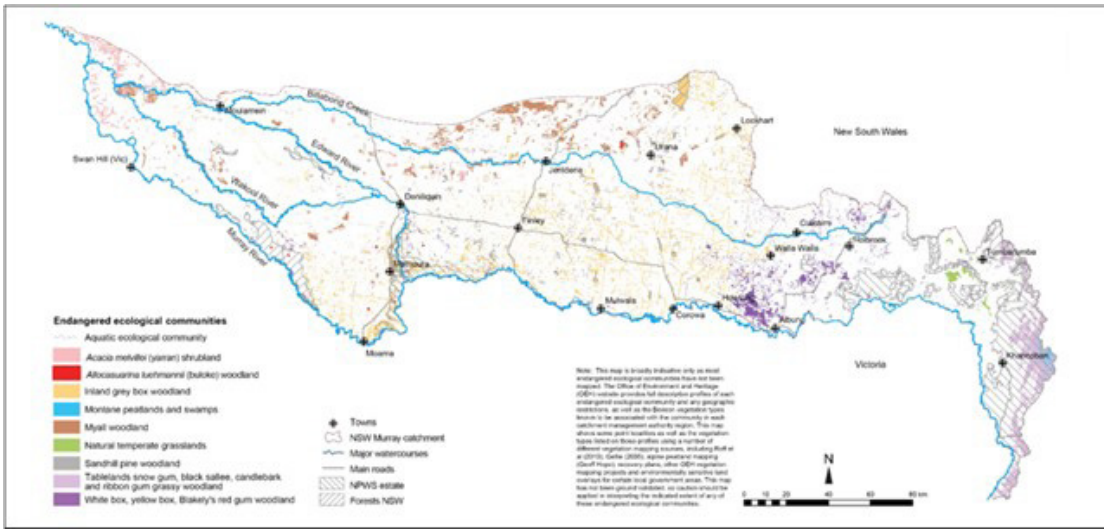


Figure 8. Murray Region Native Vegetation Formations

Risks to the native vegetation of the Murray include:

- Land clearance and degradation associated with urban encroachment
- Inappropriate grazing regimes
- Fragmentation into small remnants
- Loss or decline of mature trees due to dieback
- Lack of natural regeneration for understorey and canopy species
- Invasion by exotic plants
- Fertiliser use
- Inappropriate application of herbicides
- Firewood collection
- Soil salinity.



Terrestrial biodiversity in the Murray region

Biodiversity in the Murray region is declining. While our terrestrial ecosystems support more than 500 species of vertebrates and 2,350 species of plants, 70 vertebrates, and 62 plants are formally listed as threatened under Government legislation (Table 2).

Table 2. Murray Region Threatened Terrestrial Species and Communities

Scientific Name	Common Name	Class	NSW BC or FM Act Status	EPBC Act Status
<i>Acacia phasmoides</i>	Phantom Wattle	Plant		Vulnerable
<i>Ammobium craspedioides</i>	Yass Daisy	Plant	Vulnerable	Vulnerable
<i>Anthochaera phrygia</i>	Regent Honeyeater	Bird	Critically Endangered	Critically Endangered
<i>Aprasia parapulchella</i>	Pink-tailed Worm-lizard	Reptile	Vulnerable	Vulnerable
<i>Argyrotegium nitidulum</i>	Shining Cudweed	Plant		Vulnerable
<i>Ardeotis australis</i>	Australian Bustard	Bird	Endangered	
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow	Bird	Vulnerable	
<i>Austrostipa metatoris</i>	Null	Plant	Vulnerable	Vulnerable
<i>Austrostipa wakoolica</i>	Null	Plant	Endangered	Endangered
<i>Brachyscome muelleroides</i>	Mueller Daisy	Plant	Vulnerable	Vulnerable
<i>Brachyscome papillosa</i>	Mossgiel Daisy	Plant	Vulnerable	Vulnerable
<i>Burhinus grallarius</i>	Bush Stone-Curlew	Bird	Endangered	
<i>Burramys parvus</i>	Mountain Pygmy-possum	Mammal		Endangered
<i>Caladenia arenaria</i>	Sand-hill Spider-orchid	Plant	Endangered	Endangered
<i>Caladenia concolor</i>	Crimson Spider-orchid	Plant	Endangered	Vulnerable
<i>Caladenia tensa</i>	Greencomb Spider-orchid	Plant		Endangered
<i>Caladenia versicolor</i>	Candy Spider-orchid	Plant		Vulnerable
<i>Caladenia xanthochila</i>	Yellow-lip Spider-orchid	Plant		Endangered
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	Bird	Vulnerable	Endangered
<i>Calotis glandulosa</i>	Mauve Burr-daisy	Plant		Vulnerable
<i>Calyptorhynchus lathami lathami</i>	South-eastern Glossy Black-Cockatoo	Bird	Endangered	Vulnerable
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	Mammal	Vulnerable	
<i>Certhionyx variegatus</i>	Pied Honeyeater	Bird	Vulnerable	
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Mammal	Vulnerable	Vulnerable
<i>Chalinolobus picatus</i>	Little Pied Bat	Mammal	Vulnerable	

Scientific Name	Common Name	Class	NSW BC or FM Act Status	EPBC Act Status
<i>Chthonicola sagittata</i>	Speckled Warbler	Bird	Vulnerable	
<i>Circus assimilis</i>	Spotted Harrier	Bird	Vulnerable	
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern)	Bird	Vulnerable	
* <i>Colobanthus curtisiae</i>	Curtis' Colobanth	Plant		Vulnerable
* <i>Cullen parvum</i>	Small Scurf-pea	Plant	Endangered	
<i>Cyclodomorphus praealtus</i>	Alpine She-oak Skink	Reptile		Endangered
<i>Daphoenositta chrysoptera</i>	Varied Sittella	Bird	Vulnerable	
<i>Dasyurus maculatus maculatus</i>	Spotted-tail Quoll, Tiger Quoll	Mammal	Vulnerable	Endangered
* <i>Delma impar</i>	Striped Legless Lizard	Reptile	Vulnerable	Vulnerable
* <i>Deyeuxia pungens</i>	Narrow-leaf Bent-grass	Plant		Vulnerable
^ <i>Diuris ochroma</i>	Pale Golden Moths	Plant		Vulnerable
<i>Diuris callitrophila</i>	Oaklands Donkey Orchid	Plant	Endangered	
<i>Diuris tricolor</i>	Pine Donkey Orchid	Plant	Vulnerable	
^* <i>Dodonaea procumbens</i>	Trailing Hop-bush	Plant		Vulnerable
<i>Epthianura albifrons</i>	White-fronted Chat	Bird	Vulnerable	
<i>Eucalyptus leucoxydon subsp. pruinosa</i>	Yellow Gum	Plant	Vulnerable	
<i>Falco hypoleucos</i>	Grey Falcon	Bird	Vulnerable	Vulnerable
<i>Falco subniger</i>	Black Falcon	Bird	Vulnerable	
^* <i>Genoplesium vernale</i>	East Lynne Midge-orchid	Plant		Vulnerable
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet	Bird	Vulnerable	
^ <i>Glossopsitta pusilla</i>	Little Lorikeet	Bird	Vulnerable	
<i>Glycine latrobeana</i>	Clover Glycine	Plant		Vulnerable
<i>Grantiella picta</i>	Painted Honeyeater	Bird	Vulnerable	Vulnerable
^ <i>Haloragis exalata subsp. exalata</i>	Square Raspwort	Plant		Vulnerable
<i>Hamirostra melanosternon</i>	Black-breasted Bustard	Bird	Vulnerable	
<i>Hieraaetus morphnoides</i>	Little Eagle	Bird	Vulnerable	
<i>Hirundapus caudacutus</i>	White-throated Needletail	Bird		Vulnerable
<i>Lathamus discolor</i>	Swift Parrot	Bird	Endangered	Critically Endangered
<i>Leipoa ocellata</i>	Malleefowl	Bird		Vulnerable

Scientific Name	Common Name	Class	NSW BC or FM Act Status	EPBC Act Status
[^] <i>Lepidium aschersonii</i>	Spiny Pepper-cress	Plant		Vulnerable
<i>Lepidium hyssopifolium</i>	Peppercress	Plant		Endangered
[^] <i>Lepidium monoplocoides</i>	Winged Pepper-cress	Plant	Endangered	Endangered
<i>Leptorhynchos orientalis</i>	Lanky Buttons	Plant	Endangered	
<i>Leucochrysum albicans subsp. tricolor</i>	Hoary Sunray	Plant		Endangered
[^] <i>Liopholis guthega</i>	Guthega Skink	Reptile		Endangered
<i>Liopholis montana</i>	Mountain Skink	Reptile		Endangered
<i>Lophochroa leadbeateri</i>	Major Mitchell's Cockatoo	Bird	Vulnerable	
<i>Lophoictinia isura</i>	Square-tailed Kite	Bird	Vulnerable	
<i>Maireana cheelii</i>	Chariot Wheels	Plant	Vulnerable	Vulnerable
[^] <i>Mastacomys fuscus mordicus</i>	Broad-toothed Rat	Mammal	Vulnerable	Vulnerable
<i>Melanodryas cucullata cucullate</i>	Hooded Robin (south-eastern)	Bird	Vulnerable	
[^] <i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern)	Bird	Vulnerable	
[^] <i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	Mammal	Vulnerable	
<i>Myotis macropus</i>	Southern Myotis	Mammal	Vulnerable	
<i>Neophema pulchella</i>	Turquoise Parrot	Bird	Vulnerable	
<i>Ninox connivens</i>	Barking Owl	Bird	Vulnerable	
<i>Ninox strenua</i>	Powerful Owl	Bird	Vulnerable	
<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat	Mammal	Vulnerable	Vulnerable
<i>Pachycephala inornata</i>	Gilbert's Whistler	Bird	Vulnerable	
<i>Pachycephala olivacea</i>	Olive Whistler	Bird	Vulnerable	
[^] <i>Pedionomus torquatus</i>	Plains-wanderer	Bird	Endangered	Critically Endangered
<i>Petauroides volans</i>	Greater Glider	Mammal	Endangered	Endangered
<i>Petaurus australis australis</i>	Yellow-bellied Glider	Mammal	Vulnerable	Vulnerable
<i>Petaurus norfolcensis</i>	Squirrel Glider	Mammal	Vulnerable	
<i>Petroica boodang</i>	Scarlet Robin	Bird	Vulnerable	
<i>Petroica phoenicea</i>	Flame Robin	Bird	Vulnerable	
<i>Petroica rodinogaster</i>	Pink Robin	Bird	Vulnerable	
[*] <i>Pezoporus occidentalis</i>	Night Parrot	Bird		Endangered

Scientific Name	Common Name	Class	NSW BC or FM Act Status	EPBC Act Status
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	Mammal	Vulnerable	
[^] <i>Phascolarctos cinereus</i>	Koala	Mammal	Endangered	Endangered
<i>Pimelea bracteata</i>	Null	Plant	Critically Endangered	Critically Endangered
<i>Pimelea spinescens</i> subsp. <i>spinescens</i>	Spiny Rice-flower	Plant		Critically Endangered
[^] <i>Polytelis anthopeplus monarchoides</i>	Regent Parrot (eastern)	Bird	Endangered	Vulnerable
<i>Polytelis swainsonii</i>	Superb Parrot	Bird	Vulnerable	Vulnerable
[*] <i>Pomaderris cotoneaster</i>	Cotoneaster Pomaderris	Plant		Endangered
[^] [*] <i>Pomaderris pallida</i>	Pale Pomaderris	Plant		Vulnerable
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler	Bird	Vulnerable	
[^] <i>Prasophyllum bagoense</i>	Bago Leek-orchid	Plant		Critically Endangered
<i>Prasophyllum innubum</i>	Brandy Marys Leek-orchid	Plant		Critically Endangered
[^] <i>Prasophyllum keltonii</i>	Kelton's Leek-orchid	Plant		Critically Endangered
[^] <i>Prasophyllum</i> sp. <i>Moama</i>	Moama Leek-orchid	Plant	Critically Endangered	
[*] <i>Prasophyllum morganii</i>	Mignonette Leek-orchid	Plant		Vulnerable
[*] <i>Prasophyllum petilum</i>	Tarengo Leek Orchid	Plant	Endangered	Endangered
<i>Prasophyllum validum</i>	Sturdy Leek-orchid	Plant		Vulnerable
[^] <i>Pseudomys fumeus</i>	Smoky Mouse	Mammal		Endangered
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Mammal	Vulnerable	Vulnerable
[^] [*] <i>Pterostylis despectans</i>	Lowly Greenhood	Plant	Critically Endangered	Endangered
<i>Pterostylis oreophila</i>	Blue-tongued Orchid	Plant		Critically Endangered
<i>Pultenaea humilis</i>	Dwarf Bush-pea	Plant	Vulnerable	
<i>Pycnoptilus floccosus</i>	Pilotbird	Bird		Vulnerable
[^] [*] <i>Ranunculus anemoneus</i>	Anemone Buttercup	Plant		Vulnerable
[^] <i>Rutidosia leiolepis</i>	Monaro Golden Daisy	Plant		Vulnerable
[^] [*] <i>Rytidosperma pumilum</i>	Feldmark Grass	Plant		Vulnerable
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-Bat	Mammal	Vulnerable	
[^] <i>Sclerolaena napiformis</i>	Turnip Copperburr	Plant	Endangered	Endangered
<i>Senecio behrianus</i>	Stiff Groundsel	Plant		Endangered

Scientific Name	Common Name	Class	NSW BC or FM Act Status	EPBC Act Status
[^] <i>Senecio garlandii</i>	Woolly Ragwort	Plant	Vulnerable	
* <i>Senecio macrocarpus</i>	Large-fruit Fireweed	Plant		Vulnerable
* <i>Senecio psilocarpus</i>	Swamp Fireweed	Plant		Vulnerable
<i>Solanum karsense</i>	Menindee Nightshade	Plant	Vulnerable	Vulnerable
<i>Stagonopleura guttata</i>	Diamond Firetail	Bird	Vulnerable	
<i>Suta flagellum</i>	Little Whip Snake	Reptile	Vulnerable	
* <i>Swainsona murrayana</i>	Slender Darling-pea	Plant	Vulnerable	Vulnerable
[^] <i>Swainsona plagiotropis</i>	Red Darling-pea	Plant	Vulnerable	Vulnerable
* <i>Swainsona pyrophila</i>	Yellow Swainson-pea	Plant		Vulnerable
<i>Swainsona recta</i>	Small Purple-pea	Plant		Endangered
<i>Swainsona sericea</i>	Silky Swainson-pea	Plant	Vulnerable	
[^] <i>Synemon plana</i>	Golden Sun Moth	Insect	Vulnerable	Vulnerable
<i>Thelymitra alpicola</i>	Alpine Sun-orchid	Plant	Vulnerable	
[^] <i>Thesium australe</i>	Austral Toadflax, Toadflax	Plant		Vulnerable
* <i>Tympanocryptis pinguicolla</i>	Victorian Grassland Earless Dragon	Reptile		Endangered
<i>Tyto novaehollandiae</i>	Masked Owl	Bird	Vulnerable	
<i>Tyto tenebricosa</i>	Sooty Owl	Bird	Vulnerable	
<i>Varanus rosenbergi</i>	Rosenberg's Goanna	Reptile	Vulnerable	
<i>Vespadelus baverstocki</i>	Inland Forest Bat	Mammal	Vulnerable	
* <i>Wilsonia rotundifolia</i>	Round-leafed Wilsonia	Plant	Endangered	
[^] <i>Zieria citriodora</i>	Lemon-scented Zieria	Plant		Vulnerable

* Indicates the threatened terrestrial species and communities that are 'expected to occur' or 'may occur' in the Murray region according to Atlas of Living Australia data as at November 2022

[^] Currently targeted by the NSW Threatened Species Recovery Program (Saving Our Species)

Community Name	Class	NSW BC or FM Act Status	EPBC Act Status
Acacia melvillei Shrubland	EEC	Endangered	
Sandhill Pine Woodland	EEC	Endangered	
Grey Box (<i>Eucalyptus microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	TEC	Endangered	Endangered
Weeping Myall Woodlands	TEC	Endangered	Endangered

Community Name	Class	NSW BC or FM Act Status	EPBC Act Status
Natural Grasslands of the Murray Valley Plains	TEC		Critically Endangered
Mallee Bird Community of the Murray Darling Depression Bioregion	TEC		Endangered
Plains mallee box woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions	TEC		Critically Endangered
Natural Temperate Grassland of the South Eastern Highlands	TEC		Critically Endangered
Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions	TEC	Endangered	Endangered
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	TEC	Critically Endangered	Critically Endangered

Threats to terrestrial biodiversity

The main threats to the natural assets and resources within the Murray region are:

- Climate change
- Diseases
- Fire
- Firewood removal
- Fragmentation
- Inappropriate grazing
- Lack of funding
- Lack of knowledge
- Loss of native understorey diversity
- Loss or lack of replacement paddock trees
- Native vegetation clearing
- Overabundant kangaroos
- Overabundant noisy miners
- Pest animals
- Road maintenance
- Terrestrial, aquatic, and woody weeds
- Urbanisation
- Visitor activities.



Aquatic ecosystems

Waterways of the Murray region

The Murray region contains over 12,000 km of natural waterways (Figure 9) with an additional 866 km of constructed drains and canals.

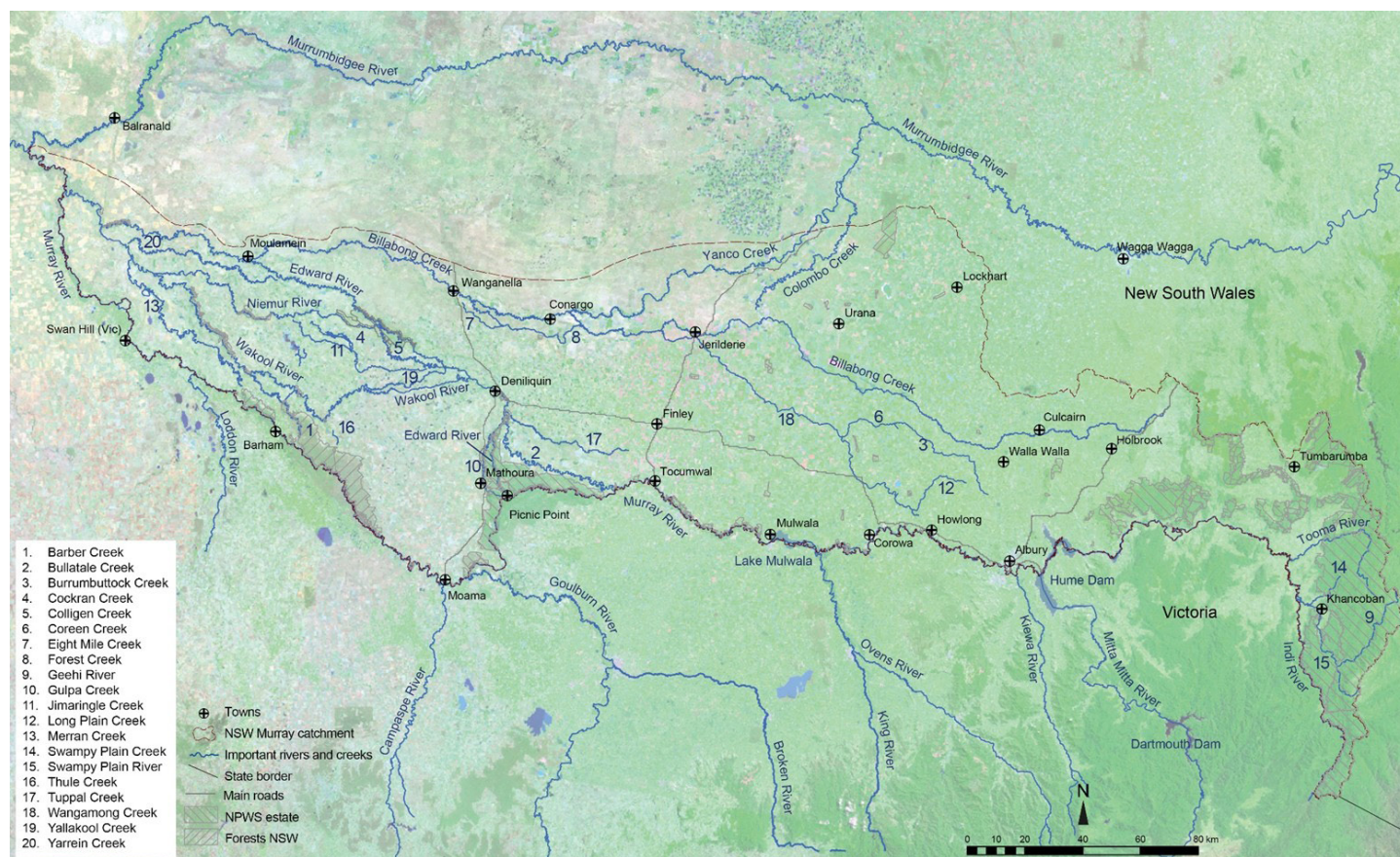


Figure 9. Murray Region Major Waterways

Our waterways include rivers and creeks of national and international significance (Table 3).

Table 3. Murray Region Major Waterways

Name	Length (km)	Significance
Barber's Creek	89	Part of Ramsar site
Billabong Creek	647	Longest Creek in Southern Hemisphere
Bullatale Creek	112	Adjacent to Ramsar site
Burrumbuttock Creek	36	Tributary of Billabong Creek system
Cockran's Creek	82	Adjacent to Ramsar site
Colligen Creek	64	Adjacent to Ramsar site
Coreen Creek	32	Tributary of Billabong Creek system
Colombo Creek	148	Important component of Billabong Creek system
Edward River	382	Bypass route for Barmah Choke
Eight Mile Creek	59	High ecological value
Forest Creek	216	High ecological value
Geehi River	52	Headwaters of the Murray River
Gulpa Creek	52	Part of Ramsar site

Name	Length (km)	Significance
Indi River	3	Headwaters of the Murray River
Jimaringle Creek	34	Important component of Edward-Wakool system
Long Plain Creek	21	Tributary of Billabong Creek system
Merran Creek	183	Important component of Edward-Wakool system
Murray River	1,223	Longest River in Australia
Murrumbidgee River	203	High ecological value
Niemur River	152	Important component of Edward-Wakool system
Swampy Plain Creek	32	Headwaters of the Murray River
Swampy Plain River	89	Headwaters of the Murray River
Thule Creek	25	Adjacent to Ramsar site
Tooma River	84	Headwaters of the Murray River
Tuppal Creek	82	Bypass route for Barmah Choke
Wakool River	384	Important component of Edward-Wakool system
Wangamong Creek	138	Tributary of Billabong Creek system
Yallakool Creek	53	Important component of Edward-Wakool system
Yanco Creek	246	Important component of Billabong Creek system
Yarrein Creek	185	Important component of Edward-Wakool system

According to River Styles scoring, 10% of the natural waterways in the Murray region are in poor condition, 75% in moderate condition and 15% in good condition. At sub-catchment level, most of our region's waterways are in poor condition, with an area-weighted mean River Condition Index score of 0.4 (Figure 10).

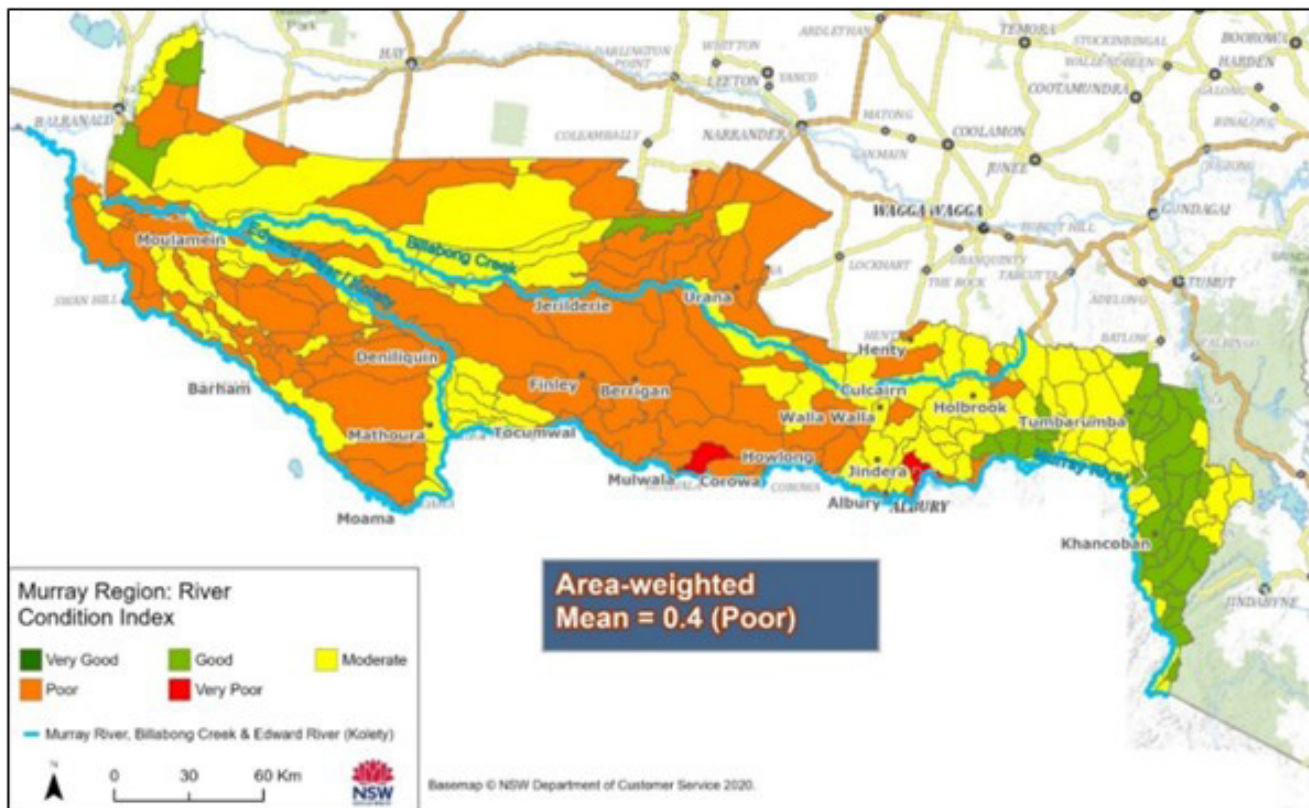


Figure 10. Murray Region River Condition Index for Sub-catchments (DPI Water 2022)

Threats to waterways

Threats to Murray region waterways were identified by Murray CMA in 2010 (Table 4).

Table 4. Murray Region Major Waterways

Physical Threats	Capacity Threats
Changed flow and watering regimes	Resource limitations
Stock access	Knowledge gaps
Modification of in-stream habitat	Lack of landholder participation
Destruction of native riparian vegetation	Lack of organisational collaboration
Sediment input	
Salinity	
Acid sulphate soils	
Diffuse and point source pollutants	
Pest invasion	

Wetlands of the Murray region

Wetlands are a significant ecosystem type in the Murray region, ranging from groundwater fed fens and bogs in the eastern highlands to old river channels, billabongs, and deflation basins in the western lowlands.

6,350 wetlands have been identified and mapped across 70% of the Murray region. Characteristics of these wetlands include:

- Most wetlands are less than 2 ha
- 78% of wetlands are on privately owned land
- Most wetlands are old stream channels
- Wetlands most commonly fill from nearby stream floodwaters
- One third of wetlands have been cleared of native vegetation
- Most wetlands are in a moderate condition, with only 2% in “near pristine” condition.

The region has several sites officially recognised as significant, including the NSW Central Murray Forests Ramsar site, the Yanga floodplain wetlands, Gayini/Nimmie-Caira, Walla Walla Swamp, Kosciusko Alpine Fens, Bogs and Lakes, and the Wakool-Tullakool Evaporation Basins.



NSW Central Murray Forests Ramsar Site

The NSW Central Murray Forests Ramsar site is comprised of 3 discrete but inter-related units: the Millewa, Werai, and Koondrook-Pericoota Forests (Figure 11).

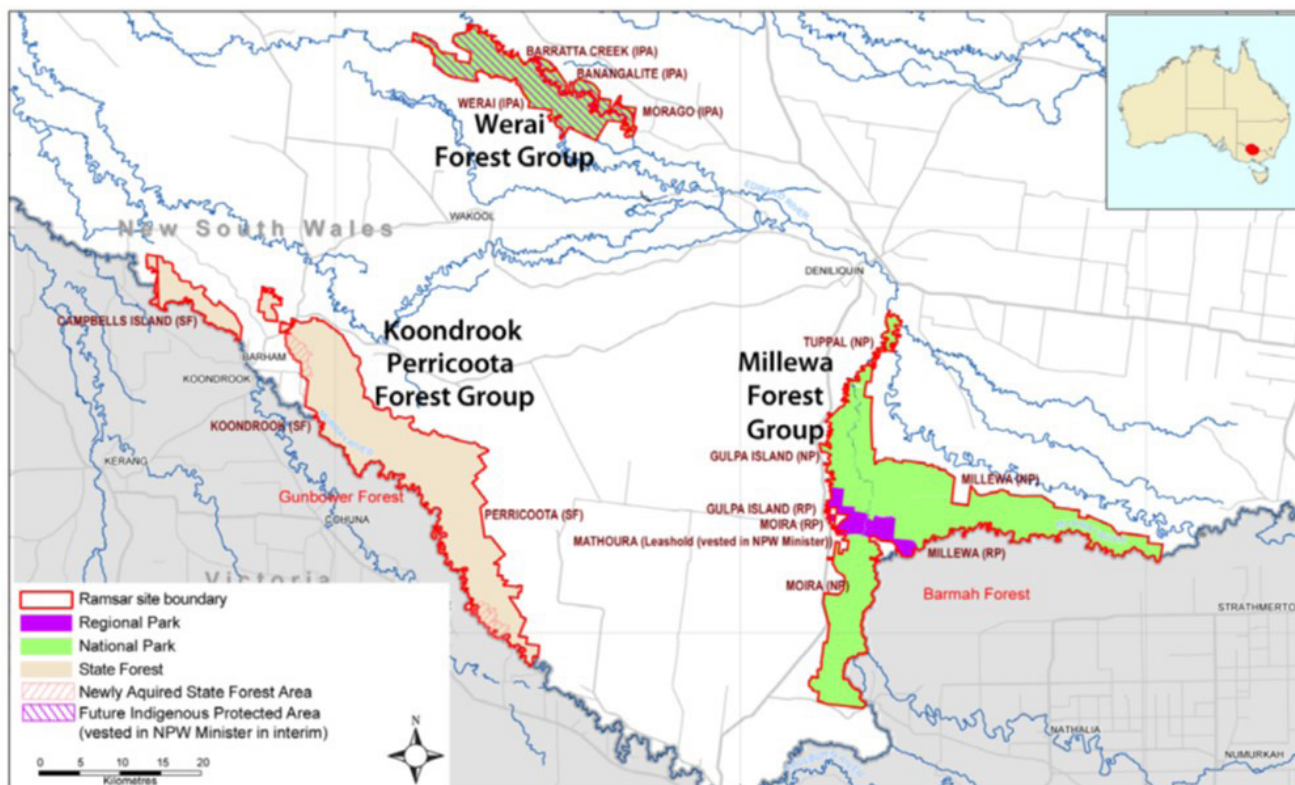


Figure 11. NSW Central Murray Forests Ramsar Site

The Ramsar site is the largest complex of tree-dominated floodplain wetlands in southern Australia and Australia's largest parcel of River Red Gum Forests. Two of the sub-units on the site are listed as icon sites for The Living Murray initiative.

The site contains at least 11 threatened species, provides habitat for 13 species listed in migratory bird agreements and regularly supports over 20,000 waterbirds.

Threats to the Ramsar site include water resource use, climate change, forestry activities, altered fire regimes, invasive species, human disturbance, and acid sulphate soils.

Yanga floodplain

The Yanga Floodplain (Figure 12) spans nearly 72,000 ha of River Red Gum Forest, Black Box Woodland, Lignum Shrubland and Nitre Goosefoot Shrubland within the NSW Riverina Bioregion.

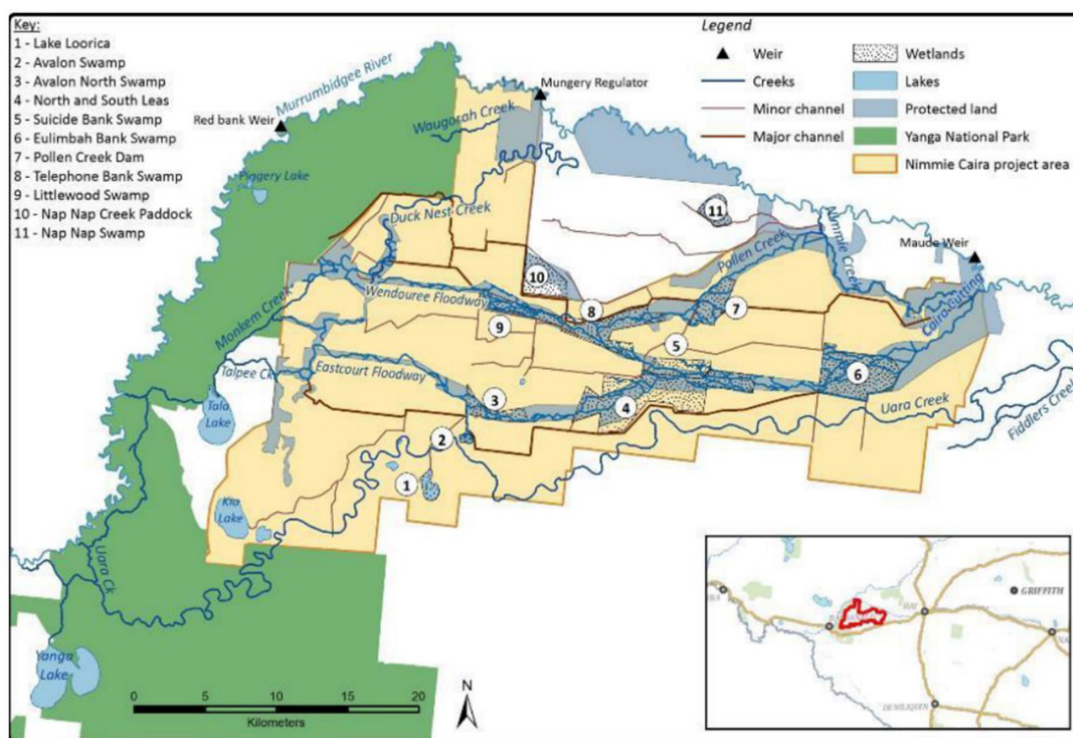


Figure 12. Lowbidgee Floodplain DIWA Site (Yanga and Gayini/Nimmi-Caira)

The Yanga National Park is uniquely located in a transition zone between landscapes formed by fluvial processes to the east and landscapes formed by aeolian processes to the west. This has resulted in an unusual situation in which different landforms, vegetation associations and soil types sit side by side.

The site includes the Murrumbidgee Lakes, Swamps and Lunettes, an over-cleared landscape with minimal representation in the National Reserve System. The site is one of the most biologically diverse areas in the NSW Riverina Bioregion, providing habitat for 23 threatened animals, including one of the largest known populations of the nationally endangered Southern Bell Frog.

The parks are a rich cultural landscape deriving from thousands of years of Aboriginal management of the Lowbidgee by the Wathi Wathi, Mutthi Mutthi and Nari Nari peoples.

Gayini/Nimmie-Cara

Gayini/Nimmie-Caira is an 85,000 ha, former irrigation property in NSW's south-west and is the largest remaining area of wetlands in the Murrumbidgee Valley. The site is a semi-arid floodplain system, comprised of 19 former farming properties, public road reserves, and irrigation channels. Environmental values on the site include remnant vegetation communities, significant wetlands, and water bird rookeries.

This Aboriginal cultural heritage site includes a high number of human remains and the property was handed back to the Nari Nari people in 2018. Management of the site aims to balance biodiversity, Aboriginal cultural values, agricultural production, education, and scientific research.

Other significant wetlands

There are other significant wetlands located in the Murray region along the Edward River, Billabong Creek and at the eastern end of Lake Mulwala (Figure 13).

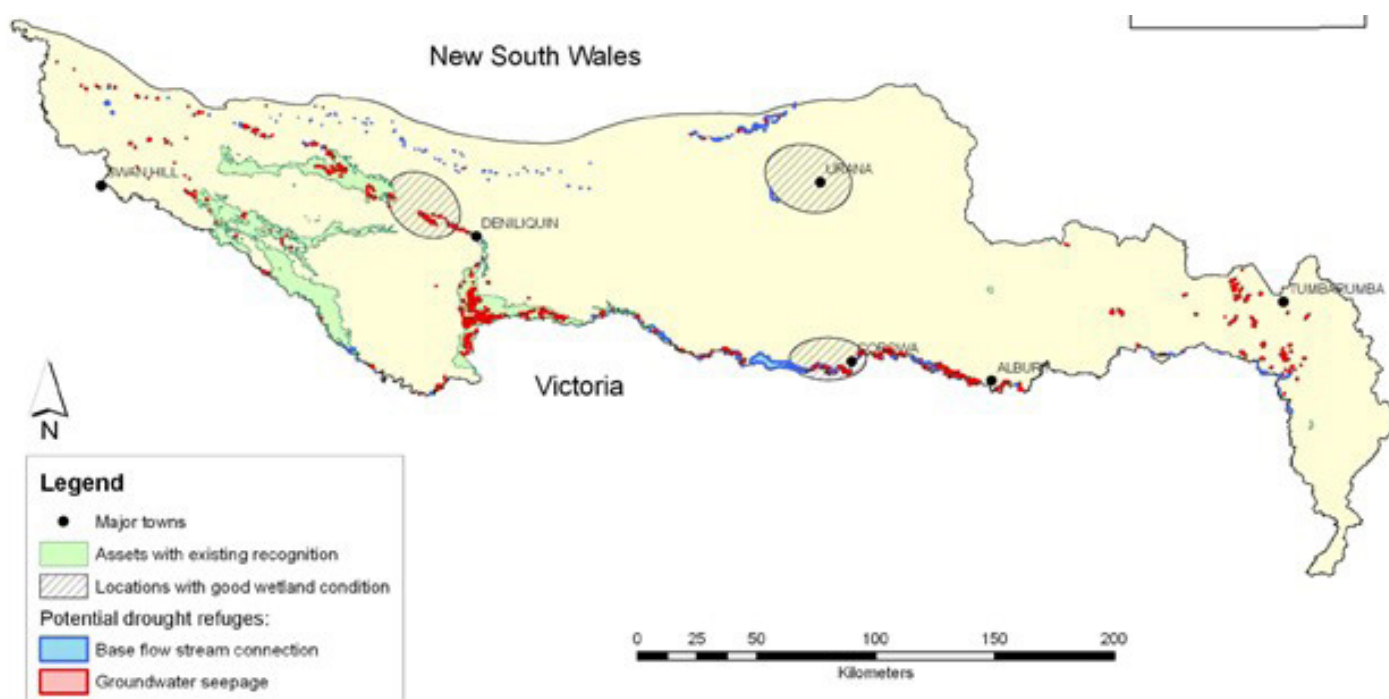


Figure 13. Murray Region Significant Wetlands

These wetlands source their water from groundwater seepage or base flows from perennial streams, therefore they have a high probability of retaining water during drought.

Threats to the condition of wetlands in the region include changes to hydrology, climate change, altered fire regimes, forestry activities, invasive pests, acid sulphate soils and human disturbance.

Aquatic threatened species of the Murray region

Due to the prevalence of aquatic ecosystems throughout the Murray region, we have many aquatic native species. The significant impacts on our wetlands and waterways have resulted in many of these species becoming threatened (Table 5).

Table 5. Murray Region's Threatened Aquatic Species and Communities

Scientific Name	Common Name	Class	NSW BC or FM Act Status	EPBC Act Status
<i>Amphibromus fluitans</i>	River Swamp Wallaby-grass	Plant	Vulnerable	Vulnerable
<i>Anseranas semipalmata</i>	Magpie Goose	Bird	Vulnerable	
<i>Bidyanus bidyanus</i>	Silver Perch	Fish	Vulnerable	Critically Endangered
<i>^Botaurus poiciloptilus</i>	Australasian Bittern	Bird	Vulnerable	Endangered
<i>Calidris ferruginea</i>	Curlew Sandpiper	Bird		Critically Endangered
<i>Callitriche cyclocarpa</i>	Western Water-starwort	Plant	Vulnerable	
<i>^Carex raleighii</i>	Raleigh Sedge	Plant	Endangered	
<i>Craterocephalus fluviatilis</i>	Murray Hardyhead	Fish	Critically Endangered	Endangered
<i>^Crinia sloanei</i>	Sloane's Froglet	Frog	Vulnerable	Endangered
<i>*Eleocharis obicis</i>	A spike rush	Plant		Vulnerable
<i>*Eriocaulon australasicum</i>	Austral Pipewort	Plant	Endangered	Endangered

Scientific Name	Common Name	Class	NSW BC or FM Act Status	EPBC Act Status
<i>Eucalyptus cadens</i>	Warby Range Swamp Gum	Plant		Vulnerable
<i>Galaxias rostratus</i>	Flat-headed Galaxias	Fish		Critically Endangered
<i>Grus rubicunda</i>	Brolga	Bird	Vulnerable	
* <i>Heleioporus australiacus</i>	Giant Burrowing Frog	Frog		Vulnerable
* <i>Limosa lapponica baueri</i>	Nunivak Bar-tailed Godwit	Bird		Vulnerable
<i>Limosa limosa</i>	Black-tailed Godwit	Bird	Vulnerable	
^ <i>Litoria booroolongensis</i>	Booroolong Frog	Frog	Endangered	Endangered
^ <i>Litoria raniformis</i>	Southern Bell Frog	Frog	Endangered	Vulnerable
^ <i>Litoria spenceri</i>	Spotted Tree Frog	Frog	Endangered	Critically Endangered
<i>Litoria verreauxii alpina</i>	Verreaux's Alpine Tree Frog	Frog	Endangered	Vulnerable
<i>Maccullochella macquariensis</i>	Trout Cod	Fish	Endangered	Endangered
<i>Maccullochella peelii</i>	Murray Cod	Fish	Endangered	Vulnerable
<i>Macquaria australasica</i>	Macquarie Perch	Fish	Endangered	Endangered
* <i>Myriophyllum porcatum</i>	Ridged Water-milfoil	Plant		Vulnerable
<i>Nannoperca australis</i>	Southern Pygmy Perch	Fish	Endangered	Vulnerable
<i>Notopala sublineata</i>	River Snail	Invert	Endangered	
* <i>Numenius madagascariensis</i>	Eastern Curlew	Bird		Critically Endangered
^ <i>Oxyura australis</i>	Blue-billed Duck	Bird	Vulnerable	
^ <i>Pilularia novae-hollandiaea</i>	Austral Pillwort	Plant	Endangered	
* <i>Prototroctes maraena</i>	Australian Grayling	Fish		Vulnerable
^ <i>Pseudophryne corroboree</i>	Southern Corroboree Frog	Frog	Endangered	Critically Endangered
<i>Pterostylis cheraphila</i>	Floodplain Rustyhood	Plant		Vulnerable
^ <i>Rostratula australis</i>	Australian Painted Snipe	Bird	Endangered	Endangered
^ <i>Stictonetta naevosa</i>	Freckled Duck	Bird	Vulnerable	
* <i>Thaumatoperla alpina</i>	Alpine Stonefly	Insect		Endangered
<i>Xerochrysum palustre</i>	Swamp Everlasting	Plant		Vulnerable

* Indicates the threatened terrestrial special and communities that are 'expected to occur' or 'may occur' in the Murray region according to Atlas of Living Australia data

^ Currently targeted by the NSW Threatened Species Recovery Program (Saving Our Species)

Community Name	Class	NSW BC or FM Act	EPBC Act
Alpine Sphagnum Bogs and Associated Fens	TEC		Endangered
Aquatic ecological community in the natural drainage system of the lower Murray River catchment	TEC	Endangered	
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps	TEC	Endangered	
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	TEC		Critically Endangered

Distribution of the Murray region's threatened freshwater fish are indicated below (Figure 14).



Figure 14. Murray Region's Threatened Freshwater Fish Indicative Distributions.

Soils of the Murray region

The soils in the Murray Region reflect a large variation in climate, parent material and changing relief from the mountain ranges in the east of the region to the plains of the west. As elevation drops and climate changes from alpine to semi-arid, soils change from sandy yellow earths and chocolate soils to solodised red-brown earths and grey clay soils.

In the Southern Highlands, soils on steep slopes are stony and shallow while in the more undulating country and the Southwest Slopes, yellow and red duplex soils are predominant. These soils are of low to medium fertility and prone to erode. Siliceous sands occurring over much of the granitic country, found east of the Hume Freeway are generally acidic and prone to gully erosion. The chocolate soils formed on the small pockets of basalt around Tumbarumba are generally fertile. Yellow solodic soils occur in the drainage lines around Albury and Holbrook, while the floodplains of the Murray and Billabong systems are a complex mixture of reworked alluvial, red-brown earths, grey and brown clays and yellow solonetzic soils. On the Riverina Plain, the soils are grey and brown clays of heavy texture and are alluvium in origin.

The main factor in soil distribution is prior stream deposition occurring on the meander floodplain, with marginal hydromorphic red-brown earths occurring close to the floodplain, and grey and brown heavy textured soils on the boundary of the floodplain. Further towards the catchment's western margin, aeolian deposits and solodised brown soils cover most of the area with much lighter textured soils, derived from littoral sediments.

A key indicator for land health is whether soil is being formed or lost. If soil is being lost, so too is the economic and ecological potential. Significant areas in the east of the Murray Region have a high erosion hazard due to steep slopes, soil types, removal of deep-rooted perennial vegetation, bush fires, intense rainfall following drought, pest species, and unsustainable land use practices (Figure 15).

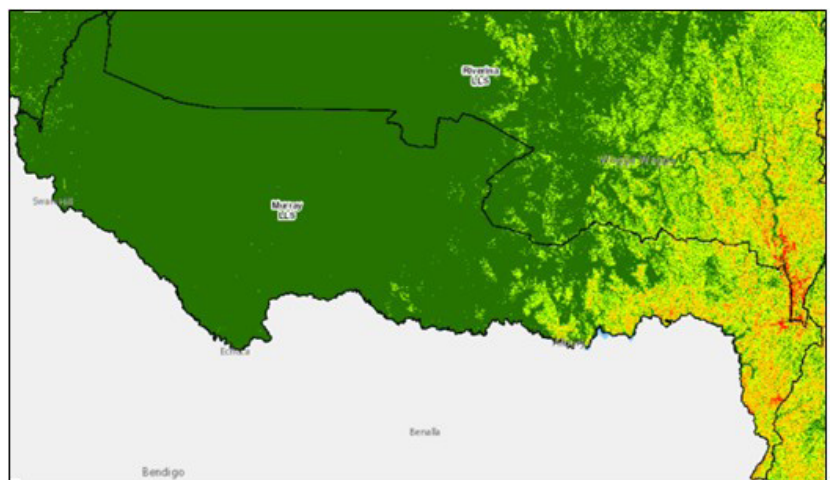


Figure 15. Murray Region Annual Mean hillslope Erosion 2018–2020 (t/ha/yr) (SEED 2022)

Soil loss results in significant sediment movement to the upper reaches of the Murray River and sand slugs detrimentally impact on water quality and aquatic health. In the western part of the region, wind erosion affects production on the lighter mallee soils and manifests during late summer, particularly if land is under fallow or in a cultivation phase.

Soil acidity, salinity, sodicity, compaction and erosion all impact on the economic, social, and environmental wellbeing of the region. Soil acidity levels of pH 5.0 (CaCl₂) or below are commonly found within the central and eastern areas of the region and soils continue to become more acidic because of intensive farming (Figure 16).

Soil sodicity is predominantly found in the heavier clay soils of the western region where low organic matter levels and moderately low porosity levels are found in the soils used for crop production (Figure 17).

Groundwater recharge, increased soil salinity and water quality impacts are a significant issue for the Murray region. Dryland salinity within the Southwest Slopes bioregion is a priority issue in addition to irrigation salinity in the central and western parts of the region (Figure 18).

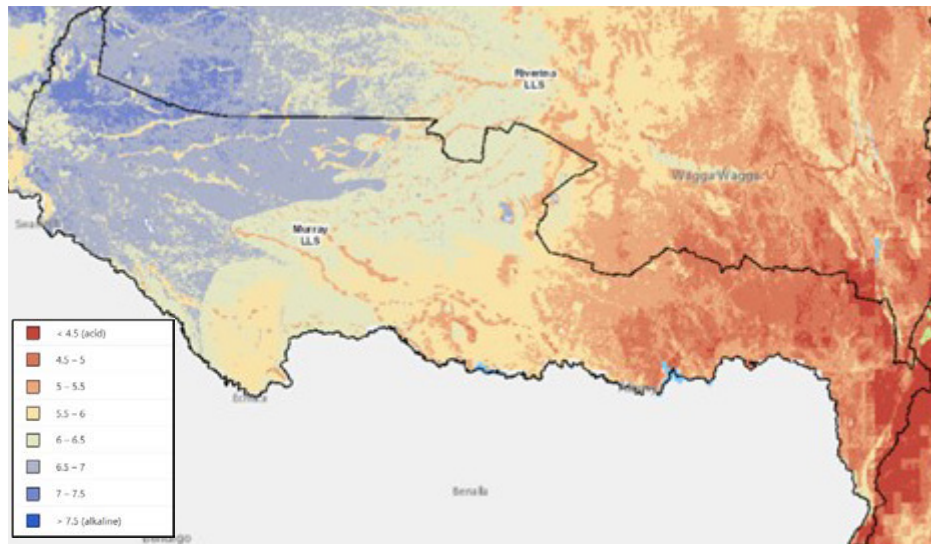


Figure 16. Murray Region Soil Acidity (pH in the top 10 cm of soil) (SEED 2022)

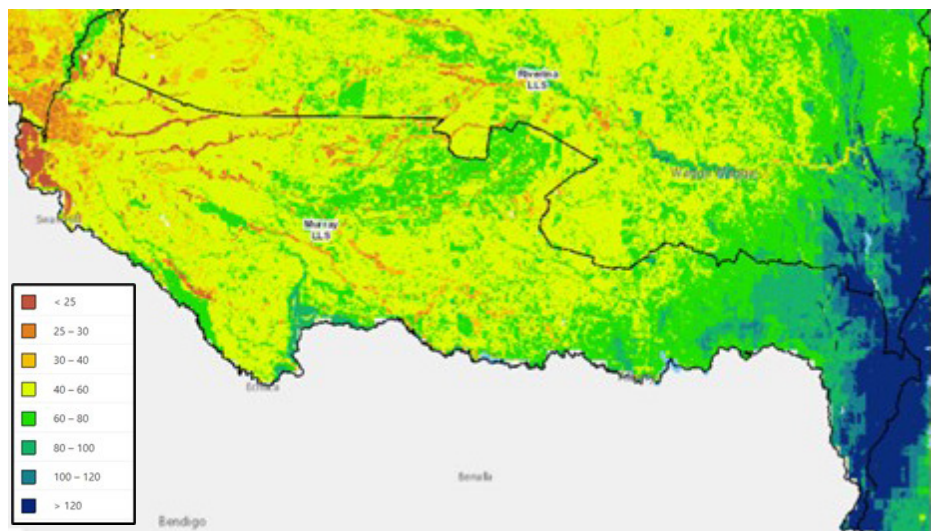


Figure 17. Murray Region Soil Organic Carbon Stocks (t/ha in the top 30cm of soil). (SEED 2022)

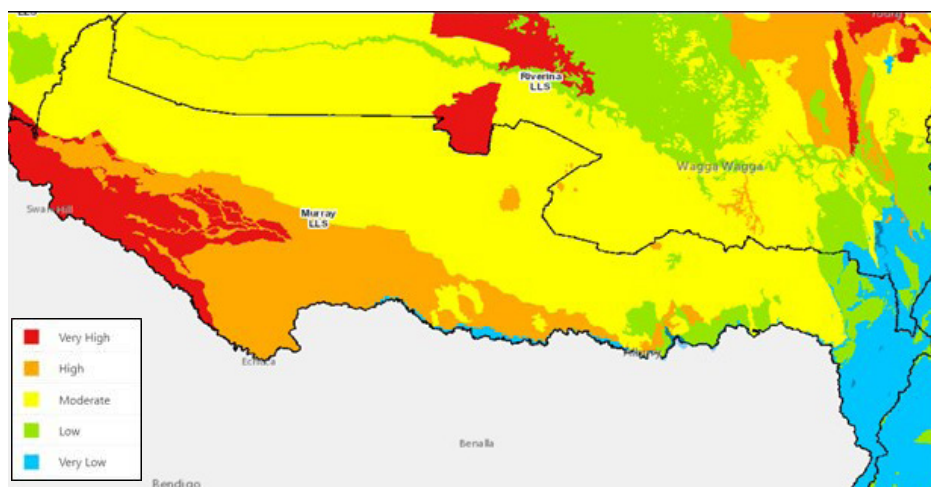


Figure 18. Murray Region Soil Organic Carbon Stocks (t/ha in the top 30cm of soil). (SEED 2022)

Land is continuing to be developed within the Murray Region for agricultural, urban and lifestyle purposes. These developments present potential risks to the health and stability of natural resources (Table 6).

Table 6. Murray Region Soil Risks

Threats	Mitigating Actions
Soil acidification	Minimising disturbance of soil
	Soil testing and interpretation
	Treatment options
Hillslope erosion	Nitrification of legumes and associated rhizobia
	Crop species selection
	Groundcover management
	Assess land capability
	Grazing management
	Revegetation
Wind erosion	Stock access removal.
	Groundcover management
	Stubble retention
	Grazing management
	Species adapted to climate for groundcover improvements
Soil carbon	Pasture species
	Stubble retention
	Dry matter increase through species selection
	Maintaining adequate groundcover

The impact of climate change on natural assets

Climate change is expected to adversely impact the Murray Region. Species will be directly impacted by the effects of temperature, rainfall, and water availability on foraging and breeding behaviours. Species could also be indirectly affected by climate change impacts on habitat and landform.

Species with the following traits or habitats may also be vulnerable to the impacts of climate change.

- Species dependent on habitat that is likely to disappear or become unsuitable
- Species with narrow ranges of physiological tolerances
- Species that have specialised dependent relationships with other species
- Species that have restricted habitat or existing decline caused by other threatening processes
- Species that have limited capacity to move at the rate dictated by climate change
- Species that have limited ability to adapt in situ.

The likely impacts of climate change on natural ecosystems across the state at a regional level include:

- Changes to the structure, composition, and function of ecosystems through the loss of sensitive species and the spread of invasive species
- Changes to the distributions of individual species with northerly species extending further south and ecosystems contracting to higher altitudes resulting in changes in primary and secondary production
- Changes in the frequency and intensity of fire resulting in the loss of fire-sensitive species and changes in forest structure and composition

- High-altitude treeless communities are likely to contract
- Snow-dependent species are likely to be lost as they will be unable to migrate to suitable habitats
- Reduced rainfall, loss of spring snowmelt and altered rainfall seasonality are likely to cause major ecological changes in the Murray region.

Priority species and systems at risk from climate change impacts in the Murray Region include:

- *Burramys parvus* – Mountain pygmy-possum
- *Litoria raniformis* – Southern bell frog
- *Pseudophryne corroboree* – Southern corroboree frog
- *Pedionomus torquatus* – Plains-wanderer
- *Polytelis anthopeplus* – Regent parrot
- Inland wetlands and floodplains
- Montane peatlands and all other alpine TECs.

Priority actions to reduce impacts of climate change on biodiversity in the Murray Region are:

- Creating and protecting more habitat, including through biodiverse carbon plantings
- Creating corridors that allow species to move across the landscape
- Conserving genetic diversity.

Case study: Murray LLS seedbank

Well-sampled and documented seed collections provide cost-effective means of conserving genetic diversity for future conservation work. Under good storage conditions, some native seeds retain viability for hundreds of years. Seedbanks could prove invaluable in assisting with long-term biodiversity and climate change impacts.

Murray LLS maintains a seedbank of native plant species from the Murray region, including a number of threatened species.

The Murray LLS Seedbank is used for re-establishment of native vegetation in the wild, however it is also an insurance policy for the extinction of threatened species.

Murray LLS is exploring options to expand the geographic coverage of its seed bank.



Stakeholder interests in NRM in the Murray region

First Nations priorities

Murray LLS is committed to ongoing consultation with first nations people and has developed a regional Aboriginal Community Advisory Group. Murray LLS regularly engages with groups and individuals as part of its Regional Aboriginal Engagement Strategy. The strategy aims to enrich relationships, create opportunities, and enhance respect for Aboriginal peoples and communities.

Case study: Traditional ecological knowledge

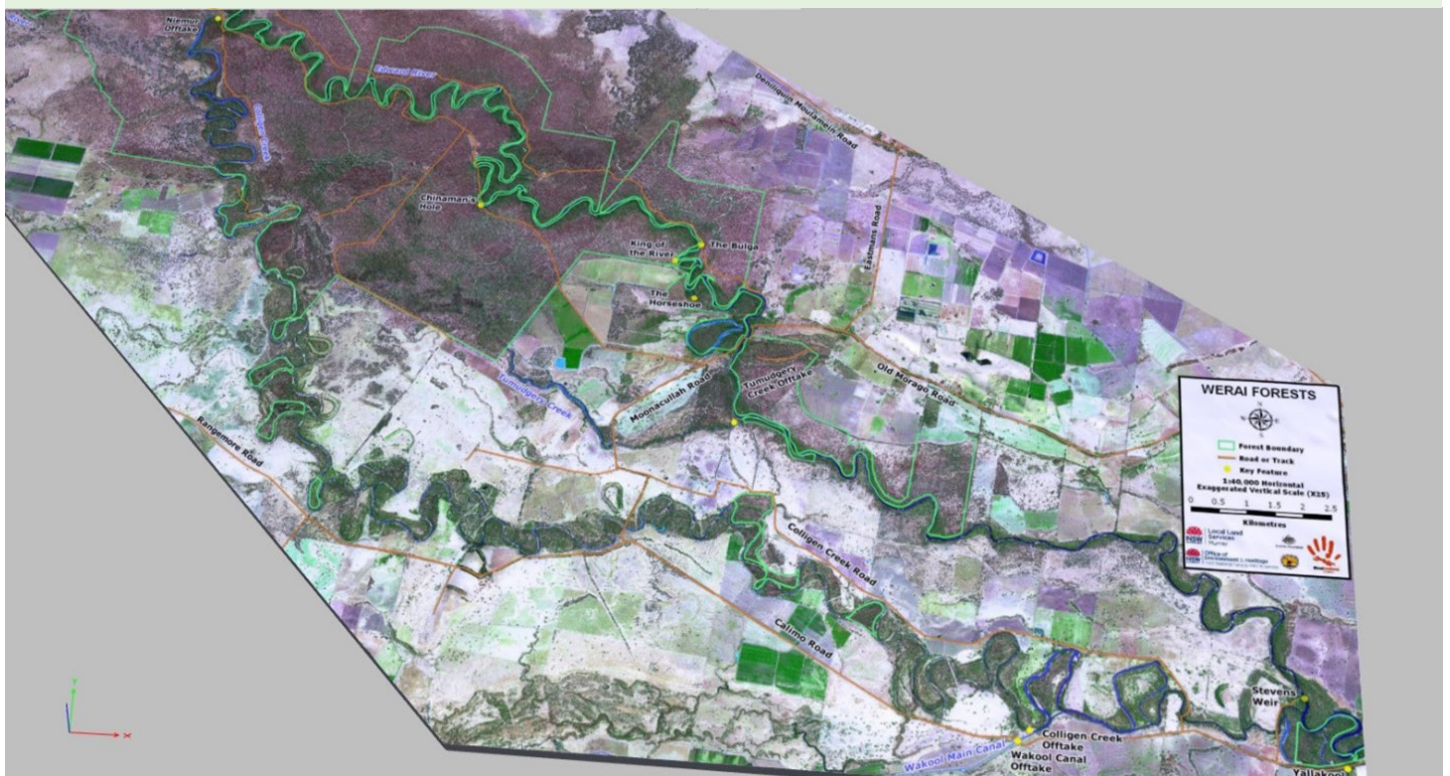
Aboriginal people have lived within the landscapes of the Murray region for tens of thousands of years. They have used the land and its resources for food, shelter, medicine, spiritual connection and to form the foundations of Dreamtime and oral histories.

First Nations people in the Murray Region are leading Australian efforts to map traditional ecological knowledge in a way that can be captured by western geographic information systems.

Land use and occupancy mapping is built through a collection of conversations about the traditional use of resources and occupancy of land, which is then illustrated as a map. This technique of recording past and present land use can map generational changes of land use due to environmental changes.

Yorta Yorta people pioneered land use and occupancy mapping in Australia in 2008. Since then, Murray LLS has supported other local first nations people capture traditional ecological knowledge and their cultural traditions.

For example, a digital 3D model of the Werai Forest was developed to add value to First Nations' land use.



Community priorities

The Murray region is home to an extremely active and capable NRM community. Murray LLS is committed to supporting, engaging with, and collaborating with landholders, groups, and the community to achieve positive NRM outcomes. This engagement program includes the coordination of a Local Community Advisory Group and supporting the Murray Landcare Collective (Figure 19).

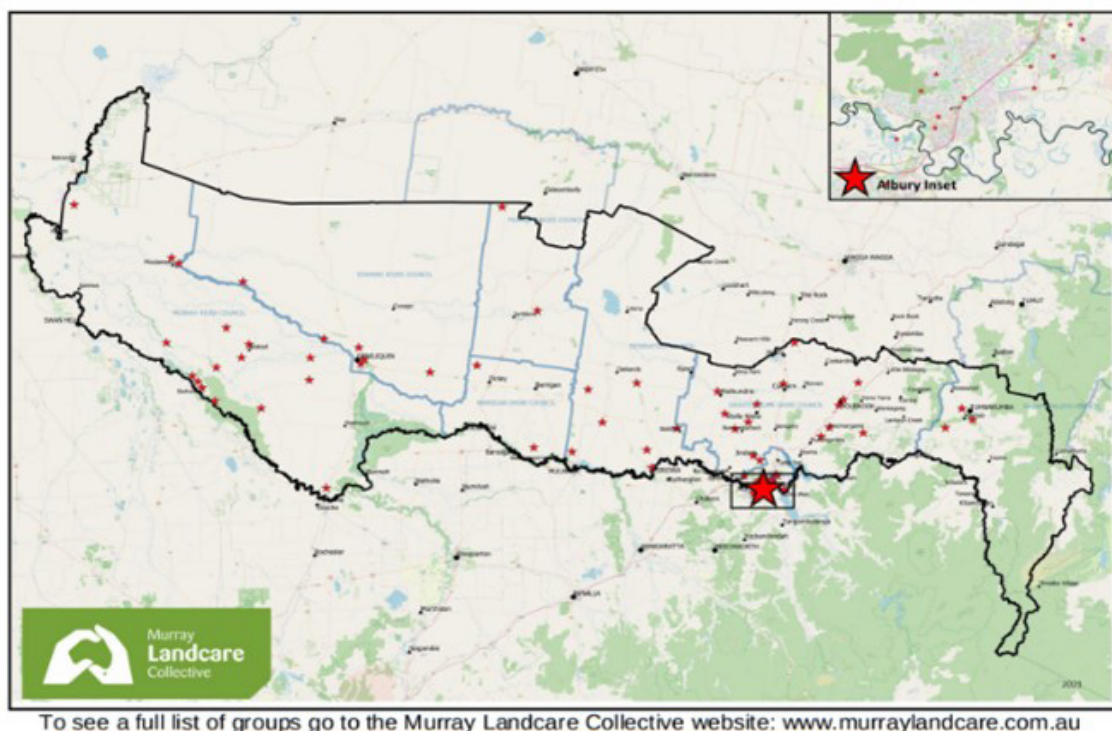


Figure 19. Murray Landcare Groups

Murray LLS's collaborative approach has identified a number of community priorities for the Murray region including:

- Environmental protection and rehabilitation
- Sharing of traditional Indigenous and modern management practices
- Cultural connections being respected, and employment opportunities explored
- Community wellbeing supported by access to green spaces
- Ecosystem service provision being recognised
- Supporting the establishment of good practice standards.

Ongoing engagement with stakeholders will inform future planning and service delivery.

Industry priorities

The following key Industry frameworks are relevant to the Murray region:

- Australian Beef Sustainability Framework
- Australian Sheep Sustainability Framework
- Sustainable Rice Platform
- Cotton Australia
- Grains.

Murray LLS has identified emerging risks and opportunities for agricultural industries in the Murray region.

Table 7. Murray Region Risks and Opportunities for Key Agricultural Industries

Item	Detail
Risks	<ul style="list-style-type: none"> • Continuing threats to biodiversity, land, and water assets • Seasonal variability and climate change • Current and emerging biosecurity threats • Reduced funding for environmental outcomes • Legislative uncertainty for water access and use • Vegetation communities across the region are degraded and fragmented • Introduced weeds and pest animals are widespread • Wetlands and waterways are degraded with altered flow regimes • Diversity and abundance of native fauna is reduced.
Opportunities	<ul style="list-style-type: none"> • High-performance organisation with skilled staff • Innovative technology and emerging markets • Collaboration with first nations people.

State government priorities

NRM legislative instruments are included in the *Biodiversity Conservation Act 2016*, the *Local Land Services Act 2013*, and the *Fisheries Management Act 1994*.

The *Biodiversity Conservation Act 2016* provides a framework for listing threatened species, the development of the Native Vegetation Regulatory Map and guidance on investment in biodiversity conservation across NSW. In 2017 the NSW Government developed a landscape prioritisation framework to support decision making on investment in biodiversity conservation. This framework identifies priority landscapes based on the following principles:

- Areas of high environmental value
- Areas that improve ecological connectivity and resilience to climate change
- Areas that contribute towards a comprehensive, adequate, and representative protected area system
- Areas where high environmental value assets are under the greatest threat.

Priority landscapes across NSW require urgent action to address biodiversity decline (Figure 20).

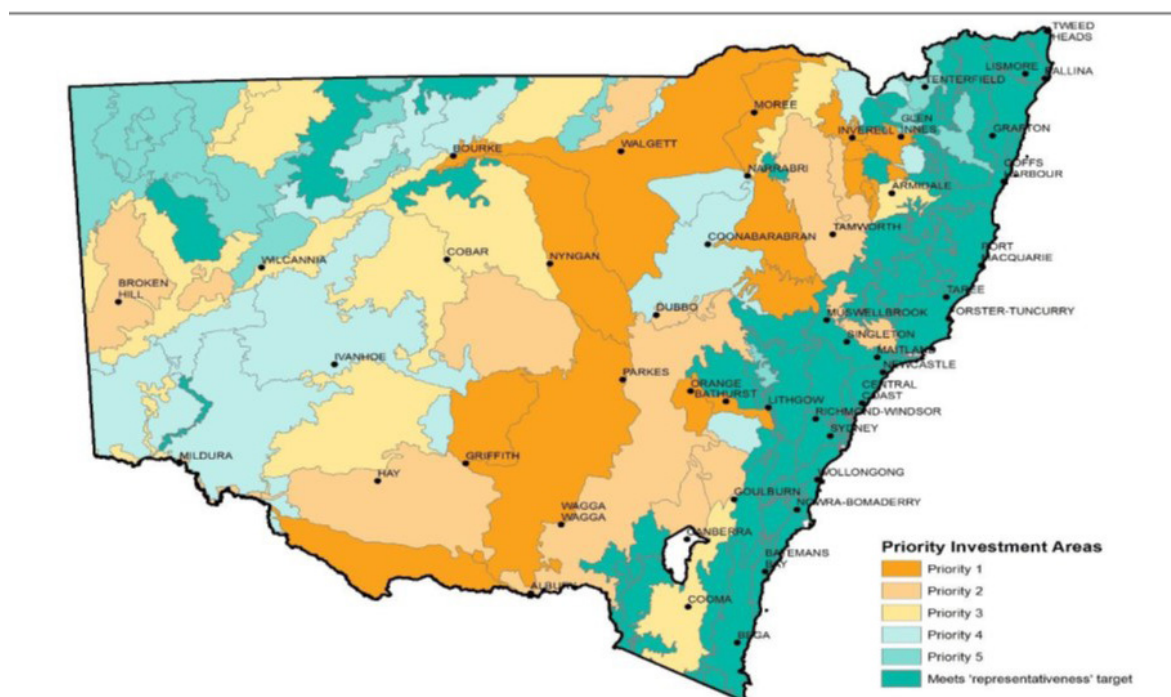


Figure 20. Murray Region Priority Landscapes

The Fisheries Management Act is relevant to NRM through its inclusion of processes to list aquatic threatened species. Priorities in relation to this legislation have been described in Section 3.

The *Local Land Services Act 2013* constitutes LLS as a statutory corporation and sets out its functions and responsibilities. LLS has a statutory role to:

- Provide and facilitate education and training in connection with agricultural production, biosecurity and NRM
- Provide and administer grants, loans, subsidies, or other financial assistance for activities
- Communicate, consult, and engage with the community to encourage participation in the delivery of local land services
- Facilitate targeted local delivery of programs and services to meet community, client, and customer needs.

LLS has developed an NRM Framework to guide its activities across the state (Figure 21).

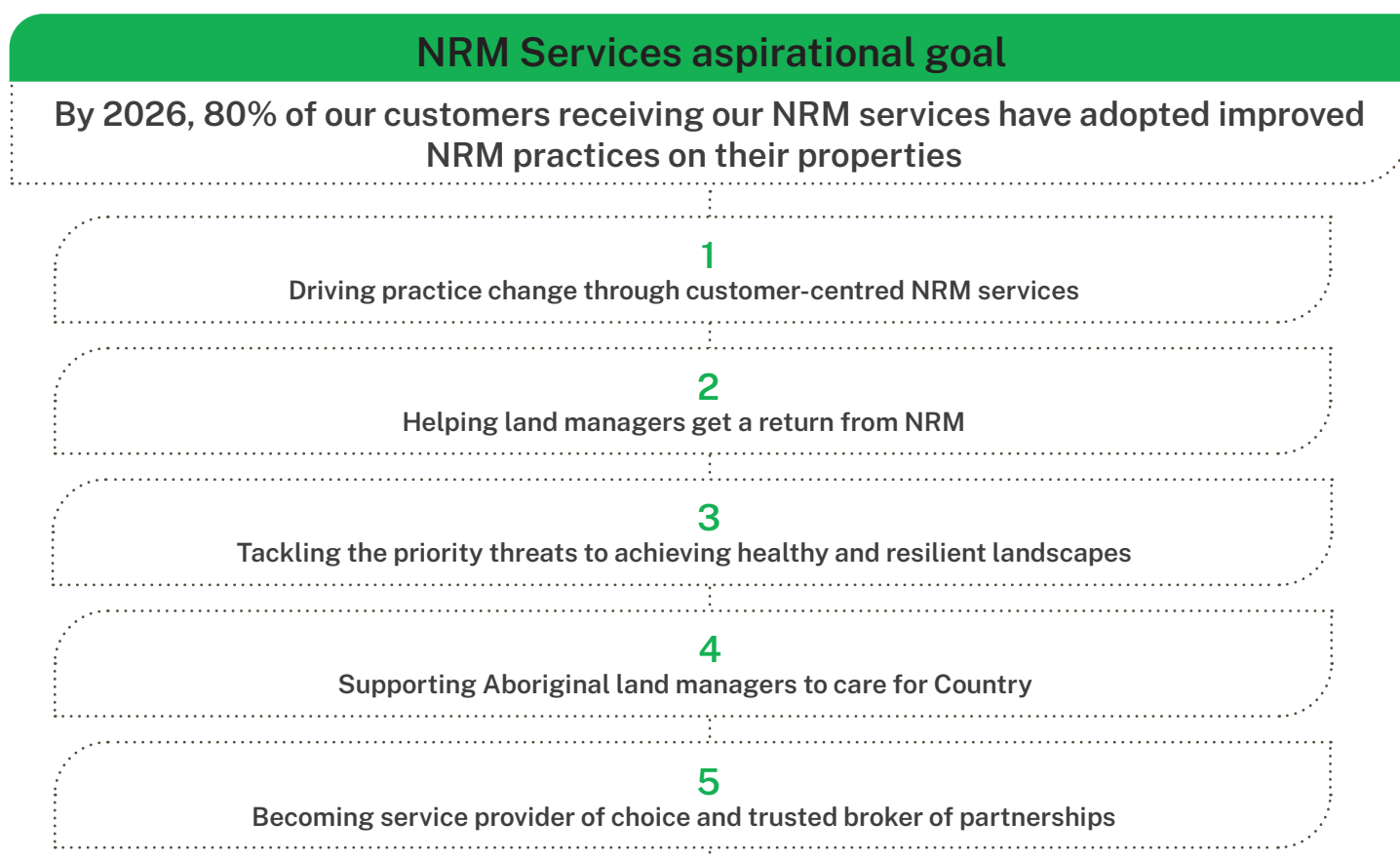


Figure 21. LLS NRM Framework

Federal government priorities

The Government's NRM investment mechanism is the Regional Land Partnerships (RLP) branch of the National Landcare Program (NLP). The RLP is a key mechanism used by the Government to give effect to the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth). The RLP is the largest component of the NLP, which aims to support natural resource management, biodiversity protection and sustainable agricultural practices. The Government has identified 6 long-term outcomes to be achieved over the next 5 years.

Outcome	
Ramsar Sites	By 2023, there is restoration of, and reduction in threats to, the ecological character of Ramsar sites, through the implementation of priority actions.
Threatened Species	By 2023, the trajectory of species targeted under the Threatened Species Strategy, and other EPBC Act priority species, is stabilised or improved.
World Heritage Areas	By 2023, invasive species management has reduced threats to the outstanding universal value of world heritage properties through the implementation of priority actions.
Threatened Ecological Communities	By 2023, the implementation of priority actions is leading to an improvement in the condition of EPBC Act listed threatened ecological communities.
Soil, Vegetation, and Biodiversity	By 2023, there is an increase in the awareness and adoption of land management practices that improve and protect the condition of soil, biodiversity, and vegetation.
Climate and Market Adaptation	By 2023, there is an increase in the capacity of agriculture systems to adapt to significant changes in climate and market demands for information on provenance and sustainable production.



A summary of Murray regional assets and investment priorities relevant to the RLP outcomes are detailed in Table 8.

Table 8. Murray region Assets and Investment Priorities

RLP Outcome	Murray regional assets and investment priorities
1 – Ramsar sites	NSW Central Murray Forests Ramsar site
2 - Threatened Species	<p>Australasian Bittern - (<i>Botaurus poiciloptilus</i>)</p> <p>Malleefowl - (<i>Leipoa ocellata</i>)</p> <p>Plains-wanderer - (<i>Pedionomus torquatus</i>)</p> <p>Regent Honeyeater - (<i>Anthochaera Phrygia</i>)</p> <p>Swift Parrot - (<i>Lathamus discolor</i>)</p> <p>Brush-tailed Rock-wallaby - (<i>Petrogale penicillate</i>)</p> <p>Koala - (<i>Phascolarctos cinereus</i>)</p> <p>Mountain Pygmy-possum - (<i>Burramys parvus</i>)</p> <p>New Holland Mouse - (<i>Pookila Pseudomys novaehollandiae</i>)</p> <p>Stiff Groundsel - (<i>Senecio behrianus</i>)</p> <p>Murray Hardyhead - (<i>Craterocephalus fluviatillis</i>)</p> <p>Southern Bell Frog - (<i>Litoria raniformis</i>)</p> <p>Southern Corroboree Frog - (<i>Pseudophryne corroboree</i>).</p>
4 - Threatened Ecological Communities	<p>Grey Box (<i>Eucalyptus microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia</p> <p>Weeping Myall Woodlands</p> <p>Natural Grasslands of the Murray Valley Plains</p> <p>Mallee Bird Community of the Murray Darling Depression Bioregion</p> <p>Plains mallee box woodlands of the Murray Darling Depression, Riverina, and Naracoorte Coastal Plain Bioregions</p> <p>Natural Temperate Grassland of the South-eastern Highlands</p> <p>Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions</p> <p>White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland</p> <p>Alpine Sphagnum Bogs and Associated Fens</p> <p>Seasonal Herbaceous Wetlands of the Temperate Lowland Plains.</p>

RLP Outcome	Murray regional assets and investment priorities
5 - Soils, Biodiversity and Vegetation on Farms	Increasing the extent and condition of vegetation on farms Increasing biodiversity on farms Reducing soil erosion Reducing soil salinity Increasing soil carbon Managing soil acidity.
6 - Supporting Agricultural Systems to Adapt to Change	Increased capacity for agricultural systems to adapt to climate change Increased capacity for agricultural systems to adapt to changing market demands for information on provenance and sustainable production.

Key documents that support RLP investment in threatened species and communities are the Australian Government's Threatened Species Strategy and Threatened Species Strategy Action Plan.

Threatened Species Strategy objectives

1. To improve the trajectories of priority threatened species by 2031
2. To improve the condition of priority places by 2031

Threatened Species Strategy action areas

Direct action areas

- Mitigating new and established risks
- Conserving, restoring, and improving habitat
- Emergency preparedness and response
- Climate change adaptation and resilience

Supporting action areas

- Effective planning for conservation
- Knowledge and tools
- Forging stronger partnerships
- Community leadership and engagement

Threatened Species Strategy prioritisation principles

- Prioritising species and places under severe and imminent threat
- Prioritising species and places where recovery action will benefit other species
- Prioritising species and places where action can make a difference and is cost-effective
- Prioritising species and places of cultural significance
- Prioritising species and places that are unlike any other
- Achieving balance in selected species and places

The Government has numerous other international commitments, responsibilities, and initiatives relevant to Murray LLS's core business, therefore Murray LLS is keen to explore additional ways to partner with government.

Other potential Government partnership opportunities include:

- The National Indigenous Ranger Sector Strategy
- The Commonwealth Environmental Water Office's Environmental Activities Framework
- The Murray-Darling Basin Plan and The Living Murray Initiative
- Expected new commitments arising from the COP15 meeting in December 2022
- Paris Agreement climate commitments
- The Australian Farm Biodiversity Certification Scheme.

External analysis

Murray LLS regularly undertakes analysis of its environment to identify trends, opportunities and risks (Figure 22).



Figure 22. Murray Region NRM PESTEL Analysis

NRM priorities for the Murray region 2023 – 2028

The key tool providing NRM guidance for Murray LLS over next 5 years is the Murray LLS NRM Logic Model (Figure 23). The model aligns with Murray LLS’s NRM Framework and Murray Local Strategic Plan.

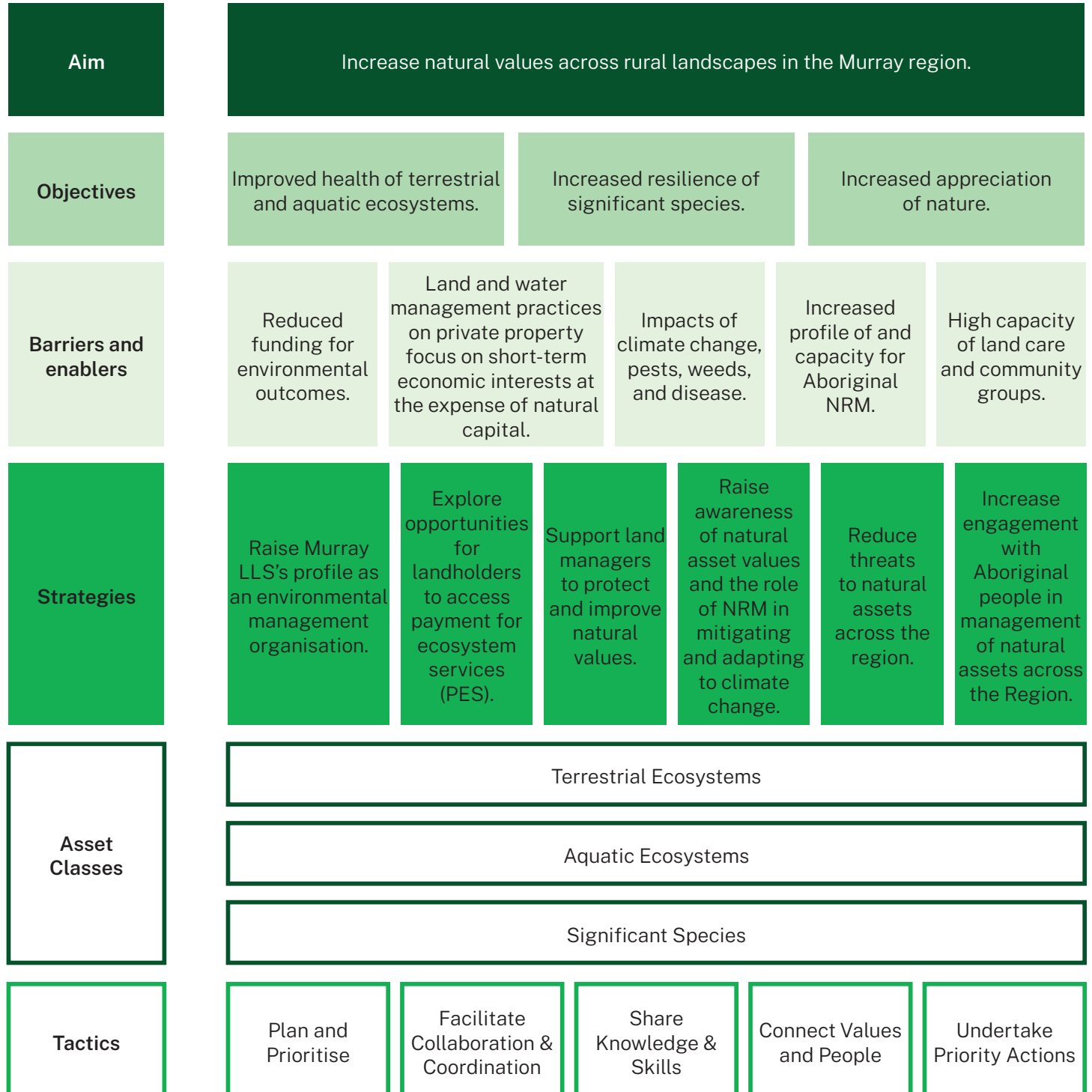


Figure 23. Murray Region NRM Logic model

Terrestrial ecosystem objectives

Aim	Increase natural values across rural landscapes in the Murray Region
Primary Objective	Improve the health of terrestrial ecosystems: <ul style="list-style-type: none"> • Increased extent of native vegetation • Improved condition of native vegetation • Increased abundance and diversity of native terrestrial fauna.
Secondary Objective	Increase appreciation of nature

Given the huge historical loss of native vegetation and biodiversity in the Murray region and the urgent need for climate mitigation, the focus for terrestrial ecosystems over the next 5 years is to undertake large-scale vegetation repair and biodiversity gains. This can be achieved by bringing the worst sites up to a moderate condition.

Over-cleared vegetation types will also be prioritised to re-build landscape function, create new population centres for threatened species and build corridors to support climate migration. Over-cleared vegetation types consist of state and federally listed Endangered Ecological Communities and areas flagged as high priority for repair (Figure 24).

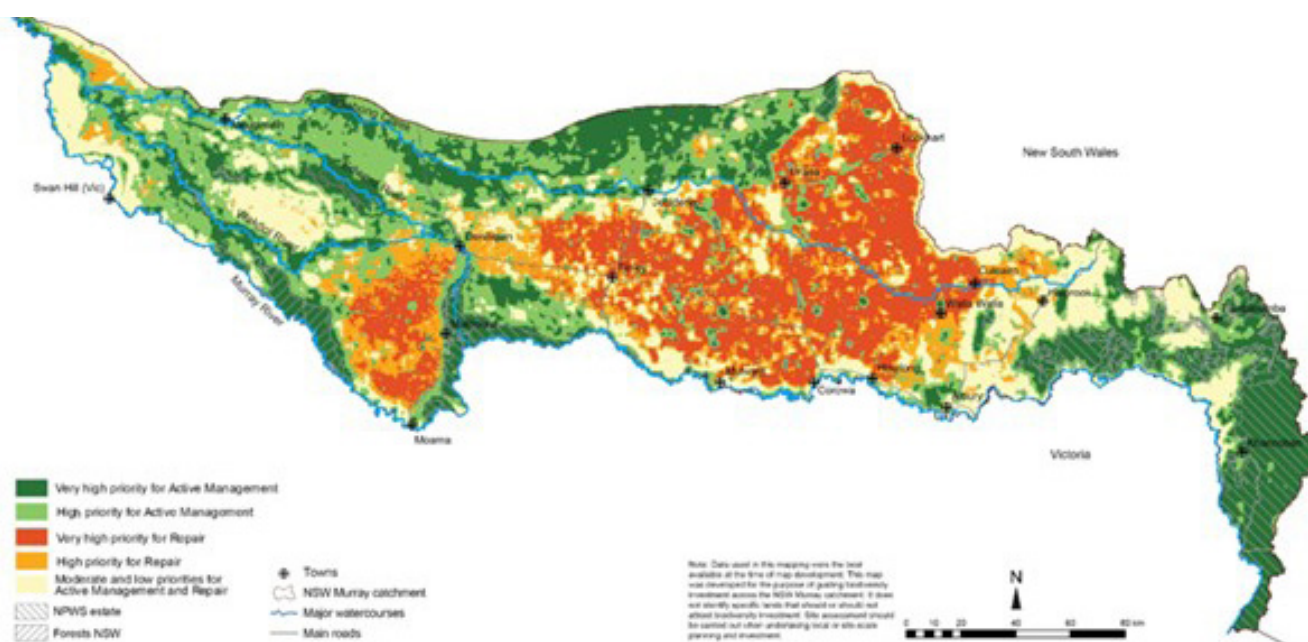


Figure 24. Murray Region Priority Areas

Murray LLS has identified priority actions and targets for terrestrial ecosystems in the Murray region (Table 9).

Table 9. Murray Region Priority Actions and Targets 2023–2028

Prioritised Strategies	Tactics	Actions	Focus
Protect and improve	Plan and prioritise. Collaborate and cooperate. Undertake priority actions.	Undertake revegetation activities in the most critically impacted and over-cleared vegetation types. Address soil salinity as a critical hydrogeological attribute impacting on vegetation condition and recovery. Undertake biodiverse carbon plantings.	Endangered Ecological Communities. Areas flagged in Murray Biodiversity Management Plan (BMP) Repair map. Saline areas of the far west. Locations identified by commercial customers for revegetation including for biodiverse carbon plantings.
LLS capacity and profile	Plan and prioritise. Share knowledge and skills. Collaborate and cooperate.	Maintain our organisational capacity in relation to native revegetation services. Build our capacity in relation to Payment for Ecosystem Services (PES) schemes and behavioural change initiatives. Build partnerships with relevant industry bodies.	Murray Seed Services Unit. Australian Farm Biodiversity Certification Scheme. Australian Holistic Management Cooperative. Meat and Livestock Australia. Cotton Australia. SunRice Australia. Grains Research and Development Corporation.
Raise awareness of values	Connect values and people.	Behavioural change initiatives focusing on biosecurity, animal welfare, pollination, integrated pest management, and the recreational and cultural benefits of native vegetation.	Livestock farmers and croppers within priority areas.
Raise awareness of role of NRM in climate change	Connect values and people. Share knowledge and skills.	Behavioural change initiatives promoting climate change mitigation and adaptation abilities of native vegetation.	All farmers and rural community members.
Payment for Ecosystem Services (PES)	Share knowledge and skills. Plan and prioritise. Collaborate and cooperate.	Connect landholders to initiatives that will support them to undertake priority actions.	Livestock farmers and croppers within priority areas.

Prioritised Strategies	Tactics	Actions	Focus
First Nations People	Connect values and people. Collaborate and cooperate. Share knowledge and skills.	Provide opportunities for First Nations People to work on Country and access natural resources for cultural purposes and Indigenous Enterprise. Support first nations people to record and share their Traditional Ecological Knowledge (TEK) in relation to terrestrial ecosystems.	Local Aboriginal Land Councils (LALCs), Traditional Owner groups, and Aboriginal organisations within priority areas.

Aquatic ecosystem priorities

Aim	Increase natural values across rural landscapes in the Murray Region
Primary Objective	<p>Improve the health of aquatic ecosystems.</p> <ul style="list-style-type: none"> • Improved condition of riparian vegetation and in-stream habitat • Improved condition of wetlands • Increased abundance and diversity of native aquatic fauna.
Secondary Objective	Increase appreciation of nature

Waterways and wetlands

Waterways in the Murray region have been and continue to be heavily impacted by land and water development practices, resulting in poor condition at the reach and sub-catchment scale. Murray LLS plan to take action to address the major threats of stock access, modification of in-stream habitat, destruction of native riparian vegetation and sediment input by collaborating with landholders and river users.

Inland wetlands and floodplains are particularly vulnerable to climate change impacts therefore protecting freshwater systems will become increasingly important. We must also take urgent action to protect existing wetlands and restore degraded sites.

Murry LLS will focus on:

- Identifying large sites with outstanding ecological and cultural values that are suitable for developing partnerships with local first nations people
- Targeting at risk wetland types.



Wetland and waterway prioritisation tool

The Murray Wetland and Waterway Prioritisation Tool is a spatially linked data exploration package that includes data on all mapped wetlands and streams in the region which can be prioritised.

Criteria available to prioritise waterways

- Name
- Sub-catchment
- Waterway type
- Length
- Condition
- Recovery potential
- Threatened species observations
- Community asset status including cultural value
- Tenure
- Soil type
- Presence of an Indigenous Land Use Agreement
- Land capability category
- Land use
- Existing of mining title
- Previous work by Murray LLS
- Heritage listing
- Sednet Erosion risk score
- Woody vegetation loss score
- Water sharing plan
- Degree of hydrological modification

Criteria available to prioritise wetlands

- Wetland area
- Water source
- Ramsar or DIWA listing
- Threatened species observations
- Community asset status including cultural value
- Tenure
- Soil type
- Presence of an Indigenous Land Use Agreement
- Land capability category
- Land use
- Existence of a mining title
- Previous work by Murray LLS
- EEC status
- Heritage listing
- Sednet Erosion Risk score
- Woody vegetation loss score
- Water sharing plan
- Degree of hydrological modification

The Murray wetland and waterway prioritisation tool was applied to stream reaches in the Murray region with weightings for poor condition, high recovery potential and identification as an indigenous or community asset. The 3 sub-catchments prioritised for waterway rehabilitation are:

- Kolety/Edward-Wakool River system
- Streams of the South-West Slopes sub-catchment
- Billabong-Yanco Creek system.

Using the same criteria for wetlands, the 3 wetlands prioritised for protection are:

- NSW Central Murray Forests Ramsar Site
- Yanga Floodplain
- Gayini/Nimmie-Caira.

Undertaking work in these areas and the actions identified in Table 10 will result in improved condition of aquatic ecosystems in the Murray region.

Table 10. Murray Region Aquatic Ecosystems Priority Actions and Targets 2023–2028

Prioritised Strategies	Tactics	Actions	Focus
Protect and improve	Plan and prioritise. Share knowledge and skills. Collaborate and cooperate. Undertake priority actions	Undertake activities to improve riparian and in-stream habitat in river systems with strong community connections. Protect rare wetlands at imminent and critical risk from climate change. Address gully erosion as a critical process impacting on stream health. Support recovery of degraded wetlands.	Edward-Wakool River System. Billabong-Yanco Creek System. Streams of the South-West Slopes. Montane peatlands. High erosion risk gullies in the Upper Murray and Hume landscapes. Poor-condition wetlands in agricultural landscapes.
First Nations People	Connect values and people. Collaborate and cooperate. Share knowledge and skills.	Provide opportunities for first nations people to access natural resources for cultural purposes and indigenous enterprise. Support first nations people to record and share their TEK in relation to aquatic ecosystems.	Central Murray Forests Ramsar Site. Low-bidgee Floodplain including Yanga and Gayini/Nimmie-Caira. LALCs, traditional owner groups, Aboriginal organisations and other first nations people.
LLS capacity and profile	Plan and prioritise. Share knowledge and skills. Collaborate and cooperate.	Build our capacity in relation to PES schemes and behavioural change initiatives. Build partnerships with relevant industry bodies.	Australian Holistic Management Cooperative. Meat and Livestock Australia. Cotton Australia. SunRice Australia, GRDC.
Raise awareness of values	Connect values and people.	Behavioural change initiatives promoting a stewardship ethic for aquatic ecosystems.	Farmers with target wetlands and waterways on or adjacent to their properties.
Raise awareness of role of NRM in climate change	Connect values and people. Share knowledge and skills.	Promote awareness of the potential impacts of wetland degradation on climate change and the benefits of rehabilitation. Promote awareness of the role of aquatic and riparian refuges in climate change adaptation.	All farmers and rural community members.
Payment for Ecosystem Services (PES)	Share knowledge and skills. Plan and prioritise. Collaborate and cooperate.	Connect landholders to initiatives that will support them to undertake priority actions.	Farmers with target wetlands and waterways on or adjacent to their properties.

Significant species priorities

Aim	
Increase natural values across rural landscapes in the Murray Region	
Primary Objective	Increased resilience of significant species. <ul style="list-style-type: none"> • Improved habitat for threatened and iconic species • Reductions in threats to threatened and iconic species.
Secondary Objective	Increase appreciation of nature

The Murray region has experienced substantial biodiversity losses since European settlement and there are ongoing risks to both rare and common species. Therefore, it is imperative that action is taken over the next 5 years to curb biodiversity losses. This can be achieved by undertaking holistic landscape management directed at delivering benefits for guilds or clusters of species with similar habitat requirements and/or threat profiles rather than focusing on a single species or population. Murray LLS also has a strong focus on delivering biodiversity gains and range expansion to build species resilience.

A wide range of approaches are utilised to identify species, communities and landscapes for targeted investment including:

- Prioritisation systems of other agencies in collaboration with identification of emerging threats in the region.
- Spatial overlays of known and potential distributions of threatened species intersected with collated information on habitat requirements and threat profiles.
- Consultation with the community on iconic species.

Murray LLS has identified priority actions and targets for significant species in the Murray region (Table 11).

Table 11. Murray Region Priority Actions and Targets for Significant Species 2023–2028

Prioritised Strategies	Tactics	Actions	Focus
Protect and improve	Plan and prioritise. Share knowledge and skills. Collaborate and cooperate. Undertake priority actions.	Undertake activities to increase the extent, condition, and connectivity of habitat suitable for species and clusters. Address key risks to species and clusters. Support re-introduction and range expansion initiatives for target species and clusters.	Threatened species and community clusters. Threatened and iconic species identified for action.
LLS capacity and profile	Plan and prioritise. Share knowledge and skills. Collaborate and cooperate.	Maintain Murray LLS capacity for native revegetation. Build partnerships with technical experts and community.	Murray Seed Services Unit. NSW DPE and DPI, universities, non-government organisations, and community groups.
Raise awareness of values	Connect values and people.	Behavioural change initiatives focusing on the importance of biodiversity, expanding habitat, and developing a stewardship ethos for future generations.	All farmers and rural community members.
First Nations People	Connect values and people. Collaborate and cooperate. Share knowledge and skills.	Provide opportunities for first nations people to work on Country. Support First Nations People to record and share their TEK in relation to significant species.	LALCs, traditional owner groups, Aboriginal community organisations and other first nations people within priority areas.

Implementation

Murray LLS supports the protection and sustainable management of natural assets and resources in our region with funding from a range of sources, including federal, state, and local governments, philanthropic organisations, fee-for-service arrangements and private investment. Murray LLS plans to deliver a variety of projects over the next 5 years (Table 12).

Table 12. Murray NRM Projects and Service Priorities and Proposed Funding Sources

Projects and services	LLS	NSW (other)	Aust Gov (NHT)	Aust Gov (other)	Other
Terrestrial Ecosystems					
Seed Services (ongoing)					✓
Farming with Nature Program (proposed)			✓	✓	
Cotton Australia Sustainability Framework Pilot (2 year)	✓				
Woodlands and Sandhills Behaviour Change Project (5 year)	✓				
Environmental Markets Project (5 year)	✓				
Follow the Flowers Project					✓
Woodlands Biodiversity & Carbon Tender Pilot (2 year)		✓			
Green Gully Salinity Remediation (2 year)					✓
Kapooka Revegetation Initiative (2 year)					✓
Large-scale woodland revegetation program (5 year) - Funding source yet to be identified					
Aquatic Ecosystems					
Refreshing Rivers Program (8 year)		✓			
Upper Murray Erosion Control (5 year) - Funding source yet to be identified					
Erosion intervention and waterway protection in West Hume area (2 year)		✓			
Murray Wetland Recovery Program (5 year) - Funding source yet to be identified					
Healing Country Program (proposed)			✓	✓	
Significant Species					
Threatened Native Fish Recovery Project (1 year)					✓
Superb Parrot Flyways Project (1 year)		✓			
Special Places Program (proposed)			✓		
Wild Orchids Project (2 year)	✓	✓			

Note: Identified projects are subject to change due to funding constraints, new opportunities and additional information becoming available.

NSW Government investment in Murray regional NRM

The NSW Government provides resources to Murray LLS to achieve positive land use outcomes. This is achieved by providing support to land managers to better manage natural resources, respond to biosecurity risks and improve primary production. Murray LLS also partners with other NSW agencies including NSW Environmental Trust, NSW Biodiversity Conservation Trust and the Biodiversity and Conservation division to deliver projects, programs and services.

Proposed Australian Government investment in Murray regional NRM

The government's proposed National Heritage Trust funding will focus on healing country, special places, and farming with nature programs. These 3 programs will focus on first nations people's priorities and achieving government policy objectives. Murray LLS is also very willing to codesign new programs with the Australian Government, and is keen to ensure adaptability of programs in line with Australian Government priorities.

Healing Country Program

The problem

Sites that retain high Aboriginal cultural heritage values contain a vibrant history of occupation by first nations people. The sites also support diverse populations of plants, animals, and wetlands. The sites have been impacted and continue to be threatened by landscape and local processes. The 2021 State of the Environment report referenced that Indigenous knowledge and connections to Country are vital for sustainability and healing in Australia, therefore it is critical that we commit to undertaking these programs to protect and heal country in partnership with first nations people.

Murray LLS solution

Murray LLS will collaborate with local first nations people to identify and address risks to sites across the Murray region by establishing an Aboriginal Community Advisory Group. The advisory group will help to direct the project to achieve positive outcomes.

Target Area Plans will be developed by identifying and mapping ecological assets and culturally significant sites to identify priority actions. These plans will be continuously monitored to ensure they are achieving project objectives.

Murray LLS will build capacity of first nations people by embedding project staff within Aboriginal organisations partnering on the project. This will enable first nations people to complete works on country to protect and enhance ecological and cultural values.

Murray LLS will collaborate with scientific researchers to gain and share knowledge, identify gaps, and develop research opportunities. Murray LLS will also collaborate with local landholders to protect natural areas.



Contribution to Australian Government initiatives

This program will assist the Government to reposition our nation as a global leader in empowering first nations people in the conservation of natural and cultural heritage. It will also achieve the outcomes and objectives detailed below.

National Landcare Program (NLP) Outcome 1

By 2023, there is restoration of, and reduction in threats to, the ecological character of Ramsar sites, through the implementation of priority actions.

NLP Outcome 2

By 2023, the trajectory of species targeted under the Threatened Species Strategy, and other EPBC Act priority species, is stabilised or improved.

Threatened Species Strategy Objectives

To improve the trajectories of priority threatened species by 2031.

To improve the condition of priority places by 2031.

Indigenous Ranger Sector (IRS) Strategy – Strong Country

Increase Indigenous ranger organisations effectiveness in caring for country and achieving sustainable land and water management practices that benefit their communities.

IRS Strategy – Strong Economy

Improve on-Country programs delivered by Indigenous rangers and access to the programs for young Indigenous peoples.

Support and expand Indigenous rangers access to meaningful career pathways into and within ranger organisations, and more broadly in land and water management and other industries.

Empower Indigenous ranger organisations to undertake business services and enterprises that meet their aspirations and increase their access to resources.

IRS Strategy – Strong Culture

Empower Indigenous ranger organisations to continue to protect and maintain culture and traditional knowledge in conjunction with traditional owners and communities.

Murray Darling Basin Plan

Optimise social, economic and environmental outcomes arising from the use of basin water resources in the national interest.

Support a healthy and working Murray Darling Basin that includes healthy and resilient ecosystems with rivers and creeks regularly connected to their floodplains and, ultimately, the ocean.

Global Leader's Pledge for Nature

Australia is expected to commit to the international agreement to protect 30% of land and waters across Australia.

Program outcome, objectives and targets

Final objectives and targets will be developed collaboratively with first nations partners; however, some objectives have been developed to be achieved by 2029:

- 20% reduction in key threats to the ecological character of target sites
- 10% increase in habitat availability for/distribution of threatened aquatic species
- 20% increase in native species richness in target wetlands
- 30% increase in first nations people working on country.

Murray LLS value

This program will build on the achievements of our highly successful work in the NSW Central Murray Forests Ramsar Site over the past 10 years. Murray LLS has strong ties to the community and established partnerships with:

- Werai Land and Water Aboriginal Corporation
- Yarkuwa Indigenous Knowledge Centre
- Cummeragunja, Moama, Deniliquin, and Hay LALCs/ACAG members
- Traditional owners and First Nations People
- Western Murray Land Improvement Group
- Edward-Wakool Angling Association
- Murray Darling Wetlands Working Group.

Murray LLS regularly collaborates with agencies, educational institutions, industry, and community groups to build pathways for Aboriginal employment in the Murray region via school programs, work placements, traineeships, business support and project delivery.

Murray LLS has existing partnerships with technical experts including:

- National Parks and Wildlife Service (NSW)
- Commonwealth Environmental Water Office
- Charles Sturt University
- La Trobe University
- Forestry Corporation of NSW.

Prioritisation

Target areas have been identified using the Murray Wetland and Waterway Prioritisation Tool (Figure 25). The tool utilises data from government datasets, local wetland inventory data, community asset mapping data and scientific observations.

The target areas identified are:

- Central Murray Forests Ramsar Site (Werai, Koondrook-Perricoota and Millewa Floodplain Forests)
- Lowbidgee Floodplain DIWA Site (Yanga Floodplain and Gayini/Nimmie-Caira).

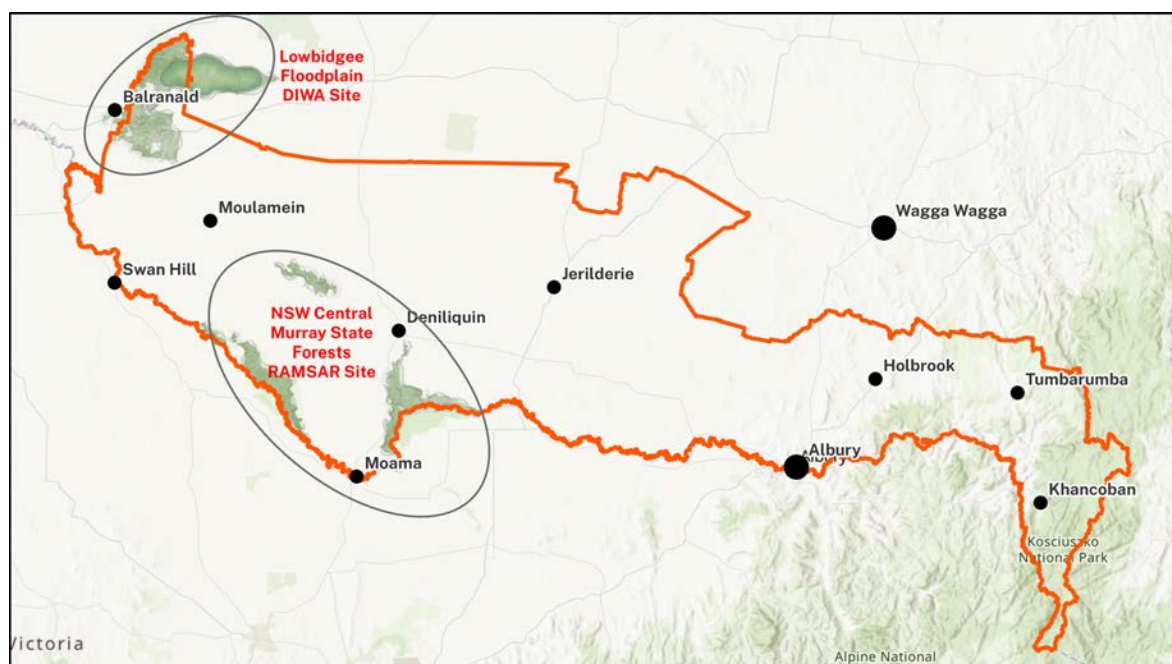


Figure 25. Healing Country Program Target Areas.

Murray LLS will develop site management plans and threatened species (Table 13) recovery plans to prioritise activities and be guided by input from first nations people.

Table 13. EPBC-listed Threatened Species and Communities in the Target Areas

Common Name	Scientific Name
River Swamp Wallaby-grass	<i>Amphibromus fluitans</i>
Regent Honeyeater	<i>Anthochaera phrygia</i>
Silver Perch	<i>Bidyanus bidyanus</i>
Australasian Bittern	<i>Botaurus poiciloptilus</i>
Mueller Daisy	<i>Brachyscome muelleroides</i>
Mossgiel Daisy	<i>Brachyscome papillosa</i>
Curlew Sandpiper	<i>Calidris ferruginea</i>
Murray Hardyhead	<i>Craterocephalus fluviatilis</i>
Sloane's Froglet	<i>Crinia sloanei</i>
Spike-Rush	<i>Eleocharis obicis</i>
Grey Falcon	<i>Falco hypoleucos</i>
Flat-headed Galaxias	<i>Galaxias rostratus</i>
Painted Honeyeater	<i>Grantiella picta</i>
White-throated Needletail	<i>Hirundapus caudacutus</i>
Swift Parrot	<i>Lathamus discolor</i>
Spiny Pepper-cress	<i>Lepidium aschersonii</i>
Trout Cod	<i>Maccullochella macquariensis</i>
Murray Cod	<i>Maccullochella peelii</i>
Macquarie Perch	<i>Macquaria australasica</i>
Chariot Wheels	<i>Maireana cheelii</i>
Ridged Water-milfoil	<i>Myriophyllum porcatum</i>
Eastern Curlew	<i>Numenius madagascariensis</i>
Corben's Long-eared Bat	<i>Nyctophilus corbeni</i>
Blue-billed Duck	<i>Oxyura australis</i>
Koala	<i>Phascolarctos cinereus</i>
Spiny Rice-flower	<i>Pimelea spinescens subsp. spinescens</i>
Regent Parrot (eastern)	<i>Polytelis anthopeplus monarchoides</i>
Superb Parrot	<i>Polytelis swainsonii</i>
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>
Floodplain Rustyhood	<i>Pterostylis cheraphila</i>
Lowly Greenhood	<i>Pterostylis despectans</i>
Australian Painted Snipe	<i>Rostratula australis</i>
Winged Pepper-cress	<i>Lepidium monoplocoides</i>
Southern Bell Frog	<i>Litoria raniformis</i>
Freckled Duck	<i>Stictonetta naevosa</i>

Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains

***Bold text indicates a "Top 100" species**



Regent Honeyeater



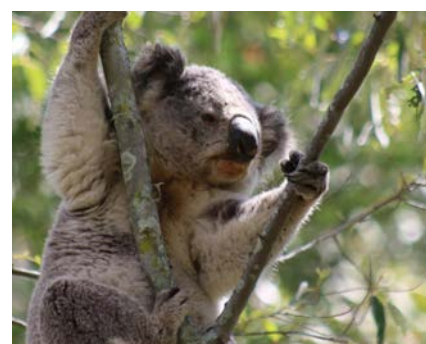
Australasian Bittern



Swift Parrot



Macquarie Perch



Koala

Case study: Ecosystem and biodiversity responses under collaborative wetland management

The NSW Forestry Corporation Flora Reserve, the Pollack Swamp, has received environmental flows regularly for the past 8 years. To improve ecological outcomes via environmental watering, a local group incorporating community members, landholders, traditional owners, Aboriginal Land Council members, and agency staff has been undertaking works at the site for the past 4 years, with support from the National Landcare Program.

The works undertaken include revegetation, cultural heritage surveys, fox control, small bodied native fish monitoring, turtle monitoring and analysing vegetation response to environmental watering.

These activities revealed that long-term fox control improved the survival rate of turtle nests and hatchlings and that cultural surveys and traditional owner knowledge influenced the duration and extent of environmental watering achieving positive social and environmental outcomes. The works also showed that vegetation extent can be accelerated by complimentary revegetation works.

The short-term benefits of the project include:

- Establishment of multi stakeholder steering committee
- Opportunities for first nations people to work on country
- Reduction in fox numbers
- Reduction in noxious weeds
- Identification of Cultural sites.

Long-term benefits include:

- Improving community understanding of wetland and cultural values
- Establishing and strengthening relationships between first nations people, community, and agencies
- Assisting in the recovery of native plant communities
- Improved water quality
- Improving habitat for colonial waterbird and frog breeding
- Building community and first nations ownership of the site
- Enabling employment for first nations people
- Potential future nursery site for threatened small bodied native fish.



Special Places Program

The problem

The 2021 State of the Environment Report stated that Australia's environmental condition is poor and continues to deteriorate. For example, over the past 5 years the number of species added to lists of conservation concern has grown by 8%.

International conservation agreements require Australia to prevent the extinction of threatened species by improving their conservation status. Accordingly, the government developed threatened species strategies and plans to highlight how an integrated approach of science, action and partnership can be used to achieve the long-term goal of reversing species decline and supporting species recovery.

Murray LLS solution

Because of the inter-connectedness of ecosystems, large-scale biodiversity conservation is the most efficient strategy to support threatened species.

Murray LLS will adopt a local area management plan (LAMP) approach to priority landscapes in the Murray region and promote the recovery of threatened species in partnership with community, industry, and government agencies.

The first stage of the process will utilise existing data and expert opinion to identify recovery actions. Murray LLS will then collaborate with landholders to undertake these actions and provide support.

On-ground revegetation activities will be undertaken by Murray LLS's Seed Services Unit to expand habitat, enabling target species to extend their range.

Steering groups will be developed to direct strategies and oversee program delivery to ensure that positive outcomes are achieved.

Contribution to Australian Government initiatives

This program will assist the Government to contribute to global efforts to halt the loss of planetary biodiversity and help achieve the following outcomes and objectives.

National Landcare Program (NLP) Outcome 2

By 2023, the trajectory of species targeted under the Threatened Species Strategy, and other EPBC Act priority species, is stabilised or improved.

National Landcare Program Outcome 4

By 2023, the implementation of priority actions is leading to an improvement in the condition of EPBC Act listed Threatened Ecological Communities.

Threatened Species Strategy Objectives

To improve the trajectories of priority threatened species by 2031.

To improve the condition of priority places by 2031.

Other objectives include:

- Improve the condition of 4 critically endangered and one endangered ecological community
- Secure populations of 5 critically endangered EPBC-listed species in the wild
- Improve the trajectories of an additional 11 EPBC-listed species
- Increase native species richness at target sites.

Murray LLS value

Murray LLS and its partners have a proven track record of improving the trajectories of threatened species and communities. Murray LLS has historical monitoring and condition assessment data for target areas and strong partnerships with organisations undertaking research in these areas. Murray LLS also has an in-house revegetation unit achieving positive biodiversity gains across the Murray region.

Murray LLS has strong partnerships with technical expert organisations including:

- Commonwealth Environmental Water Office
- NSW DPE, DPI Fisheries
- NSW Biodiversity Conservation Trust
- National Parks and Wildlife Service
- Charles Sturt University, Deakin University, Latrobe University, Griffith University, and the Australian National University
- Forestry Corporation of NSW.

Murray LLS also maintains existing partnerships with community groups, industry bodies and NGOs including:

- Birdlife Australia
- Moama, Cumeragunja, Albury, Brungle-Tumut, and Deniliquin LALCs
- Rice Growers Australia, Cotton Australia, Hume Forests
- Local Landcare and Producer Groups
- Murray Darling Wetlands Working Group.

Prioritisation

The Special Places program is focused on:

- EPBC-listed threatened ecological communities
- Threatened species that share common threats or habitats with other threatened species
- Places that contribute to the persistence of biodiversity.

Other Threatened Species Strategy principles that were included in Murray LLS's prioritisation approach were:

- Risk of extinction
- Feasibility and effectiveness
- Representativeness.

Strategic approaches for each Special Place (Figure 26) will be influenced by the priority actions detailed in National Recovery Plans.

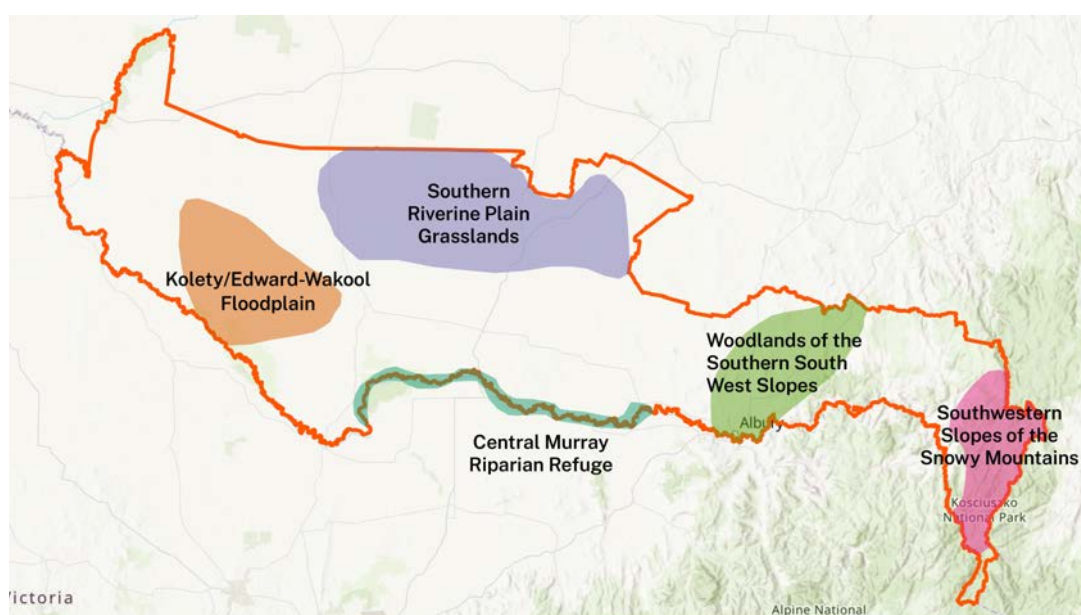


Figure 26. Draft Murray Region Special Places.

Murray LLS has also developed an application of Threatened Species Strategy to our Special Places (Table 14).

Table 14. Threatened Species Strategy for Murray Region Special Places

Special places	TSS Direct Action Areas				TSS Supporting Action Areas			
	Mitigating new and established threats	Conserving, restoring and improving habitat	Emergency preparedness and response	Climate change adaptation and resilience	Effective planning for conservation	Knowledge and tools	Forging stronger partnerships	Community leadership and engagement
Southern Riverine Plain Grasslands	✓	✓	✓					✓
Woodlands of the Southern South-West Slopes	✓	✓				✓	✓	✓
Edward-Wakool Floodplain	✓	✓			✓		✓	✓
Southwestern Slopes of the Snowy Mountains	✓		✓	✓				✓
Central Murray Riparian Refuge		✓	✓	✓			✓	✓



Priority species which may be the focus for commonwealth investment are listed in Table 15.

Table 15. Special Places EPBC Listed Threatened Species and Communities

Southern Riverine Plain Grasslands	Woodlands of the Southern South-West Slopes	Edward Wakool Floodplain	Southwestern Slopes of the Snowy Mountains	Central Murray Riparian Refuge
Natural Grasslands of the Murray Valley Plains	White Box-Yellow Gum-Blakely's Red Gum woodland ^	Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains ^	Alpine Sphagnum Bogs and Associated Fens * Natural Temperate Grassland of the South-Eastern Highlands^	Grey Box (<i>Eucalyptus microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia
Plains Wanderer (<i>Pedionomus torquatus</i>)	Swift Parrot (<i>Lathamus discolor</i>)	Southern Bell Frog (<i>Litoria raniformis</i>)	Southern Corroboree Frog (<i>Pseudophryne corroboree</i>)	Koala (<i>Phascolarctos cinereus</i>)
	Regent Honey Eater (<i>Anthochaera phrygia</i>)	Australasian Bittern (<i>Botaurus poiciloptilus</i>)	Spotted Tree Frog (<i>Litoria spenceri</i>)	Regent Honey Eater (<i>Anthochaera phrygia</i>)
	Gang Gang Cockatoo (<i>Callocephalon fimbriatum</i>)	Murray Hardyhead (<i>Craterocephalus fluviatilis</i>)	Alpine Tree Frog (<i>Litoria verreauxii alpina</i>)	Swift Parrot (<i>Lathamus discolor</i>)
	Greater Glider (<i>Petauroides volans</i>)		Blue-tongued Orchid (<i>Pterostylis oreophila</i>)	
			Brandy Marys Leek-orchid (<i>Prasophyllum innubum</i>)	
			Bago Leek-orchid (<i>Prasophyllum bagoense</i>)	
			Kelton's Leek-orchid (<i>Prasophyllum keltonii</i>)	

Bold indicates priority species which are potential focus areas for Australian Government investment.

Bold text indicates a priority species under the Australian Government's Threatened Species Strategy (DAWE 2021).

* Indicates species is currently listed as endangered.

^ Indicates species is currently listed as critically endangered.

Case study: Squirrel Glider LAMP

The purpose of Burrumbuttock Squirrel Glider LAMP is to secure viable populations of squirrel gliders in the Murray Region through community action. The LAMP process utilises the expertise of the local community to help steer the planning and implementation of threatened species conservation.

The community of Burrumbuttock was chosen for a LAMP as it contains the threatened and iconic squirrel glider and significant habitat change had occurred in the area placing the squirrels at risk of extinction.

The Squirrel Glider LAMP project is a partnership between Petaurus Education Group Inc., Murray LLS, OEH, Greater Hume Shire, West Hume Landcare, Wirraminna Environmental Education Centre, and Burrumbuttock landholders.



Farming with Nature Program

The problem

Agricultural industries rely on the quality of their soil, water, and vegetation resources to produce food and fibre. Across Australia, soil health, remnant vegetation and biodiversity are being depleted due to production pressures, rising input costs and climate change.

Australia has obligations under international conventions to protect biodiversity, soil and vegetation, and address climate change. As part of the food-bowl of Australia, the Murray region needs to take urgent action to improve the sustainability of Australia's farming systems.

Murray LLS solution

Murray LLS will collaborate with industry bodies to support the inclusion of meaningful NRM metrics and targets in the agricultural industry and roll-out of new frameworks across the Murray region.

Murray LLS will support farmers to measure, map and set goals for natural on-farm capital enabling farmers to improve land use, farm management capacity, and develop sustainable business plans.

Murray LLS will support farmers to improve farming practices in line with best practice sustainability frameworks and environmental markets such as the Australian Farm Biodiversity Certification Scheme.

Murray LLS will support farmers to develop methodologies and techniques that ameliorate soil carbon levels, reduce acidification, and salinity.

Murray LLS will support farmers to adopt practices which maintain groundcover and protect natural assets from erosion and degradation.

Murray LLS will collaborate with farmers and landholders to improve, enhance, and protect dams and waterways to support biodiversity, reduce methane emissions and provide a source of clean reliable water.

These actions will improve native vegetation, biodiversity, and soil condition and:

- Improve the sustainability of agro-ecological systems in the Murray region.
- Provide refugia and corridors to help native species adapt to climate change.
- Create a foundation of high conservation value parcels which could be considered for inclusion in the National Reserve System.
- Provide a pathway for farmers to be appropriately reimbursed for stewardship of natural resources.

Contribution to Australian Government initiatives

This project will assist the Government to maintain our nation's globally recognised status as a clean and green producer of agricultural commodities and help achieve the following outcomes and objectives.

NLP Outcomes 5

By 2023, there is an increase in the awareness and adoption of land management practices that improve and protect the condition of soil, biodiversity, and vegetation.

NLP Outcome 6

By 2023, there is an increase in the capacity of agriculture systems to adapt to significant changes in climate and market demands for information on provenance and sustainable production.

International climate commitments UNFCCC 2015; DISER 2022

Reduce greenhouse gas emissions to 43% below 2005 levels by 2030.

Net zero greenhouse gas emissions by 2050.

Agriculture Biodiversity Stewardship Policy Statement

Recognise and reward farmers who undertake new plantings of native species, as well as projects where farmers actively manage their land to protect or enhance existing native vegetation.

Capitalise on increasing private sector interest in investing in biodiversity, as companies respond to consumer and shareholder expectations about their environmental credentials.

Be world leading and allow Australian farmers to leverage their biodiversity credentials with trading partners.

Program outcome, objectives and targets

This program aims to achieve the following outcomes by 2029:

- 20% increase of farmers participating in a natural capital accounting certification scheme
- 20% improvement in natural capital scores for participating farms
- Climate change mitigation actions undertaken over 10% of the areal footprint for key agricultural industries in the Murray region
- 30% of Murray farmers report higher confidence in their ability to adapt to climate and market changes.

Murray LLS value

The Murray Region includes a huge diversity of farming systems, and farming industries which presents a unique opportunity to pilot initiatives to be rolled out across Australia. Murray LLS has existing partnerships with SunRice Australia and Cotton Australia and are developing partnerships within the beef and sheep industries.

Murray LLS has a proven track record of delivering large scale projects through the Murray Tri-State NRM Alliance, which brings together all regional NRM bodies in NSW, VIC and SA that border the Murray River.

Murray LLS has the knowledge and capacity to achieve positive outcomes via its Environmental Markets Officer and Environmental Markets Leadership Program.

Murray LLS regularly collaborates with farmers, community groups and grower groups to improve environmental markets and eco-certification schemes.

Prioritisation

Priority agricultural industries have been selected based on current prevalence in the region and/or likely future expansion into our region.

Target areas

Target areas for this project have yet to be mapped, however areas will be targeted based on:

- The areal footprints of the sheep, beef, cotton (Figure 27), rice and grain industries in the region
- Overlays of areas of known locations of threatened species and potential for extension of distribution of threatened ecological communities
- Overlays of priority areas for remediating soil salinity, acidity, and erosion.

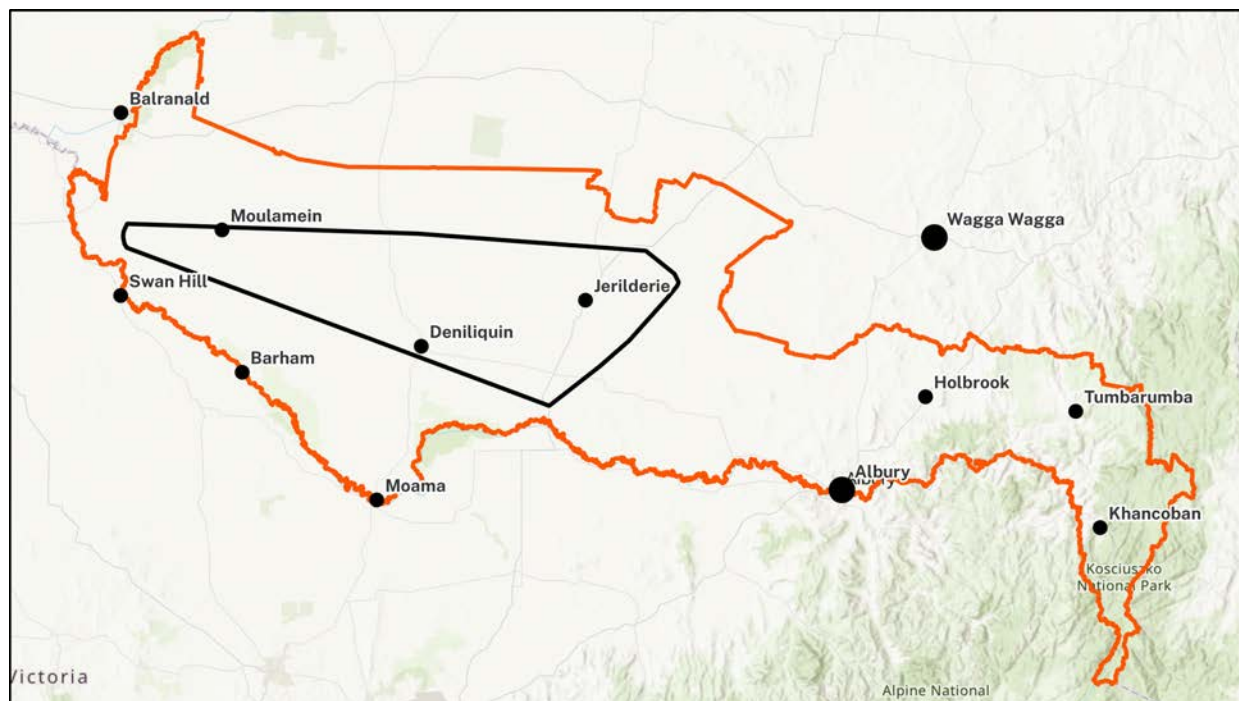


Figure 27. Murray Region Cotton Industry Footprint



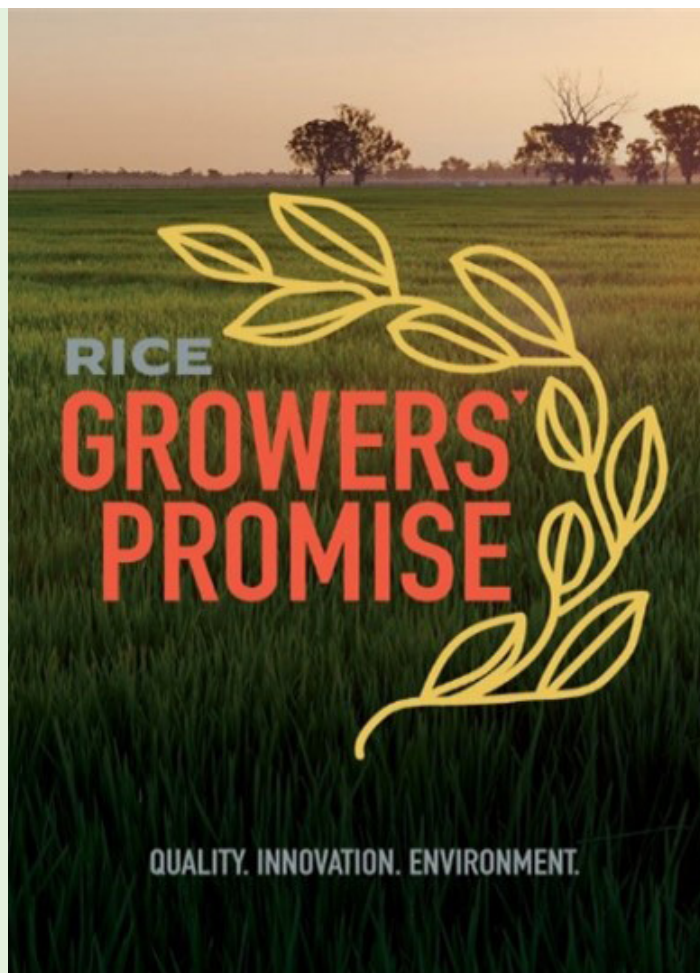
Case study: The ricegrowers' promise

Murray LLS has partnered with SunRice Australia to implement a sustainability credentials framework for the rice industry. This framework will benchmark producers' current management practices against industry best practice and international standards for rice production.

Australian growers are some of the most efficient in the world and this framework will evidence they can grow in a clean and green manner. This is essential as consumer preferences shift towards responsibly sourced produce.

The foundation of the framework is the Rice Growers' Promise, based on the United Nations and International Rice Research Institute Sustainable Rice Platform. The framework has been designed to improve sustainability within the industry whilst informing research and development practices.

The framework enables best practice and helps to improve grower's production and efficiency.



Other investment in Murray Regional NRM

Murray LLS attracts funding from Government, corporate enterprise, and not-for-profit organisations. Murray LLS undertakes fee-for-service activities for agencies, groups, and landholders. Murray LLS also has a suite of project ready concepts for which they are seeking investment (Table 16).

Table 16. Special Places EPBC Listed Threatened Species and Communities

Project/Service	Duration	Indicative Budget
Large scale woodland revegetation program	5 years	\$5,000,000
Upper Murray erosion control	5 years	\$1,000,000
Murray wetland recovery program	5 years	\$3,000,000

Tracking, adapting and sharing progress

Murray LLS's planning framework utilises logic structures at the planning stage to achieve positive outcomes. Monitoring, evaluation, reporting and continuous improvement systems are then designed (Figure 28).

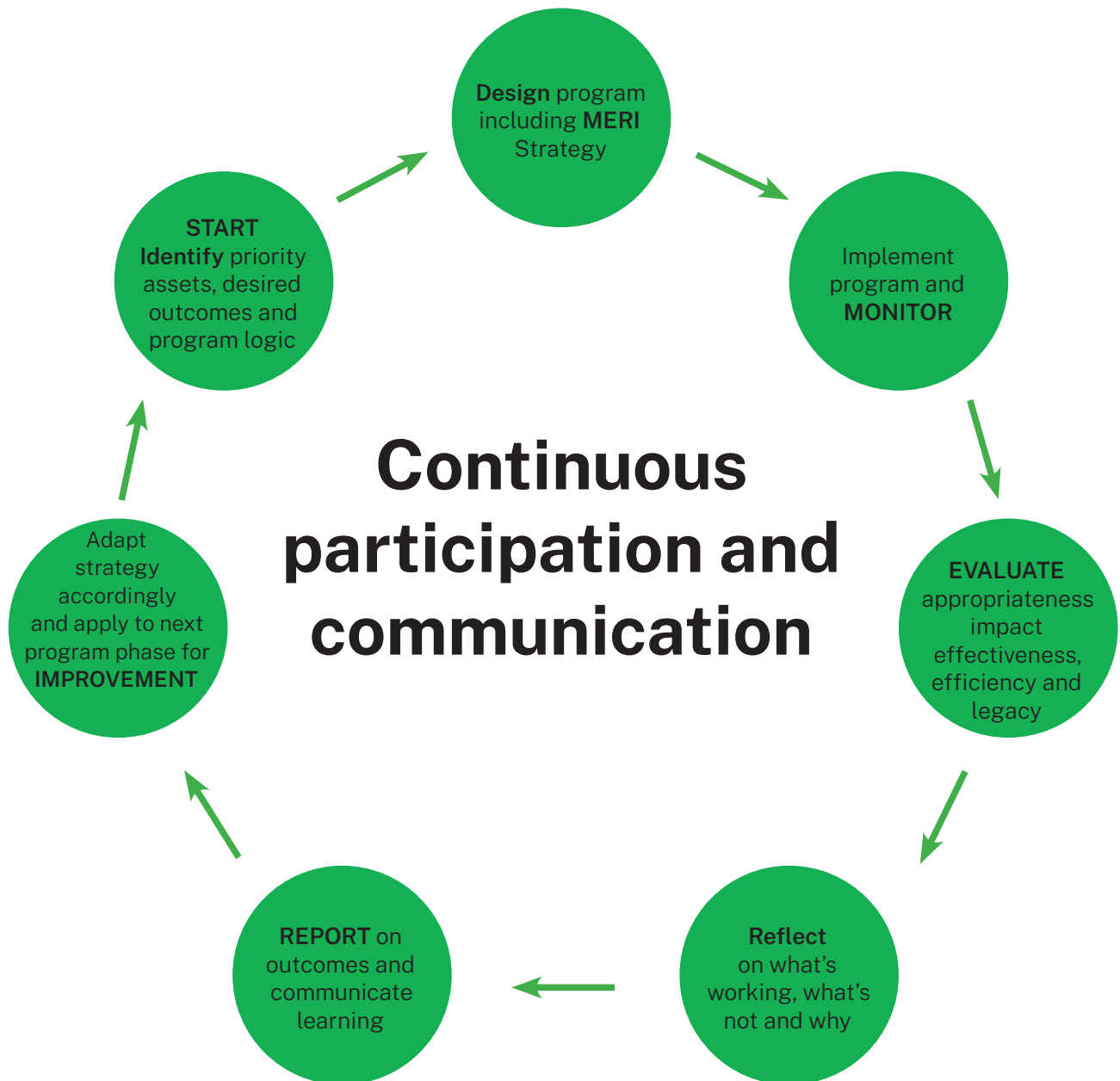


Figure 28. Murray LLS Planning Framework

Monitoring framework

Murray LLS will establish systems to monitor the effectiveness of its regional strategy to ensure outcomes are being achieved and the process is continuously improved.

To achieve this Murray LLS will undertake:

- Annual PESTEL scanning with Community Advisory Groups to identify changes in the environment
- Quarterly risk reviews to update risk management plans
- Bi-monthly reviews of emerging risks and opportunities
- Monthly evaluations of program and project budgets, milestones, and metrics
- Predictive monitoring exercises to develop project MERI plans and guide investment monitoring programs
- Monitoring and evaluation activities for each project's MERI plan
- Long-term, large-scale monitoring initiatives with partners.

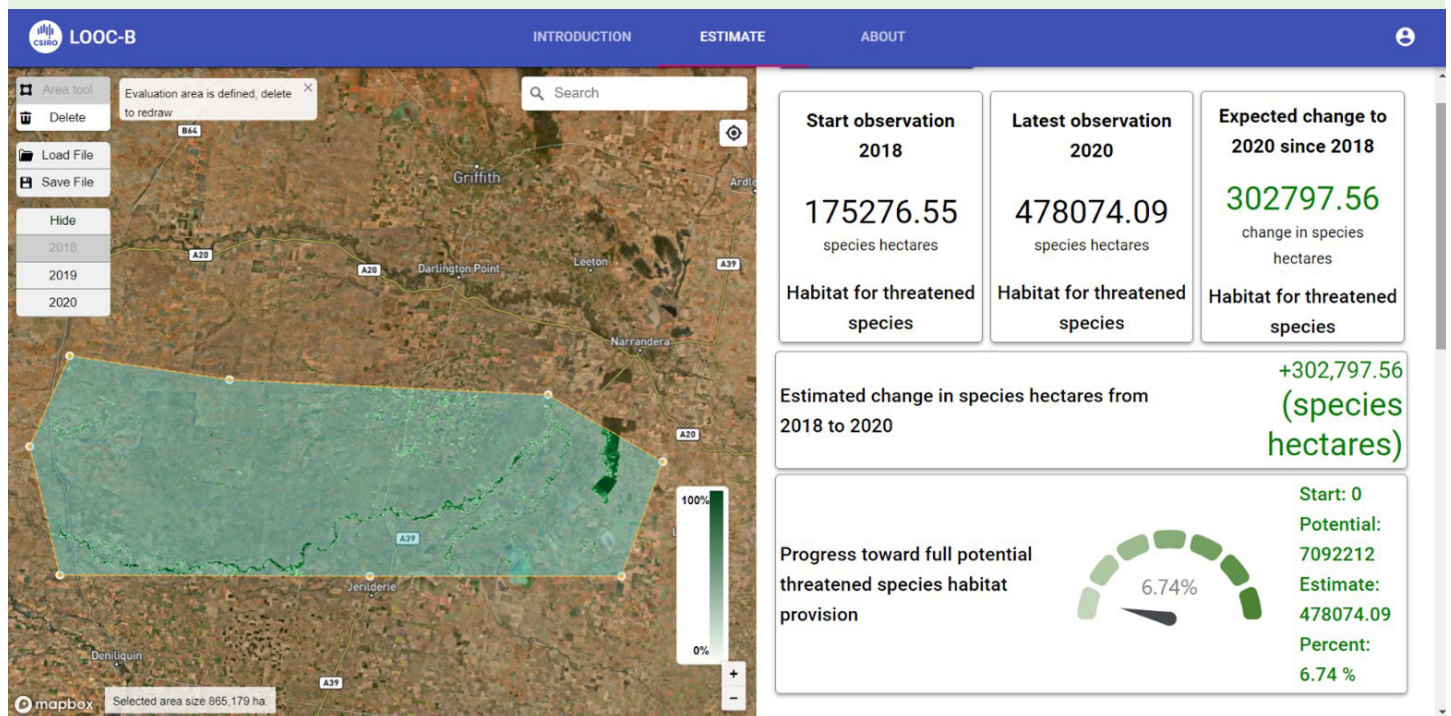
To ensure strategy objectives are being achieved the key performance indicators in Table 17 will be continuously monitored.

Table 17. Murray Local Strategic Plan NRM KPI's

Murray LLS Unit	Metric Type	Details
Natural Assets and Resources	Measures of Success (5 yr)	<ul style="list-style-type: none"> • Ecosystem health • Resilience of significant species • Appreciation of nature.
	Key Program Metrics (1 yr)	<ul style="list-style-type: none"> • Area (ha) of native revegetation • Area (ha) of native vegetation enhanced, rehabilitated, or protected • Stream length (km) river/estuary enhanced, rehabilitated, or protected. • Area (ha) of wetlands enhanced, rehabilitated, or protected • Area (ha) of threatened species, populations, or ecological communities. Enhanced, rehabilitated, or protected • Number of opportunities for Aboriginal people to support LLS decision. Making, including number of participants • Number of Aboriginal people involved in LLS activities.

Case study: LOOC-B predictive monitoring tool

Predicted habitat recovery for threatened species in the Plains Wanderer project area 2018–2020.



Monitoring plan

Murray LLS will monitor strategy effectiveness by:

- Developing mutually agreed definitions
- Embracing the complexity of conservation alliances
- Reflecting regularly and sharing lessons learned
- Collaborating on which key performance indicators can be aggregated across large scales.

Site monitoring

Site monitoring will be undertaken by environment team members to:

- Increase landholder engagement
- Ensure actions are achieving positive outcomes
- Ensure compliance with statutory obligations
- Assist with project monitoring and evaluation.

Output and outcome monitoring

Achievement of outputs identified in this strategy will be monitored via BERT, IRIS, and MyLAND project management systems. These outputs will be consolidated annually to analyse whether outcomes are being achieved.

The table below details how outcomes will be monitored.

Table 18. Outcome monitoring

Outcome	Aim
Long-term Outcome:	Improved function of terrestrial ecosystems
Medium-term Outcome: Increased abundance and diversity of native terrestrial fauna	To increase the abundance and diversity of native terrestrial fauna, activities will be undertaken to improve the condition of native vegetation and increase the extent of native vegetation. An increase in abundance and diversity of native terrestrial fauna may be monitored for adaptive management purposes or to demonstrate achievement of objectives.
Short-term Outcome: Improved condition of native vegetation	To improve the condition of native vegetation by: <ul style="list-style-type: none"> • Improving grazing management through installation of fencing. • Weed control • Pest animal control • Complimentary planting/direct seeding. The degree to which this outcome has been achieved will be measured by the <i>area of terrestrial native vegetation enhanced/rehabilitated (OG3.4)</i> .
Short-term Outcome: Increased extent of native vegetation	Activities to increase the extent of native vegetation include tube-stock planting or direct seeding. The degree to which this outcome has been achieved will be measured by the <i>area planted to terrestrial native species (OG4.6)</i> .
Long-term Outcome	Improved function of aquatic systems
Medium-term Outcome: Increased abundance and diversity of native aquatic fauna	To increase the abundance and diversity of native aquatic fauna by: <ul style="list-style-type: none"> • Improving condition of riparian vegetation • Improving condition of wetlands. An increase in abundance and diversity of native aquatic fauna may be measured for adaptive management purposes or to demonstrate achievement of objectives.
Short-term Outcome: Improved condition of riparian vegetation	To improve the condition of riparian vegetation by: <ul style="list-style-type: none"> • Improving grazing management through installing fencing. • Weed control • Pest animal control • Complimentary planting/direct seeding. The degree to which this outcome has been achieved will be measured by the <i>area of riparian native vegetation enhanced/rehabilitated (OG3.3)</i> .
Short Term Outcome: Improved condition of wetlands	To improve the condition of riparian vegetation by: <ul style="list-style-type: none"> • Improving grazing management through installation of fencing. • Weed control • Pest animal control • Complimentary planting/direct seeding. The degree to which this outcome has been achieved will be measured by the <i>area of wetland native vegetation enhanced/rehabilitated (OG3.2)</i> .

Outcome	Aim
Long-term Outcome:	Increased resilience of significant species
<p>Medium-term Outcome: Increased abundance of specific threatened species</p>	<p>To increase the abundance of targeted threatened species, activities will be undertaken to improve their habitat.</p> <p>Targeted species will be selected based on the following criteria:</p> <ul style="list-style-type: none"> • Investor priority • NSW Murray BMP • Ability to address causal effects. <p>An increase in the abundance of a particular targeted threatened species may be measured for adaptive management purposes or to demonstrate achievement of objectives.</p>
<p>Short-term Outcome: Improved habitat for specific threatened species</p>	<p>To improve the habitat for a particular threatened species, activities will be focused on the causative effects of the species being threatened. These activities will be aligned with species recovery plans, action statements, local area management plans and/or NSW Murray BMP.</p> <p>Activities to be undertaken are:</p> <ul style="list-style-type: none"> • Improving grazing management through farm infrastructure. • Weed control • Pest animal control • Complimentary planting/direct seeding • Artificial habitat. <p>The degree to which this outcome has been achieved will be measured by the <i>area managed for significant species and/or ecological communities (OG7.5)</i>.</p>

Appendix 1. NLP outcomes in the Murray region

Outcome 1 – Ramsar sites

The Murray NRM region has a number of internationally significant wetlands, including several floodplain forests identified as part of the NSW Central Murray Forests Ramsar site (Harrington and Hale, 2011).

This Ramsar site covers approximately 84,000 ha and takes in the Millewa, Koondrook-Pericoota and Werai Forests (location shown in Figure A1.1). The site spans the traditional Country of the Wamba Wamba, Barapa Barapa and Yorta Yorta Nations.

The site is dominated by river red gum forests and woodlands, wet grasslands and marshes located on the floodplain of the Murray River. Wetland habitats at the site support nationally and internationally significant populations of wetland birds and fish.

The wetlands also support at least 3 species of mammal, 7 species of frog, 3 species of freshwater turtle and a number of reptile taxa closely associated with wetland and aquatic habitats. These wetlands represent significant natural, social, cultural and economic resources, and influence surrounding river hydrology, water quality and biodiversity.

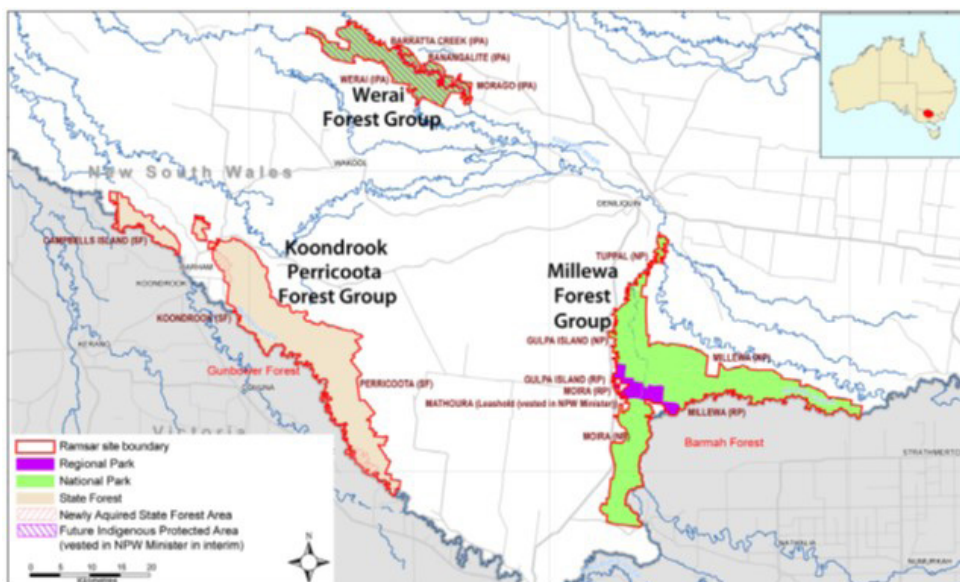


Figure A1.1. Location and land tenure of the NSW Central Murray Forests Ramsar

Under the Ramsar convention, the Commonwealth must ensure the 65 designated Ramsar sites in Australia maintain, or improve, their ecological character. The NSW Central Murray Forests Ramsar site was listed in 2003. The site met the following 5 criteria at the time of listing. The site however no longer meets criterion 5 due to lack of quantitative evidence.

- Criterion 1: Representative, rare, or unique example of a natural or near-natural wetland
- Criterion 2: Supports threatened species or threatened ecological communities
- Criterion 4: Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions
- Criterion 5: Regularly supports 20,000 or more waterbirds
- Criterion 8: Important source of food for fishes, spawning ground, nursery and/or migration path for fish stocks.

Key threats to the ecological character of this Ramsar site include):

- water resource use
- climate change
- forestry activities
- altered fire regimes
- invasive species
- human disturbance (public use pressures)
- acid sulphate soils.

In partnership with local First Nations people and public and private land managers, Murray LLS has been delivering services to reduce the impacts of key threats on the ecological character of the NSW Central Murray Forests Ramsar site since 2007 and has the capacity to continue to deliver high-quality services that aim to further reduce these threats and enhance the ecological character of the NSW Central Murray Wetlands Ramsar site.

Outcome 2 – Threatened species

The diverse landscapes of the Murray NRM region support a wide range of vegetation communities and habitats for a significant number of native plant and animal species. These include 61 plants and 54 animals that are listed as threatened in NSW or Australia (see Tables 3 and 7). The Murray NRM region is home to thirteen species targeted under the Australian Government's Threatened Species Strategy as priority species, including 5 of 20 birds, 4 of 20 mammals, 1 of 9 fish, 2 of 3 frogs and 1 of 30 plants:

- Australasian Bittern *Botaurus poiciloptilus*
- Malleefowl *Leipoa ocellata*
- Plains-wanderer *Pedionomus torquatus*
- Regent Honeyeater *Anthochaera phrygia*
- Swift Parrot *Lathamus discolor*
- Brush-tailed Rock-wallaby *Petrogale penicillate*
- Koala (Qld, NSW, ACT) *Phascolarctos cinereus*
- Mountain Pygmy-possum *Burramys parvus*
- New Holland Mouse, Pookila *Pseudomys novaehollandiae*
- Murray Hardyhead *Craterocephalus fluviatilis*
- Southern Bell Frog *Litoria raniformis*
- Southern Corroboree Frog *Pseudophryne corroboree*
- Stiff Groundsel *Senecio behrianus*.

The threats to the prosperity of all of these species are primarily land clearing, habitat loss, changed fire and hydrological regimes, pest plant and animals and lack of data.

Murray LLS worked extensively with State and Australian Government agencies and local communities to develop the NSW Murray Biodiversity Management Plan (BMP) which aims to help investors prioritise biodiversity management across the Murray NRM region. Murray LLS has been using the Murray BMP to deliver high-quality threatened species programs to stabilise and improve the trajectory of threatened species in the Murray NRM region since 2012. Murray LLS threatened species programs are also developed and delivered in accordance with:

- Actions to address priorities in the Threatened Species Strategy
- The EPBC Act. Part 13
- Recovery Plans
- Conservation Advice
- Threat Abatement Plans.

International conservation agreements require Australia to ensure that the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, is improved and sustained. The priorities for investment for threatened species identified in the Murray BMP closely align with the investment priorities identified by the Australian Government through the Regional Land Partnerships Program. Murray LLS has the capacity to deliver high quality services that aim to stabilise and improve the trajectory of species targeted under the Threatened Species Strategy and other priority EPBC Act priority species.

Outcome 4 – Threatened ecological communities

Australia has 77 Threatened Ecological Communities listed under the EPBC act that require action to ensure their survival into the future. Ecological communities are important because of their unique combination of native biodiversity, distinctive landscape values, vital habitat qualities and for the ecosystem services they provide. These include the natural management of air, water and soil nutrients; the reduction or control of erosion and salinity; provision of breeding/feeding habitat for species (e.g. for fish species) and carbon storage. Their natural values also contribute to the tourism and recreation industries and the productivity of farmlands and fisheries. In addition, ecological communities have strong cultural significance for both Indigenous and non-Indigenous Australians.

There are 14 ecological communities in the Murray NRM region listed as threatened under NSW or Australian legislation. This includes 10 threatened ecological communities (TEC) listed under the EPBC Act:

- Alpine Sphagnum Bogs and Associated Fens
- Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains
- Weeping Myall Woodlands
- Natural Grasslands of the Murray Valley Plains
- Natural Temperate Grassland of the South Eastern Highlands
- Mallee Bird Community of the Murray Darling Depression Bioregion
- Plains mallee box woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions
- Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia.

Threats

- Climate change
- Land clearing
- Fire –lack of and too much
- Pests and weeds
- Changes to hydrology
- Corporatisation of family farms
- Impacts of tourists and tourist development
- Land values and farm profitability
- Urban spread
- Sale of gazetted/paper-laneways/TSRs and potential for clearing
- Roadside veg management/clearing
- Habitat fragmentation
- Security of past investment & potential clearing.

Outcome 4 – Threatened ecological communities cont.

Murray LLS has partnered with the NSW Office of Environment and Heritage (OEH) to undertake extensive vegetation mapping in the Murray NRM region. The outcome of this mapping is a comprehensive understanding about the current extent and condition of vegetation communities across the entire Murray NRM region. To complement the regional vegetation mapping, Murray LLS programs are also developed and delivered in accordance with:

- EPBC Act, Part 13
- Recovery Plans
- Conservation Advice
- Listing Advice
- Threat Abatement Plans.

Murray LLS has the capacity and capability to deliver high-quality services that aim to improve the condition of EPBC Act listed threatened ecological communities for the Murray NRM region.

Outcome 5 – Soil, biodiversity and vegetation on-farm

Over 80% of the land in the Murray region is freehold, with 90% of that being agricultural land which has been extensively cleared. This broad scale landscape modification has resulted in significant loss of native vegetation leaving highly fragmented, small patches of remnant vegetation, low condition vegetation and loss of ecosystem function and species loss. Such a highly cleared landscape creates significant impediments for wildlife, including lack of suitable habitat and barriers to movement across the landscape.

Subsequently it is widely recognised that declining biodiversity is a key issue for the region and is linked directly to over-clearing of native vegetation, predominantly for agricultural production. This loss of vegetation and biodiversity is demonstrated in the fact that there are 8 threatened ecological communities identified in the region with 3 of these listed as critically endangered. Improved extent and management of native vegetation on farms also offers benefits to agricultural productivity through the provision of ecosystem services.

In order for individuals, industries and institutions to change there are 3 essential elements which are needed. Firstly, there must be a desire or commitment to change. Secondly, they must have the knowledge or knowhow to change. Thirdly, they must have the capacity to change.

As an organisation, Murray LLS has the ability to influence all 3 of these key factors. This places Murray LLS in a unique position to be able to directly influence the willingness, knowledge and capability of individuals, industries and institutions to make the necessary change(s) to improve the natural resource management and production-based outcomes the Australian Government is seeking.

Through considerable staff expertise, community engagement and past and current program delivery, we have built an extensive knowledge of the importance of soil health to agricultural productivity and profitability, biodiversity and the ecosystem services they support.

Outcome 5 – Soil, biodiversity and vegetation on-farm cont

Maintaining healthy soils is particularly important for the health and prosperity of the Murray NRM Region. The Murray NRM region is an agricultural powerhouse, growing a considerable proportion of the food and fibre used by the nation and contributing substantially to international markets.

To ensure that we are delivering the most up to date and relevant services to our communities, Murray LLS invests and participates in a range of programs, such as our own soil monitoring program, a wetlands carbon project, an acid soils project in partnership with NSW DPI and an airborne soil monitoring project in partnership with the former NSW OEH. Further, we continually engage with our communities to support or challenge our evidence. We have some of the most experienced soil and agronomy staff in Australia with over 30 years' experience in delivering high-quality projects.

Soil acidification

Soil acidification is a natural process, accelerated by some agricultural practices and without treatment soil acidification will have a major impact on agricultural productivity and sustainable farming systems. Producers may recognise the impacts of soil acidity as lost productivity and reduced income through; reduced yields of acid sensitive crops and pastures, poor establishment of perennial pastures, failure of perennial pasture to persist. Acidic soils also impact the community through; reduced vegetative cover and accelerated water runoff and erosion, irreversible degradation of the clay content of soil, hence reduced fertility and increase nitrate pollution of ground water and reduced water quality (Upjohn et al 2005).

In 2007 Murray LLS designed and delivered a soil benchmarking and monitoring project at key sites across the region. The project has identified subsurface acidity as a concern in the high rainfall areas of the Murray region (Murray LLS, unpublished data). Murray LLS has strong agricultural community connections through its Board, community advisory group, community groups and committees. Community/producer groups have identified soil acidification as the main risk to soil health and productivity in the Murray region.

Erosion

Soil provides the foundation for most of what we see around us. Soil is fundamental in both the water and carbon cycles, which underpin the very existence of the planet. Soil provides the backbone to our food production, and our natural environment and much of its biodiversity.

From the national perspective, managing our soil resource is essential in maintaining the very lifestyle Australian's enjoy today. Soil health and management have a significant impact of our food production, and the quality of the water we drink and the air we breathe. Healthy soils grow healthy foods, which grow healthy communities –urban and rural (Campbell, 2008).

But the soil is often taken for granted. Poor soil health and management can ultimately have significant impacts at local, regional and National scales. Food production can fall, impacting on food security, greenhouse gas emissions can increase, water quality is impacted, and can directly impact human health (dust and smoke).

Outcome 5 – Soil, biodiversity and vegetation on-farm cont

Because of the characteristics of many of our soils (such as their age, low organic carbon levels, low nutrient status, physical and chemical properties, clay content, subsoil problems etc), they are often left more prone to the impacts of erosion.

Soil erosion remains a major problem across Australia (Campbell, 2008). Soil erosion can occur from a range of sources – hillslope erosion, gully erosion, river and stream bank erosion, and broadscale land erosion generated from wind (dust). All of these, to varying levels, are issues in the Murray catchment.

According to SedNET modelling (Murray CMA 2009), the eastern Murray catchment sediment yields are potentially 49 kiloton/year from hillslope erosion (not taking into account groundcover conditions), 116 kiloton/year from gully erosion with the remainder of sediment occurring as a result of stream or riverbank erosion. This represents a significant cost to production through lost nutrients, degradation of soil health, loss of soil carbon and reduction of the soil's ability to support high production pasture systems and soil biodiversity. Additionally, nutrient and sediment loads contribute to environmental, infrastructure and amenity decline throughout the catchments by reducing water quality, damaging in stream habitat, impacting on recreational and consumptive uses, and creating expensive infrastructure issues both on farm and to the wider public. There exists a significant opportunity to reduce potential sediment yield through implementing practices that reduce hillslope and gully erosion with a new generation of farmers under more variable climatic conditions. This can be achieved through ensuring groundcover is maintained above critical benchmarks at high-risk times of the year.

Soil loss due to wind erosion affects a range of agricultural industry sectors and is primarily related to groundcover maintenance and management. Practices such as strategic grazing and minimum tillage have been shown to reduce wind erosion impacts while overgrazing (and a reduction in groundcover) and stubble-burning are known to increase rates of soil loss. As well as influencing the quantity of soil mobilised into the atmosphere, stubble-burning directly affects air quality through smoke and particulate matter in suspension. Dust and smoke releases have impacts at a scale well beyond that of the degradation site, and these aggregate across the landscape.

Given the scale of the issue and its resultant impacts, Murray LLS has been working closely to monitor wind erosion in the region in partnership with NSW OEH and neighbouring regions. Atmospheric dust levels are continuously monitored; groundcover levels measured remotely, and land management practices are assessed to determine the condition of the landscape, and to determine what land management practices (and seasonal conditions) may be impacting on this condition.

Given this history, the strong relationships with agencies and the community, and the intrinsic knowledge that exists within the organisation, Murray LLS is well placed to be able to deliver programs and services to assist in identifying the key drivers of erosion in the Murray region and respond with appropriate interventions to minimise further soil erosion.

Outcome 5 – Soil, biodiversity and vegetation on-farm cont

Soil carbon

Carbon is critical to soil function and productivity, and a main component of and contributor to healthy soil conditions.

Soil organic carbon is the carbon associated with soil organic matter. Soil organic matter is the organic fraction of the soil that is made up of decomposed plant and animal materials as well as microbial organisms but does not include fresh and undecomposed plant materials, such as straw and litter, lying on the soil surface (Chan, 2008).

From an agricultural perspective, soil and yield tend to improve when the soil organic carbon level increases. Higher soil organic carbon promotes soil structure or tilth meaning there is greater physical stability. This improves soil aeration and water drainage and retention and reduces the risk of erosion and nutrient leaching. Soil organic carbon is also important to chemical composition and soil biology, including fertility and nutrient holding capacity.

Soil management plays a critical role in whether the carbon remains in the soil or is released to the atmosphere. Agricultural practices can impact both the amount and the composition of soil organic carbon and hence also the soil's physical, biological, and chemical condition, the combination of things that defines soil health. Farm practices that affect carbon therefore impact agricultural productivity and resilience (the soil's ability to deal with weather extremes) and the carbon cycle itself.

In the irrigated soils of the Murray region, increasing organic carbon has a positive impact on soil structure, chemistry and biology. Soils with low organic carbon in the Murray region tend to be more 'fragile' than those with adequate amounts, so their structural integrity is more prone to damage from forces such as cultivation, compaction and surface irrigation. Additionally, soils with low organic carbon levels in these irrigated soils provide less mineralised nitrogen to plants so crops need extra fertiliser nitrogen to maintain yields. The current agricultural activities in the Murray LLS region have caused a decline in soil organic carbon levels that need to be addressed before more soil damage occurs.

Murray LLS is well placed, given the relationships it has with various research institutions and agencies, local producer groups and resource managers, to assist the Australian Government deliver its desired outcomes in the Murray region.

Outcome 6 – Supporting agricultural systems to adapt to change

By the very nature of agricultural production in Australia, producers have always faced the need to change. Whether the need to change be in response to climatic conditions, declining terms of trade, threats from introduced pests and disease, the need to better manage our natural resources, changing market and consumer demands and tastes, or changing policy conditions and frameworks, Australia primary producers have generally embraced and responded to the need to change and adapt.

Murray LLS is paying particular attention to the latest science on major climate trends and modelling, many of which predict an uncertain future for rural communities, agriculture and industries in the Murray NRM region. Climate change is likely to be one of the major disrupters in the region in the short-term, particularly climate variability and extremes. Climate modelling for the Murray LLS regions predicts with high confidence:

Increases in:

- average daily temperature
- hot days
- heat waves
- high fire danger days
- extreme rainfall events.

Decreases in:

- winter and spring rainfall
- frosts.

Murray LLS regularly engages with its local communities through community advisory groups, Landcare collective and committees, to discuss the impacts of change on landholders and industry in the Murray region. We know that our communities will see:

- climate change as the biggest adaptation driver in parts of region – particularly in the west
- plant species selection as vital to future viability for farms and ecosystems and the need for tools/approaches for making decisions around species selection
- invasive species likely to increase with climate change
- emergency management extremes – more shocks (fire, drought, floods) that are more intense than in the past
- volatility/vulnerability from the low equity land managers / shocks – likely to see more in future.

Murray LLS has been at the forefront of trying to understand the complexity of change which may be on the horizon for producers in our region, and importantly assisting in understanding the range of adaptation strategies which may be necessary to become more resilient and sustainable.

As an example, in partnership with NSW DPI and Charles Sturt University, Murray LLS has completed a series of studies identifying the likely range of impacts of climate change to producers in our area dryland cropping and grazing, and for the first time, looking at the effects on irrigation businesses, incorporating both biophysical and economic impacts.

Outcome 6 – Supporting agricultural systems to adapt to change cont.

Community participation in regional land partnerships delivery

Murray LLS is also acutely aware of how some of this work is viewed by some in our community, and have deliberately taken a strategic approach in commissioning this work, and extending the results of this to the community.

Because of our understanding of the issues surrounding the need to adapt to the range of external influences, our appreciation of our local communities and the production systems they implement, the level of knowledge that is held within the organisations, and the strong relationships Murray LLS holds with leading research organisations, the organisation is well placed to be able to deliver the outcomes the Australian Government is seeking in support of agricultural systems adapting to change.

The Murray Community and Indigenous Participation Plan sets out how Murray LLS will partner with and include communities in the planning and implementation of our work. It acts on responsibilities identified under the *LLS Act (2014)* and commitments given in our Aboriginal Engagement Strategy. It includes guiding principles, plans and policy to develop and maintain mutually beneficial relationships with First Nations peoples and local communities. It provides the framework to ensure that all of our regional strategies are implemented with comprehensive community participation.

While the Community and Indigenous Participation Plan details key stakeholders relevant to our whole organisation, the following sectors are of specific interest for this plan:

- Commonwealth agencies (e.g. Department of Environment, Department of Agriculture, Murray Darling Basin Authority)
- State Government entities (e.g. NSW DPIDPE, NPWS, FC NSW)
- Agricultural industry bodies (e.g. AWI, MLA, Ricegrowers Association, Sunrice Australia, Cotton Australia, Murray Irrigation Limited)
- Education, training and research institutions
- Conservation NGOs and special interest environmental groups
- Local Government, and the Riverina and Murray Regional Organisation of Councils
- LALCs
- Indigenous business, organisations and other groups
- Landcare, producer and other types of community groups and associated networks
- Local community advisory groups, weeds committees and pest animal groups.

We use the International Association of Public Participation’s engagement framework to conduct stakeholder analyses and identify appropriate levels, methods and topics of engagement for different stakeholder sectors. The decision matrix we use is shown in Figure A1.2.

		Project success dependency					
		No dependence (0)	Little dependence (1)	Some dependence (2)	Moderate dependence (3)	Significant dependence (4)	Critical dependence (5)
Influence of stakeholder	No influence (0)	NO ACTION (0)	NO ACTION (0)	INFORM (0)	INVOLVE (0)	INVOLVE (0)	INVOLVE (0)
	Little influence (1)	NO ACTION (0)	INFORM (1)	INFORM (2)	INVOLVE (3)	INVOLVE (4)	INVOLVE (5)
	Some influence (2)	INFORM (0)	INFORM (2)	INFORM (4)	INVOLVE (6)	INVOLVE (8)	INVOLVE (10)
	Moderate influence (3)	CONSULT (0)	CONSULT (3)	CONSULT (6)	COLLABORATE (9)	COLLABORATE (12)	COLLABORATE (15)
	Significant influence (4)	CONSULT (0)	CONSULT (4)	CONSULT (8)	COLLABORATE (12)	COLLABORATE (16)	EMPOWER (20)
	Critical influence (5)	CONSULT (0)	CONSULT (5)	CONSULT (10)	COLLABORATE (15)	EMPOWER (20)	EMPOWER (25)

Figure A1.2. Decision matrix for IAP2 spectrum of public participation

Table A1.1. Community participation in proposed Regional Land Partnerships initiatives.

Proposed Project	Regional Priorities	Opportunities Identified for Community and Aboriginal Participation
Healing Country Program	NSW Central Murray Forests Ramsar site Lowbidgee Floodplain	<ul style="list-style-type: none"> • Establishment of an Aboriginal Advisory Group to steer the project direction • Community and Indigenous participation in project steering committee and consultation on development of target area plans • Aboriginal employment through Project Delivery including hosting of project staff with Aboriginal Community-Controlled Organisations • Indigenous Rangers conduct on-ground works • Opportunities to meet on Country • Welcomes to Country and celebration of key annual Indigenous events on Country • Opportunities for landholders on freehold land adjacent to sites to participate in co-ordinated pest and weed control programs • Partnership with technical experts, conservation NGOs and citizen scientists in monitoring programs.
Special Places Program	Southern Riverine Plain Grasslands Woodlands of the Southern South-West Slopes Kolety/Edward-Wakool Floodplain Southwestern Slopes of the Snowy Mountains Central Murray River Refuge	<ul style="list-style-type: none"> • Community and Indigenous participation on project steering committee and consultation in development of LAMPs • Strong partnerships with Landcare and producer groups • Landholders in target areas participate in incentives programs, behaviour-change initiatives and peer support networks • Opportunities for First Nations People to work on Country • Partnership with technical experts, conservation NGOs and citizen scientists in monitoring programs
Farming with Nature Program	Throughout the Murray LLS region	<ul style="list-style-type: none"> • Opportunities for landholders to participate in incentives programs, farm mapping exercises, behaviour change initiatives and peer support networks • Opportunities for landholders to connect to industry bodies and eco-certification schemes. • Partnership with technical experts, NGOs and citizen scientists in monitoring programs • Opportunities for landholders to participate in programs which demonstrate best practice in soil amelioration practices, waterway protection and biodiversity enhancement.

When engaging with First Nations People in relation to TEK, we apply the 4 CARE principles for Indigenous data governance: collective benefit, authority to control, responsibility and ethics (www.gida-global.org/care).

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