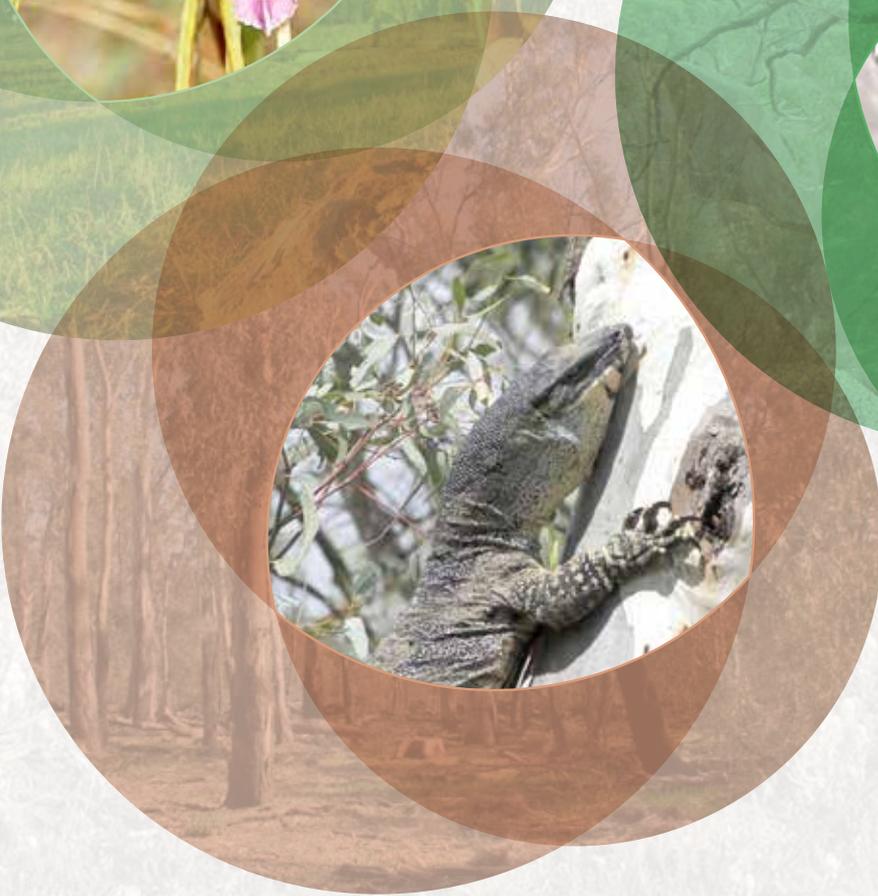


New South Wales Murray
**Biodiversity
Management Plan**

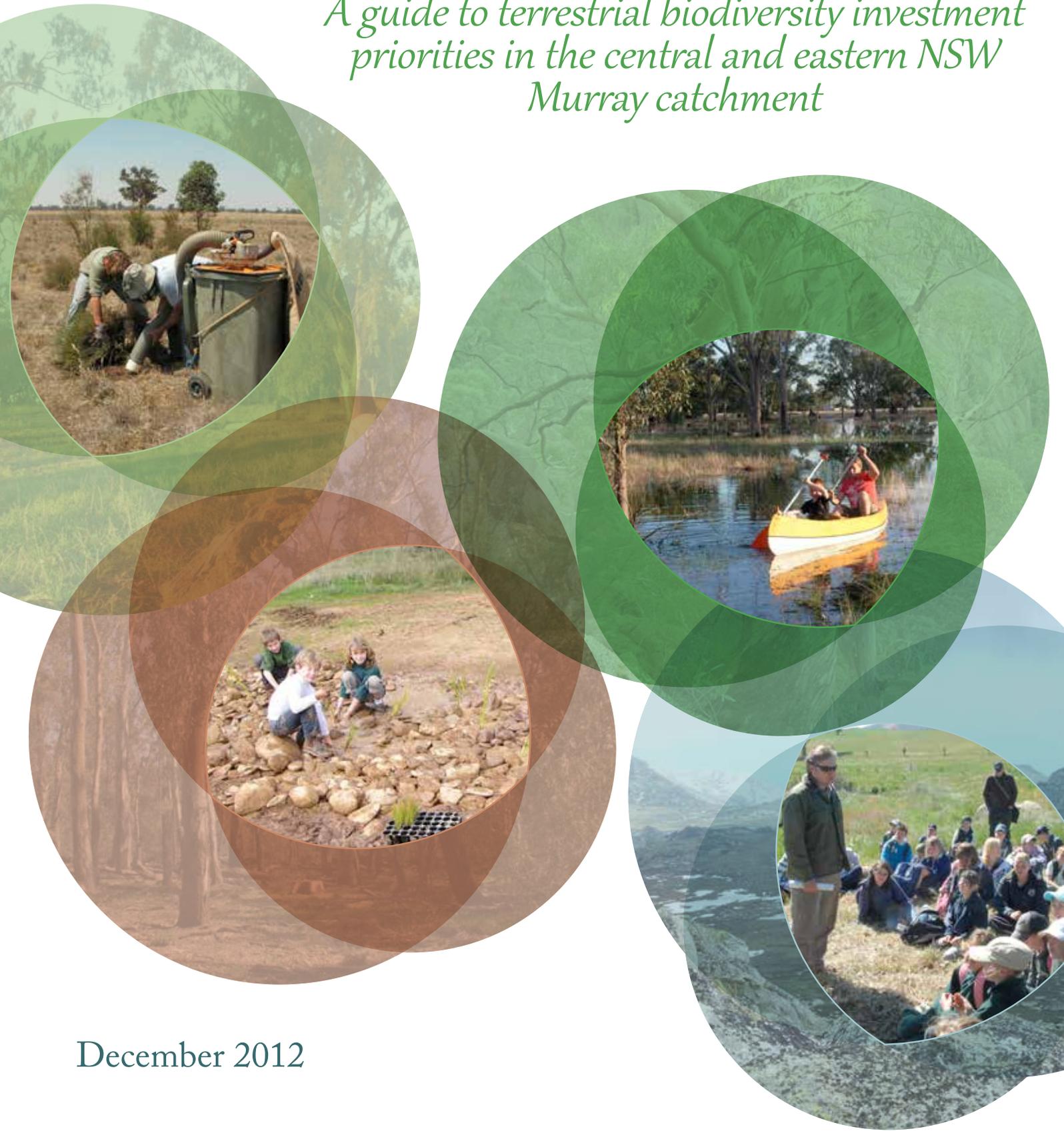
*A guide to terrestrial biodiversity investment
priorities in the central and eastern NSW
Murray catchment*



December 2012

New South Wales Murray
**Biodiversity
Management Plan**

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Abbreviations and acronyms

BFT	Biodiversity Forecasting Tool
BMP	Biodiversity Management Plan
CMA	Catchment Management Authority (as defined before October 2012)
EEC	endangered ecological community
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cwlth)
FM Act	<i>Fisheries Management Act 1994</i> (NSW)
LHPA	Livestock Health and Pest Authority (as defined before October 2012)
NPWS	National Parks and Wildlife Service
NSW	New South Wales
NSWVCA	New South Wales Vegetation Classification and Assessment Database
OEH	Office of Environment and Heritage (formerly Department of Environment, Climate Change and Water (NSW))
PAS1	New South Wales Priority Action Statement for Threatened Entities (Version 1 2007)
PAS2	New South Wales Priority Action Statement for Threatened Entities (Version 2 2009)
S2S	Slopes to Summit
TSC Act	<i>Threatened Species Conservation Act 1995</i> (NSW)

Note: Administrative and boundary changes to Murray CMA as of October 2012

This plan was developed for the Murray CMA boundary as defined prior to changes announced by the NSW Minister for Primary Industries in October 2012. It does not cover the western part of the Murray catchment – formerly part of the Lower Murray Darling catchment. Where this plan refers to the NSW Murray catchment it is referring to the region shown in Figure 1.1.

Summary

The New South Wales Murray catchment supports diverse plants, animals and natural habitats that are unique to south-eastern Australia. This long, narrow catchment flows from the highest alpine peaks in Australia through the forests, grassy woodlands and grasslands of the South Western Slopes and then westwards across the Riverine Plains of semi-arid woodlands, grasslands and shrublands. The variability of the catchment's rainfall, rivers, creeks, billabongs, wetlands, soils and topography all contribute to the variety of natural life.

At the most basic level, our society relies on healthy, complex and functioning natural ecosystems to keep our air and water clean, pollinate our crops, and help keep pests and diseases in check. Past practices and increasing agricultural and urban pressures on the NSW Murray landscape all have the potential to impact on natural biodiversity. Maintaining and improving biodiversity is necessary for the catchment for many reasons and it is important to identify areas to invest in to ensure we retain the benefits of our natural biodiversity and maintain a thriving agricultural and urban community.

To develop these investment priorities, the NSW Office of Environment and Heritage (OEH) and the Murray Catchment Management Authority (Murray CMA) created new catchment-wide spatial datasets, including mapping of vegetation communities, vegetation condition and threats to vegetation condition. These new mapping layers were combined with existing information to produce modelled maps that identify priority areas where Active Management or Repair

actions will have the greatest benefit for biodiversity in the catchment.

The NSW Murray Biodiversity Management Plan (the Murray BMP) also includes descriptive biodiversity information to help refine investment decisions. The information incorporates people's values, threatened and iconic species information, and specific site-based ecological criteria.

No map or model is ever perfect. Decisions about whether to invest time and resources in managing or restoring a site ultimately rest with the land manager, and will require on-ground checking at the site. The Murray BMP highlights the types of landscapes and sites that significantly contribute to the catchment's biodiversity. It aims to inspire land managers and help them investigate or take up biodiversity management investment options.

The key objective of the NSW Murray Biodiversity Management Plan (Murray BMP) is to provide spatial and descriptive guidance on where investment in biodiversity management will have the greatest benefit for biodiversity.

Main messages

- Biodiversity is what makes our local, catchment and Australian landscapes unique. Areas of naturally diverse native bush are aesthetically and culturally important, and remind us of the intricacy and uniqueness of the landscapes in which we live.
- Biodiversity underpins our quality of life and our livelihoods. We rely on healthy, complex and functioning natural ecosystems to keep our air and water clean, pollinate our crops, grow food and fibre, and help keep pests and diseases in check. Everyone has a role in managing biodiversity.
- The NSW Murray catchment is biologically diverse and supports a range of ecosystems, ecological communities and vegetation types. These include alpine fields (highly exposed, low-growing alpine plant communities), heathlands and herbfields in the east; semi-arid woodlands and shrublands in the west; and grassy woodlands, floodplain woodlands, natural grasslands, and freshwater and forested wetlands. More than 500 vertebrate species and 2350 plant species occur in the NSW Murray catchment.
- People value biodiversity. Members of the NSW Murray catchment community identified nearly 500 'assets' in a series of workshops. The most commonly nominated types of assets were areas of native vegetation (bushland), rivers and creeks, wetlands, Aboriginal cultural assets, and significant plants and animals.
- Biodiversity values are highest in areas where native vegetation is in high condition and is well connected to other areas of vegetation. These areas occur across public and private land.



Lowesdale replanting
Photo: Natasha Lappin

- Biodiversity is declining— 78 vertebrates and 40 plants in the NSW Murray catchment are formally listed as threatened under NSW and Australian Government legislation. Native vegetation communities have been extensively cleared for agricultural production and some are now listed as endangered. In particular, Grassy Woodlands and Grasslands now cover less than 10 per cent of their original extent.
- Threats to existing biodiversity need to be actively managed. Areas of native vegetation that are healthy and functioning have the potential to decline if threats to their viability are not actively managed. In the NSW Murray catchment, the main threats are pest animals and weeds, agricultural development, urban development, road maintenance, firewood removal, inappropriate fire (including wildfire) and climate change.
- It is important to prioritise biodiversity investment to ensure that the greatest benefit can be achieved in the most cost-efficient way. It is equally important to recognise the value of agricultural production and other land uses in the NSW Murray catchment.
- Priority areas for Active Management are mostly in the upper, central north and west of the NSW Murray catchment. Recommended actions for these areas are weed and pest management and appropriate fire management to maintain and improve the current extent and condition of native vegetation.
- Repair is needed in some areas to prevent further declines in vegetation communities and loss of species. Priority areas for Repair are primarily in the overcleared landscapes that were formerly Grassy Woodlands, and are primarily on private land. Recommended actions for priority Repair investment areas are 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.
- We need to act to save threatened and other important species. The NSW Murray catchment supports more than 120 threatened species, populations and ecological communities; nationally and internationally recognised migratory bird species; and a range of other species that people nominated as worthy of conservation management. Prioritising investment in management for these species is important to ensure that the greatest biodiversity benefit can be achieved from limited resources.
- The information in the Murray BMP can be used in different ways by different users. Case studies show how the mapping information can be used to assess the current or potential future biodiversity values of a site or larger area.

Consultation to inform the NSW Murray Biodiversity Management Plan

The Murray BMP was developed with input from people with a range of interests in the NSW Murray catchment, including people who live and work in the catchment. The steering committee for the Murray BMP first met in March 2010. Membership of the committee was by invitation from the OEHL and Murray CMA. The committee had terms of reference, was chaired by an independent facilitator, and included representatives from groups and organisations across the catchment (Appendix 1.1). The committee developed the vision, objectives and principles for the Murray BMP.

To reflect people's aspirations for biodiversity management across the NSW Murray catchment, a variety of opportunities for input into the Murray BMP have been provided. For example, the Murray CMA Biodiversity Asset Identification Workshops, conducted in mid 2010, contributed to the development of the Murray BMP. At each of the workshops, participants were reminded about the value of their contributions to the Murray BMP. These workshops and the outcomes are discussed in Chapter 2. Other biodiversity planning projects that have contributed to the Murray BMP are discussed in further detail in Chapter 4.



1

Introduction

1 Introduction

Key points

- Healthy ecosystems provide vital services, such as filtering pollutants from the air, water and soil; producing food and fibre; and reducing the impacts of disease outbreaks and natural disasters.
- The NSW Murray Biodiversity Management Plan (the Murray BMP) presents new maps of native vegetation types and their condition for the whole NSW Murray catchment, and provides guidance on where investment in biodiversity management will have the greatest benefit.
- The Murray BMP provides a regional context for biodiversity management at the catchment scale, and complements NSW Government and Australian Government conservation policy.
- Anyone who manages land in any capacity can influence biodiversity in their local landscape. The information in the Murray BMP can be used by land managers, community groups, investors, and government and non-government organisations.

Biodiversity means the variety of all life forms: different plants (from the smallest mosses, herbs and grasses to shrubs and tall trees), animals (invertebrates, fish, amphibians, reptiles, birds and mammals) and fungi; the genes they contain; and the ecosystems in which they live.

Ngangaanha-gu
karraay billas dya
karraay billas duraay
Ngangaanha ngindhu

Look after the land and
rivers and the land and
rivers will look after you.

Wiradjuri Council of Elders

Australia is one of the world's 17 megadiverse nations (Conservation International, cited in Williams et al. 2001).

It is home to more than one million species of plants and animals, many of which are endemic—93 per cent of Australia's frogs, 89 per cent of reptiles, 45 per cent of land birds,

82 per cent of mammals and 85 per cent of flowering plants are found only in Australia (COAG 1996).

Healthy ecosystems provide many of nature's most vital services, including filtering pollutants from the air, water and soil; producing food and fibre; and reducing the impacts of disease outbreaks and natural disasters (DECCW 2010b). Protecting biodiversity and ecosystem services has real and valuable benefits to people. As custodians of the land for future generations of all species, we have a duty of care to minimise our impacts on biodiversity.

1.1 The NSW Murray catchment¹

The NSW Murray catchment area is shown in Figure 1.1. This area is also known as the Murray Catchment Management Authority (Murray CMA) area. The catchment supports a high level of biodiversity across a broad range of landscapes and ecosystems. It is geographically diverse, extending from Australia's highest mountains in the east to the confluence of the Murray and Murrumbidgee rivers in the west. The Murray River and other major waterways of the NSW Murray catchment provide many habitats and natural resources to sustain biodiversity. The many different terrestrial ecosystems and vegetation communities also greatly influence biodiversity on land and in water, from alpine to semi-arid areas.

The diverse landscapes of the NSW Murray catchment support a wide range of vegetation communities and habitats for a significant number of native plant and animal species. These include 40 plants, 78 animals, 3 populations and 14 ecological communities listed as threatened in NSW or Australia (Appendix 5.2). More than 20 internationally protected migratory bird species visit the NSW Murray catchment (Appendix 5.4).

The NSW Murray catchment supports a population of around 105,000 people. Grazing, dryland and irrigated cropping, forestry and horticulture within the catchment contribute a significant proportion of Australia's total agricultural production. One of the

¹ Changes to Murray Catchment Management Authority's boundary (effective from October 2012): it should be noted that this plan covers the central and eastern Murray catchment (the former Murray catchment), and does not extend into the western Murray catchment (the former Lower Murray Darling catchment). Where this plan refers to the NSW Murray catchment it is referring to the region shown in Figure 1.1.

Throughout the Murray BMP, areas are described as priorities for 'Active Management' or 'Repair'.

Active Management areas have vegetation that is in relatively high condition and well connected. These areas need ongoing management to maintain their biodiversity values. Repair areas have low-condition vegetation in small, fragmented and isolated remnants. These areas need revegetation (replanting and promoting natural regeneration) and restoration management to improve their biodiversity values.

Similar priority maps were generated in the Northern Rivers and Border Ranges biodiversity management plans (DECCW 2010a, 2010b) using the equivalent term 'Conserve' instead of Active Management.

key challenges facing natural resource managers in the NSW Murray catchment is balancing the cultural and social values of people in the catchment and the requirements of agricultural production with the need to ensure the long-term survival of species, populations, ecological communities and other natural assets.

1.2 Background to the NSW Murray Biodiversity Management Plan

The New South Wales Murray Biodiversity Management Plan (Murray BMP) identifies priorities for efficient and effective investment in terrestrial biodiversity management across all tenures and land uses in the NSW Murray catchment. The information in the Murray BMP has been used to inform the new Murray Catchment Action Plan, and other NSW Government and Australian Government strategies.

The Murray BMP uses a range of terrestrial biodiversity information, including newly collected survey data, up-to-date vegetation mapping, innovative modelling, previous biodiversity planning and prioritisation efforts, expert panels and local knowledge. This information was used to generate maps, tables and figures that identify opportunities to maintain and improve biodiversity and ecological processes by managing and repairing native vegetation.

The Murray BMP also presents information about sites and landscape types that people who live and work in the NSW Murray catchment identify as important for biodiversity. This information will help to guide investment programs that are likely to have greater traction with the NSW Murray catchment community.

The Murray BMP Steering Committee developed the following vision, objective and principles.

Vision

The Murray BMP will contribute to healthy, productive and resilient environments and communities that are necessary for long-term management and conservation of biodiversity in the NSW Murray catchment.

Objective

The Murray BMP will collate, interpret and present strategic priorities for investment in biodiversity

management across the NSW Murray catchment. It will be a public living document underpinned by community collaboration, engagement and partnerships.

Principles

The Murray BMP's principles are derived from and shaped by the laws and regulations that govern catchment management authorities (CMAs), Australian Government and NSW Government standards and investment preferences, best available knowledge, community expectations, and Murray CMA's Strategic Plan and Biodiversity Policy.

The Murray BMP:

- recognises that engaging the range of communities across the catchment is vital to successful biodiversity management
- promotes natural resource management change through consultation, constructive relationships and partnerships with key stakeholders
- encompasses the spiritual, cultural and economic significance and values of the landscape held by traditional owners
- recognises the existing and potential biodiversity values within productive agricultural landscapes of the NSW Murray catchment
- identifies priority actions that will improve or maintain biodiversity of the NSW Murray catchment

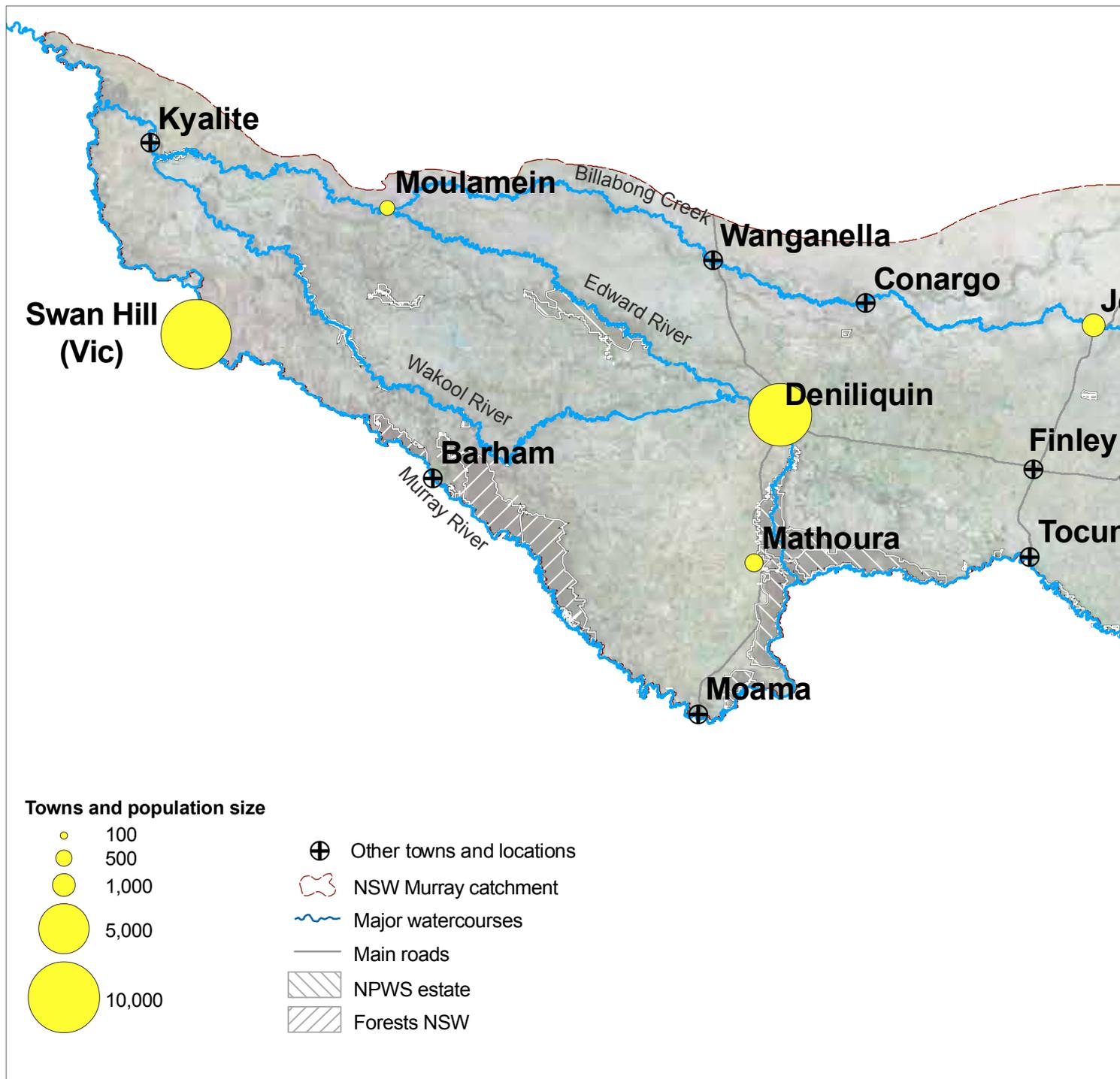
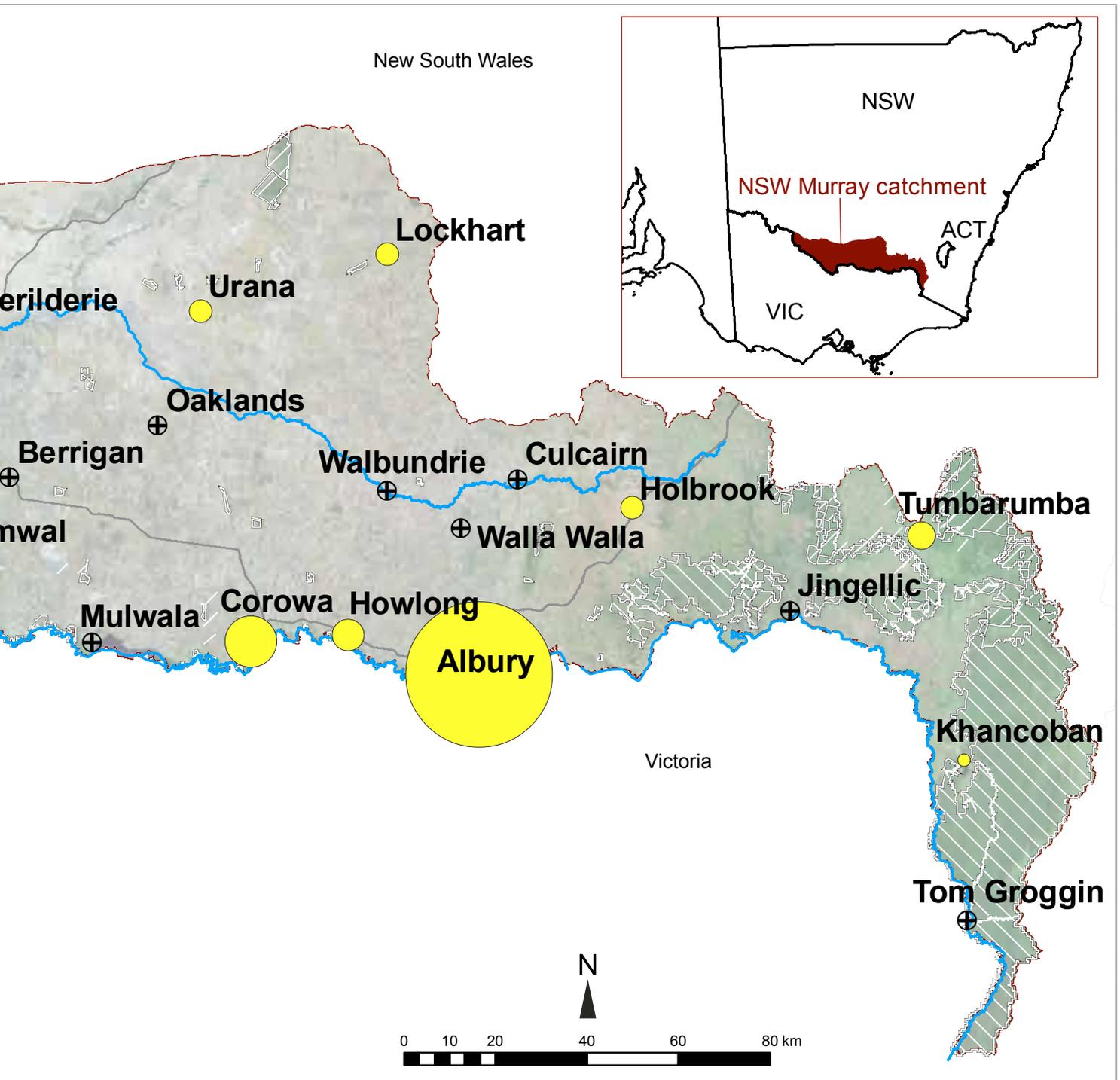


Figure 1.1 The NSW Murray catchment (also known as the Murray Catchment Management Authority area)²

- aims to provide a ‘snapshot’ of the condition, extent or connectivity of existing viable and sustainable populations of a range of native plants and animals
- uses best available knowledge to prioritise assets, taking into account conservation value and the risk from threats
- identifies priorities for lasting improvements in natural resource condition across a range of scales
- prioritises actions to ensure multiple outcomes.

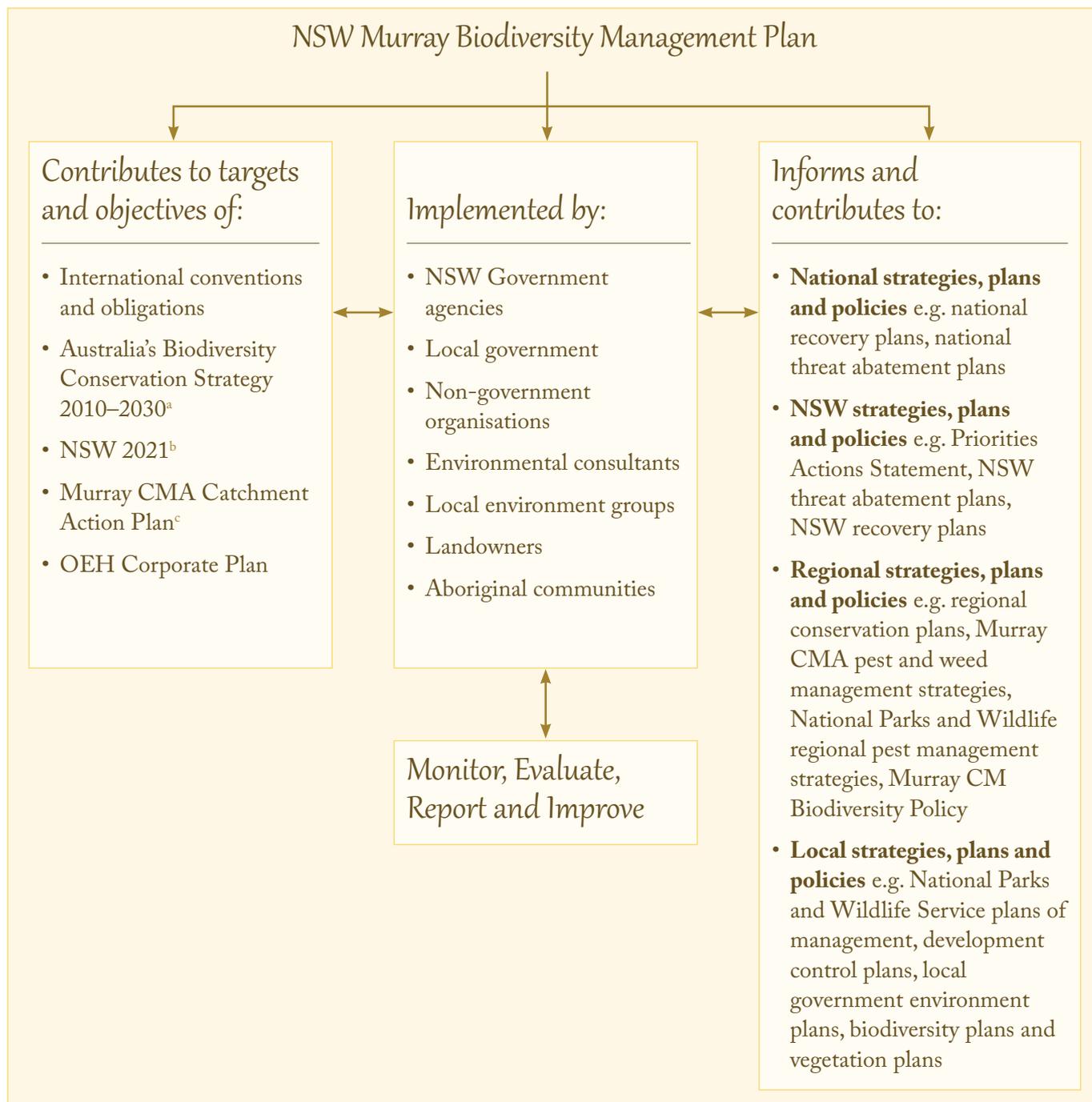
² Changes to Murray Catchment Management Authority’s boundary (effective from October 2012): it should be noted that this plan covers the central and eastern Murray catchment (the former Murray catchment), and does not extend into the western Murray catchment (the former Lower Murray Darling catchment). Where this plan refers to the NSW Murray catchment it is referring to the region shown in Figure 1.1.



1.2.1 Conservation legislation and planning context

A range of Australian Government and NSW Government laws and planning policies are relevant to the protection and management of biodiversity in the NSW Murray catchment; these cover various jurisdictions and spatial scales (Appendix 1.2). The Murray BMP does not replace these existing

strategies, policies and plans, but complements them by providing a regional context to plan integrated biodiversity management actions at a catchment scale or finer. Importantly, the Murray BMP contributes to the information needed to meet the targets in several important national and international plans and strategies (Appendix 1.2). The links between existing key strategies and the Murray BMP are shown in Figure 1.2.



a NRMCC (2010), b DPC (2011), c MCMA (2006a)

Figure 1.2 Interaction between the NSW Murray Biodiversity Management Plan and other strategies, policies and plans

1.3 The importance of a biodiversity management plan for the NSW Murray catchment

As our understanding of natural resource management grows, it is becoming clear that managing threats

to biodiversity will require thinking and action over greater spatial and biological scales, over longer time frames and with greater local input than has been previously attempted. It is no longer sufficient or efficient to fund isolated programs to manage issues such as widespread species decline or the loss of critical landscape-scale fauna movement routes. Instead, we

need to identify threats and collaborate across sites, local landscapes and regions to mitigate these threats in a coordinated way, beyond existing local efforts (DECCW and I&I 2010).

A large proportion of the alpine and montane areas of the upper NSW Murray catchment is protected and managed within Kosciuszko National Park. Major new parks have also been gazetted on the Murray River to conserve river red gum forests. However, most native vegetation in the Murray catchment is owned and managed on private or public land that is used primarily for purposes other than conservation. It is across these landscapes that many of the greatest gains for biodiversity conservation can be made. This can be done by engaging and building effective relationships with the NSW Murray catchment community, and promoting local identification of priority areas and ownership of problems and solutions.

1.4 Who can use the NSW Murray Biodiversity Management Plan?

The Murray BMP identifies priorities for investment in biodiversity management across all tenures and land uses in the NSW Murray catchment. It provides spatial and descriptive guidance on where investment in biodiversity management will have the greatest benefit.

Anyone who manages land in any capacity has the potential to influence biodiversity in their local landscape. People who can use the Murray BMP to help make decisions include:

- private land managers, small-scale and large-scale farmers, croppers and graziers
- local groups who conduct natural resource management projects in their landscape, including projects on public lands
- local government, particularly for environmental management of roadsides and local government-owned land, and for developing community-based projects
- NSW Government land managers, including the Parks and Wildlife Group (PWG) of OEH, Forests NSW, Livestock Health and Pest Authorities (LHPA), NSW Catchments and Lands, and NSW Roads and Maritime Services.

- Australian Government and NSW Government departments (including Murray CMA and the NSW Office of Environment and Heritage (OEH)) that manage environmental investment programs such as Catchment Action NSW, Environmental Trust, Caring for our Country and the Biodiversity Fund
- non-government organisations that invest in natural resource management projects in the NSW Murray catchment.

People who are seeking investment assistance to manage or repair vegetation on their property can use the Murray BMP to determine if their site is in an Active Management area (with intact and high-condition native vegetation; see Figure 4.1), or a Repair area (with less or lower-condition native vegetation; see Figure 4.2). Landholders can use the Murray BMP to help identify the vegetation communities on their properties (see Figure 2.5) or the type of activities that may benefit a significant species on or near their properties (see Sections 5.1.3 and 5.2.5).

Investors who are interested in improving biodiversity in the NSW Murray catchment can use the Murray BMP to target their investment and link their efforts to a landscape-scale project. Investment priorities for sites, issues and species in the Murray BMP have been identified using the latest scientific techniques, reviewed by experts in a range of biological fields and developed in collaboration with the people of the NSW Murray catchment.

The case studies in Chapter 6 also provide examples of how the information in the Murray BMP can be used.

1.5 Limitations of the data

The Murray BMP focuses on the terrestrial biodiversity of the NSW Murray catchment, including wetland vegetation, flora and fauna. The plan takes the importance of aquatic ecosystems and their biodiversity values into consideration, but does not specifically assess aquatic biodiversity.

The terrestrial mapping and modelling methods used to identify priority areas for biodiversity investment are constrained by the data available at the time of preparation, the quality of these data, and the scale at which the mapping and modelling techniques were

applied. These constraints (summarised in Table 1.1) should be carefully considered when interpreting and using the information in the Murray BMP. The methods are explained in the appendices to Chapter 4.

The descriptive and spatial information and identified priorities in the Murray BMP are an essential strategic starting point for biodiversity management planning at the site level and larger scales. However, the Murray BMP should not be used as the sole basis for investment decisions. Additional information will be needed about potential investment sites, including ground validation of the vegetation type, extent, condition and other biodiversity values at

the site; or whether the site is appropriate for the proposed activity.

1.6 Related information

The following appendices are available on CD by contacting Murray Catchment Management Authority, or online at www.murray.cma.nsw.gov.au.

Appendix 1.1 NSW Murray Biodiversity Management Plan Steering Committee

Appendix 1.2 Conservation legislation and planning context

Table 1.1 Summary of the limitations of the data used in the NSW Murray Biodiversity Management Plan

Product	Limitations
NSW Murray Biodiversity Management Plan	<ul style="list-style-type: none"> Restricted to terrestrial biodiversity priorities and does not address aquatic biodiversity
Vegetation mapping	<ul style="list-style-type: none"> Mapping method incorporates limited ground validation, and map accuracy has been assessed at 58–78% (see Appendix 2.10). Ongoing validation will improve mapping for future adoption in updated BMP products and priorities
Vegetation condition mapping	<ul style="list-style-type: none"> Models based on extrapolation from a large number of vegetation plots in Victoria; field data from the smaller number of vegetation plots within the NSW Murray catchment were collected in different years and seasons Data represent a snapshot in time and do not incorporate variation in vegetation condition over seasons or years; vegetation condition is likely to be overestimated in some irrigation areas Does not distinguish between native and exotic-dominated non-native vegetation, and cannot be used reliably to separate the two categories as defined under the <i>Native Vegetation Act 2003</i> (NSW)
Threats mapping	<ul style="list-style-type: none"> Underpinned by land use mapping that has limited accuracy in some parts of the NSW Murray catchment and has not been recently updated Accuracy influenced by categorisation of input data layers, e.g. unavoidable inclusion of ‘paper roads’ (planned roads that have never been built) in road data layer, or inclusion of ephemeral creeks in streams layer Based on storylines with assumptions about the key drivers of threats to biodiversity and limited by datasets available to map the impact on terrestrial vegetation condition only (see Appendix 3.4) Insufficiently detailed data to map climate change threats Insufficient data available to map pest animal threats (notably for key threats of foxes and rabbits)
Biodiversity Forecasting Tool models	<ul style="list-style-type: none"> Uses vegetation condition as a surrogate measure of biodiversity value Modelling limited to threats that have an impact on terrestrial vegetation condition (e.g. does not account for impacts of fox predation on biodiversity) Pre-European vegetation extent (used to model Repair priorities) only mapped to level of ‘Broad vegetation types’ in the NSW Murray catchment
Biodiversity assets	<ul style="list-style-type: none"> Limited to the number of people and experts who provided input to the process People at the asset identification workshops were asked to identify assets that were significant to them, not just biodiversity assets Community-identified assets were not prioritised
Threatened species management areas	<ul style="list-style-type: none"> Not prioritised Boundaries were subjectively developed by field experts



2

**Overview
of the NSW
Murray catchment**

2 Overview of the NSW Murray catchment

Key points

- The NSW Murray catchment covers 3,517,000 hectares (35,170 square kilometres). It supports more than 100,000 people, 500 species of vertebrates and 2350 species of plants.
- The NSW Murray catchment has tens of thousands of years of Indigenous history, and traditional owners' relationship with the landscape continues today. European settlers first explored and colonised the area in the early to mid-1800s.
- Landscapes in the catchment range from alpine to semi-arid, and include five bioregions. The variations in climate and physical features across the catchment contribute to a diversity of soil types.
- The catchment incorporates 22,500 kilometres of watercourses, including rivers and wetlands of national and international significance.
- Vegetation communities vary across the catchment and include 11 of the 12 native vegetation formations in NSW. The condition of these vegetation communities also varies.
- More than 80 per cent of land in the catchment is private freehold; of this, 90 per cent is used for agriculture. The catchment also includes 10 nature reserves, 2 state conservation reserves and 1 regional park.
- The NSW Murray catchment community has a long history of involvement in biodiversity management. Participants in workshops identified nearly 500 sites, assets and species of significance that they consider to have biodiversity, cultural and spiritual values.

The NSW Murray catchment includes diverse physical and biological features that support a wide variety of ecosystems and vegetation communities. The landscapes range from alpine and montane in the east to arid shrublands and alluvial plains in the

west, and are influenced by patterns in climate, soils, vegetation, fauna and land use. The catchment provides habitats for thousands of species of plants, animals and invertebrates—more than 500 species of vertebrates (28 frogs, 66 reptiles, 321 birds and 88 mammals) and more than 2350 species of plants have been recorded in the catchment (Atlas of NSW Wildlife database³). More than 120 species, populations and ecological communities in the catchment are listed as threatened under NSW Government legislation (*Threatened Species Conservation Act 1995*) or Australian Government legislation (*Environment Protection and Biodiversity Conservation Act 1999*).

2.1 The people of the region

Traditional custodians and their descendants have been part of the environment for many tens of thousands of years and those peoples 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. No distinction is made between the people and all living things.

The land and rivers of the NSW Murray catchment were, and continue to be, culturally, spiritually, socially and economically significant to the Wiradjuri, Yorta Yorta, Mutthi Mutthi, Wamba Wamba, Barapa Barapa, Pangerang and Monaro peoples.

Historically, the population of Aboriginal peoples of the Murray Valley was quite large. It concentrated around the area's abundant and diverse natural resources that are associated with the river system and its tributaries and wetlands.

The first Europeans to explore the Murray catchment were Hume and Hovell, who travelled through the upper Murray in 1824 and crossed the Murray River at Albury. Sturt and Mitchell explored the lower Murray–Darling area in 1829, and Morris explored the country around the Edward and Wakool rivers in 1842.

Shortly after these explorations, the first colonisers arrived in the catchment and took up extensive grazing runs. Important phases in European history within the catchment include the pastoral era, the gold rushes, the paddle steamer trade, the railway-sleeper timber cutters, rail and motor transport networks, large-scale

3 www.bionet.nsw.gov.au

cropping, river regulation, irrigation, urbanisation and tourism. Traditional owners in the Murray played an integral role in the establishment of many of the early catchment industries and their history is shared by all the people of the catchment.

Today, the NSW Murray catchment is home to more than 100,000 people distributed among the 14 local government areas. The region is dominated by three major regional centres that are co-located with Victorian towns along the Murray River: Albury/Wodonga, Echuca/Moama and Murray Downs/Swan Hill. The region's population is projected to grow, particularly in the larger centres and along the Murray River, where there is strong demand for new housing in sensitive river-based areas (DoP 2009).

The NSW Murray catchment supports the Nations and peoples of the Barapa Barapa, Monaro, Mutthi Mutthi, Pangerang, Wamba Wamba, Wiradjuri and Yorta Yorta, and the Aboriginal Land Councils of Albury and District, Balranald, Bega, Brungle/Tumut, Deniliquin, Eden, Merrimans, Moama, Narrandera, Wagga Wagga, Wagonga, Wamba Wamba and Yorta Yorta (Cummeragunja) (Appendix 2.1).

Since European colonisation the traditional lifestyle of the first peoples has adapted to different ways of living, but their relationship with the landscape continues, along with a diversity of cultural activities and responsibilities. Traditional camping, hunting and ceremonial grounds in most parts of the country have been modified or destroyed by extensive development from agricultural and urban growth. What sites do remain are not only more highly valued by the traditional owners, but also held in high esteem by non-Aboriginal peoples.

Access to Country and its resources is essential for the continuation of cultural practices, spiritual renewal and maintaining links with the land and caring for Country. Under NSW and Australian law, Aboriginal sites are required to be protected and conserved for the future. The NSW Government has also committed to transfer certain areas of state forest, including Werai Forest in the west of the NSW Murray catchment, to an Aboriginal landholding body for management by the Aboriginal community (NRC 2011). Several small grants of land have also

been made in the NSW Murray catchment through the Indigenous Land Council. Across the NSW Murray catchment, however, there is very little access to identified Aboriginal-owned or managed land. This increases the importance of traditional owner access to public lands for cultural purposes, including management.



Scar tree (top), wheat field, cropping
Photos: Harvey Johnston, Bill Bott, Natasha Lappin



Figure A Asset identification workshop, Jerilderie, 2010

Table A Participation in the NSW Murray Biodiversity Management Plan community workshops

Type	Number of workshops/ interviews/panels	Total assets identified
Aboriginal workshop	2	38
Community workshop	9	250
Expert panel	3	119
Expert interview	6 interview opportunities (some individual, some with small groups)	77
Total		484

In June and July 2010, Murray CMA held a series of workshops to allow the catchment community to identify key assets and areas of high value in the NSW Murray catchment. These included riverine, cultural and terrestrial biodiversity assets. Workshops were held in Albury, Corowa, Deniliquin, Holbrook, Jerilderie (Figure A), Tocumwal, Tooleybuc, Tumbarumba and Urana. Aboriginal community workshops were held in Albury and Deniliquin. A total of 154 people attended these workshops.

Additional assets were identified through three expert panels, which included participation by the Murray BMP Steering Committee, and interviews with individual experts and small groups of experts. These are shown in Table A; Appendices 2.2–2.4 describe the workshops and outcomes in more detail.

Most participants at the community workshops described themselves as farmers or landholders. Urban residents also attended most workshops (RDC 2010). Participants in the community workshops identified a total of 250 assets in the NSW Murray catchment. Appendix 2.4 describes the biodiversity assets identified from the community workshops, expert panels and interviews. The information has been modified to protect privacy.

Participants at the Aboriginal consultation workshops identified assets with cultural or spiritual significance to Aboriginal people. In both Aboriginal workshops, participants noted that biodiversity assets were inseparable from cultural assets. In total, almost 500 biodiversity assets were identified in the various workshops (summarised in Figure B).

Almost half of the nominated assets related to remnant native vegetation and its habitat value. The reasons for this were not explored with workshop participants. However, most people gave anecdotal information about the sites they nominated, including comments such as ‘It’s a good patch of bush’, ‘It’s the only bit of bush left around there’, and ‘That bit there, it’s always full of birds’. The second most frequently identified asset type was rivers and creeks, followed by cultural assets and wetlands. Other important assets included significant species such as endangered spider orchids, bush foods, wallabies, plovers, echidnas, turtles, plains-wanderers and superb parrots.

Participants were also asked to identify threats to the assets they had nominated, where possible. Of the 460 threats that were identified, the most common were terrestrial weeds, flow regulation of watercourses, pest animals and grazing.

Several assets were identified that were not specifically related to biodiversity (e.g. Wymah Reserve near Albury, which was nominated as an important gathering point). However, most sites that were nominated as important cultural sites (such as ‘the only place where catfish can be caught’) are potentially also important for their biodiversity values, and may be excellent sites for establishing projects to improve natural assets.

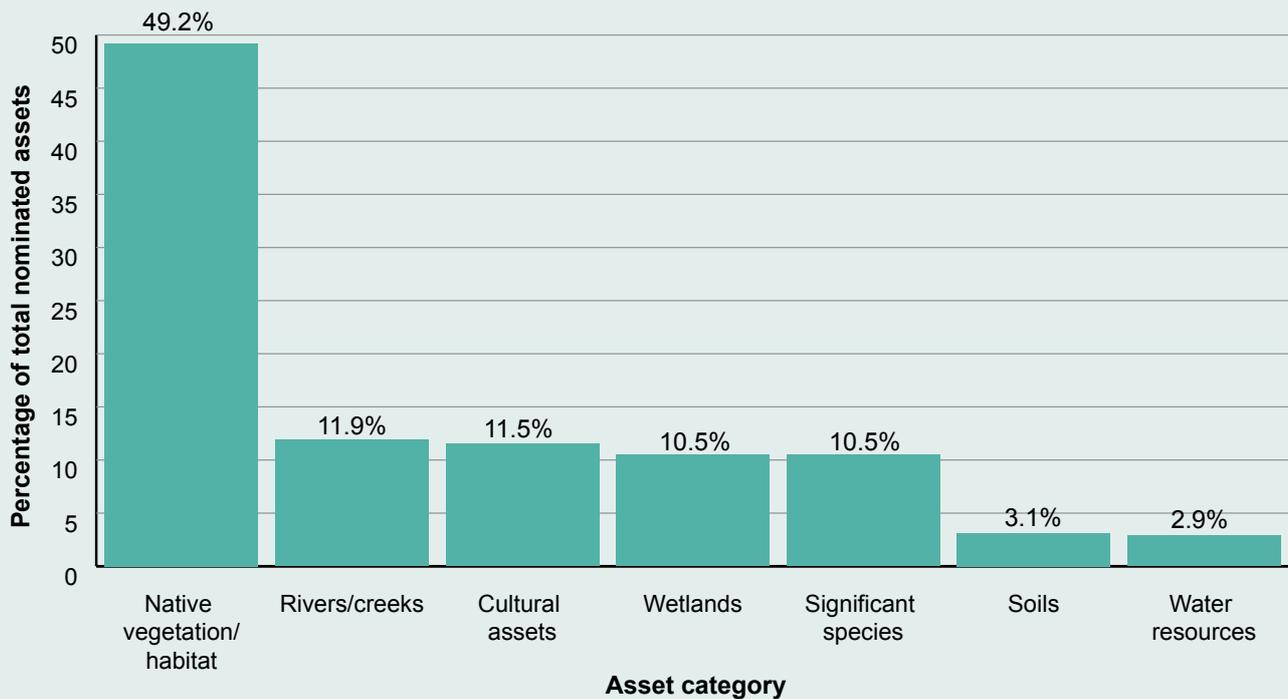


Figure B Assets in the NSW Murray catchment, summarised by category (per cent of total nominated assets)

Figure C shows the geographic spread of assets nominated by workshop participants. Most identified assets were close to the towns where workshops were held, and to the road and river networks. Murray CMA has more specific information on asset location; Appendix 2.4 has further information about individual nominated assets.

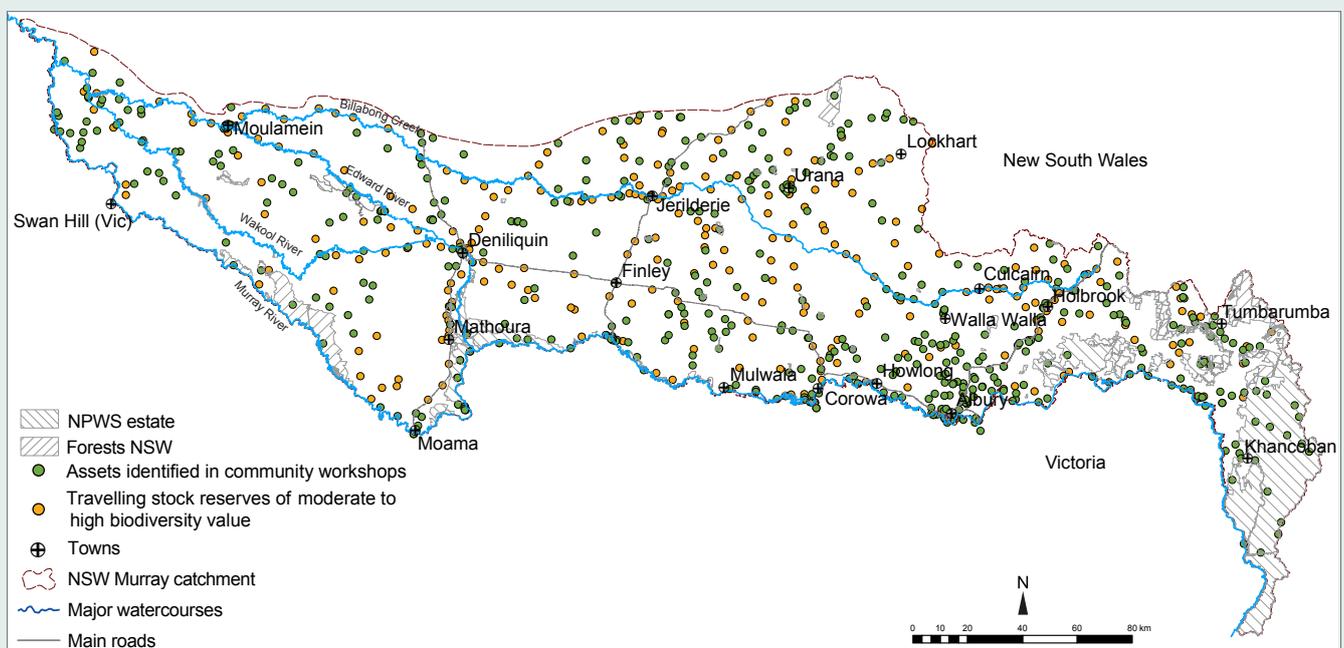


Figure C Point map of biodiversity assets nominated in community and Aboriginal asset identification workshops, panels and interviews

Additional information is provided in Appendices 2.2–2.4.

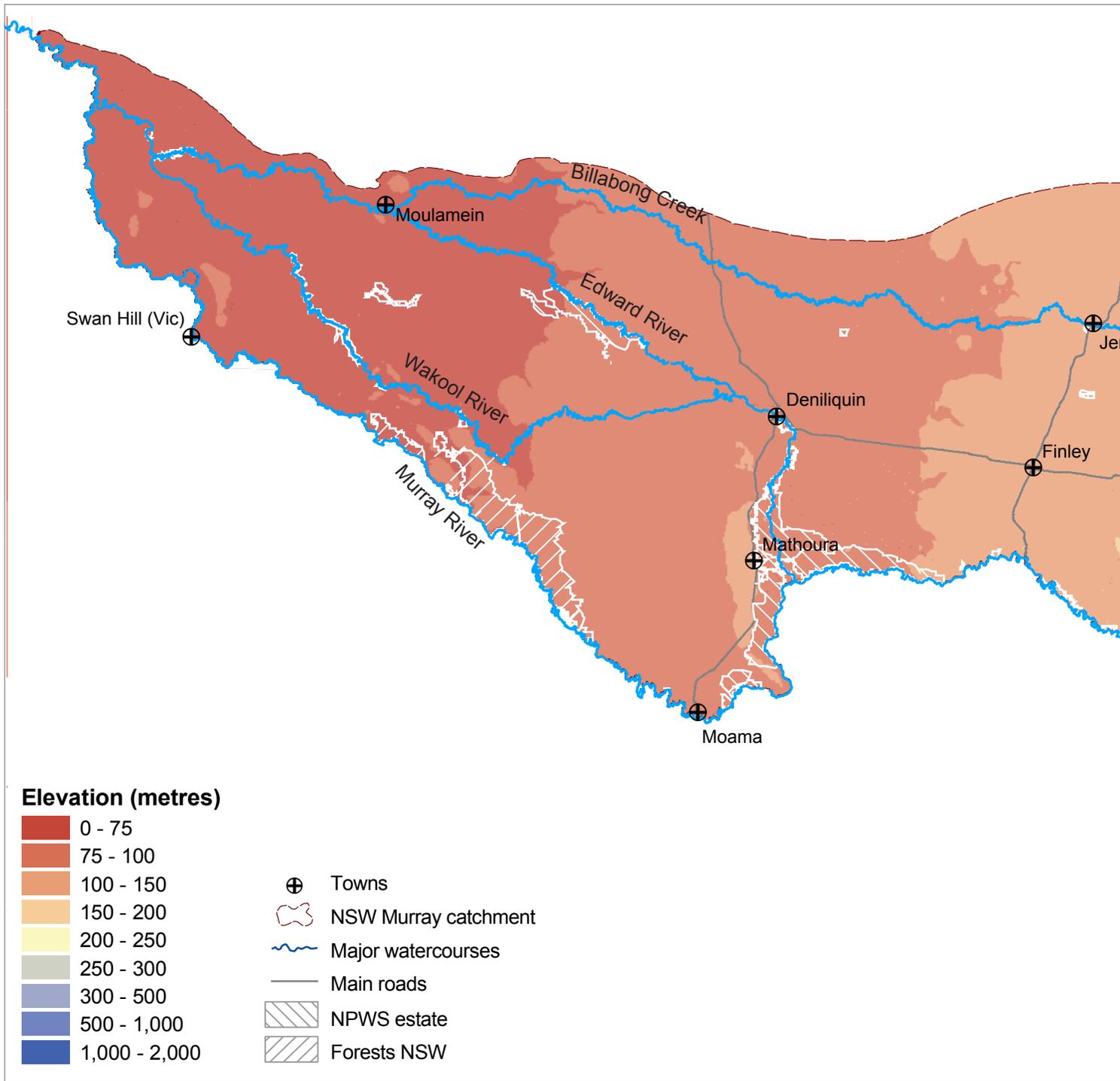


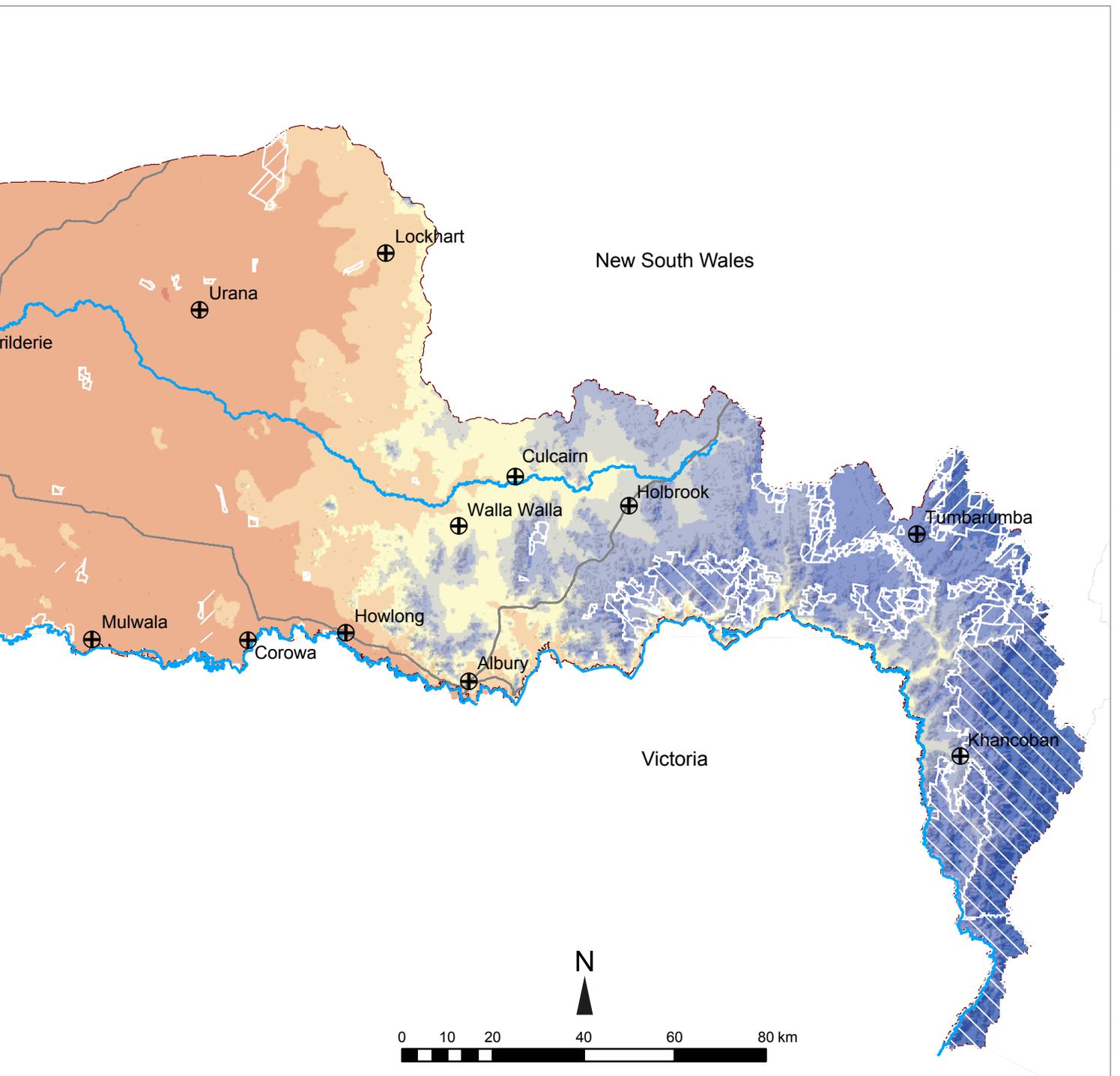
Figure 2.1 Elevation map of the NSW Murray catchment

2.2 Landscapes and bioregions

The NSW Murray catchment covers 3,517,000 hectares (35,170 square kilometres). It extends from the Australian Alps mountain range in the east to where the Murray and Murrumbidgee rivers meet in the west. This represents an elevation gradient of greater than 2000 metres above sea level in the

east to around 70 metres above sea level in the west (Figure 2.1).

The Interim Biogeographic Regionalisation for Australia maps large, geographically distinct areas of similar climate, geology, landform, vegetation and animal communities (Environment Australia 2000). Five bioregions have been identified in the NSW



Murray catchment (DEWHA 2008) (Figure 2.2, Table 2.1).

The Australian Alps bioregion runs along the eastern edge of the NSW Murray catchment and constitutes the highest section of the Great Dividing Range. The landscape is characterised by peaked ranges supporting herbfield and heathland communities

more than 1850 metres above sea level; broad, forested subalpine and montane valleys between 1850 and 1100 metres above sea level and interspersed with tableland woodlands less than 1100 metres above sea level (NPWS 2003). It includes Mount Kosciuszko at 2228 metres and the Kosciuszko National Park.

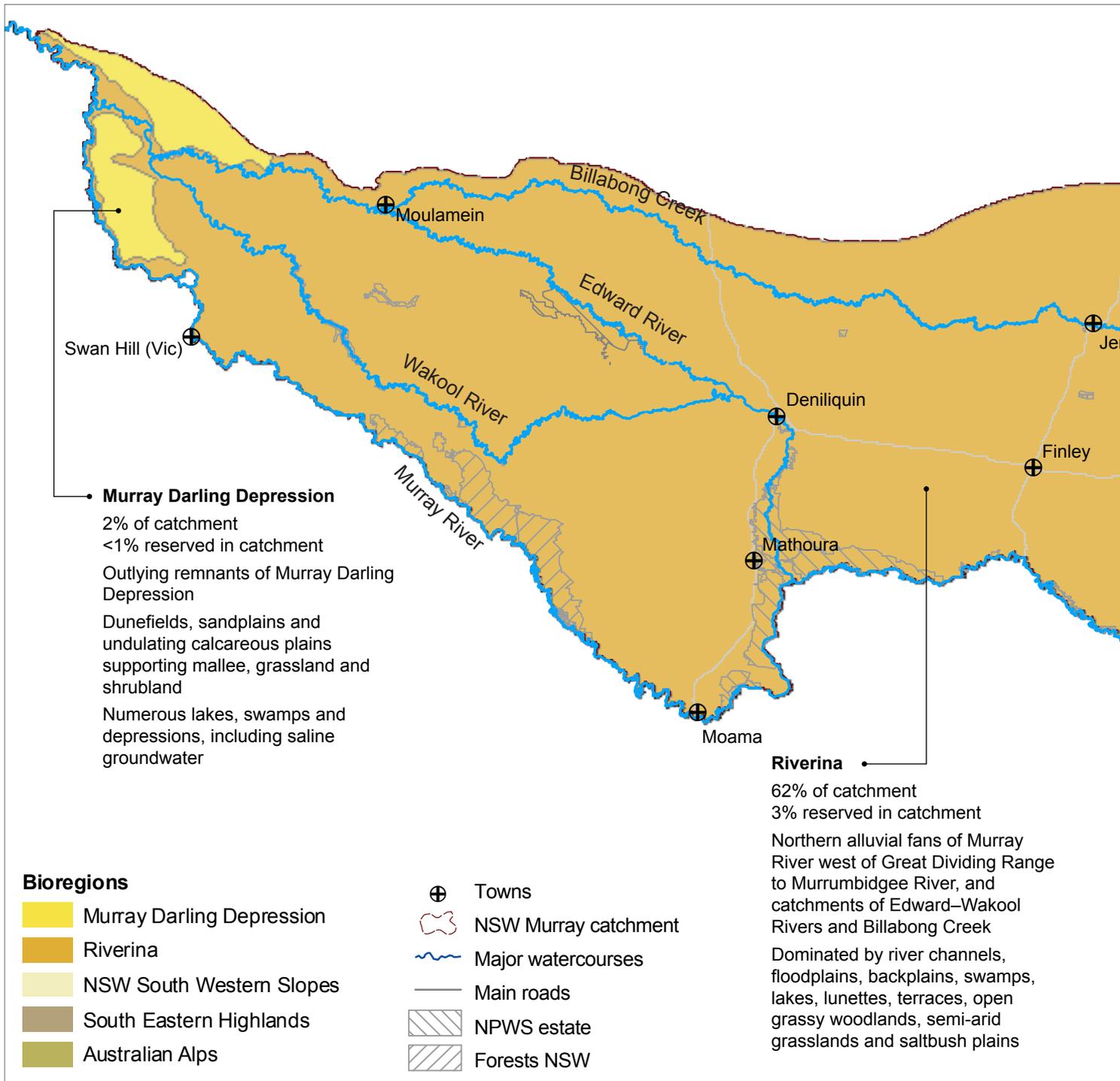
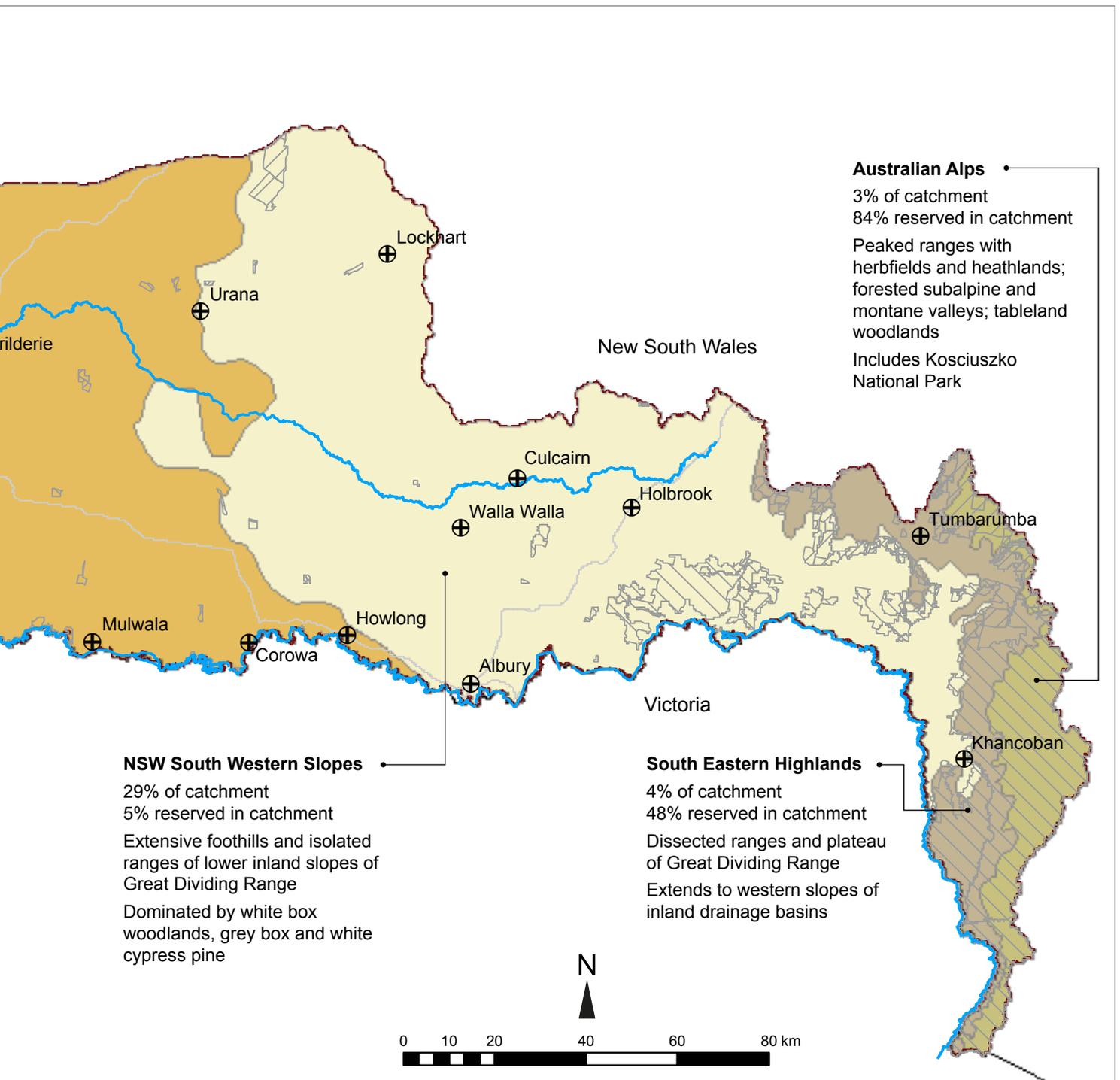


Figure 2.2 Interim Biogeographic Regionalisation for Australia bioregions in the NSW Murray catchment

The South Eastern Highlands bioregion is bordered to the east by the Australian Alps. The region covers the dissected ranges and plateau of the Great Dividing Range that is topographically lower than the Australian Alps and, in the Murray region, extends to the western slopes of the inland drainage basins (NPWS 2003).

The NSW South Western Slopes bioregion is an extensive area of foothills and isolated ranges comprising the lower inland slopes of the Great Dividing Range and includes Woomargama National Park. In the eastern hill country, woodlands of white box (*Eucalyptus albens*) are dominant. To the west and north, vegetation communities may be dominated by



grey box (*Eucalyptus microcarpa*) and white cypress pine (*Callitris glaucophylla*) (NPWS 2003).

The Riverina bioregion of the NSW Murray catchment takes in the northern alluvial fans of the Murray River west of the Great Dividing Range to its junction with the Murrumbidgee River near Swan Hill, and most of the catchments of the Edward–Wakool Rivers and Billabong Creek systems (MCMA 2006b). This

bioregion is dominated by river channels, floodplains, backplains, swamps, lakes, lunettes, terraces, open grassy woodlands, semi-arid grasslands and saltbush plains (NPWS 2003). Although relatively poorly reserved in NSW, a large proportion of river red gum forests in this bioregion is now protected within the Murray Valley National Park.

Table 2.1 Percentage of the NSW Murray catchment in each bioregion and the percentage of each bioregion located within conservation reserves across the catchment

Bioregion	Area of bioregion in catchment (ha)	% of catchment	% of bioregion reserved in catchment	% of bioregion reserved in NSW
Australian Alps	108,423	3	84	82
South Eastern Highlands	153,706	4	48	15
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

Note: Reservation calculations refer to National Parks and Wildlife Service estate

Outlying remnants of the Murray Darling Depression bioregion encroach into the western ‘tail’ of the NSW Murray catchment. This landscape is characterised by dunefields, sandplains and undulating plains of brown calcareous soils that support mallee, grassland and shrubland vegetation. The area has very little structured drainage, but numerous lakes, swamps and depressions are present, some of which are driven by saline groundwater (NPWS 2003).

2.3 Physical features

The NSW Murray catchment forms part of the Murray Basin, which covers 30 million hectares (300,000 square kilometres) of south-eastern Australia. The Murray Basin is bounded by the Great Dividing Range in the south and east, the Mount Lofty Ranges in the west and the low divide separating it from the Great Artesian Basin in the north. The climate is cool temperate in the elevated east, while the west is semi-arid with high temperatures and evaporation rates that exceed rainfall. Within Murray CMA, annual average ranges from 1600 mm in the Alps to 700 mm at Albury, and 323 mm west of Moulamein (Figure 2.3).

The diversity of soils in the NSW Murray catchment reflects the large variation in climate, parent material and changing relief from the mountain ranges in the east to the plains of the west. Further details of the geology, soils and climate of the catchment are discussed in Appendix 2.5.



Billabong Creek (left), Morgan’s Lookout
Photos: David Parker

2.4 Rivers and wetlands

The NSW Murray catchment contains approximately 22,500 kilometres of watercourses. These waterways and their associated riverine environments are some of the most significant natural areas in the catchment. In particular, the Murray River—including its associated anabranches, floodplains and wetlands—is a natural resource of regional, state and national significance. The Murray River is also an essential part of the economy, history, folklore and Indigenous culture of the NSW Murray catchment.

Major rivers and creeks in the NSW Murray catchment and adjacent areas are shown in Figure 2.4. Further discussion of the major watercourses is provided in Appendix 2.6.

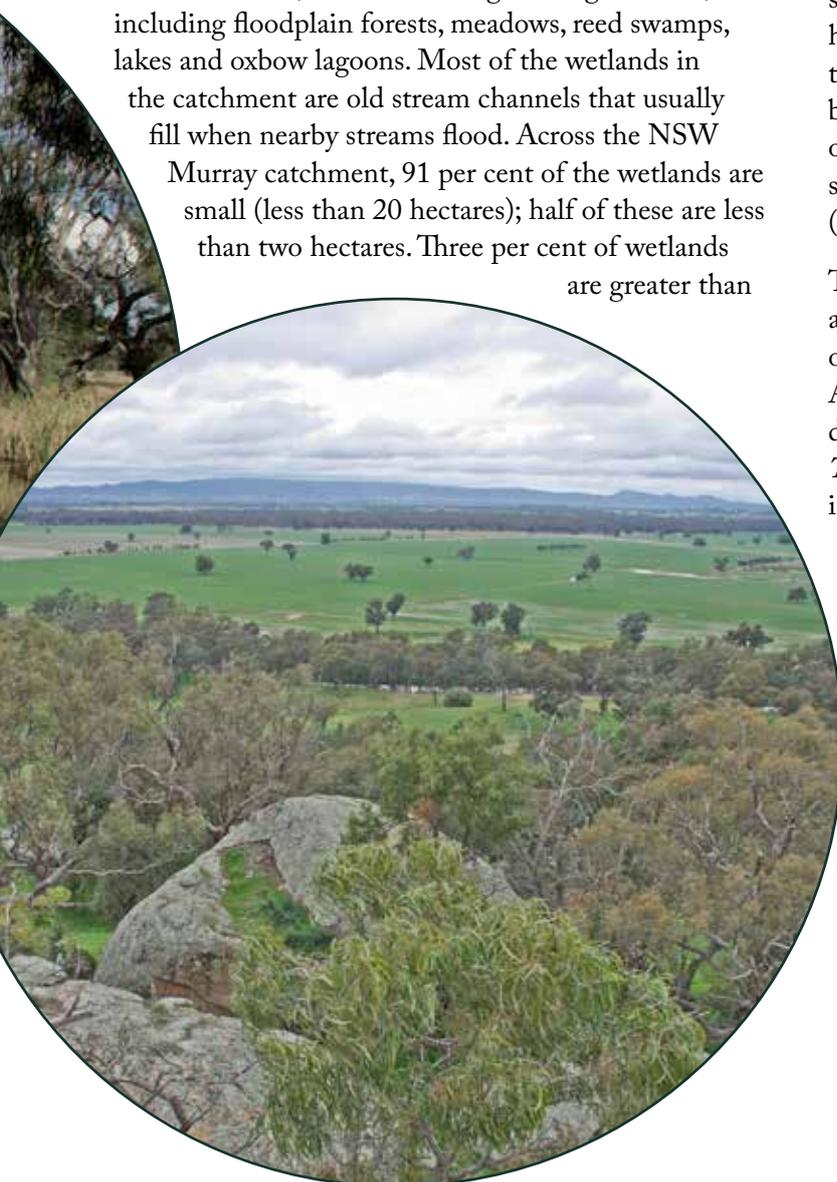
The NSW Murray catchment supports wetlands of international, national and regional significance, including floodplain forests, meadows, reed swamps, lakes and oxbow lagoons. Most of the wetlands in the catchment are old stream channels that usually fill when nearby streams flood. Across the NSW Murray catchment, 91 per cent of the wetlands are small (less than 20 hectares); half of these are less than two hectares. Three per cent of wetlands are greater than

50 hectares and one per cent is greater than 100 hectares (Bowen 2010). One-third of the wetlands in the NSW Murray catchment have been cleared of their native vegetation and only two per cent are considered to be in a near-pristine state (Bowen 2010).

Of particular significance in the NSW Murray catchment are two large floodplains that span the Victoria and New South Wales border: the Barmah–Millewa Forest (66,000 hectares) and the Gunbower–Koondrook–Perricoota Forests (50,000 hectares). Both these sites are listed as icon sites under the Living Murray initiative, and as Wetlands of International Importance under the Ramsar Convention (Bowen 2010). Werai Forest is also listed as a Ramsar site. These large wetlands influence the Murray River's hydrology, by mitigating floods; water quality, by depositing sediment; and health, by providing organic carbon and invertebrates. The wetlands regularly support 20,000 or more waterbirds, and provide a habitat network for at least eight species of globally threatened fauna and 13 species listed in migratory bird agreements with Japan, China and the Republic of Korea (see Appendix 5.4). The wetlands also contain significant social, cultural and economic resources (MCMA 2006b).

The Wanganella Swamp system is the largest wetland area on Forest Creek. It has records of 64 species of waterbirds, including breeding records of brolga, Australasian bittern, painted snipe and blue-billed duck, which are listed as vulnerable under the *Threatened Species Conservation Act 1995* (NSW). More information on important wetlands can be found in Chapter 5.

Wetlands of the Murray catchment (Bowen 2010, known as the wetlands inventory) maps the wetlands listed under the Directory of Important Wetlands of Australia, the Ramsar Convention on Wetlands and the Living Murray river restoration initiative. Other wetland systems in the catchment have been mapped by Kingsford et al. (2003).



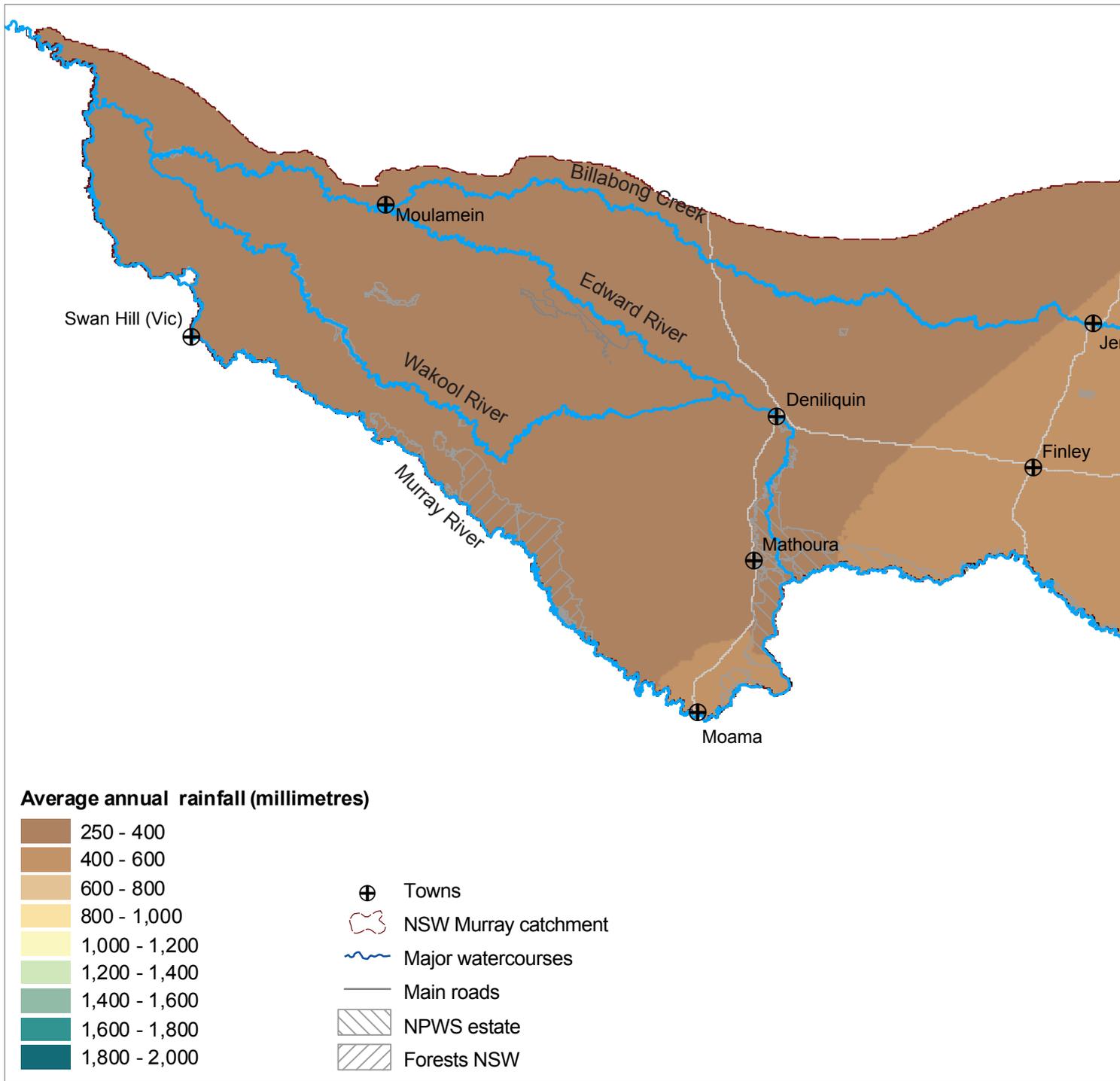
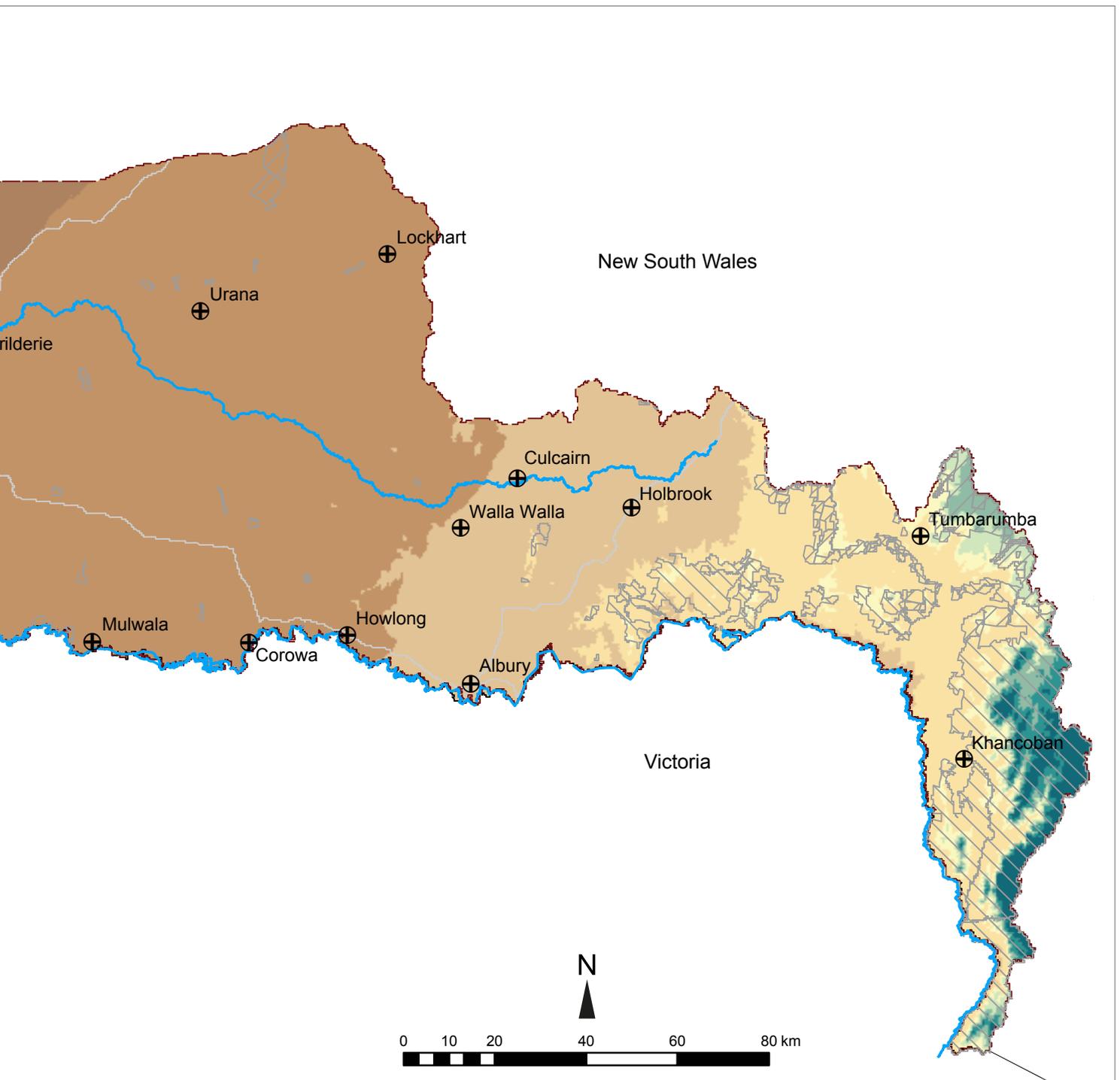


Figure 2.3 Average annual rainfall in the NSW Murray catchment

2.5 Vegetation

Vegetation communities in the NSW Murray catchment broadly reflect the altitude, available moisture and landform gradients across the catchment (Roff et al. 2010a,b). Some of these gradients can be steep. For example, plant species limited to alpine and montane conditions dominate in the east, but

are replaced by other species over a relatively short distance within the South Eastern Highlands or the upper NSW South Western Slopes bioregion, depending on the individual species. Other changes in vegetation composition occur between the lower NSW South Western Slopes and the Riverina bioregions, and between the Riverina and the Murray–Darling Depression. The NSW South Western Slopes has its own characteristic species, but also mixes with species



more characteristic of the South Eastern Highlands (higher altitudes and more moisture) and the Riverina (lower altitudes and drier).

At the local level, vegetation communities are influenced by the underlying substrates (geology and soils). Some vegetation communities are only found on particular types of soils or geological formations; for example, the tall open forest community of

broad-leaved peppermint (*Eucalyptus dives*), Norton's box (*Eucalyptus nortonii*) and red stringybark (*Eucalyptus macrorhyncha*) is found only on red clay on hills. The effects of land management history can be seen in the landscapes of the central and western catchment. Historical and ongoing land clearing has led to changes in vegetation, such as grasslands and areas of scattered trees replacing forest and woodland.



Figure 2.4 Major waterways in and adjacent to the NSW Murray catchment



2.5.1 Mapping and modelling

Vegetation maps and models were a critical input to the Murray BMP. This section gives a brief outline of the methods used; detailed information can be found in the appendices to this chapter.

In 2010, OEH released a fine-scale vegetation map of the NSW Murray catchment that used recognition software to separate vegetation at the stand scale, combining spatial modelling and visual interpretation (Roff et al. 2010a, Appendix 2.7). This approach was used to map the catchment west of Albury and used the NSW Vegetation Classification and Assessment (NSWVCA) classification (Benson 2006, 2008 and Benson et al. 2010).

Mapping for the area east of Albury, including the Australian Alps, used data prepared for the Comprehensive Regional Assessment in 2000, which was updated in 2005 (Gellie 2005). The eastern mapping used a different vegetation classification to the NSWVCA. In the Murray BMP, these are referred to as 'eastern types'.

A pre-clearing vegetation layer was modelled in a separate process to determine the vegetation classes with the highest probability of occurrence at each cell before clearing (described in Appendix 2.8). This model was specifically used for the development of the Biodiversity Forecasting Tool priority investment maps (see Chapter 4).

2.5.2 Vegetation formations

Vegetation in the NSW Murray catchment was mapped at the scale of vegetation type, including 53 NSWVCA types (Benson 2006, 2008 and Benson et al. 2010) and 46 eastern types (Gellie 2005) (see Appendix 2.7 for the vegetation map at this scale and Appendix 2.9 for information about vegetation types). These vegetation types were also grouped by structure and appearance into vegetation formations, based on Keith (2004) (see Appendix 2.9). The NSW Murray catchment supports 11 of the 12 native vegetation formations in NSW; these are shown in Figure 2.5 and listed in Table 2.2. Appendix 2.9 describes the vegetation types included in each formation.

Alpine Complex vegetation comprises heathlands, herbfields, bogs and the uniquely alpine fjaeldmarks. The common features of the vegetation in this

formation are seasonal dormancy, snow tolerance, and dominance by small-leaved shrubs, herbs and tussock grasses. The Alpine Complex occurs at the highest elevations in the catchment. All of the current distribution of this formation in the catchment is reserved.

Wet Sclerophyll Forests are also known as tall open forests (Specht 1970). They have a tall straight-trunked eucalypt canopy with either a shrubby or grassy understorey. Shrubs generally have broad soft leaves (mesophyllous). The more open understorey of the grassy subformation reflects the slightly drier habitats and a transition towards Grassy Woodland and Dry Sclerophyll Forest. In the NSW Murray catchment, these forests occur on the western extensions of the Great Divide, in the Australian Alps and South Eastern Highlands bioregions. More than 70 per cent of the current distribution of this formation in the catchment is reserved.

Rainforests have a closed and continuous tree canopy of soft, horizontal leaves. They occur in reliably moist and fertile areas that are protected from fire. They are very diverse, but generally lack eucalypts. Although a very small amount of Cool Temperate Rainforest was mapped in the east of the catchment, at the scale of mapping the area is very small, so this formation has been included as Wet Sclerophyll Forest.

Dry Sclerophyll Forests encompass a diverse range of vegetation and occur in a wide range of habitats, generally on infertile soils. Canopy species are commonly eucalypts. Two subformations reflect a difference in the understorey: shrubby or shrub/grass. Understorey shrubs are largely hard-leaved (sclerophyllous). The shrub/grass Dry Sclerophyll Forests form a transition between the Grassy Woodlands and the shrubby subformation. In the NSW Murray catchment, this formation occurs mainly in the NSW South Western Slopes and South Eastern Highlands. Almost 50 per cent of the current distribution of this formation in the catchment is reserved.

Grassy Woodlands are dominated by widely spaced eucalypts—typically boxes and red gums—and a diverse ground cover of grasses and herbs. They are the original vegetation of the wheat and sheep belt, extending from southern Queensland to central Victoria. Grassy Woodlands occur throughout the NSW Murray catchment. This formation is more than

Table 2.2 Area of each vegetation formation remaining and percentage reserved in the NSW Murray catchment, and percentage cleared in NSW and the Murray catchment

Vegetation formation	Area remaining in catchment (ha)	Percent of vegetation that has been cleared		Percent of remaining vegetation in reserves	
		in catchment ^a	in NSW ^b	in catchment	in NSW ^a
Forested Wetlands	219,216	30–50	30–70	24	<20
Arid Shrublands (chenopod subformation)	200,777	30–50	<30	<1	<10
Semi-arid Woodlands (grassy and shrubby subformations)	167,045	>50	10–>90	2	<10
Dry Sclerophyll Forests (shrub/grass and shrubby subformations)	151,695	30–70	30–70	48	<50
Grasslands	123,597	>90	10–>90	1	<10
Grassy Woodlands	115,418	>90	>70	53	<20
Wet Sclerophyll Forests	105,042	<30	<70	78	<50
Freshwater Wetlands	41,946	30–50	<30–70	4	<10
Alpine Complex	12,609	0	<10	100	~100
Heathlands	4,255	Not mapped ^c	<30	75	<70
Saline Wetlands	6	Not mapped ^c	<10	<1	<30

^a D. Keith pers. comm. 2012

^b Keith (2004)

^c These formations are not mapped in the NSW Murray catchment on the David Keith formation map

90 per cent cleared in the catchment. Of the current extent in the catchment, about 50 per cent is reserved.

Semi-arid Woodlands are quite widespread in the NSW Murray catchment, but poorly represented in the reserve system. Dominant trees are eucalypts, sheoaks, wattles or cypress pines, with drought-resistant shrubs and ephemeral grasses and herbs in the ground layer. There are two subformations with very different understoreys: the grassy subformation tends to occur on floodplains, while the shrubby subformation occurs on slightly more elevated areas. Only two per cent of the current distribution of this formation in the catchment is reserved.

Arid Shrublands have two distinctly different subformations: acacia and chenopod. Only the chenopod subformation occurs in the NSW Murray catchment. Chenopod shrublands are dominated by low shrubs such as saltbush, bluebush and copperburr, mostly less than 1.5 metres in height. Less than one per cent of the current distribution of this formation in the catchment is reserved.

Heathlands share many features of their ecology with the shrubby subformation of Dry Sclerophyll Forests, but are distinguished by a lack of trees, other than short mallee forms or occasional emergents. A small amount of Southern Montane Heath has been mapped in the higher-elevation, eastern catchment. More than 70 per cent of the current distribution of this formation in the catchment is reserved.

Grasslands are dominated by perennial tussock grasses with broad-leaved herbs in the inter-tussock spaces. They are characterised by a lack of woody plants and are widely distributed across NSW. In the NSW Murray catchment, Grasslands are mapped largely on the Riverine Plain. Only one per cent of the current distribution of this formation in the catchment is reserved. Temperate Montane Grasslands also occur in the South Eastern Highlands bioregion, though at the scale of mapping do not appear on Figure 2.5.

Forested Wetlands are freshwater wetlands dominated by trees, generally restricted to riverine corridors and floodplains subject to periodic inundation. In the

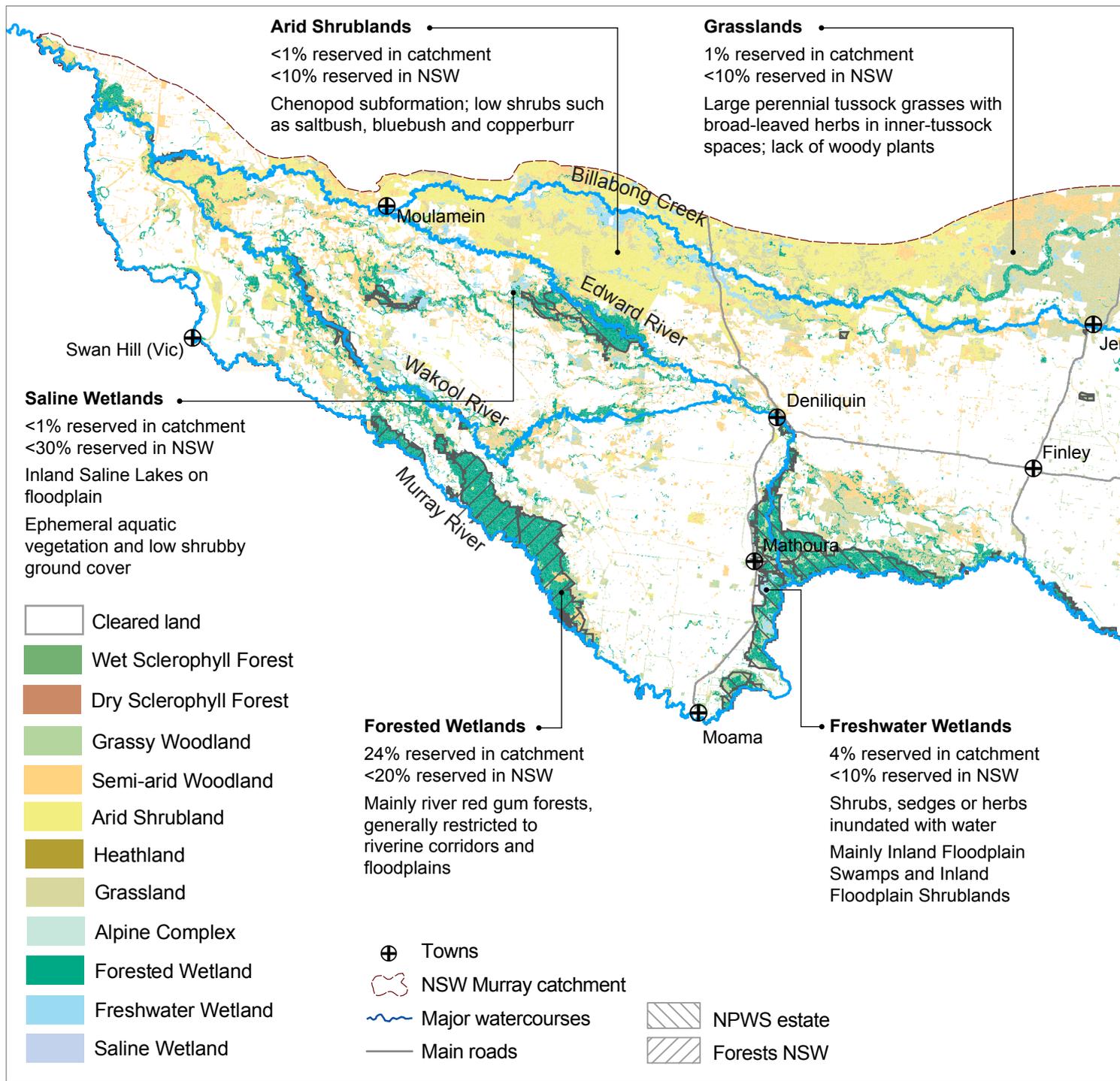
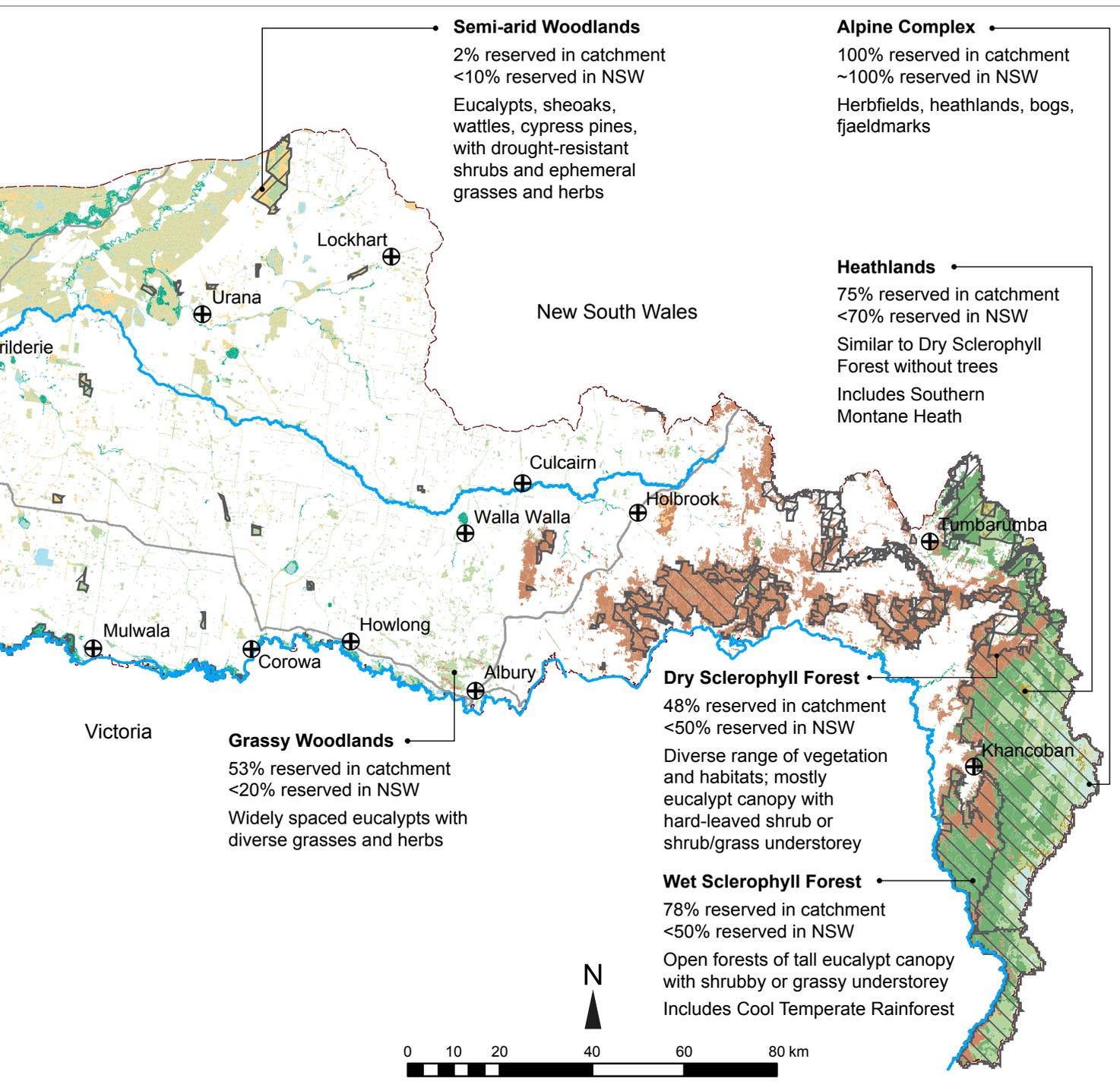


Figure 2.5 Native vegetation formations of the NSW Murray catchment

NSW Murray catchment, this is the most widespread vegetation formation, consisting mainly of river red gum forests. The river red gum forests of the Riverina are of national and international environmental significance, and the Millewa forest—together with the Barmah forest in Victoria—forms the largest river red gum forest in the world. Less than 30 per cent of the current distribution of this formation in the catchment is reserved.

Freshwater Wetlands are areas of vegetation dominated by shrubs, sedges or herbs, either permanently or temporarily inundated by water. In the NSW Murray catchment, this formation comprises mainly Inland Floodplain Swamps and Inland Floodplain Shrublands. Only four per cent of the current distribution of this formation in the catchment is reserved.



Saline Wetlands make up a tiny part of the NSW Murray catchment as Inland Saline Lakes on the Murray River floodplain. This is predominantly ephemeral aquatic vegetation and low shrubby ground cover, which occurs on the edge of lake beds and associated channels on heavy clays. Less than one per cent of the current distribution of this formation in the catchment is reserved.

Statewide clearing figures are available for each NSWVCA vegetation type (www.environment.nsw.gov.au/research/Vegetationinformationsystem.htm). Clearing figures are also available for the eastern vegetation types, but were calculated for the Comprehensive Regional Assessment study area of that project, which does not coincide with the entire NSW Murray catchment. It was considered

appropriate for the Murray BMP to use the clearing figures for vegetation formations drawing on both the grouped Roff et al. (2010a,b) types and the David Keith formation map.

Some of the figures in Table 2.2 come from David Keith's vegetation formation mapping (Keith 2004, D. Keith pers. comm. 2012): the percentage of remaining vegetation in reserves in NSW, the percentage cleared in the catchment, and the

percentage cleared in NSW. The Keith formation map does not show heathlands or saline wetlands within the NSW Murray catchment, because the mapping is at a broader scale than the Roff et al. (2010a) map prepared for the Murray BMP. The Roff et al. (2010a) vegetation type mapping, which is grouped into formations, provides the figures for the area of each formation remaining in the catchment and the percentage of each formation currently in reserves.

2.5.3 Vegetation condition

Vegetation condition is a measure of the cumulative impacts of pressures on vegetation, the ecosystem processes that support vegetation, and the indigenous fauna that interact with it (Oliver et al. 2010).

Pressures on vegetation include changes in land use and land management, invasion by exotic plant species and exotic pest animals, overabundant herbivores (native and exotic), and changes in fire regimes and climate. To monitor vegetation condition at the regional scale, it is important to know how these pressures affect vegetation condition at the local scale.

In 2010–11, the OEH collaborated with the Victorian Department of Sustainability and Environment to develop a series of vegetation condition maps across the NSW Murray catchment (Figure 2.6) and the adjoining Murrumbidgee CMA area (Oliver et al. 2010). These maps used existing vegetation plot data; new data from two key areas, the upper and western Murray (using approximately 330 plots); and new 'null' value sites (cleared or non-native vegetation sites with scores of zero for vegetation condition). These maps contributed significantly to the generation of priority Active Management and Repair maps in the Murray BMP (see Chapter 4). The vegetation condition map represents a snapshot in time and includes the condition of non-native vegetation as recognition that it still provides some biodiversity value. Appendix 2.10 includes further detail on the vegetation condition mapping.



Riverine Grassland
Photos: Damon Oliver

2.6 Land tenure and land use

The NSW Murray catchment supports a population of more than 100,000 people and includes a wide range of land tenures. Table 2.3 shows the major land tenures in the catchment.

It is clear from these data that private landholders are vital contributors to biodiversity management—more than 80 per cent of land in the NSW Murray catchment is classified as private freehold.

Table 2.3 Land tenure in the NSW Murray catchment

Land tenure		Number of units	Area (ha)	Area in catchment (%)
Private freehold			2,835,913	81
Leasehold		28	22,795	<1
Private conservation	Wildlife refuge	52	197,248	6
	In-perpetuity property vegetation plan	11	1,213	<1
	Murray CMA management agreement or fixed-term property vegetation plan	189	40,584	1
	Nature Conservation Trust covenant	17	4,207	<1
	OEH conservation agreement (formerly called Voluntary conservation agreement)	2	204	<1
National parks and wildlife estate	National park	4	234,858	7
	Declared wilderness	4	84,610	2
	Nature reserve	11	15,734	<1
	State conservation area	2	7,254	<1
	Aboriginal area	1	89	<1
	Historic site	439	unknown	unknown
	Regional park	1	9,471	<1
	Land vested in the minister (Part 11 of the NPW Act) for future Aboriginal management	5	21,489	<1
Forests NSW estate	State forest	21	131,622	4
	Flora reserve	12	7,827	<1
	Timber reserve	4	745	<1
NSW Crown lands	Crown reserve	5,157	85,557	2
	Travelling stock reserve	427	44,013	1
	Local government reserve	156	2,541	<1

NPW Act = *National Parks and Wildlife Act 1974* (NSW); OEH = NSW Office of Environment and Heritage

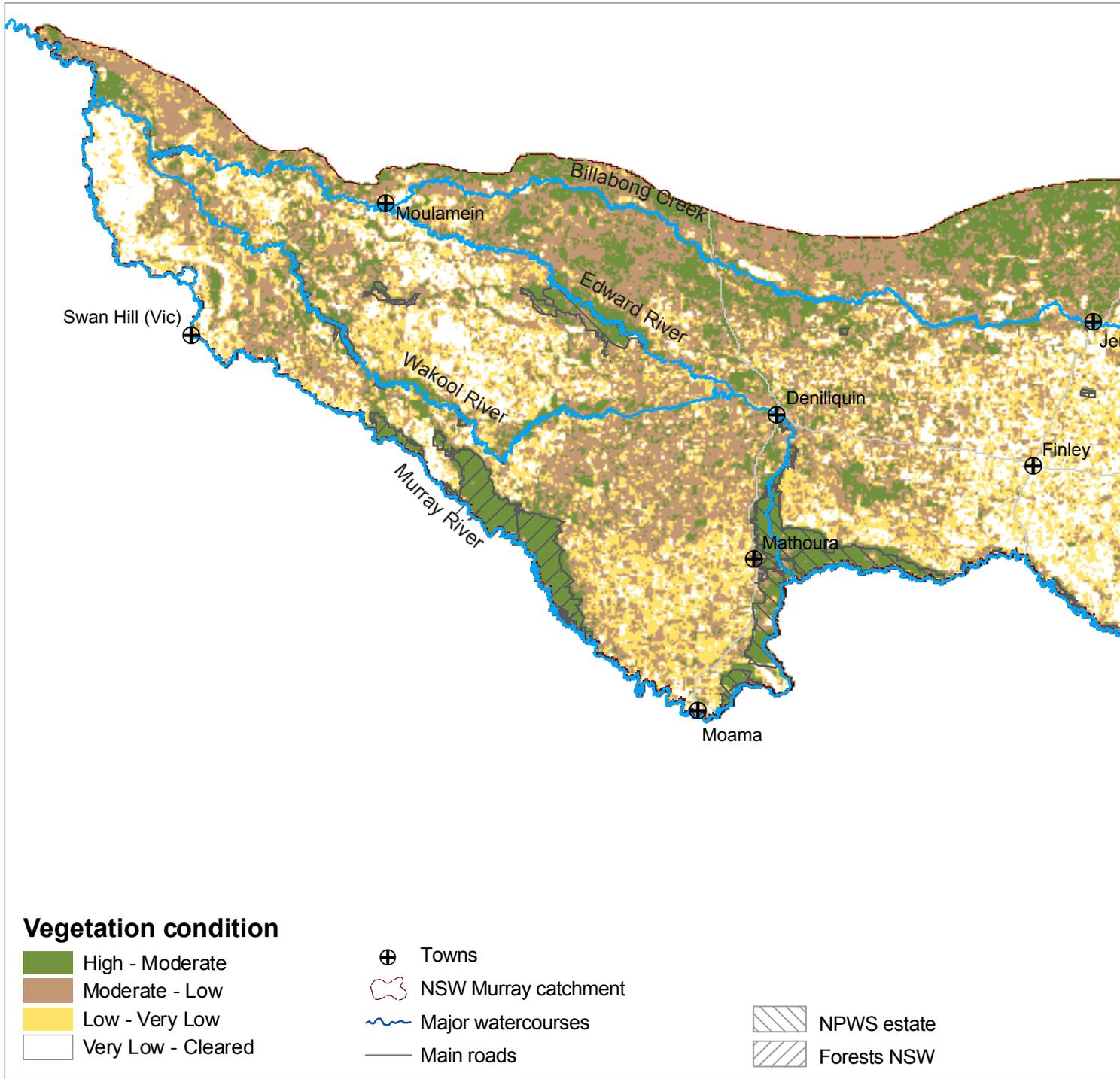
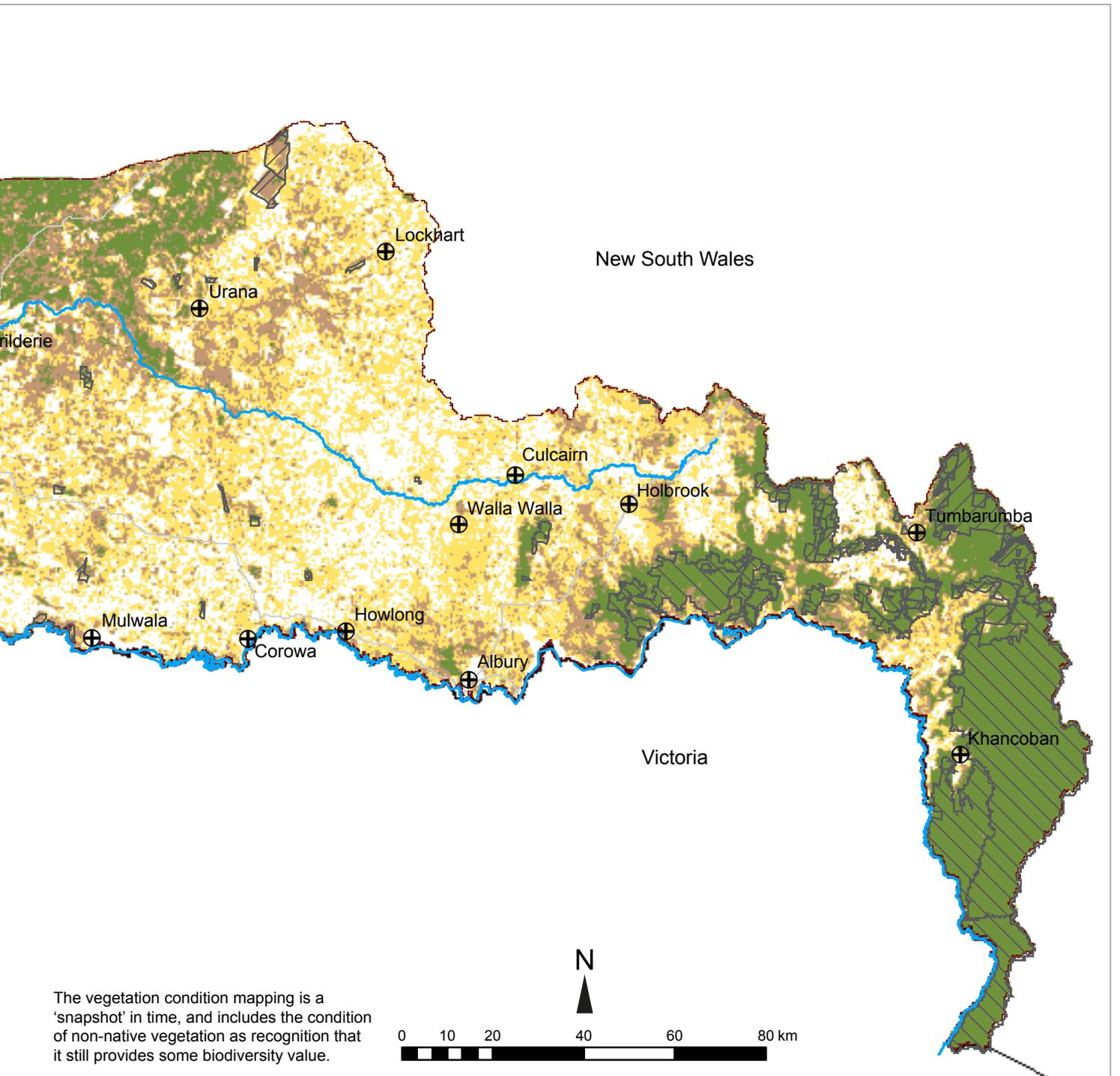


Figure 2.6 Combined vegetation condition map of the NSW Murray catchment

Agriculture on privately owned land, including grazing, dryland cropping, irrigation and horticulture, is the dominant land use in the NSW Murray catchment and is carried out on approximately 75 per cent of the land area. Figure 2.7 shows current land use in the catchment.

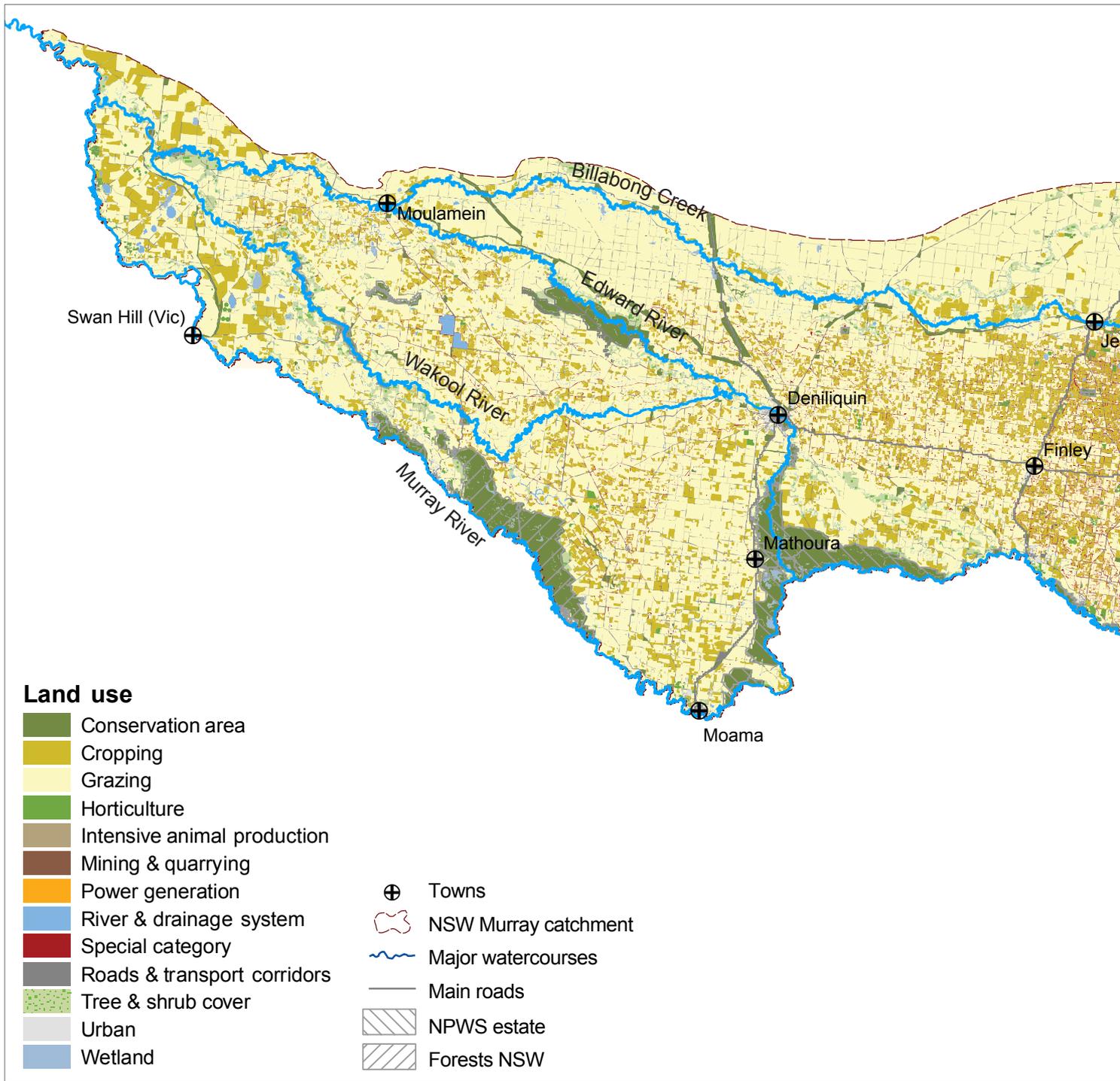
Public land in and adjacent to the catchment is mapped in Figure 2.8. Public land managed specifically for conservation includes four national parks (Kosciuszko, Woomargama, Benambra and Murray Valley), one regional park and 11 nature reserves managed by the National Parks and Wildlife Service (NPWS), and more than 5000 flora reserves and



Crown reserves managed by the NSW Department of Primary Industries Forests and Crown Lands divisions.

The National Park Estate (Riverina Red Gum Reservations) Bill 2010 vests the Werai group of forests in the minister administering the *National Parks and Wildlife Act 1974* (NSW), under Part 11 of that Act, from 1 July 2010. Following negotiations with the Aboriginal community, these forests will be

vested in an appropriate Aboriginal organisation for conservation management. The Bill makes it clear that these lands can be divested for purposes that go beyond the objects of the National Parks and Wildlife Act. This will allow Aboriginal communities to engage in ecologically sustainable commercial activities that will help to support the land's contribution to the National Reserve System.

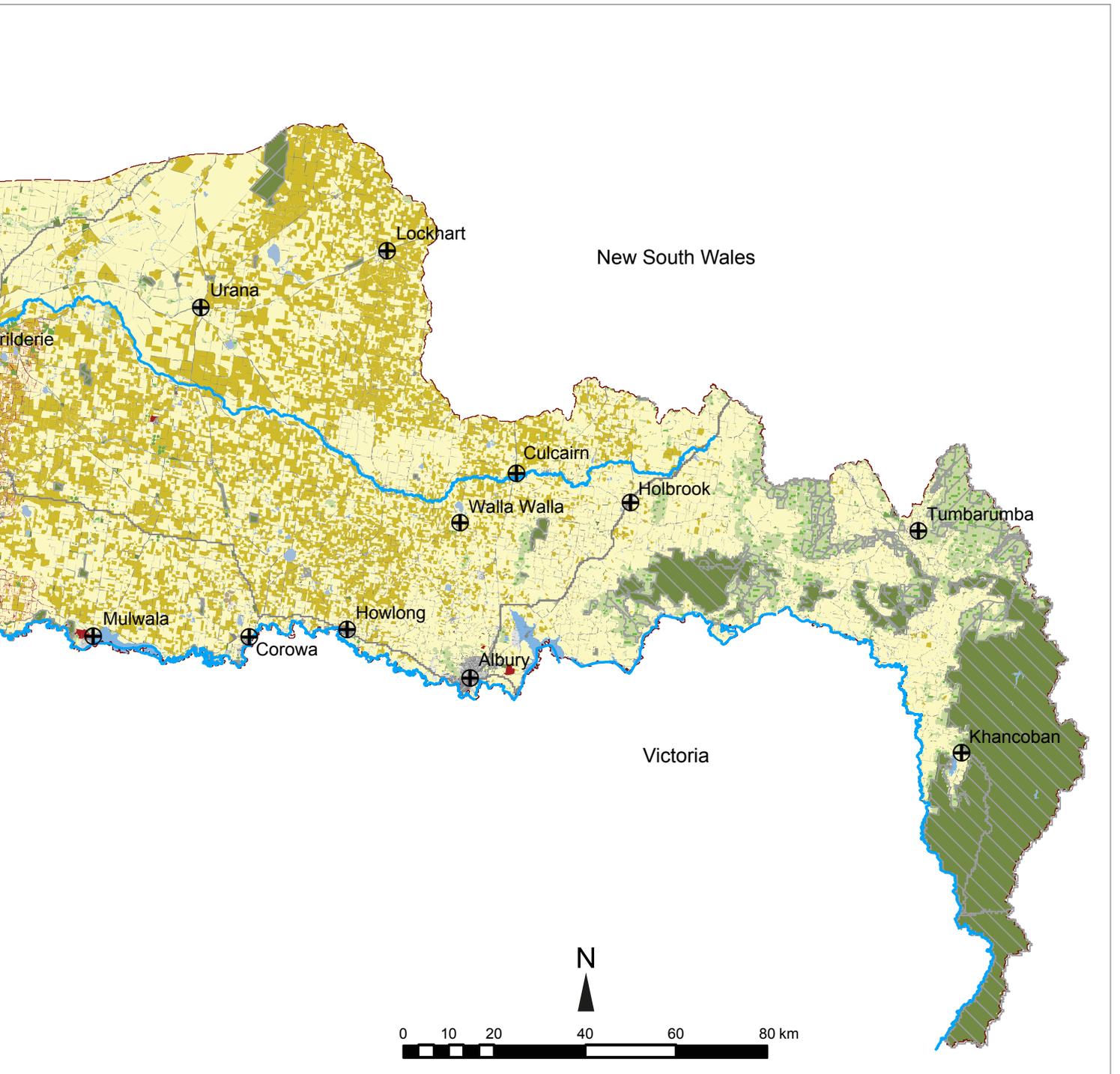


Note: Forestry (predominantly from plantations and some native forests) is also extensively practised on both Crown and private lands.

Figure 2.7 Land use in the NSW Murray catchment

In Figure 2.8, these lands are mapped as NPWS estate because they are currently managed by NPWS; they include the former Banangalite, Barratta Creek, Morago, Stevens Weir and Werai state forests. These are shown in detail in Figure 2.9.

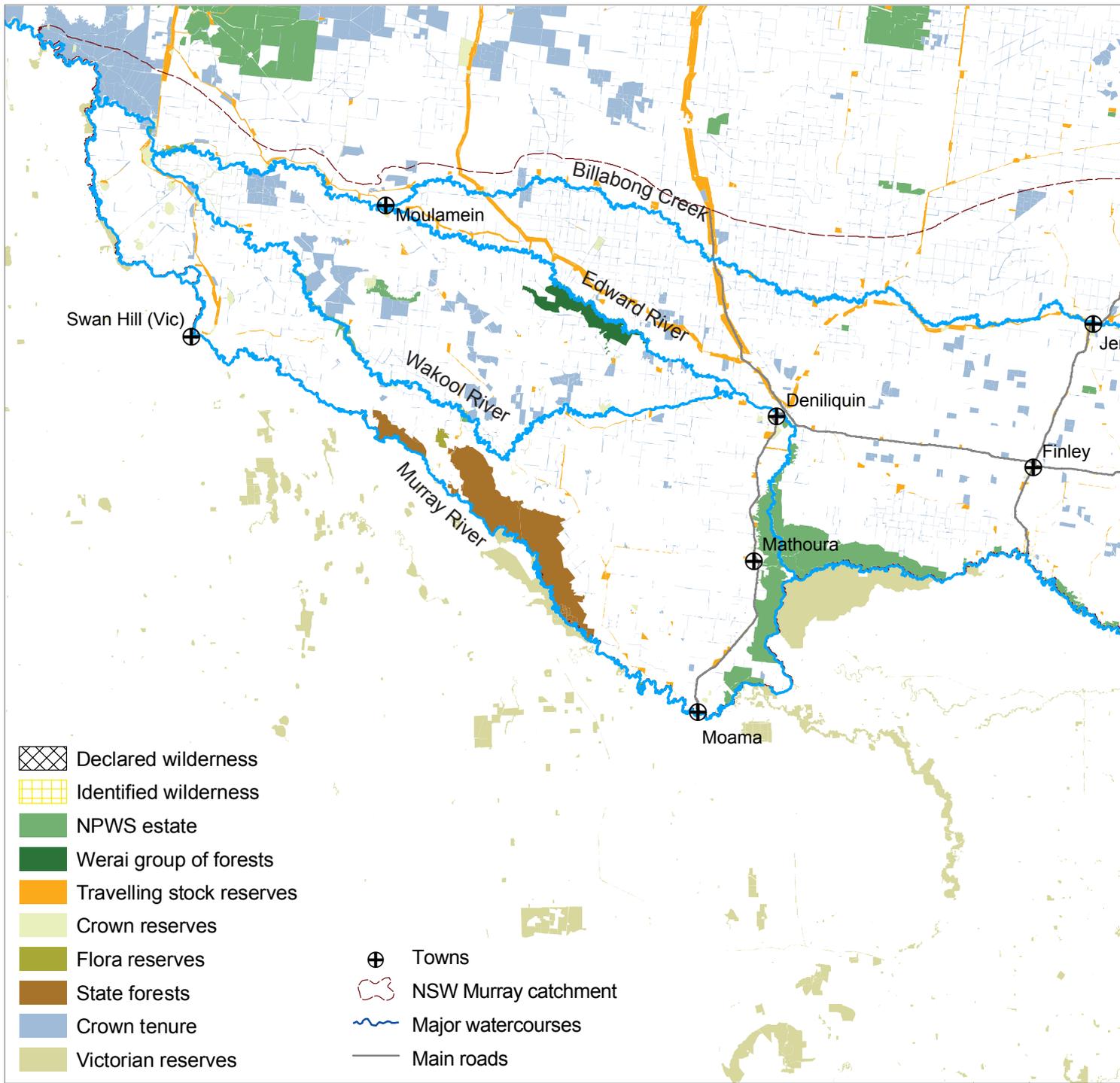
Other managers of public land that supports native vegetation include local government (e.g. commons and roadside reserves), Livestock Health and Pest Authorities (travelling stock reserves), RailCorp (rail corridors), the Roads and Maritime Services (some roadside reserves), Landcare and other community groups (some Crown lands).



2.7 Historical investment in biodiversity management

There is a long history of people being involved in biodiversity conservation and restoration in the NSW Murray catchment. At a national level, environmental issues (particularly salinity) became more broadly

acknowledged and accepted in the 1980s. Landcare groups including West Hume, Green Gully and Holbrook were established in the late 1980s and early 1990s. This period was characterised by an interest in revegetation of cleared areas ('greenfield plantings'), with many small private landholder and community group projects funded through Greening Australia's



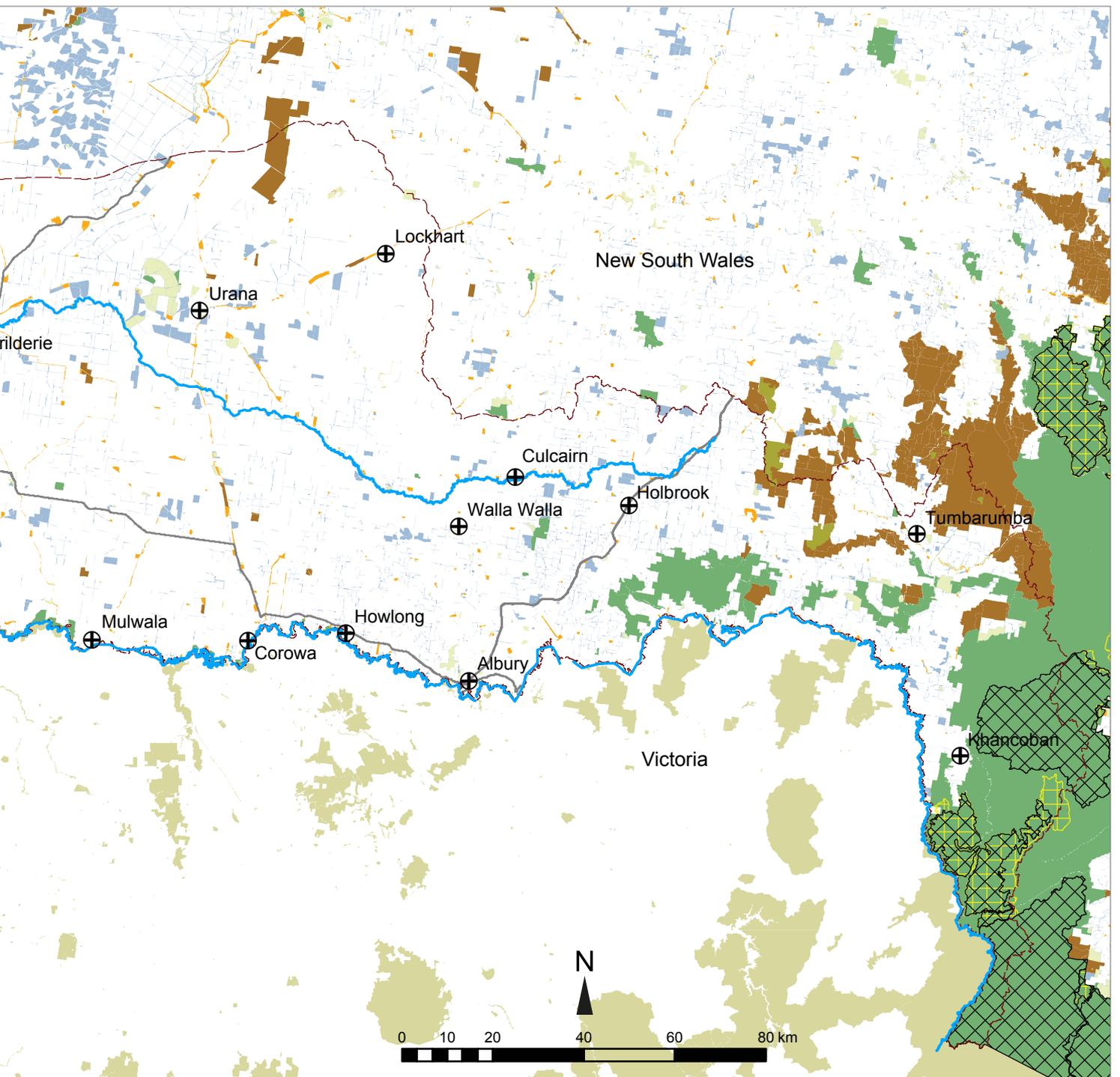
NPW Act = *National Parks and Wildlife Act 1974* (NSW); NPWS = National Parks and Wildlife Service

Note: The Werai group of forests are vested in the minister under Part 11 of the NPW Act

Figure 2.8 Public land in the NSW Murray catchment and surrounds

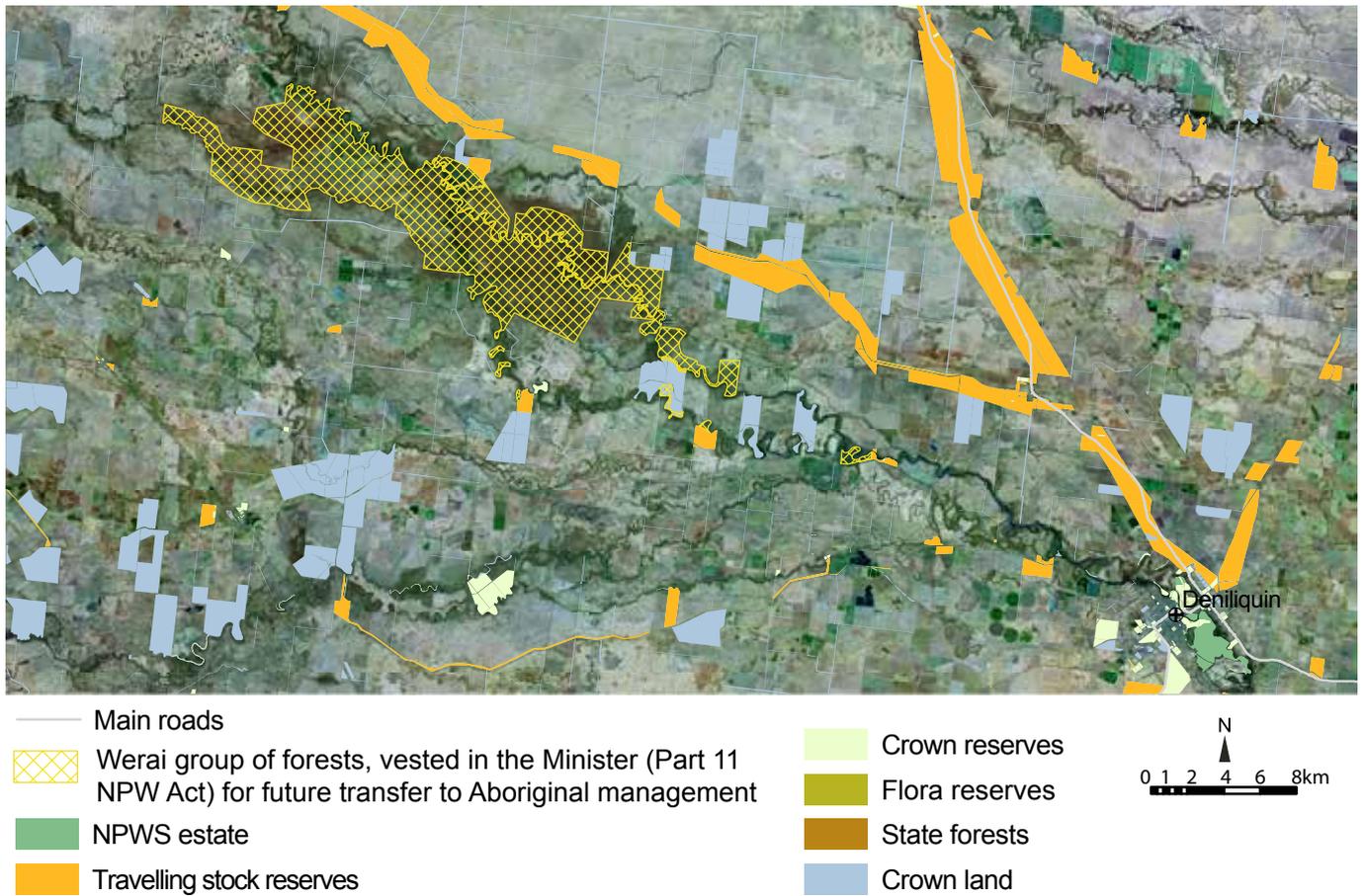
‘One Billion Trees’ program. Greening Australia also initiated a seed bank and associated direct-seeding practice, and encouraged cell propagation, the collection and use of locally native seed, and the improved management of remnant native vegetation.

In the mid-1990s, increased funding from the Australian Government and the NSW Government (e.g. Natural Heritage Trust, National Action Plan for Salinity and Water Quality, National Landcare Program) combined with more strategic natural resource management planning and implementation



(e.g. Land and Water Management Plans, Sub-catchment and Property Planning) to increase the scale of native vegetation works. More recently, funding from government investors (notably the Australian Government’s Caring for our Country initiative) has focused on improving management of

remnant native vegetation, with funding delivered through multi-partner projects and regionally through catchment management authorities. Through extension programs with passionate wildlife ecologists during the late 1990s and early 2000s, the people of the Murray catchment have gained a greater appreciation of the



NPW Act = *National Parks and Wildlife Act 1974* (NSW); NPWS = National Parks and Wildlife Service

Figure 2.9 The Werai group of forests, vested in the minister under Part 11 of the *National Parks and Wildlife Act 1974* (NSW)

value of native vegetation for sustaining native fauna populations.

Currently, a range of organisations across the NSW Murray catchment influence regional land and biodiversity management. For example, Albury City Council have produced a Draft Regional Biodiversity Strategy to guide activities that seek to protect and enhance biodiversity in Albury, with a focus on local native flora and fauna (AlburyCity 2012). Appendix 2.11 shows the management boundaries for catchment management authorities in NSW and

Victoria, local government areas and Livestock Health and Pest Authorities.

Table 2.4 shows a snapshot of the biodiversity work undertaken by people in the NSW Murray catchment with the assistance of NSW Government and Australian Government funding. More than 80 per cent of projects were conducted on private property. Since 2004, 10,534 hectares of land have been direct-seeded. Table 2.4 does not include farm forestry, seed production, offsets for clearing of vegetation, or works undertaken without government funding.

Table 2.4 Government-funded biodiversity work in the NSW Murray catchment, 1989–2011

Investment years	Area of actively managed remnant native vegetation ^a (ha)	Area of greenfield native vegetation planted (ha)	Length of streams with actively managed riparian vegetation (km)	Funding organisation (regional NRM plan)
1989–2001	30,000	6,293	1,700	Murray Irrigation Limited (LWMP) Landcare Greening Australia Local government (various) ^b
2002–03	425	153	68	DIPNR (Murray Blueprint)
2003–04 ^c	12,801 ^d	905	119	Murray CMA (Murray CAP)
2004–08	16,278 ^d	1541	566	
2004–05	172		25	
2005–06	341		13	
2004–08	1,734			Murray Wetlands Working Group
2005–08	13,335	4,060	433	Murray Irrigation Limited (LWMPs)
2007–08	1,336			Murray CMA nest egg program (Murray CAP)
2008–09	112	781		Murray Irrigation Limited (Murray CAP)
2008–09	4,082	241	154	Murray CMA (Murray CAP)
2009–10	5,191	291	142	
2010–11	6,098	327	124	
Totals	91,905	14,592	3,344	

CAP = Catchment Action Plan; CMA = catchment management authority; DIPNR = NSW Department of Infrastructure Planning and Natural Resources; ha = hectare; km = kilometre; LWMP = Land and Water Management Plans; NRM = natural resource management

- a Actively managed remnant native vegetation typically includes fencing to manage grazing, pest and weed control, and enhancement planting or direct seeding. Most remnant enhancement and revegetation works used local native species.
- b Biodiversity works were undertaken through a variety of plans and projects, including the Murray Catchment Management Committee Strategy, Irrigated and Dryland Land and Water Management Plans, Landcare Sub-catchment Plans, Landcare projects and Greening Australia projects.
- c On-ground delivery from these investment years was in the period 1 January 2005 – 30 June 2006.
- d Includes investment in 14,532 ha of public lands (high conservation value: travelling stock reserves and local government roadsides) between 2004 and 2006.

Sources: Earl (2003), Willinck (2003), Wilson (2006), MCMA (2011)

2.8 Related technical information

The following appendices are available on CD by contacting Murray Catchment Management Authority, or online at www.murray.cma.nsw.gov.au.

- Appendix 2.1 Indigenous Nations in the NSW Murray Biodiversity Management Plan region
- Appendix 2.2 Community biodiversity asset identification workshop: summary of methods and results
- Appendix 2.3 Asset identification collation sheet
- Appendix 2.4 Assets described at asset identification workshops
- Appendix 2.5 Physical features of the NSW Murray catchment
- Appendix 2.6 Key rivers in the NSW Murray catchment
- Appendix 2.7 Mapping vegetation in the NSW Murray catchment
- Appendix 2.8 Pre-clearing vegetation modelling
- Appendix 2.9 Vegetation classification table
- Appendix 2.10 Vegetation condition mapping and limitations
- Appendix 2.11 Contemporary management boundaries



3

Threats to biodiversity

3 Threats to biodiversity

Key points

- A threat to biodiversity is anything that can cause a change in the biodiversity balance, such as the presence of a pest animal, an activity such as urban development, or a process such as climate change.
- Knowing the location and severity of threats contributes significantly to understanding where resources might best be used to deliver the best biodiversity outcomes.
- Key threats to biodiversity in the NSW Murray catchment were identified by listing all known threats to biodiversity and narrowing the list to those that are relevant for the catchment.
- Experts used two different methods to rank the threats, and combined these lists to identify the key threats to biodiversity in the NSW Murray catchment. Specific objectives and action plans were created for each of these threats.
- Nine of these threats were also mapped according to the likelihood of their occurrence and the severity of the consequences, using vegetation condition as a surrogate measure.

3.1 Background

Threats to biodiversity vary. They can be persistent processes that lead to gradual declines in habitat condition or population sizes, or sudden, high-intensity events that lead to rapid change. Threats may affect a wide range of species and be geographically widespread, or they may be species-specific or site-specific. A combination of threats may also interact to produce a response that is greater than would be expected if each threat operated individually.

Threats can cause an imbalance in biodiversity by their direct or indirect effects on one or more of the following:

- habitat loss

- habitat modification
- loss of individuals/populations
- loss of genetic integrity.

A key aspect of biodiversity management is to address threats by reducing or eliminating their impact. Identifying, prioritising and mapping the extent of potential threats in the NSW Murray catchment will allow us to develop threat abatement actions that are appropriate to the scale of the threat. It is also important to realise that investment in biodiversity management may be less desirable in areas that are under very high threat, particularly where threat abatement is not possible, practical or cost-effective. Knowing the location and severity of threats contributes significantly to understanding where resources might best be used to deliver the best biodiversity outcomes.

3.2 Identifying threats

Key threats to biodiversity in the NSW Murray catchment were identified by listing all known threats to biodiversity and narrowing the list to those relevant to the planning area.

A comprehensive list of threats to biodiversity was compiled from:

- the International Union for Conservation of Nature (IUCN) Unified Classification of Direct Threats (IUCN 2006)
- threats listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), NSW *Threatened Species Conservation Act 1995* (TSC Act) and NSW *Fisheries Management Act 1994* (FM Act)
- threats to specific assets that were identified during a series of workshops (see 'Community workshops to identify biodiversity assets' in Chapter 2) and expert panels and interviews.

Using expert knowledge, this list was condensed to exclude threats that were not relevant to the NSW Murray catchment.



Photo: Alison Skinner

Figure 3.1 Loss and lack of natural regeneration of ageing paddock trees is a threat to biodiversity in agricultural landscapes



Photo: Doug Mills

Figure 3.2 The European red fox, a widespread predator of native animals

A total of 103 individual threats were identified as having an impact on biodiversity in the NSW Murray catchment. These were categorised into 10 broad threat groups:

- loss of habitat
- modification of habitat
- weeds
- anthropogenic climate change
- chemical use
- feral herbivores
- competition and predation from introduced fauna
- overabundant native fauna
- disease
- institutional barriers/governance.

Activities that are not permitted were included in the list of individual threats, because it was assumed that these activities sometimes still occur and contribute to biodiversity decline. Broadscale clearing of native vegetation is illegal under the *Native Vegetation Act 2003* (NSW) unless it improves or maintains environmental outcomes. Similarly, removing firewood from travelling stock reserves without a permit is an offence in the Murray catchment and carries a fine. The full list of threats is provided in Appendix 3.1.

Changes to hydrological regimes resulting from river regulation was identified as a major threat to biodiversity by many of the community and expert workshop participants. This plan addresses threats to terrestrial biodiversity. Addressing threats to aquatic biodiversity, including river regulation is outside the scope of this plan.

Of the key threatening processes listed under the EPBC Act, TSC Act and FM Act, 28 are relevant to the

In the Murray BMP, the term 'threat' describes something that can cause a change in the biodiversity balance. This may be the presence of a pest animal, an activity such as urban development, or a process such as climate change or loss of paddock trees (Figures 3.1 and 3.2). Threats differ in their extent, in our ability to manage them, and in their impacts on biodiversity.

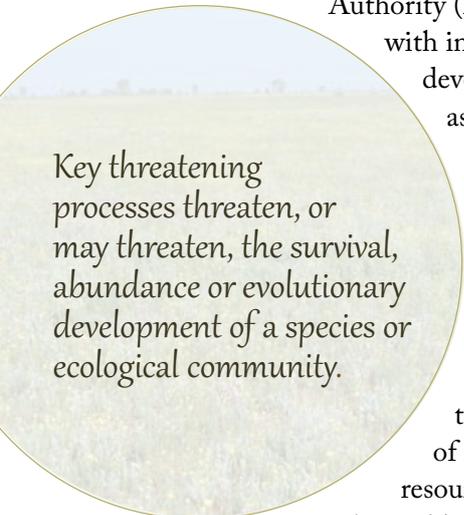
NSW Murray catchment (see Appendix 3.2). Threat abatement plans may be developed for listed key threatening processes. A threat abatement plan lists the actions needed to reduce the impact of the threat on the affected native species and ecological communities, and therefore assist their long-term survival in the wild.

3.3 Ranking threats

The 103 threats identified in the NSW Murray catchment were ranked using two methods:

- 1 An expert panel identified and ranked the top 20 threats based on their overall contribution to biodiversity decline across the NSW Murray catchment. This ranking took into consideration the geographic extent of the threat; therefore, very high-impact threats may have been excluded if they were considered to be highly localised (e.g. the threat caused by orange hawkweed in the Upper Murray Alpine Wilderness area).

- 2 NSW Office of Environment and Heritage (OEH) and Murray Catchment Management Authority (Murray CMA) staff, with input from experts, developed a matrix of key assets, assemblages and key threatening processes identified during the workshops on asset identification (see Chapter 2). Assets included ecological communities, individual threatened species, groups of species with similar resource requirements (termed 'assemblages'), and non-threatened 'iconic' or 'significant' species identified through consultation. The matrix is shown in Appendix 3.3. Ecologists with expert knowledge of flora and fauna of the Murray catchment were asked to identify and rank key threats according to their relative impact on each asset (species or ecological community). The impact score considered the overall effects of threats on habitat loss, habitat modification, loss of individuals and genetic integrity of assets. The highest



ranked threats were those that had a high to very high impact rating across numerous significant biological assets.

The two ranked lists of threats were compared and combined to produce a list of the key threats to biodiversity in the NSW Murray catchment (Table 3.1). The top-ranked threats were generally consistent between the two approaches. In this list, the closely correlated threats of climate change and prolonged drought were grouped together. Overarching threats such as lack of funding and lack of knowledge were also included in the list, although they influence other threats, and so have an indirect impact on biodiversity.

Key threats to biodiversity will be further refined for local districts through Murray CMA's Catchment Action Planning review process, which is being implemented throughout 2012.

3.4 Mapping threats

In the context of the New South Wales Murray Biodiversity Management Plan (Murray BMP), assessing where threats are most likely to occur across the catchment has two main purposes:

- 1 To provide a key input to the Biodiversity Forecasting Tool (BFT), which uses a model of future condition of vegetation to identify priority areas for Active Management or Repair of native vegetation (see Chapter 4). The future condition of vegetation is predicted based on the effects of (multiple) identified threats on current vegetation condition.
- 2 To help identify where threat abatement works are required and will have the greatest biodiversity benefit. For example, targeting pest control in areas where the pest and its impacts are most prevalent, or targeting market-based incentive programs for the maintenance of native pasture in areas where native species loss due to pasture improvement is known to be greatest.

The 103 threats identified for the NSW Murray Catchment were ranked and the highest ranked are presented here. The full list of threats is provided in Appendix 3.1. Many of these other threats may have significant local impacts.

Table 3.1 Key threats to biodiversity in the NSW Murray catchment

Source of threat (alphabetical order)	Threat category	Mapped?^a	Threat likelihood and mitigating factors
Climate change/prolonged drought	Modification of habitat	No	Significant threat across the catchment, and particularly high threat in alpine areas. Expectation that the threat can be partially mitigated in non-alpine areas by improving habitat connectivity and condition to assist vegetation resilience and species movement.
Firewood removal/loss of standing trees (dead or alive)/timber collection	Modification of habitat	Yes	Moderate threat across the catchment. Permits required for firewood collection on public land, and collection not generally permitted in national parks. Commercial collection of timber for firewood and garden mulch from private land is regulated under the NV Act; collection on private land for personal use is unregulated
Fragmentation/isolation effects (including genetic isolation, erosion effects, edge effects)	Modification of habitat	Yes	Significant threat across the catchment. Clearing of native vegetation is regulated under the NV Act. Edge effects reduced by buffering remnants and improving landscape-scale connectivity
Illegal clearing or legal clearing under the NV Act for routine agricultural management activities and asset protection	Clearing of vegetation	No	Threat occurs across the catchment, but highly localised. Clearing of native vegetation is regulated under the NV Act. Clearing is permitted for routine agricultural management activities and asset protection
Inappropriate grazing leading to loss of native understorey diversity and suppression of regeneration	Modification of habitat	Yes	Significant threat across the catchment, particularly in drought years
Loss or lack of replacement of paddock trees	Clearing of vegetation/ modification of habitat	Yes	Significant threat in cropping and grazing areas across the catchment. Clearing of native vegetation is regulated under the NV Act
Overabundant kangaroos	Overabundant native fauna	No	Significant threat across the catchment, particularly in drought years
Overabundant noisy miners	Overabundant native fauna	No	Emerging threat in modified, nutrient-enriched grassy woodlands
Pasture improvement leading to loss of native understorey diversity	Modification of habitat	Yes	Threat varies across the catchment. Risk lower in low rainfall areas. Clearing of native vegetation is regulated under the NV Act
Pest animals—cats ^b	Competition and predation from introduced fauna	No	Significant threat to native fauna, particularly around towns
Pest animals—foxes ^b	Competition and predation from introduced fauna	No	Significant threat to native fauna across the catchment
Pest animals—rabbits ^b	Modification of habitat	No	Significant threat to vegetation across the catchment including to vulnerable plant species
Rapid change of management (e.g. intensification due to change of tenure)	Modification of habitat	No	Low threat at the broader scale, high threat at specific sites
Repeated high-intensity/high-frequency fire, including wildfire	Modification of habitat	Yes	Moderate threat across the catchment

continued...

Table 3.1 continued

Source of threat (alphabetical order)	Threat category	Mapped? ^a	Threat likelihood and mitigating factors
Road/track maintenance/linear infrastructure	Clearing of vegetation	Yes	Moderate threat across the catchment
Terrestrial herbaceous weeds (e.g. <i>Phalaris</i> , African lovegrass)	Weeds	Yes ^c	Significant threat across the catchment
Terrestrial woody weeds (e.g. boxthorn, willows)	Weeds	Yes ^c	Threat varies across the catchment
Urbanisation	Clearing of vegetation	Yes	High threat in areas zoned for residential development under local environment plans
Visitor activities (e.g. mountain biking, tourists)	Modification of habitat	No	Localised threat. Recreational activities regulated on public lands
Lack of funding ^d	Institutional barrier/governance	No	
Lack of knowledge ^d	Institutional barrier/governance	No	
Organisational-related impediments ^d	Institutional barrier/governance	No	

NV Act = *Native Vegetation Act 2003* (NSW)

a Not all threats could be mapped for the New South Wales Murray Biodiversity Management Plan (see Section 3.4)

b Other pest animals including pigs, deer and wild dogs have been noted as having significant local impacts on biodiversity in the Murray, but did not rank in the top 20 threats.

c For the purpose of threat mapping, terrestrial herbaceous weeds and terrestrial woody weeds were combined.

d These are overarching, indirect threats that may influence the likelihood and severity of other direct threats to biodiversity.

Note: The 103 threats identified for the NSW Murray Catchment were ranked, and the highest ranked are presented here. The full list of threats is provided in Appendix 3.1. Many of these other threats may have significant local impacts.

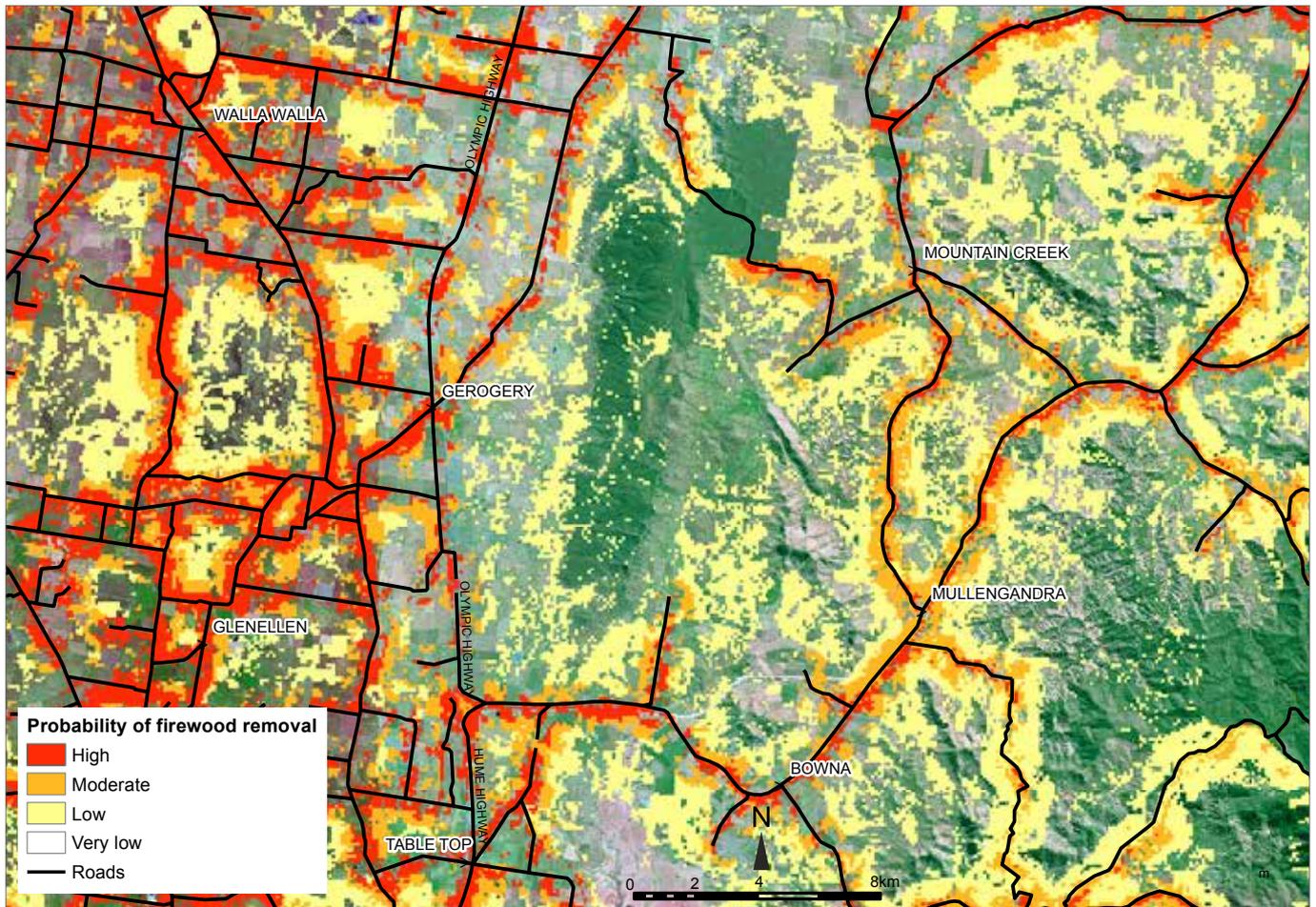
Of the key ranked threats (Table 3.1), only a subset could be mapped to show the likelihood of the threats occurring and the consequences for native vegetation condition across the catchment. The nine threats that could be mapped were:

- firewood removal/loss of standing trees (dead or alive)
- fragmentation/isolation
- inappropriate grazing leading to loss of native understorey diversity
- loss or lack of replacement of paddock trees
- pasture improvement leading to loss of native understorey diversity
- repeated high-intensity/high-frequency fire
- road/track maintenance/linear infrastructure
- terrestrial weeds
- urbanisation.

Some of the key threats identified in the expert panels, community workshops and the threats matrix

(Appendix 3.3) could not be mapped consistently across the catchment, due to high levels of uncertainty or insufficient data to confidently determine the distribution of the threat. Examples of such threats are foxes and prolonged drought.

Threats such as lack of knowledge or lack of funding are thematic, with only indirect biophysical impacts; it is therefore inappropriate to map them. Many key threats cannot be mapped because there are no appropriate surrogates to represent these threats, and so they cannot be measured. If threats do not affect terrestrial vegetation condition (e.g. foxes, cats), they cannot be mapped using the BFT. In particular, threats to aquatic assets cannot be mapped using this method. All the unmapped threats are still important, and have been given due consideration in the Murray BMP with regard to how they may affect key investment areas that have been mapped using the BFT.



Note: Red indicates areas where the threat is more likely to occur. This is independent of the impact of the threat on biodiversity, which is influenced by the initial condition of the vegetation before the threat occurs.

Figure 3.3 Threat map: firewood removal

3.4.1 Threat probability

Threat probability maps were developed for the nine key threats to terrestrial biodiversity. An example of these is presented in Figure 3.3. These threat maps represent a model of the extent (distribution) of each threat using existing spatial data, and do not measure their impact on biodiversity assets in a given location. The data used in the development of the threat probability maps were restricted to datasets available for the whole of the NSW Murray catchment. The type of data used was determined by the geographic and biophysical factors that were thought to have the greatest influence on the likelihood of a threat occurring in any given area. For example, the probability of pasture improvement leading to the loss of native understorey diversity is more likely to occur on private property and in areas under grazing land use. It is less likely to occur on very steep slopes and

in areas where rainfall is too low to warrant pasture improvement. The combination of factors used to predict the likelihood of a threat occurring was termed a ‘storyline’. Storylines were developed for each threat and these underpinned the threat probability maps.

The threat storyline for Figure 3.3 shows that the threat to biodiversity from firewood removal was considered to be greatest on private property and along and near roads, within approximately 50 kilometres of urban centres. The likelihood was also greater on smallholdings, travelling stock reserves, and state forests where the vegetation type was suitable for firewood collection.

The underpinning spatial datasets used to model threats were land use, tenure, property size, vegetation type, spatial context (degree of clumping of remnant vegetation), slope, ruggedness, land capability, current

vegetation condition, rainfall zone, proximity to urban areas, proximity to roads and proximity to water (Appendix 3.4).

To estimate biodiversity values at the local, landscape and catchment scale—and predict changes to biodiversity values in the future—the type of vegetation community or formation and the vegetation condition were used as surrogates for biodiversity. This is based on the premise that large, intact areas of native vegetation in high condition will support a greater range of native plants and animals than smaller, fragmented and degraded vegetation remnants. Native vegetation is the most useful surrogate for biodiversity, because its extent and condition can be measured and mapped.

Using the BFT, regional biodiversity is highest where a large proportion of the original vegetation is present (i.e. there has been minimal clearing of vegetation) and where vegetation condition is high. As discussed in Chapter 2, catchment-wide mapping of different vegetation communities (Roff et al. 2010a,b) and vegetation condition (Oliver et al. 2010) was conducted for the NSW Murray catchment during the development of the Murray BMP.

Nine vegetation condition components were assessed by field survey and used to model vegetation condition for the catchment:

1. native plant species richness
2. native overstorey cover
3. native midstorey cover
4. native groundcover—grass
5. native groundcover—shrubs
6. native groundcover—other
7. exotic plant cover
8. number of trees with hollows
9. amount of fallen timber.

3.4.2 Threat consequence

The consequence of a threat on biodiversity is defined by the combined decline or reduction in each of the nine vegetation condition components as a result of the threat. Consequence maps were developed for all nine key threats to terrestrial biodiversity in the NSW Murray catchment (see Appendix 3.5); an example is provided in Figure 3.4.

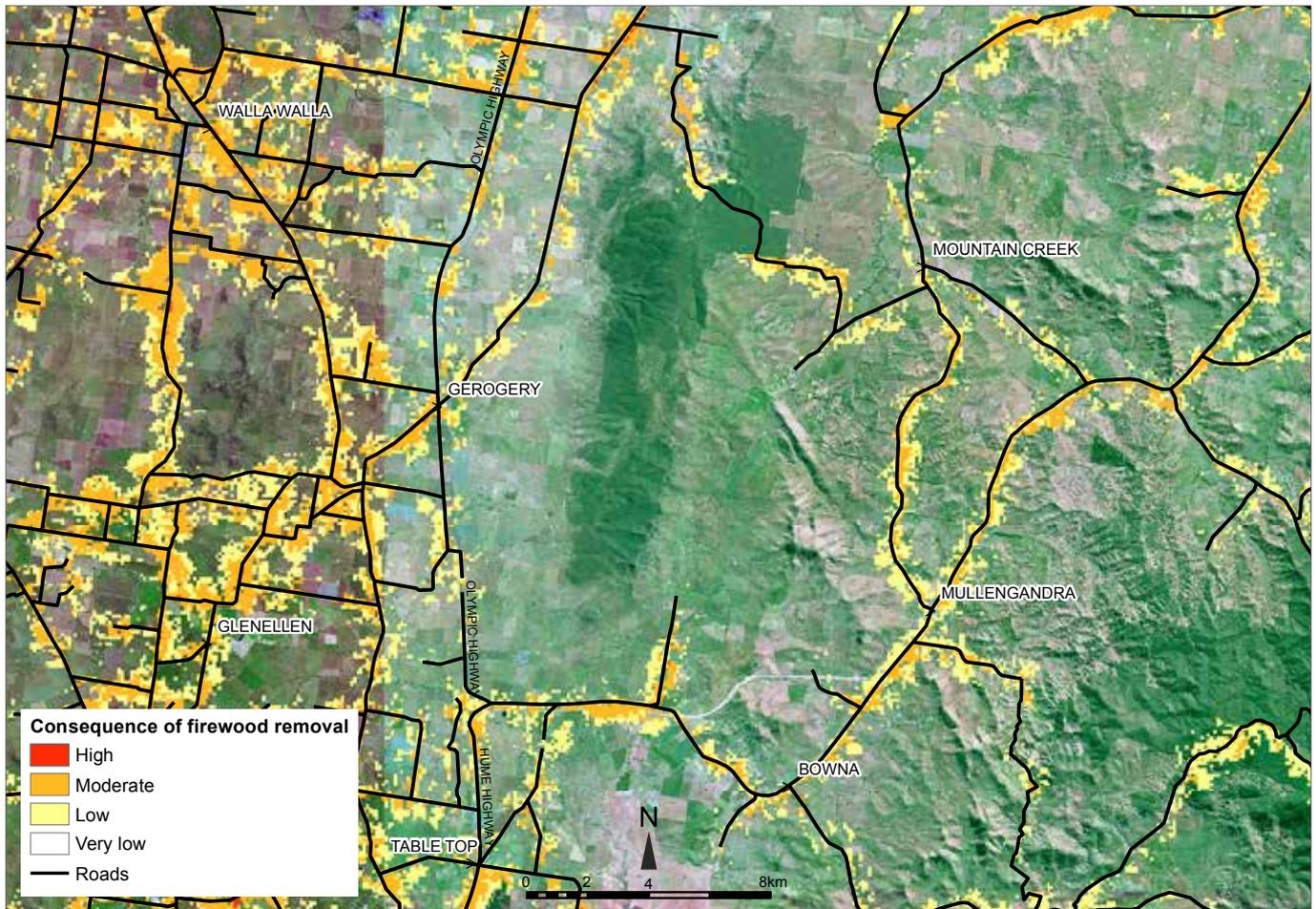
Consequence values (low to high) are the relative reduction or increase in current condition compared with the original condition. For two of the nine mappable threats (terrestrial weeds and repeated high-intensity/high-frequency fire), the consequence of a threat on vegetation condition scores was influenced by the type of vegetation. It was concluded that terrestrial weeds would have a relatively higher impact on vegetation with a grassy ground layer than vegetation with a shrubby ground layer. This is because grassy ground layers typically have more fertile soils, a greater likelihood of being modified for primary production, greater exposure to weeds, and greater likelihood of weed establishment and dominance. Likewise, alpine vegetation is considered to be more likely to be severely affected by catastrophic wildfire and hazard reduction burns than other vegetation types. Alpine vegetation was therefore scored differently to other non-alpine vegetation types for the threat of repeated high-intensity/high-frequency fire.

The relative contribution (weightings) of the vegetation condition components to overall condition score was determined according to vegetation type, because some components (e.g. overstorey, fallen timber) are less important in some vegetation communities (e.g. grasslands). The weightings applied to the condition components for each vegetation type are provided in the aggregation matrix in Appendix 3.6.

The threat consequence maps were overlaid on mapped areas of high-condition vegetation that were predicted to have the greatest future decline, to identify the possible threats attributed to the future decline. The most appropriate form of threat abatement can then be targeted towards landscapes where the benefit will be greatest, as presented in Section 4.1.1.

3.5 New and emerging threats

Threats to biodiversity are not static. Changes in climate and management practice over time can influence the extent and severity of existing threats, as well as present new threats. During the Murray BMP's development, several new and significant threats to biodiversity were identified, and it is inevitable that new threats will emerge in the future. Combinations of changing climate, incursions of new weeds, pests and diseases, and new or more severe land use pressures are likely to create new threats.



Note: Red indicates areas where the impact of firewood removal on biodiversity would be expected to be highest, if the threat occurs as predicted in the probability map.

Figure 3.4 Threat consequence map: firewood removal

Several new and emerging threats to biodiversity in the Murray catchment are noted in Appendix 3.1. These include:

- **Myrtle rust.** This fungus affects plants in the Myrtaceae family and has the potential to spread across south-eastern Australia and the Murray catchment. The National Myrtle Rust Transition to Management program was established in 2011 in recognition of the infeasibility of eradicating the disease.
- **Orange hawkweed.** This weed is currently found in Kosciuszko National Park in the upper NSW Murray catchment. It has the potential to spread across grasslands, grassy woodlands and the pastoral zone (see Box 3.1).
- **Potentially adverse impacts of re-forestation for carbon sequestration.** Potential threats to biodiversity posed by carbon plantings themselves relate primarily to the use of inappropriate species (i.e. non-local or potentially invasive species), inappropriate densities (i.e. planting woodland species in forest densities) and inappropriate placement of plantings that could affect catchment water supply. Plantations are regulated under the *Plantations and Reafforestation Act 1999* (NSW).
- **Changes to water regimes.** River regulation already has a major effect on aquatic biodiversity. Future changes to water regimes may threaten both terrestrial and aquatic biodiversity,—for example, river red gum forests—if the frequency and extent of flooding fall outside the bounds of natural variability. Addressing the impacts of river regulation on biodiversity is outside the scope of the Murray BMP.
- **Water reform resulting in the loss or modification of wetland habitats.** Water reform to increase the efficiency of water delivery and allocation of water for environmental purposes will significantly benefit biodiversity in some areas (e.g. icon sites, the Murray River channel, some wetlands and

Box 3.1

An emerging threat to biodiversity: orange hawkweed

Orange hawkweed (*Hieracium aurantiacum*) is a rosette-forming forb that has recently been identified as a significant threat to Australia's environment and to agriculture in temperate areas. In NSW, it is currently confined to around 230 infestations, all within Kosciuszko National Park. These infestations cover almost 11 hectares in total within a broader area of around 10,000 hectares. A smaller infestation in the Victorian Alps has funding of nearly \$1 million per year for eradication.

Orange hawkweed can reproduce by runners and seed (dispersed by wind, water and animals), and can grow and reproduce in a wide range of environmental conditions. It grows in the spaces between tussock grasses and competes with native forbs and seedlings of native shrubs and trees, making it a significant threat to the biodiversity of montane grasslands and subalpine woodlands. Modelling suggests that orange hawkweed is capable of infesting temperate areas across NSW, Victoria and Tasmania: potentially affecting up to 27 million hectares of land within grazing and conservation land uses. It has already become a major weed in North America, Japan and New Zealand. In New Zealand, it can completely dominate the vegetation, and agricultural losses due to the weed are estimated to be more than NZ\$250 million per year (Peter Espie, Research Fellow, University of Otago, New Zealand, pers. comm. February 2012).

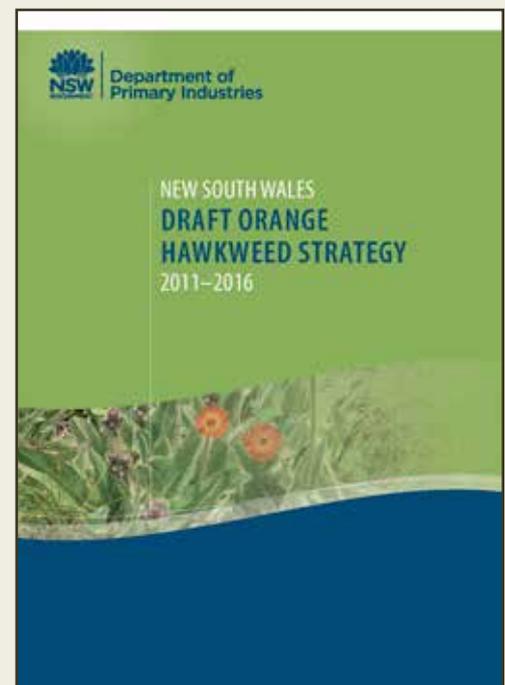
The draft orange hawkweed strategy identifies stakeholders, objectives and specific actions needed to:

- prevent establishment of new infestations
- eradicate existing infestations
- prevent and reduce spread
- increase capacity to detect and manage the weed.

Orange hawkweed is an emerging threat with potentially severe and widespread effects on biodiversity. A rapid and coordinated response is critical to containing, controlling and eradicating this species. The response to all new and emerging threats needs to consider their potential spread and impact, define objectives and actions that are specific to the threat, and identify the roles and responsibilities of relevant stakeholders.



Orange hawkweed (Photo: Neville Walsh)



Draft orange hawkweed strategy

floodplain areas). The proposed closure of some artificial watercourses (i.e. water delivery channels) threatens biodiversity where species have become reliant on these water sources. These trade-offs must be noted in water management plans. Addressing threats to aquatic assets resulting from river regulation is outside the scope of the Murray BMP.

- **Future mining activities.** Mining is currently limited to extraction of road base materials, gypsum and specialty building products. However, there are a number of coal, mineral and petroleum exploration licences, and applications for exploration licences, within the catchment. Large quantities of sand and river-washed gravel are extracted annually to service the building and construction industries of the catchment.

3.6 Addressing threats

The Murray BMP compiles the key threats to terrestrial biodiversity in the NSW Murray catchment (see Table 3.1). The predicted consequences of the key threats on future biodiversity values were mapped using vegetation condition as a surrogate measure. This has enabled areas at greatest risk of decline to be identified for threat abatement works. These are presented in Chapter 4 as priority areas to invest in Active Management or Repair of native vegetation.

Specific objectives and actions to address key threats, and the key stakeholders relevant to each threat, are shown in the tables below (Sections 3.6.1–3.6.20). These action plans to address key threats can be applied at varying scales, according to need and capacity.

3.6.1 Climatic impacts, including prolonged drought

Biodiversity affected	<ul style="list-style-type: none"> • Potentially all biodiversity • Species with highly restricted distributions, or populations on the edge of the natural range for their species • Species that occur in regions where drought and climate change will have the greatest likely impacts
Scale of effect	Catchment-wide
Key influences on extent and severity	<ul style="list-style-type: none"> • Geographic location • Current landscape resilience/functionality/land capability • Extent, type and condition of native vegetation • Current and past land management practices • Level of other threats
Key stakeholders	<ul style="list-style-type: none"> • Murray CMA • OEH • National Parks and Wildlife Service (NPWS) • Livestock Health and Pest Authorities • Crown Lands • NSW Department of Primary Industries • Local government • Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPC)

continued...

Management objective 1 To minimise climatic impacts on biodiversity	Outcome 1.1 Extent, condition and connectivity of habitat at local and regional scales is improved to maximise opportunities for species' movement and adaptation to change Actions <ul style="list-style-type: none"> • Promote incentives and private land covenants within climate change corridors (see Slopes to Summit (S2S) priority areas⁴) and identified priority Active Management and Repair areas in Chapter 4 • Improve linkages between remnants in priority areas through active revegetation or managing to promote natural regeneration, using priority maps in Chapter 4 • Encourage investment in biodiverse plantings for carbon sequestration in priority areas for biodiversity conservation and restoration • Remove or reduce impact of physical barriers restricting the movement and dispersal of fauna (including aquatic species) • Encourage local government to protect climate change linkages within local management planning instruments
	Outcome 1.2 Activities that ameliorate climate change impacts are promoted Actions <ul style="list-style-type: none"> • Promote awareness of climate change-related threats to biodiversity in the NSW Murray catchment through the S2S partnership • Incorporate risk from climate change and mitigation measures into planning instruments and processes (including CMA project plans) • Adapt weed, pest and fire management practices to take account of potential climate change impacts • Promote the role of the individual in climate change mitigation (e.g. car pooling, reducing energy and water use) • Promote local climate change initiatives to supplement larger-scale climate change strategies
	Outcome 1.3 Knowledge, understanding and communication of climate change research is increased Actions <ul style="list-style-type: none"> • Investigate which species are most at risk from climate change • Incorporate best available knowledge of climate change into adaptive management of threatening processes in the NSW Murray catchment • Promote research to improve knowledge on climate change-related themes: <ul style="list-style-type: none"> - impacts on different vegetation communities caused by extended droughts - identification of climate refuges - population size, mobility and environmental niches • Consider nominations in state and federal legislation for listing of species identified as being at high risk from climate change • Implement management actions to assist threatened species categorised as site-managed under the New South Wales Priority Action Statement for Threatened Entities (Version 2) • Assess the potential application of translocation and ex situ management actions for threatened and significant flora and fauna species that may be specifically affected by climate change and implement these actions as required

⁴ www.greateasternranges.org.au/partnerships/partnerships/slopes-to-summit-s2s

3.6.2 Firewood removal/loss of standing trees (dead or alive)

Biodiversity affected	<ul style="list-style-type: none"> • Ground-dwelling reptiles • Small mammals and birds that forage or nest in fallen timber • Hollow-dependent fauna • Invertebrates
Scale of effect	Site-specific, but greatest within 50 kilometres of larger towns and urban areas
Key influences on extent and severity	<ul style="list-style-type: none"> • Cost and availability of commercial firewood • Cost and availability of alternative fuel sources • Public awareness (or lack thereof) of the impacts of firewood collection on native species • Social norms/peer influence in maintaining ‘messy paddocks’
Key stakeholders	<ul style="list-style-type: none"> • OEH • NPWS • Livestock Health and Pest Authorities • Local government • NSW Rural Fire Service • Forests NSW • Traditional owners
Management objective 2 To reduce the removal of standing or fallen timber in high-conservation-value areas	<p>Outcome 2.1 Habitat for native reptiles and fauna dependent on fallen timber is maintained</p> <p>Actions</p> <ul style="list-style-type: none"> • Raise awareness among private and public landholders on the importance of fallen timber and standing dead trees to native fauna • Raise awareness among landholders and fire management authorities that coarse woody debris is not a significant contributor to fire risk or intensity, and as such needs to be protected from hazard reduction activities where practicable • Promote low-intensity (‘cool’) burns where fuel reduction is required, to retain coarse woody debris • Promote compliance with local government, Crown Lands and Livestock Health and Pest Authorities regulations on the collection of firewood on roadsides and reserves • Promote to consumers the use of sustainably managed resources and alternative fuel types • Promote to private landholders and public land managers the relocation of woody debris from clearing activities to sites where it can be retained • Provide controlled access for sustainable firewood collection in state forests • Provide accessible locations for firewood collection in state forests

3.6.3 Fragmentation and isolation effects (including genetic isolation, erosion effects, edge effects)

Biodiversity affected	All native plants and animals
Scale of effect	Catchment-wide, but most pronounced in NSW South Western Slopes and eastern Riverina
Key influences on extent and severity	<ul style="list-style-type: none"> • Past clearing/land use history • Productivity of the landscape
Key stakeholders	<ul style="list-style-type: none"> • Murray CMA • OEH • Australian Government Department of Sustainability, Environment, Water, Population and Communities • NSW Department of Primary Industries • Local government
Management objective 3 To protect native vegetation from further fragmentation, isolation and degradation	<p>Outcome 3.1 Active management of threats associated with fragmentation, degradation and rehabilitation undertaken across private and public tenure</p> <p>Actions</p> <ul style="list-style-type: none"> • Implement rehabilitation and restoration actions in priority areas according to: <ul style="list-style-type: none"> - repair priority investment areas identified in the Murray BMP (see Figure 4.2 and Appendices 4.5 and 4.6) - priorities identified in local government biodiversity strategies - OEH management plans, restoration plans and strategies, and other relevant strategic plans - areas identified as having high stakeholder engagement in existing rehabilitation and restoration programs • Revegetate cleared land within priority Repair areas and corridor (e.g. S2S, statewide and national corridors) linkages using best practice methods • Investigate the inclusion of priority Repair areas in rehabilitation schemes for BioBanking, local government environment plans, NSW and Commonwealth carbon forest planting and credit trading schemes • Promote the rehabilitation and management of native vegetation on public land through targeted incentive programs • Where appropriate, ensure local provenance flora is selected for revegetation and rehabilitation projects • Support provision of extension advice, training and support to landholders outside identified Repair priorities in the NSW Murray catchment

3.6.4 Illegal clearing and legal clearing for routine agricultural management activities/clearing for asset protection

Biodiversity affected	All native plants and animals
Scale of effect	Local or remnant scale
Key influences on extent and severity	<ul style="list-style-type: none"> • Landholder motivations • External drivers (changes in market commodities, drought) • Perceived fire threat
Key stakeholders	<ul style="list-style-type: none"> • Private landholders • Murray CMA • OEH • Rural Fire Service (RFS) • Local government
Management objective 4 To protect native vegetation and species from clearing	<p>Outcome 4.1</p> <p>Incentive schemes to protect native vegetation from clearing are promoted</p> <p>Actions</p> <ul style="list-style-type: none"> • Promote partnerships between government and non-government agencies to deliver combinations of incentives (e.g. S2S partnership) • Encourage local government and regional natural resource management agencies to develop partnerships with non-government conservancy groups (e.g. Nature Conservation Trust of NSW) that offer voluntary incentive schemes • Encourage landholders to seek a land value review from the NSW Valuer General where land managed for conservation outcomes is valued as productive land • Investigate and promote options for financial incentives for private landholders for native vegetation conservation or restoration in priority areas • Promote incentives, including the provision of resources such as trees, fencing materials and materials for weed control, the delivery of biodiversity-related training and extension advice • Encourage and promote opportunities for conserving native vegetation through land acquisition, conservation covenants, property vegetation plans and other incentive mechanisms. Focus efforts in priority areas, particularly in corridors and high priority Active Management areas (see Figures 4.1 and 4.3)
	<p>Outcome 4.2</p> <p>The Native Vegetation Act is used to its full extent to protect native vegetation from clearing</p> <p>Actions</p> <ul style="list-style-type: none"> • Promote compliance with state and Australian Government legislation to prevent clearing or degradation of native vegetation • Consider the Murray BMP in the review or preparation of environmental planning instruments including local, regional and state environment planning policies, the BioBanking scheme and carbon offsets to improve biodiversity outcomes
	<p>Outcome 4.3</p> <p>The Bush Fire Environmental Assessment Code is used consistently to protect against unnecessary impacts during hazard reduction activities</p> <p>Actions</p> <ul style="list-style-type: none"> • Promote the opportunity to apply for an environmental assessment under the Bush Fire Environmental Assessment Code through the NSW Rural Fire Service. RFS officers can assess activities and issue environmental approvals (Hazard Reduction Certificates) free of charge.

3.6.5 Inappropriate grazing leading to loss of native understorey diversity

Biodiversity affected	<ul style="list-style-type: none"> • Native understorey and groundlayer native plants • Regeneration of shrub and tree species • Ground-dwelling mammals, birds and reptiles
Scale of effect	<ul style="list-style-type: none"> • Local property scale • Catchment-wide, although mainly in South Western Slopes and Riverina bioregions
Key influences on extent and severity	<ul style="list-style-type: none"> • Landholder economic/financial motivations • Landholder knowledge and capacity • Social norms/peer influence • External drivers (changes in market commodities, drought)
Key stakeholders	<ul style="list-style-type: none"> • Private landholders • NSW Department of Primary Industries • Murray CMA • Livestock Health and Pest Authorities • OEH • NPWS • Crown Lands • NSW Roadside Environment Committee
Management objective 5.1 To reduce the impacts of domestic livestock on native vegetation	Outcome 5.1 Grazing-sensitive plants and animals, native vegetation, wetlands and water bodies are protected from overgrazing and trampling by domestic livestock Actions <ul style="list-style-type: none"> • Provide financial support for landholders to manage grazing pressure for biodiversity outcomes • Encourage rotational or strategic grazing regimes to allow seeding of native species and maintain ground cover • Provide information to landholders regarding sustainable stocking rates, based on land capability, to minimise land and habitat degradation such as erosion, soil compaction and loss of ecological values • Actively manage the habitat values of riparian vegetation and wetlands by restricting or excluding domestic livestock, providing off-stream watering points and implementing appropriate weed management • Provide information to landholders on the production and biodiversity benefits of reducing grazing pressure on areas that support threatened entities or high-conservation-value vegetation • Erect and maintain adequate stock-proof fencing along conservation reserve boundaries • Encourage exclusion of stock or the use of strategic grazing on roadsides, Crown lands and travelling stock reserves identified as being of high conservation value
Management objective 5.2 To reduce the impacts of feral and overabundant native herbivores on key biodiversity assets, including native vegetation	Outcome 5.2 Key biodiversity assets are less impacted by feral and overabundant native herbivores. Actions <ul style="list-style-type: none"> • Continue to control rabbits across the NSW Murray catchment, particularly where they are having a significant impact on native vegetation and threatened plant populations • Identify and assess areas in which overabundant kangaroo populations are having a significant impact on native vegetation and threatened plant populations • NPWS continue to fund and implement feral horse control in and adjacent to the Pilot, Main Range and Jagungal Wilderness Areas

3.6.6 Loss or lack of replacement of paddock trees

Biodiversity affected	<ul style="list-style-type: none"> • Hollow-dependent fauna • Species that use paddock trees as stepping stones for dispersal or migration, foraging habitat or as a seasonal resource
Scale of effect	Catchment-wide
Key influences on extent and severity	<ul style="list-style-type: none"> • Overgrazing and/or continuous grazing around mature paddock trees (preventing recruitment) • Accidental loss of trees during stubble burns • Public awareness of the importance of paddock trees • Social norms/peer influence in maintaining ‘messy paddocks’
Key stakeholders	<ul style="list-style-type: none"> • Murray CMA • OEH • Private landholders • Local government
Management objective 6 To maintain paddock trees in agricultural areas as a critical resource for hollow-dependent fauna	<p>Outcome 6.1</p> <p>Premature loss of paddock trees is minimised</p> <p>Actions</p> <ul style="list-style-type: none"> • Identify areas that contain high densities of mature and hollow-bearing trees as areas of high conservation value in planning instruments and land management negotiations • Raise awareness among landholders of the importance of paddock trees to native fauna • Reinstate ‘importance of paddock tree’ educational campaigns in high-loss areas, such as cropping areas where losses due to stubble burning occur
	<p>Outcome 6.2</p> <p>Regeneration of paddock trees to replace ageing trees is promoted</p> <p>Actions</p> <ul style="list-style-type: none"> • Promote rotational grazing practices to increase chances of regeneration around paddock trees • Investigate options for outcomes-based incentive programs that promote tree recruitment • Promote the retention of paddock trees in local government development processes

3.6.7 Overabundant kangaroos

Biodiversity affected	<ul style="list-style-type: none"> • Native groundlayer plants • Local threatened flora populations • Ground-dwelling fauna populations
Scale of effect	Catchment-wide, but highly variable and mainly on public lands
Key influences on extent and severity	<ul style="list-style-type: none"> • Climatic conditions • Availability of food and water • Level of population control and commercial harvesting
Key stakeholders	<ul style="list-style-type: none"> • Landholders • Murray CMA • OEH • NPWS • Murray CMA Aboriginal Technical Group • Non-government conservation organisations • Traditional owners and Aboriginal organisations
Management objective 7 To manage numbers and impacts of overabundant kangaroos on biodiversity values in the NSW Murray catchment	<p>Outcome 7.1 Reduced impacts of overabundant kangaroos on biodiversity values</p> <p>Actions</p> <ul style="list-style-type: none"> • Assess and identify areas in the NSW Murray catchment where overabundant kangaroos are exerting a significant negative impact on biodiversity assets such as threatened plant populations (as for Outcome 5.2) • Implement kangaroo management as part of management plans for private land stewardship • Implement kangaroo management as part of identified threatened species management detailed in the NSW Threatened Species Website or in NSW Priority Action Statement for Threatened Entities Version 2 (PAS 2) site-managed threatened species projects • Review policy and management frameworks relevant to the management of kangaroo numbers and impacts on public lands including NPWS estates and revise where appropriate to reduce impacts to biodiversity assets

3.6.8 Overabundant noisy miners

Biodiversity affected	<ul style="list-style-type: none"> • Birds of conservation concern, particularly those that are less than 50 grams in weight • Native remnant vegetation health
Scale of effect	Grassy Woodland remnants, predominantly in the South Western Slopes
Key influences on extent and severity	<ul style="list-style-type: none"> • Extent and level of fragmentation of native vegetation • Soil fertility • Vegetation type • Food availability • Climate
Key stakeholders	<ul style="list-style-type: none"> • Murray CMA • OEH • NPWS • Private landholders • Tertiary and research institutions • Crown Lands • Livestock Health and Pest Authorities
Management objective 8 To assess and manage overabundant noisy miners and their impacts in the NSW Murray catchment	<p>Outcome 8.1</p> <p>Reduction in the impacts of overabundant noisy miners on the woodland birds and woodland health in the NSW Murray catchment</p> <p>Actions</p> <ul style="list-style-type: none"> • Assess the relative abundance of noisy miners and level of impact on the woodland bird assemblage and woodland vegetation health, before considering management actions to reduce their impact across landscapes in the NSW Murray catchment • Undertake vegetation restoration works that discourage the influx of noisy miners through the use of dense shrub and understorey plantings, and appropriate size, shape and connection of vegetation • Develop clear and practical policy on noisy miner management in NSW to allow ecological culling through a permit process that incorporates monitoring and reporting of outcomes • Conduct trial ecological culling of noisy miners at sites and local landscapes where they are overabundant and demonstrated to have exerted a significant detrimental effect on smaller bird species' richness and abundance. These sites should be part of previous or current habitat restoration programs • Monitor, measure and report the outcomes of ecological culling to inform future noisy miner management actions
	<p>Outcome 8.2</p> <p>Increased awareness of the impact of overabundant noisy miners on small woodland birds and woodland vegetation, and involvement in management to reduce their impacts</p> <p>Actions</p> <ul style="list-style-type: none"> • Distribute existing and new extension material about noisy miner impacts and management to landholders and land managers, particularly those involved in active woodland habitat restoration works • Incorporate new information, and guidelines from the Australian Centre for Ecological Analysis and Synthesis National Noisy Miner Working Group, into educational and extension materials

3.6.9 Pasture improvement leading to loss of native groundlayer diversity

Biodiversity affected	<ul style="list-style-type: none"> • Native grasses • Herbs and forbs • Ground-dwelling fauna
Scale of effect	Farm-scale; South Western Slopes, eastern Riverina, upper Murray
Key influences on extent and severity	<ul style="list-style-type: none"> • Landholder economic/financial motivations • Landholder knowledge and capacity • Social norms/peer influence • External drivers (changes in market commodities, drought)
Key stakeholders	<ul style="list-style-type: none"> • Private landholders • Murray CMA • NSW Department of Primary Industries • OEH
Management objective 9.1 To maintain or increase the extent and condition of native grasslands and native grassy woodlands in the NSW Murray catchment	<p>Outcome 9.1 Improved landholder capacity to manage native pastures</p> <p>Actions</p> <ul style="list-style-type: none"> • Investigate incentives to protect high-condition grasslands in high-priority Active Management areas (see Chapter 4, Figure 4.1) and also the priority high-condition areas that are under greatest threat • Investigate incentives to restore or improve the condition of low-condition grasslands in the high-priority Active Management and Repair areas (see Chapter 4) • Promote capacity-building activities relating to native pasture management and the benefits of low-fertiliser-input farming systems, targeting the upper Murray, NSW South Western Slopes and eastern Riverina regions • Support research into practical techniques to restore grasslands and the grassy understorey
	<p>Outcome 9.2 Improved understanding of the extent and loss of native grasslands</p> <p>Actions</p> <ul style="list-style-type: none"> • Measure and map the current extent and condition of native grasslands in the planning area • Assess the rate of loss or degradation of native grasslands in the Murray catchment due to pasture improvement

3.6.10 Pest animals

The three pest animals identified in the key threats to the NSW Murray catchment were cats, foxes and rabbits. However, because there is no pest animal management strategy for the NSW Murray catchment, the objectives listed here have been developed for multiple pests. Other notable pest animals in the Murray catchment include feral pigs, deer, feral goats, wild dogs, and feral honeybees.

Biodiversity affected	<ul style="list-style-type: none"> • Cats and foxes affect small to medium-sized ground-dwelling fauna • Rabbits affect groundlayer herbaceous native plants, and regenerating seedlings of shrubs and trees • Pigs affect groundlayer plants and ground-dwelling fauna
Scale of effect	Catchment-wide
Key influences on extent and severity	<ul style="list-style-type: none"> • Environmental conditions • Cat owner awareness in urban and peri-urban areas • Frequency and extent of fox baiting by private and public land managers • Collective rabbit control efforts of public and private land managers • Frequency and extent of feral animal control by private and public land managers
Key stakeholders	<ul style="list-style-type: none"> • Livestock Health and Pest Authorities • Murray CMA • Local government • Private landholders • NPWS • Crown lands • Tertiary and research institutions • NSW Game Council • OEH

continued...

Management objective 10 To protect native vegetation and critical habitat from the impact of pest animals	Outcome 10.1 A consistent approach to the strategic control of pests is encouraged through partnerships and alliances between key agencies and private landholders Actions <ul style="list-style-type: none"> • Develop a pest management strategy for the Murray catchment that promotes a coordinated cross-jurisdictional approach to the detection, control, monitoring and reporting of new and emerging pest animals • Develop strategies for integrated pest management that involve landholders, government agencies and independent hunters and trappers • Support integrated programs through a cross-border pest animal network and regional pest animal advisory committees • Conduct regular pest management forums to share latest information and strategies • Promote landholder monitoring of pest animals through existing pest programs (e.g. FeralScan website www.feralscan.org.au/rabbitscan)
	Outcome 10.2 New and emerging pests are prevented from establishing Actions <ul style="list-style-type: none"> • Undertake regular surveillance of known and potential locations where emerging pests have been recorded in recent years • Target landholders and local government in pest animal awareness programs • Conduct ecological research to quantify the impacts of the pest animal on native species in the NSW Murray catchment and incorporate findings into management actions if required
	Outcome 10.3 Spread of invading pest animals is limited Actions <ul style="list-style-type: none"> • Identify where the pest animal is affecting biodiversity in the planning area • Undertake control of the pest animal in locations identified above • Map control locations on a pest spatial database for the planning area • Monitor the effectiveness of the control activities, including any re-establishment • Undertake public education to discourage reintroductions of the pest animal • Update best-practice control measures from Invasive Animals Cooperative Research Centre
	Outcome 10.4 Existing pest animals are strategically controlled Actions <ul style="list-style-type: none"> • Undertake coordinated and cooperative pest animal control for threatened species as described in the NSW Fox Threat Abatement Plans, and for threatened and iconic species in Key Management Areas 2, 3, 6, 8, 9, 10, 11, 12, 20, 21, 25 and 30 in the NSW Murray catchment (Figure 5.2) • Encourage coordinated fox control in the vicinity of travelling stock reserves or priority areas for ground-dwelling threatened fauna • Fund and implement landholder stewardship schemes for threatened ground-dwelling fauna species that includes funded pest animal control (e.g. Murray CMA 'Nest Egg' program) • Develop strategies for integrated pest management that involve landholders, government agencies and independent hunters and trappers • Implement and promote monitoring and control by landholders in accordance with pest management strategies (e.g. RabbitScan website www.feralscan.org.au/rabbitscan) • Develop and implement a rabbit control program to target rabbit populations in proximity to high-conservation-value areas, particularly Sandhill Woodland and Grassland vegetation in the Riverine Plains

3.6.11 Rapid change of management (intensification; e.g. due to change of tenure)

Biodiversity affected	All native plants and animals
Scale of effect	Catchment-wide
Key influences on extent and severity	<ul style="list-style-type: none"> • Government policies • External influences (e.g. international markets affecting viability of farms, leading to property sales)
Key stakeholders	<ul style="list-style-type: none"> • Murray CMA • OEH • NPWS • Murray CMA Aboriginal Technical Group • Private landholders • Non-government conservation organisations • Traditional owners and Aboriginal organisations • Local government
Management objective 11 To ensure that any change in management of private or public lands is sustainable and improves or maintains biodiversity, particularly of threatened species	Outcome 11.1 Biodiversity is improved or maintained when land management is changed or intensified Actions <ul style="list-style-type: none"> • Ensure that any rapid change in land use improves or maintains biodiversity • Adhere to the Native Vegetation Act with regard to any future change in land management use and ensure that appropriate offsetting delivers a net positive outcome for biodiversity • Provide new owners and land managers with information and advice on achieving changes in management, including intensification, that will not negatively affect biodiversity • Ensure that change in vegetation management on newly created public and private reserves improves biodiversity, including vegetation condition and structure, and that these improvements are measured

3.6.12 Repeated high-intensity/high-frequency fire, including wildfire

Biodiversity affected	<ul style="list-style-type: none"> • Hollow-dependent fauna • Fire-sensitive flora and fauna species
Scale of effect	South Western Slopes and upper Murray
Key influences on extent and severity	<ul style="list-style-type: none"> • Life and asset protection • Public pressure to minimise fire risk (increasing pressure for regular fuel reduction burns) • Climate (extended drought, extreme weather)
Key stakeholders	<ul style="list-style-type: none"> • Local government • NSW Rural Fire Service • OEH • NPWS • Murray CMA • Murray CMA Aboriginal Technical Group • Private landholders • Traditional owners and Aboriginal organisations • Crown Lands • Livestock Health and Pest Authorities • Nature Conservation Council (Hotspots program) • Forests NSW
Management objective 12 To protect fire-sensitive vegetation communities from fire and to promote the implementation of appropriate fire regimes	<p>Outcome 12.1 Fire is excluded from fire-sensitive vegetation types</p> <p>Actions</p> <ul style="list-style-type: none"> • Identify vegetation communities that are most vulnerable to degradation from fire and undertake management activities to eliminate or reduce these impacts wherever possible • Ensure fire-management strategies eliminate or reduce the risk of fire burning areas of bogs and fens and other sensitive alpine vegetation communities and locations (e.g. wet gullies) <hr/> <p>Outcome 12.2 A consistent and coordinated approach to fire management is promoted</p> <p>Actions</p> <ul style="list-style-type: none"> • Promote a consistent and coordinated approach to fire management in the planning area by encouraging partnerships and alliances between the Rural Fire Service, local government, Murray CMA, Forests NSW and NPWS • Encourage a consistent approach to the preparation and format of fire strategy maps across all tenures • Incorporate the potential impacts of climate change on fire-management planning and incident response • Adopt the NSW Rural Fire Service Code of Practice prescriptions for threatened species

Outcome 12.3

People are informed and engaged in fire management

Actions

- Encourage partnerships and cooperation between neighbouring private and public landholders to prepare compatible and consistent fire management plans and implement hazard reduction and environmental burns across groups of properties, rather than individual properties
 - Support the implementation of fire management strategies and statements of fire management intent in NPWS estates
 - Integrate likely weed and feral pest animal post-fire response when proposing planned fire regimes and, when necessary, incorporate weed and pest management into property fire planning
 - When preparing fire plans, consider potential impacts on aquatic species from hazard reduction and environmental burns near riparian areas
 - Investigate mechanisms to reduce risk from wildfire and arson events in priority locations
-

Outcome 12.4

Ecological burns are undertaken that provide positive biodiversity outcomes

Actions

- Investigate options for funding, implementing and monitoring outcomes of environmental burns, including options for streamlining approval processes
-

Outcome 12.5

Fire planning and hazard reduction guidelines investigate species' ecological requirements

Actions

- Investigate ecological requirements of vegetation communities and related species and habitats when developing fire management plans, including hazard reduction guidelines and procedures

Knowledge gaps identified in this action should be used to inform research proposed in Outcome 12.6

Outcome 12.6

Research into effects of different burning regimes on species and ecological communities is undertaken

Actions

- Assess fire regime requirements for threatened species and their habitats in the planning area
-

3.6.13 Road and track maintenance, linear infrastructure

Biodiversity affected	<ul style="list-style-type: none"> • Groundlayer and understorey native plants • Overstorey plants • Fauna with limited dispersal capacity, where clearing is required
Scale of effect	Restricted locations, catchment-wide
Key influences on extent and severity	<ul style="list-style-type: none"> • State and federal road safety policy • Public pressure for upgrades to roads and services • Knowledge and capacity of local government and Roads and Maritime Services staff
Key stakeholders	<ul style="list-style-type: none"> • Local government • Roads and Maritime Services • Murray CMA • Private landholders • OEH • NSW Roadside Environment Committee
Management objective 13 To minimise the impact of road and track maintenance/ linear infrastructure works on native flora and fauna	<p>Outcome 13.1 A consistent and coordinated approach to roadside vegetation management is taken</p> <p>Actions</p> <ul style="list-style-type: none"> • Provide roadside vegetation assessment and management training to staff across various levels of local government • Improve data sharing to assist the management of vegetation on roadsides and reserves • Through education and incentive funding, encourage local government to negotiate and implement conservation agreements on high-conservation-value roadsides • Encourage local government to negotiate with infrastructure providers and negotiate location of new infrastructure in sensitive areas • Rigorous appraisal of environmental impact assessments is undertaken for new infrastructure works

3.6.14 Terrestrial herbaceous weeds

Terrestrial herbaceous weeds and terrestrial woody weeds were both identified as key threats to biodiversity, but are merged in the threats probability mapping (see Section 3.4).

Biodiversity affected	<ul style="list-style-type: none"> • Native plants in the ground and shrub layer • Ephemeral wetlands • Alpine peats, bogs and swamps
Scale of effect	Catchment-wide
Key influences on extent and severity	<ul style="list-style-type: none"> • Landholder capacity to manage weed outbreaks • Climatic conditions

Key stakeholders	<ul style="list-style-type: none"> • Private landholders • Eastern Riverina Noxious Weeds Advisory Group (ERNWAG)/Western Riverina Noxious Weeds Advisory Group (WRNWAG) • Local government • NSW Department of Primary Industries • Livestock Health and Pest Authorities • NPWS • Crown Lands • Forests NSW • Central Murray County Council • OEH
Management objective 14 To protect high-conservation-value native vegetation from the impact of weeds	<p>Outcome 14.1 Regional weed management strategy is implemented</p> <p>Actions</p> <ul style="list-style-type: none"> • Implement actions identified in the Regional Weed Strategy for the Murray catchment (Bosse & Verbeek 2008) (www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds) • Target priority, high-condition native vegetation that is predicted to decline from the threat of weeds (see Chapter 3) for delivery of weed control programs • Conduct weed control management for threatened flora and fauna as detailed in the OEH Threatened Species Website (www.environment.nsw.gov.au/threatenedspecies/) and in PAS2 site-managed species projects • Promote cross-tenure and cross-government partnerships in delivery of regional weed strategies • Promote weed information websites (e.g. www.riverinaweeds.org.au and www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds) • Support training and employment opportunities for people to be involved in weed control and eradication <hr/> <p>Outcome 14.2 A consistent approach to the strategic control of weeds is encouraged through partnerships and alliances between key agencies and landholders</p> <p>Actions</p> <ul style="list-style-type: none"> • Support integrated cross-agency programs and the regional weeds advisory committees ERNWAG and WRNWAG • Conduct regular weed and pest management forums in the planning area to share latest information and strategies <hr/> <p>Outcome 14.3 New weed invasions and establishment of new weeds are prevented</p> <p>Actions</p> <ul style="list-style-type: none"> • Promote the reporting of new weeds by landholders and general public to local weed officers • Implement the new weed invader alert and rapid response plan through ERNWAG/WRNWAG • Develop and implement a vehicle and equipment hygiene protocol for agencies and individuals • Promote best-practice weed containment strategies to nurseries and fodder industries to reduce weed dispersal • Prevent establishment or spread of priority weeds identified for each subregion of the planning area in the Regional Weed Strategy (Bosse & Verbeek 2008) (e.g. serrated tussock, Chilean needle grass, coolatai grass, scotch broom, gorse, ragwort; see www.riverinaweeds.org.au/Documents/images/RWS-Murray_Catchment.pdf) • Review regional strategies to identify species, locations and resources for early intervention control of new and emerging weeds affecting high-conservation-value native vegetation • Fund and implement eradication of orange hawkweed from Kosciuszko National Park

3.6.15 Terrestrial woody weeds

Terrestrial herbaceous weeds and terrestrial woody weeds were both identified as key threats to biodiversity, but are merged in the threats probability mapping (see Section 3.4).

Biodiversity affected	<ul style="list-style-type: none"> • Native groundlayer and understorey plants and regenerating overstorey species • Aquatic species (e.g. due to shading from willows) • Fauna (both positive effects e.g. provision of shelter and food, and negative effects e.g. hampered movement)
Scale of effect	Catchment-wide
Key influences on extent and severity	<ul style="list-style-type: none"> • Environmental conditions (influencing seedling establishment) • Collective control efforts of public and private land managers
Key stakeholders	<ul style="list-style-type: none"> • Private landholders • ERNWAG/WRNWAG • Local government • NSW Department of Primary Industries • Livestock Health and Pest Authorities • OEH • NPWS • Crown Lands • Central Murray County Council
Management objective 15 To protect high-conservation-value native vegetation from the impact of weeds	<p>Outcome 15.1 As per Outcome 14.1</p> <p>Actions As per actions for Outcome 14.1</p> <ul style="list-style-type: none"> • Remove terrestrial woody weeds. If weeds are not immediately impacting on the survival of a species, establish appropriate native species before weed removal to reduce detrimental impacts on species that may rely on these woody weeds for habitat.

3.6.16 Urbanisation

Biodiversity affected	All native plants and animals
Scale of effect	Concentrated around Albury and towns adjacent to the Murray River
Key influences on extent and severity	<ul style="list-style-type: none"> • Local environment plans • Growth of regional centres • External drivers (property and rental costs in large cities)
Key stakeholders	<ul style="list-style-type: none"> • Local government • OEH • Crown Lands • Department of Planning and Infrastructure
Management objective 16 To minimise the impact of urban development on native plants and animals	<p>Outcome 16.1</p> <p>Land use zoning in local environment plans promotes the protection and management of areas of high conservation value</p> <p>Actions</p> <ul style="list-style-type: none"> • OEH and local government to work together to identify and appropriately zone areas of high conservation value as part of the local environment plan process
	<p>Outcome 16.2</p> <p>Urban people are engaged in natural resource management at a local and catchment level</p> <p>Actions</p> <ul style="list-style-type: none"> • Facilitate and promote urban biodiversity programs to increase involvement in natural resource management and improve understanding of local and broader natural resource management issues • Run urban biodiversity programs to focus efforts in areas zoned for environment protection and management under the local environment plan • Provide education and extension information to help support ‘Friends of ...’ and urban Landcare groups • Promote local government regulations and educational campaigns to minimise threats to biodiversity in urban areas, such as responsible cat ownership and removal of environmental weeds from gardens

3.6.17 Visitor activities (e.g. mountain biking, tourists)

Biodiversity affected	<ul style="list-style-type: none"> • Native groundlayer and understorey plants and regenerating overstorey species • Fauna where disturbance can disrupt breeding or lead to avoidance of breeding habitat (e.g. bats)
Scale of effect	Site-specific
Key influences on extent and severity	<ul style="list-style-type: none"> • Proximity to urban population centres • Socio-economic drivers
Key stakeholders	<ul style="list-style-type: none"> • Local government • Crown Lands • OEH • NPWS • Recreational user groups • Murray CMA Aboriginal Technical Group • Traditional owners and Aboriginal organisations
Management objective 17 To minimise the impacts of visitor activities on biodiversity in high-conservation-value areas	<p>Outcome 17.1 Increased public awareness of biodiversity values in public reserves</p> <p>Actions</p> <ul style="list-style-type: none"> • Partner with recreational groups to promote sustainable and responsible use of public lands for recreation • Run awareness-raising campaigns and develop signage and educational materials to promote minimum-impact use of high-conservation-value areas • Promote grants programs for community groups and public land managers to involve people in improving the management of high-use reserves • Monitor impacts of visitor activities on threatened species in high-use reserves

3.6.18 Lack of funding

Biodiversity affected	Potentially all biodiversity
Scale of effect	Catchment-wide
Key influences on extent and severity	<ul style="list-style-type: none"> • Opposing and competing government and other funding body priorities • Poor planning and priority setting
Key stakeholders	<ul style="list-style-type: none"> • Australian Government and state governments • Local government • Murray CMA
Management objective 18 To ensure funding is sufficient for key biodiversity management actions in the NSW Murray catchment	<p>Outcome 18.1 The conservation status of the NSW Murray catchment's biodiversity is improved and threats to biodiversity values are managed better</p> <p>Actions</p> <ul style="list-style-type: none"> • Develop a new catchment action plan that provides a transparent, prioritised investment strategy for biodiversity management and conservation actions • Develop threatened species recovery plans, PAS2 species projects and projects for other investors that provide a transparent, prioritised investment framework

3.6.19 Lack of knowledge

Biodiversity affected	Potentially all biodiversity
Scale of effect	Catchment-wide
Key influences on extent and severity	<ul style="list-style-type: none"> • Lack of access to information • Ineffective development and delivery of information • Lack of information on specific biodiversity management issues
Key stakeholders	<ul style="list-style-type: none"> • Australian, state and local government • Murray CMA • OEH • NSW Department of Primary Industries • Educational institutions • Murray CMA Aboriginal Technical Group • Traditional owners and Aboriginal organisations
Management objective 19 To increase the knowledge and capacity of land managers to manage land for biodiversity conservation	<p>Outcome 19.1 Knowledge needs of landholders are identified and prioritised</p> <p>Actions</p> <ul style="list-style-type: none"> • Incorporate local knowledge into natural resource management planning • Define and identify socio-ecological systems in the planning area according to common interests (e.g. dominant land uses), issues and needs • Assess baseline natural resource management knowledge for each socio-ecological system and identify knowledge needs • Continue and increase biodiversity education and extension efforts to ensure knowledge is disseminated effectively to all stakeholders, including the use of new technology and media to communicate this information

3.6.20 Organisational-related impediments

Biodiversity affected	Potentially all biodiversity
Scale of effect	Catchment-wide
Key influences on extent and severity	<ul style="list-style-type: none"> • Key agency staff capacity and skills • Opposing agency politics and philosophies • Lack of funding
Key stakeholders	<ul style="list-style-type: none"> • Murray CMA • OEH • NPWS • Livestock Health and Pest Authorities • Crown Lands • NSW Department of Primary Industries • Local government
Management objective 20 To reduce organisational-related impediments to biodiversity conservation	<p>Outcome 20.1 Communication and information sharing between agencies and the NSW Murray catchment community is improved; a shared vision improves the compatibility of biodiversity targets developed at catchment, landscape and local scales</p> <p>Actions</p> <ul style="list-style-type: none"> • Encourage the integration of international, national, state, regional and local natural resource management plans by developing partnerships with local government • Support and develop partnerships between agencies and community groups and other stakeholders to encourage coordinated cross-tenure management and sharing of resources and information • Facilitate the exchange of data between agencies and share new vegetation extent and condition mapping for the Murray catchment with stakeholders • Improve the compatibility of data and mapping systems between organisations • Develop a process to maintain and update the list of priority species and ecological communities addressed by the Murray BMP. This includes an assessment of each new listing to ensure that any additional management actions are developed at the correct scale • Develop a process to update the biodiversity assets register developed during the community workshops

3.7 Related technical information

The following appendices are available on CD by contacting Murray Catchment Management Authority, or online at www.murray.cma.nsw.gov.au.

Appendix 3.1 Potential threats to biodiversity in the NSW Murray catchment

Appendix 3.2 Key threatening processes relevant to the NSW Murray catchment

Appendix 3.3 Matrix of key assets, assemblages and their key threatening processes

Appendix 3.4 Approach to threat modelling

Appendix 3.5 Threats consequence maps

Appendix 3.6 Aggregation matrix: vegetation condition component weightings



Lake Uranagong in flood (top), Tumbarumba School's mural 'Save the Booroolong frog', regent honeyeater
Photos: Helen Wilson, Simon Dallinger, Dean Ingwersen



4

Investing in biodiversity management

4 Investing in biodiversity management

The main objective of the New South Wales Murray Biodiversity Management Plan (Murray BMP) is to present strategic biodiversity planning information to help prioritise investment in biodiversity management. This information relates to all levels of management, from the site scale through to the catchment level. This chapter includes maps of the NSW Murray catchment showing areas in which efforts to maintain existing environmental values, manage threats and restore native vegetation will have the greatest benefit to biodiversity at the catchment scale.

The priority area maps in this chapter were created by collating all available spatial and descriptive data about biodiversity management planning in the NSW Murray catchment. This was then combined with a series of new datasets for vegetation and vegetation condition mapping (see Chapter 2 and its appendices).

Using the priority area maps

The priority areas identified in this chapter are not intended to be a definitive list of biodiversity values. The spatial data used are not sufficient to identify all important biodiversity features, particularly those at the scales of small sites. Significant biodiversity management activities also occur outside the priority areas identified here—and, if they have sound justification, they should continue to occur. Therefore, if local biodiversity values are identified that are not included in these priority area maps, these sites or values should still be considered for investment.

Key points

- Biodiversity values at the local scale are influenced by the features of the habitat, the ecological values in the landscape surrounding the site and the type of vegetation.
- The priority maps in this chapter highlight areas where efforts to maintain and conserve existing environmental values, manage threats and restore native vegetation will have the greatest benefit to biodiversity at the catchment scale.
- Active Management areas have relatively high-condition vegetation that is well connected. These areas need ongoing management to maintain their biodiversity values.
- Repair areas have low-condition vegetation in small, fragmented and isolated remnants. These areas need revegetation (replanting and promoting natural regeneration) and restoration management to improve their biodiversity values.
- The priority areas identified in these maps are not a definitive list. Other areas with biodiversity values that are not shown on these maps may still be considered for investment.
- The highest priorities for Active Management occur mostly in the upper, central north and western catchment. Recommended management actions for these areas are weed and pest management, and appropriate fire management to maintain and improve the current extent and condition of native vegetation.
- The highest priority areas for Repair occur primarily in the overcleared landscapes formerly occupied by Grassy Woodlands, and are mostly on private land. Recommended actions for Repair areas are revegetation through replanting and natural regeneration, strategic grazing, and weed and pest management to improve the extent and condition of native vegetation for biodiversity.
- Many other areas and corridors also contribute to biodiversity at the catchment scale. These include areas covered by the reserve system, national wildlife corridors, the Great Eastern Ranges and Slopes to Summit partnership region, and areas identified through other planning initiatives.

4.1 Factors affecting biodiversity at the local scale

The biodiversity values at a site are influenced by the features of the habitat, the ecological values in the landscape surrounding the site, the type of vegetation and the suite of threats present at the site.

4.1.1 Habitat features

Biodiversity is influenced by many environmental characteristics at different spatial scales. Many ecological studies, including some within the NSW Murray catchment, have shown a strong positive relationship between vegetation condition and the diversity and abundance of plants and animals (e.g. Saunders & Heinsohn 2008, Montague-Drake et al. 2009). The types of habitat features that are important to a species depend on the ecology of that species, including the spatial scales (home range, breeding and foraging habitat) that it operates in. The important habitat features that can indicate biodiversity abundance at the site scale are discussed below.

Soil type and fertility

In general, sites with good soil quality and fertility can support more biodiversity than areas with low soil fertility. Larger trees that provide more food for animals tend to grow in these areas.

Mature and hollow-bearing trees

Many birds and mammals rely on large mature trees for foraging and breeding habitat. Larger trees provide more food (nectar, pollen, seeds, fruit and lerp) and can develop hollows in their limbs where animals can roost and breed. In many areas, the largest trees on a site are paddock trees.

Tree and shrub regeneration

Tree and shrub regeneration ensures that mature trees and shrubs are replaced when they die. This provides a more structurally complex range of habitats. Many birds use patches of regeneration for foraging habitat because they attract insects; some birds nest in dense saplings. A study in the western Murray catchment found a strong relationship between tree and shrub regeneration and the abundance and species richness of

woodland birds (Lindenmayer et al. unpublished data). Regeneration also increases soil stability.

Native species in the ground layer

Sites with a ground layer comprising native grasses, forbs and herbs are important for the conservation of grassland plants and animals. These areas may occur as pure grasslands or within Grassy Woodland vegetation. In some places, native grassland areas have developed after woodland vegetation has been cleared of trees. These areas are still very important and often support rare or threatened plants such as orchids. With appropriate land management, native grassy areas can also be improved or restored to high-quality grasslands or grassy woodlands.

Fallen dead timber

Fallen dead trees, logs, branches and stumps all provide important foraging and breeding habitat for invertebrates, reptiles, birds and small mammals. The iconic bush stone-curlew needs fallen timber near its nest sites, and many small woodland birds—including the hooded robin (*Melandodryas cucullata*)—spend most of their time feeding on invertebrates from fallen timber.

Standing dead timber

Dead trees often provide important breeding habitat for birds such as the threatened superb parrot (*Polytelis swainsonii*), as well as bats and possums.

Granite rocky outcrops (inselbergs)

Rocky outcrops in the South Western Slopes of the NSW Murray catchment have significant conservation values for reptiles. These have not been mapped extensively, but a number of important sites have been identified (Michael et al. 2008).

Vegetation patch size

In general, large patches of native vegetation support a greater variety of species and larger populations of individual species than small patches, which helps to retain genetic diversity. Large patches also provide refuge for species that are susceptible to disturbances (Fischer & Stöcklin 1997), and minimise 'edge effects' (such as weed invasion) that contribute to the degradation of vegetation patches (Morgan 1998).

All these factors increase the long-term viability and survival of species and biodiversity (Lonsdale 1999).

Some species, such as owls, raptors and the hooded robin need patches of vegetation that are larger than 50 hectares to survive. However, even very small (less than one hectare) remnants can still support many plant and animal species and maintain high condition within production landscapes. Many flora species can also persist in isolated remnants that are less than one hectare in size and retain gene flow between patches (Young et al. 2005).

Vegetation patch shape

The shape of a patch can also determine the number of species that can inhabit that patch. Patches with a low edge-to-area ratio are less susceptible to impacts from weeds, overabundant native species such as noisy miners and other edge effects than are linear patches with high edge-to-area ratios.

Connectivity of vegetation

Patches that are connected to or within one kilometre of other patches allow many birds and some mammals to move across the landscape for foraging, breeding and dispersal. Connectivity does not always need a direct link between patches of vegetation; many fauna species use 'stepping stones' such as large paddock trees or clumps of shrubs or regeneration to move between patches. The vegetation map (Figure 2.5) shows the distribution of vegetation patches across the NSW Murray catchment.

Presence of significant, rare or threatened species

The presence of significant, rare or threatened species can be an important indicator of the biodiversity value of a site. Chapter 5 provides detailed information about these species and some of the management actions recommended for their future survival in the NSW Murray catchment. Migratory species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)⁵ are also included in Appendices 5.2–5.4.

Sites and areas of importance to the NSW Murray catchment community

Stakeholders and biodiversity experts in the NSW Murray catchment identified nearly 500 significant biodiversity assets, including rivers, wetlands, areas of good soil quality, roadside vegetation, and travelling stock reserves with high conservation value (see Appendices 2.2–2.4).

Other indicators

Microhabitat features, such as leaf litter, intact soil crust, native ground cover and abundance of mistletoe plants, are important habitat features for invertebrates, reptiles, and threatened and declining woodland birds (Montague-Drake et al. 2009) and small mammals (McElhinny et al. 2006). The vegetation condition of a site will also be determined by past and current land management practices. Therefore, an understanding of the management history of the site is useful.

4.1.2 Local landscape features

The ecological values across the local landscapes that surround a site also help determine the abundance and diversity of plants and animals at the site. Important local landscape features are described below.

Amount of native vegetation in the surrounding local landscape or in the 'Mitchell landscape'

The total amount of native vegetation in a local landscape, where the vegetation is, and how well it is connected are often more important drivers of biodiversity than the size of each vegetation patch. Recent studies in the NSW South Western Slopes have shown that fauna such as squirrel gliders (*Petaurus norfolcensis*) (van der Ree et al. 2004) and brown treecreepers (*Climacteris picumnus*) (Doerr et al. 2011) can inhabit small remnants (less than one hectare) if small patches are connected to mature habitat trees and there is enough connective vegetation scattered across the local landscape.

Mitchell (2002) characterised and mapped ecosystems in NSW into planning units called 'Mitchell landscapes'. The proportion of existing native vegetation cover has been estimated for each of these landscapes. Mitchell landscapes that have less than 30 per cent native vegetation remaining (i.e. are

⁵ www.environment.gov.au/cgi-bin/sprat/public/publicshowmigratory.pl

more than 70 per cent cleared) are categorised as ‘overcleared’; significant declines in some plants and animals have occurred or are likely to occur in these areas (see Appendix 4.1).

Proximity to riparian areas, wetlands and rivers

Although the Murray BMP focuses on terrestrial biodiversity, many terrestrial flora and fauna species rely heavily on the ecosystem services of riparian (streambank or riverbank) areas and aquatic ecosystems such as rivers and wetlands. Many permanent and ephemeral freshwater wetlands in the NSW Murray catchment support significant aquatic and terrestrial biodiversity values. These include Wetlands of International Importance (www.environment.gov.au/epbc/protect/wetlands.html).

The habitat and connectivity values of the many significant watercourses in the NSW Murray catchment are critical for terrestrial biodiversity, particularly birds (Fisher & Goldney 1997, Jansen & Robertson 2001). The presence and condition of aquatic and riparian habitats should be taken into consideration when assessing the overall biodiversity and habitat values of a site.

Sites or landscapes identified in other biodiversity or planning strategies

Other planning processes have identified important local landscapes and assets that can influence biodiversity abundance at the site scale. Appendix 4.1 describes sites and landscapes identified in other biodiversity identification projects, including the draft Murray Regional Strategy, OEH ‘Priority local landscapes’ in the South Western Slopes of the NSW Murray catchment, important bird areas and Murray Catchment Management Authority’s (Murray CMA’s) important native seed production areas.

4.1.3 Vegetation type

The types of native vegetation, and their extent, condition and current management, strongly influence the types and diversity of plants and animals that occur at a site. Chapter 2 describes the 11 vegetation formations across the NSW Murray catchment, and Figure 2.5 shows broadly where in the catchment these formations occur. Areas with potentially important native vegetation can be identified using the vegetation mapping information in Chapter 2, and by answering the questions in Table 4.1.

Table 4.1 Identifying potentially important vegetation communities

Characteristic		Further information
Endemism	Is the vegetation community or vegetation formation restricted to, or is a large proportion of the current extent of the vegetation community or vegetation formation within, the NSW Murray catchment area?	Examples may include some alpine vegetation communities such as swamps, bogs and fens
Extent	Is the vegetation community or vegetation formation naturally rare or ‘overcleared’ (i.e. 30% or less of original extent remains)?	Section 2.5.2 details the extent of each of the 11 vegetation formations and the proportion of each that has been cleared
Level of protection	What proportion of the vegetation formation is protected in reserves?	Vegetation formations in the NSW Murray catchment that have low levels of protection may be prioritised for investment to manage further loss and degradation from threats. Section 2.5.2 provides information about the proportion of each formation represented in the reserve system
Conservation status	Is the vegetation community listed as threatened under NSW or Australian Government legislation?	Section 5.1.3 and Figure 5.1 provide descriptive and spatial guidance to the threatened vegetation communities in the NSW Murray catchment and some specific management actions in key management areas

4.2 Priority areas for Active Management and Repair of native vegetation at the catchment scale

Maps of native vegetation (Figure 2.5), vegetation condition (Figure 2.6) and likelihood of threats (Appendix 3.5) were incorporated into a computer modelling program called the Biodiversity Forecasting Tool (BFT) to develop maps of the priority areas for investment in Active Management and Repair of native vegetation in the NSW Murray catchment. Appendices 4.2–4.4 include more information about the BFT modelling program.

The catchment-scale priority Active Management and Repair maps highlight the areas in which efforts to maintain and conserve existing environmental values, manage threats and restore native vegetation will have the greatest benefit to biodiversity at the catchment scale. Some areas are identified as priorities for both Active Management and Repair. For example, an area with moderate vegetation condition that is under threat from weeds, but is large and well connected to other vegetation patches, may need both types of management actions to optimise future biodiversity outcomes.

Appendix 4.5 includes the spread of values for the investment priorities for Active Management of remnant vegetation and the investment priorities for Repair of native vegetation. The graphs in this appendix indicate that most of the catchment has a higher Repair value and lower Active Management value, consistent with the percentage of intact vegetation remaining. The graphs reflect the highly cleared nature of the region, especially of certain vegetation communities that then become high Repair priorities across their extent. The few vegetation communities with high Active Management benefits are likely to be rare examples of the same overcleared vegetation communities that are in high condition.

4.2.1 Active Management priority areas

Active Management areas have relatively good-condition vegetation. Often, the vegetation type is rare or overcleared, and is in relatively large patches that are connected to or close to other patches. Management in these areas is needed to ensure that existing or potential threats, such as weeds, pest

animals and inappropriate fire regimes, maintain the area's current biodiversity values. Figure 4.1 shows the Active Management priority areas in the NSW Murray catchment.

The greatest biodiversity outcomes for Active Management priority areas are likely to be achieved by protecting the existing vegetation extent and condition. Options for investment in these areas include voluntary land management stewardship agreements, property vegetation plans, Nature Conservation Trust of NSW covenants, education and mentoring programs, or the addition of an area to the National Reserve System.

The BFT does not distinguish between public and private land. Therefore, priority Active Management areas are located across all tenures, including National Parks and Wildlife Service (NPWS) estate, state forests, travelling stock reserves and other Crown lands, as well as private land.

4.2.2 Repair priority areas

Repair areas are in relatively low condition or have been overcleared, and remnant vegetation is in small, fragmented and isolated patches. If these areas are restored through replanting and natural regeneration to increase the extent and condition of native vegetation, the best biodiversity outcomes at a catchment scale may be achieved. Management actions could include revegetation with local species, promotion of natural regeneration, weed control, sustainable grazing practices and appropriate fire management. In addition to improving vegetation condition and extent, these actions will contribute significantly to improving the connectivity of vegetation at the landscape scale. Actions to protect existing vegetation and biodiversity values may also be required in Repair priority areas; this could include the funding of management agreements to address key threats to biodiversity in the area.

Figure 4.2 shows the priority areas for Repair in the NSW Murray catchment.

4.2.3 Combined Active Management and Repair priority areas

Figure 4.3 shows the top two quartiles of both Active Management and Repair areas; that is, the highest priority areas for both categories. The upper, central

north and western parts of the catchment primarily require Active Management of biodiversity, while the central catchment (South Western Slopes and southern Riverina) mainly includes priority Repair areas.

Some areas require a combination of Active Management and Repair actions. For example, where a large, but isolated, patch of good-condition vegetation (i.e. Active Management area) is surrounded by cleared or low-condition vegetation (i.e. Repair area), a combination of management actions may be needed to achieve the best biodiversity outcomes.

4.2.4 Priority investment areas for individual vegetation formations

A large proportion of the NSW Murray catchment is categorised as in need of Repair (Figure 4.2). This makes it difficult for investors to prioritise areas for biodiversity management. To provide a greater level of detail and cater for different investors' preferences, the BFT was re-run for 9 of the 11 vegetation formations (see Section 2.5.2 for more information on vegetation mapping). The nine formations with maps are Grassy Woodlands, Dry Sclerophyll Forests, Wet Sclerophyll Forests (including Rainforest), Arid (chenopod) Shrublands, Semi-arid Woodlands, Grasslands, Forested Wetlands, Freshwater Wetlands and Alpine Complex. The mapped areas of Saline Wetlands and Heathlands were too small to be visible at the catchment scale.

Figure 4.4 shows the highest priority areas for both Active Management and Repair of Grassy Woodlands. Maps for other vegetation formations are shown in Appendix 4.6.

4.2.5 Using priority areas to plan for resilience to climate change

One of the key challenges for land managers and planning agencies is increasing climate change resilience into biodiversity management. Many factors determine the ability of a site, local landscape or catchment and their component species to adapt to the impacts of climate change. These include:

- geography, aspect, altitude, soil fertility
- vegetation extent, connectivity, type and condition
- proximity to landscape features such as aquatic ecosystems

- threats to biodiversity including existing habitat and potential future habitat.

Resilience to biodiversity decline is a particularly important consideration for the NSW Murray catchment and other parts of southern NSW, because significant decreases in winter rainfall and increases in maximum and minimum temperatures across all seasons are predicted to occur over the next century (CSIRO 2007, DECCW and I&I 2010). Data for these predictions were not detailed enough to inform the BFT modelling. However, the priority investment mapping information for Active Management (Figures 4.1, 4.3, 4.4 and Appendix 4.6) identifies areas that are likely to be relatively resilient to climate change if managed appropriately. Management actions in the priority Repair areas that improve the extent, condition and connectivity of native vegetation will also contribute to resilience.

Planning for resilience to climate change also requires consideration of other threats, such as feral pest species, that cannot be or have not been mapped.

4.3 Other catchment-scale priorities for biodiversity management

In addition to the catchment-scale priority Active Management and Repair areas discussed in this chapter, areas and corridors developed through other planning initiatives also contribute to biodiversity at the catchment scale. These areas should also be considered when investing in biodiversity management; some of these are described below. In most cases, the priority areas identified by other initiatives align with the priority areas identified in the Murray BMP.

4.3.1 National Reserve System

The aim of the National Reserve System is the comprehensive and adequate representation of different vegetation communities and other biodiversity values, and their protection in both formal reserve networks and non-reserved public and private lands. The NPWS estate in the NSW Murray catchment is mainly located in the alpine areas, the upper western slopes of the Great Dividing Range, and the river red gum forests of the central and western catchment (see Figure 2.8). These are all large, well-connected areas

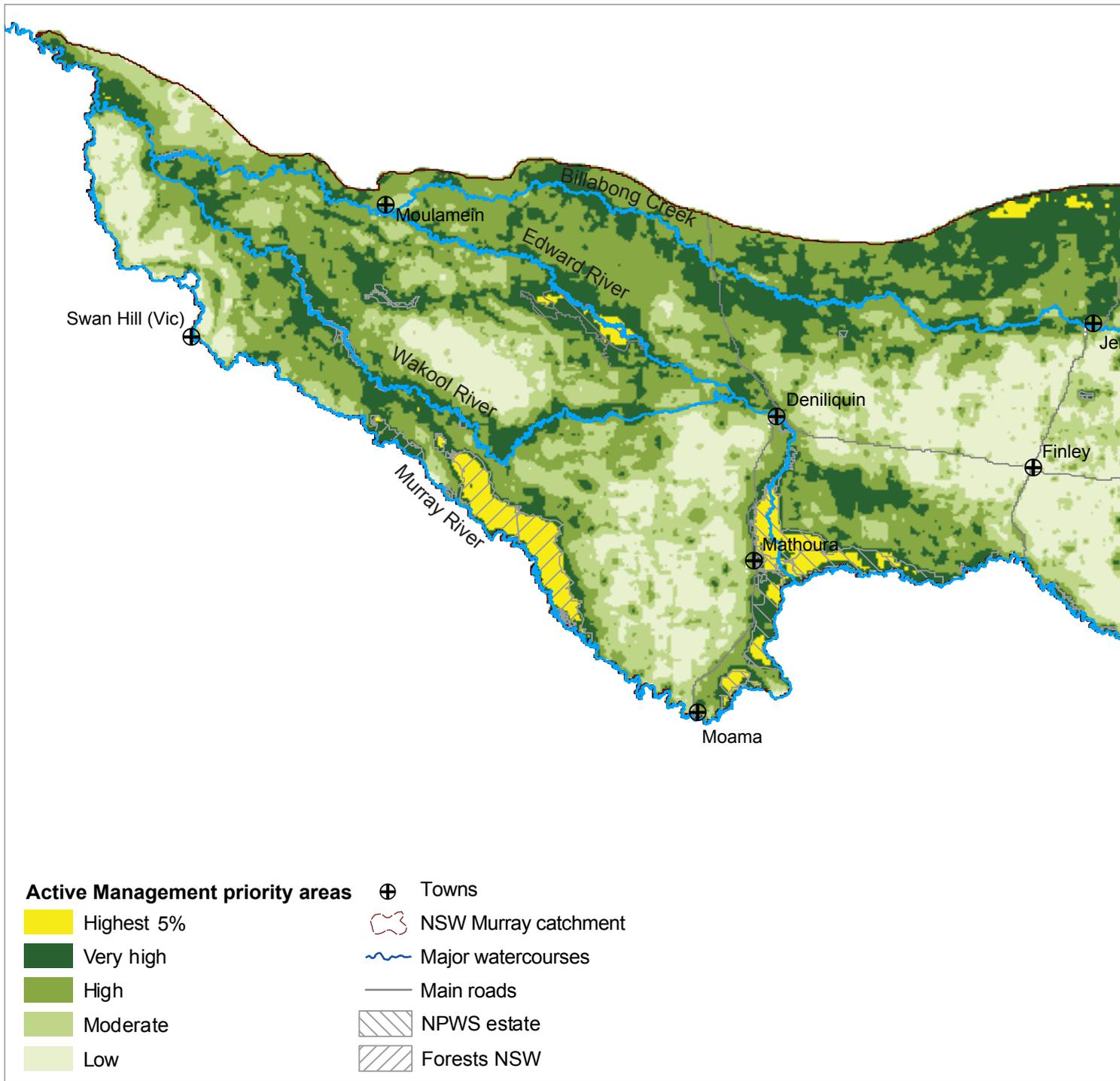
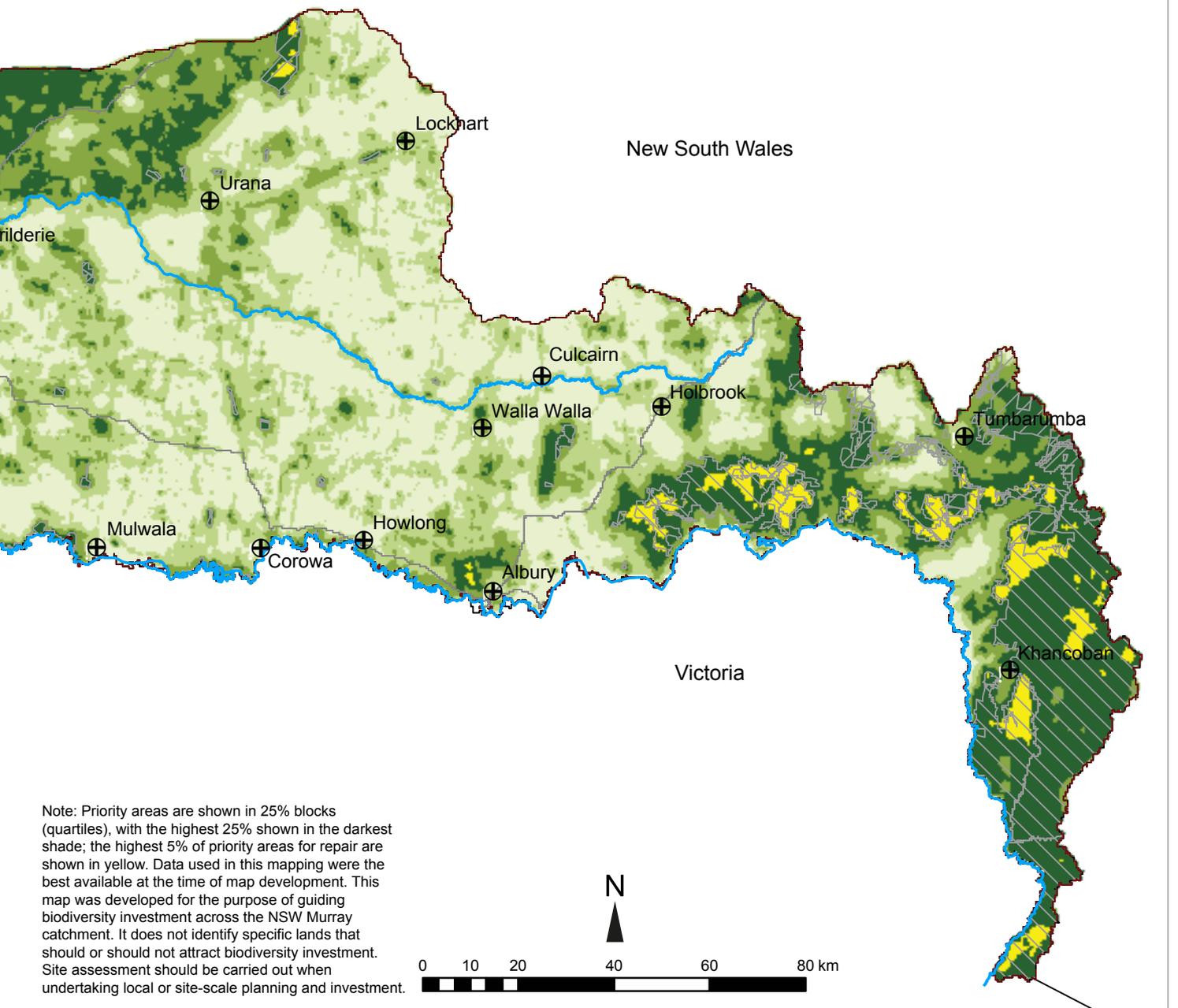


Figure 4.1 Active Management priority areas across the NSW Murray catchment



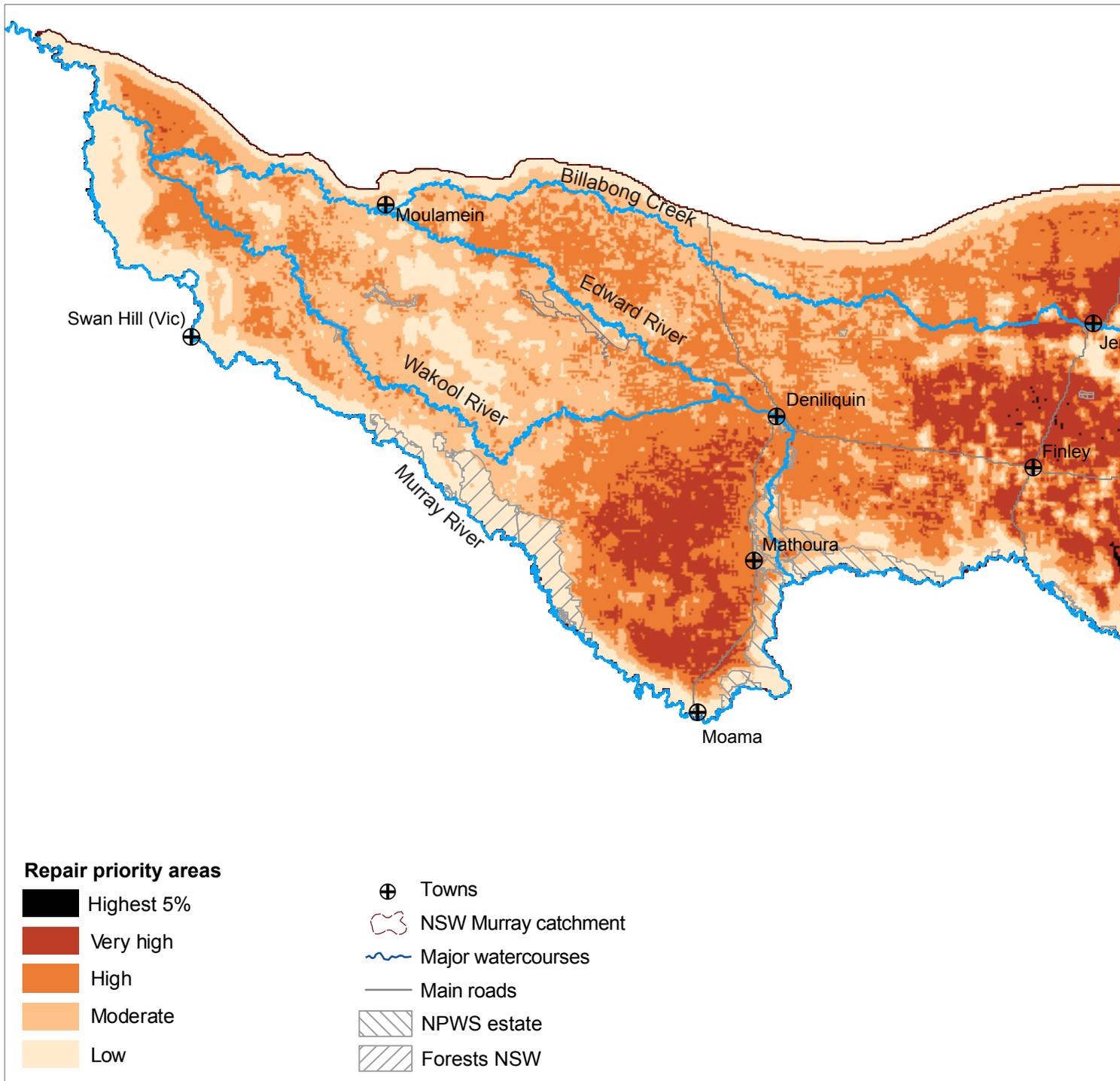
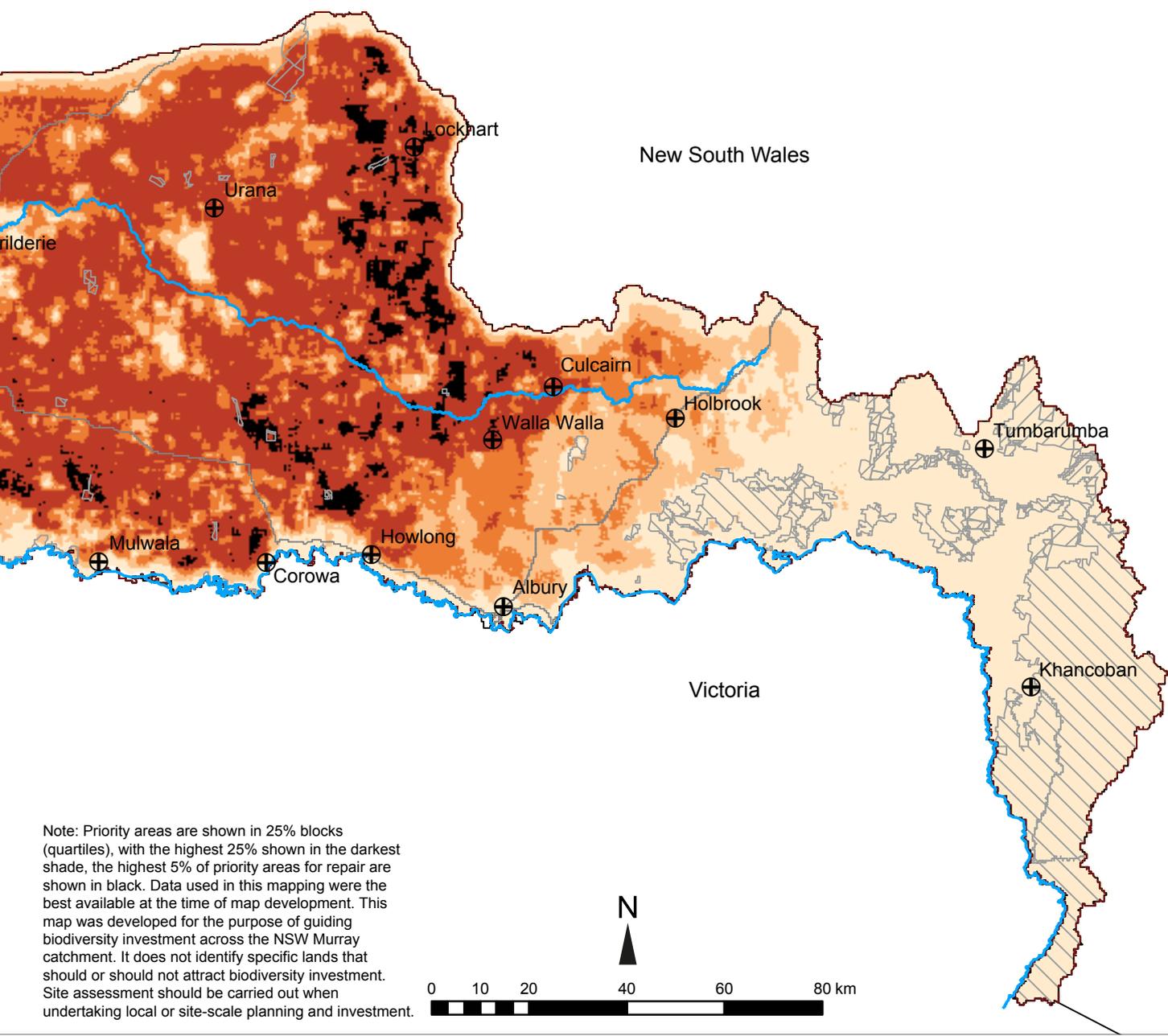


Figure 4.2 Repair priority areas across the NSW Murray catchment



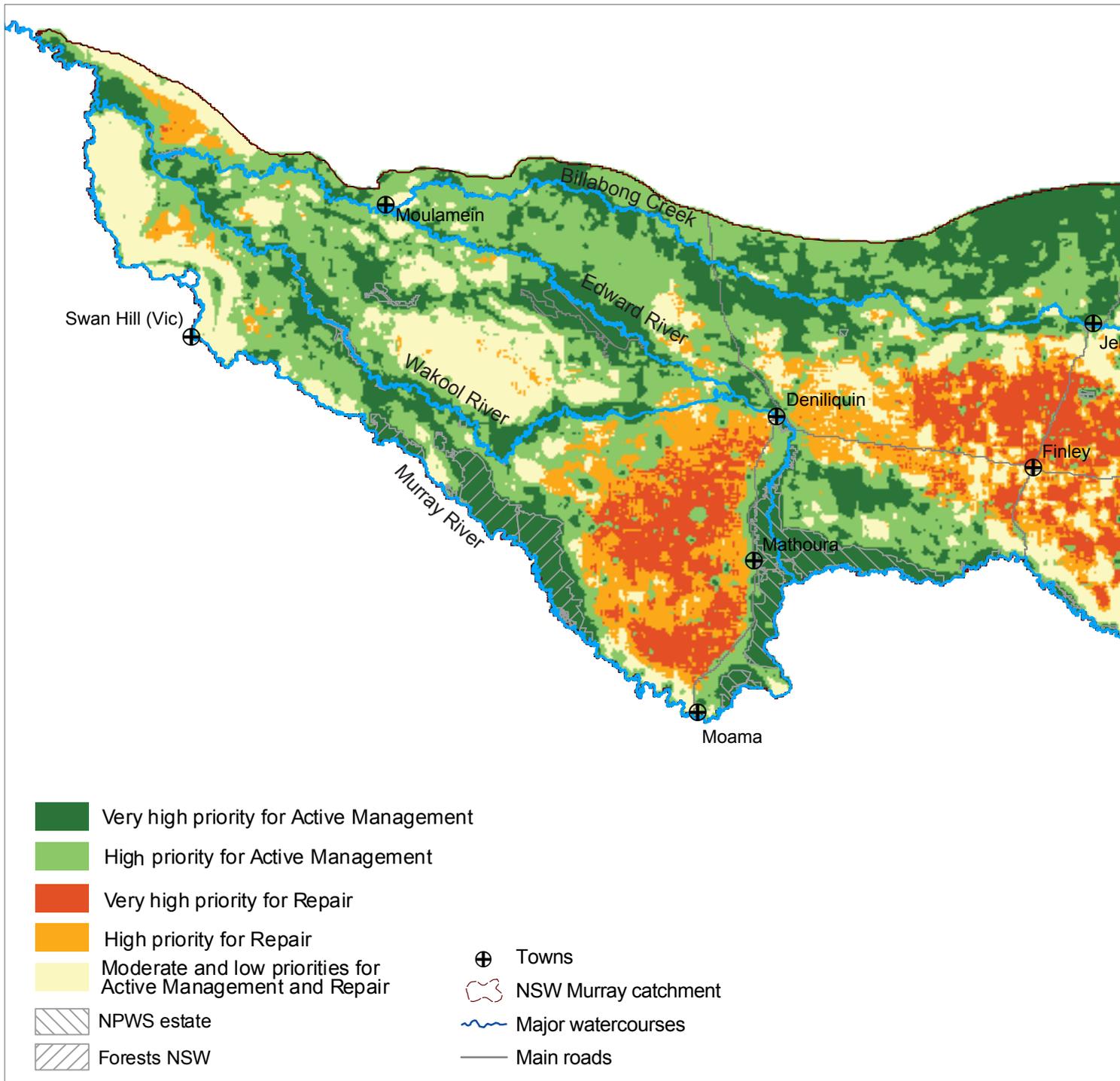
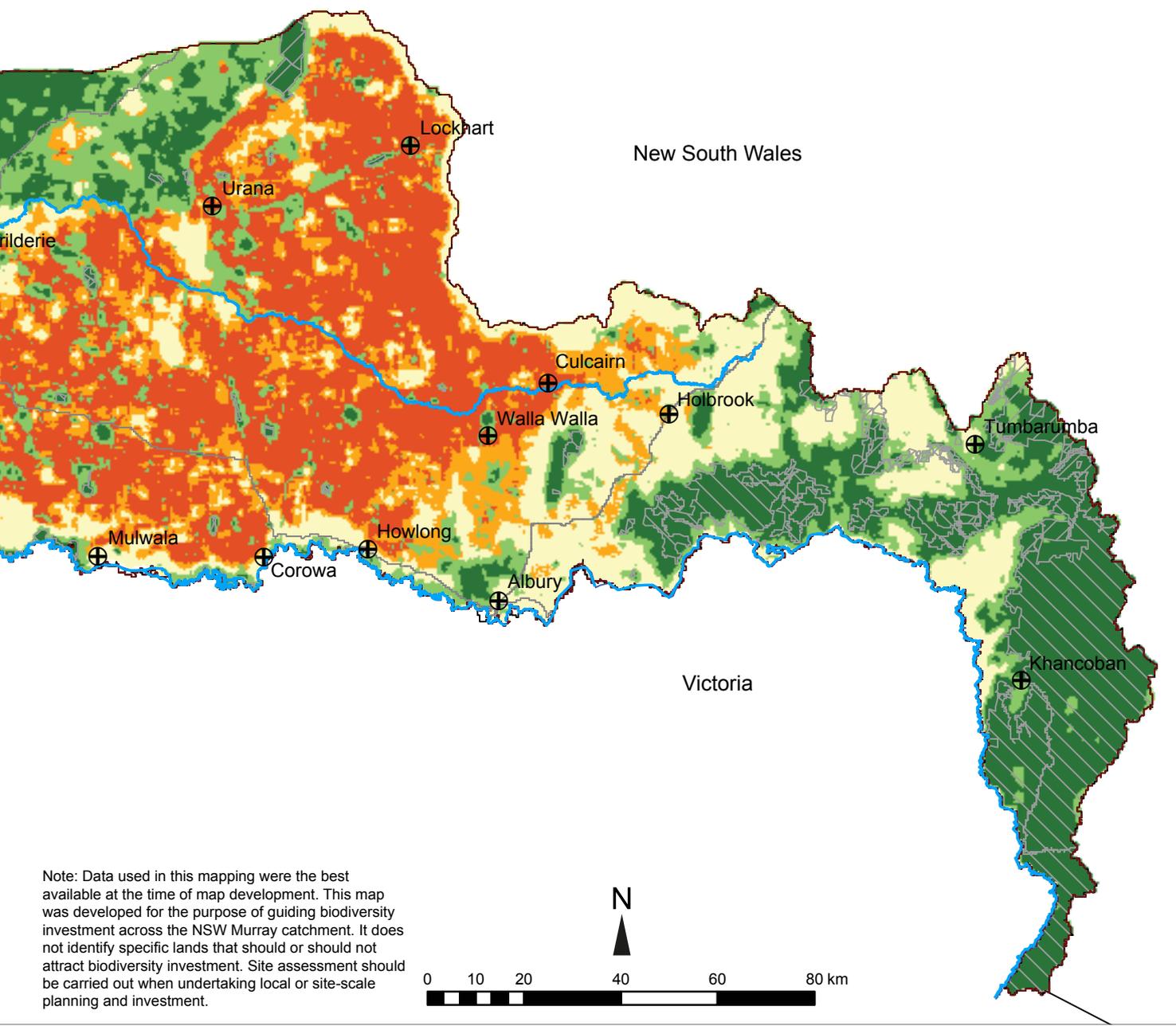


Figure 4.3 Very high and high priority areas for Active Management of remnant vegetation and Repair of native vegetation in the NSW Murray catchment



Note: Data used in this mapping were the best available at the time of map development. This map was developed for the purpose of guiding biodiversity investment across the NSW Murray catchment. It does not identify specific lands that should or should not attract biodiversity investment. Site assessment should be carried out when undertaking local or site-scale planning and investment.

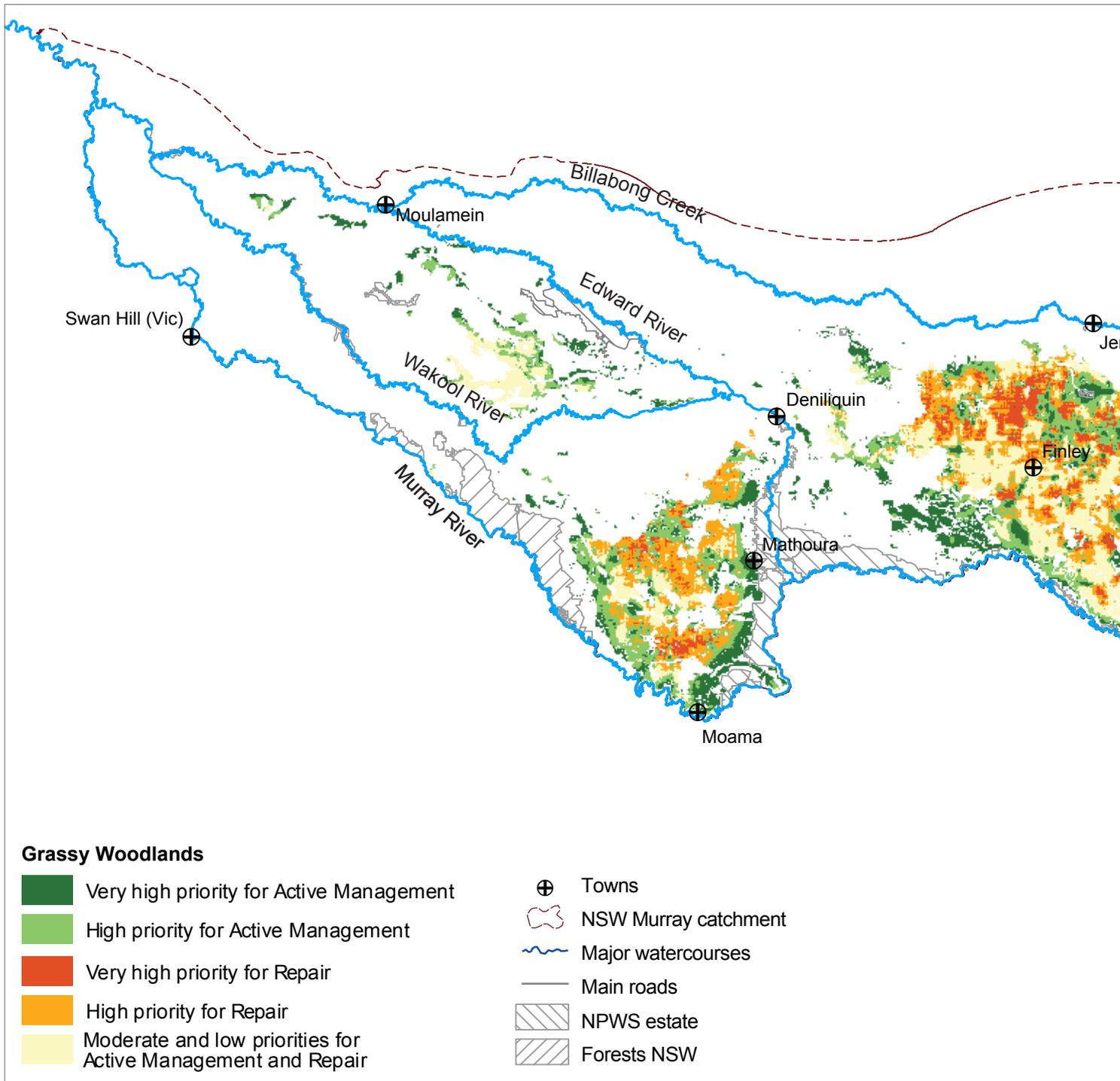
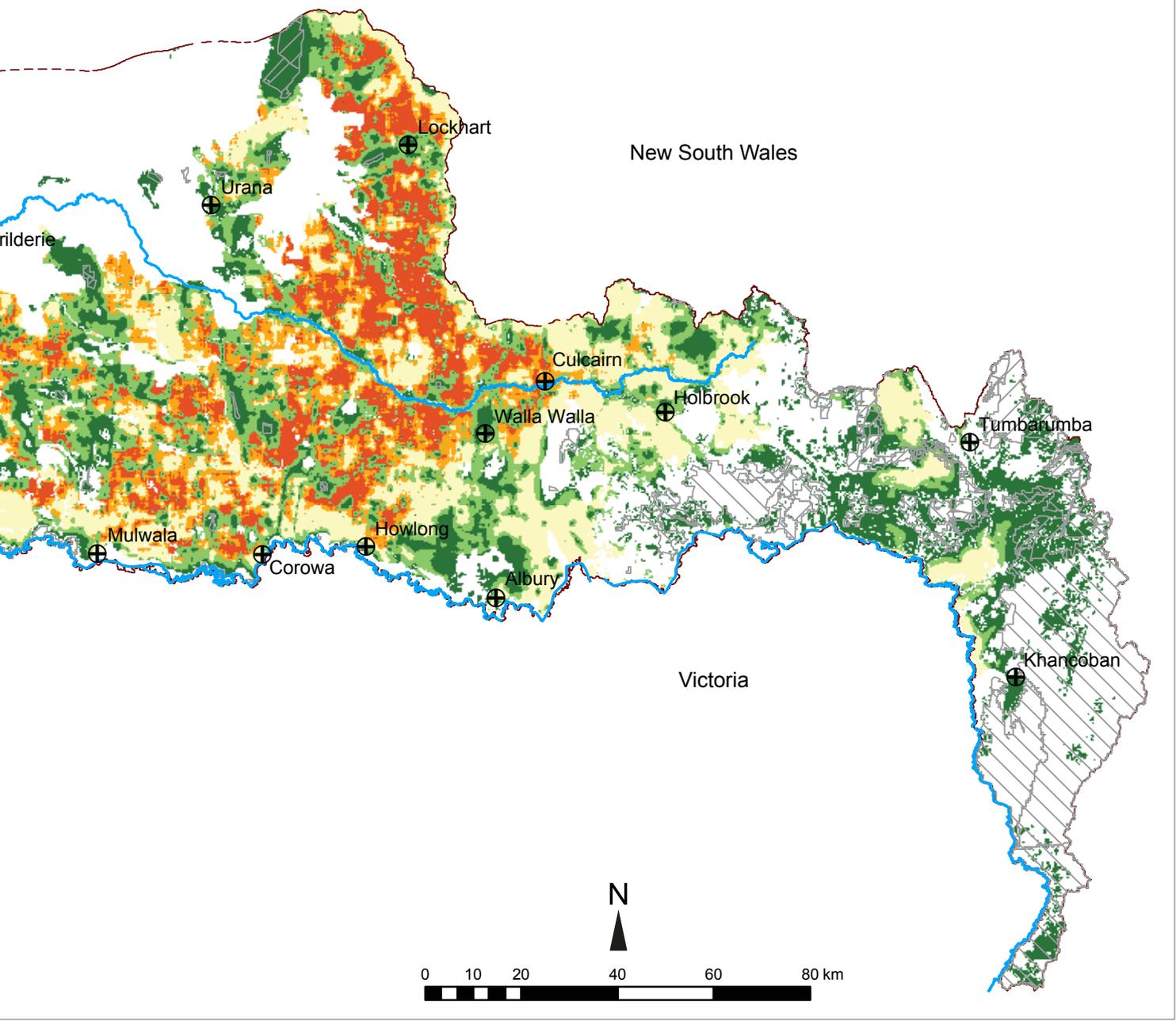


Figure 4.4 Very high and high priority areas for Active Management and Repair for Grassy Woodlands in the NSW Murray catchment



of native vegetation with high biodiversity values. In particular, the alpine parks capture a unique suite of plants and animals, including many that are confined to areas in the highest parts of Australia. The relatively new river red gum national parks provide important connectivity along the riparian habitats of the Murray and Edward river systems. The habitat values of riparian areas to terrestrial and aquatic biodiversity are well known, such as providing drought refuges for many terrestrial fauna species (Fisher & Goldney 1997, Jansen & Robertson 2001).

4.3.2 Other public lands with biodiversity values

The biodiversity and landscape value of the network of travelling stock reserves has been well documented through detailed surveys by Webster (1997, 1999a, 1999b, 2000a, 2000b, 2001a, 2001b). At the local scale, travelling stock reserves and other areas of Crown land have generally retained a high proportion of woody vegetation cover. Intermittent grazing pressure has allowed native ground and shrub cover plants to persist, providing significant habitat for many plants and animals, including threatened species (see Figure 2.8).

4.3.3 National wildlife corridors

Habitat connectivity and corridors are fundamental requirements of healthy, productive and biodiverse landscapes (NWCPAG 2012). Connectivity is particularly important for post-breeding dispersal and landscape-scale movements of mobile and nomadic fauna (Bennett 2003, Scotts 2003). There is growing recognition that we need to use various conservation and restoration mechanisms to strategically link protected areas (in the reserve system and on other tenures) with areas of remnant habitat and ecological values.

A draft national wildlife corridors plan was launched in March 2012 as a component of Australia's Biodiversity Conservation Strategy (NWCPAG 2012).⁶ The draft plan has a strategy to restore and manage ecological connections across Australian landscapes, and contribute to wildlife corridors on private and public land tenures. It describes six existing corridor initiatives across Australia, including the Great Eastern Ranges project (Section 4.3.4).

⁶ www.environment.gov.au/biodiversity/wildlife-corridors/publications/pubs/draft-wildlife-corridors-plan.pdf

The Murray BMP identifies an additional four potential corridor initiative regions, including the Edward–Wakool Rivers region within the NSW Murray catchment area. Parts of the Edward–Wakool region are identified as priority Active Management investment areas for terrestrial biodiversity (see Figure 4.1). If this region eventually becomes a national corridors initiative, the terrestrial biodiversity information in the Murray BMP should be incorporated into future strategic planning documents and funding guidelines.

4.3.4 Great Eastern Ranges and Slopes to Summit region

The Great Eastern Ranges (GER) initiative aims to protect and connect the Great Dividing Range to parts of the coast via the eastern escarpment, as well as parts of the western slopes, including the Slopes to Summit (S2S) project area that is within the Murray CMA area (see Section 4.3.5). The GER region supports a significant proportion of NSW's threatened fauna and has high forest species richness and endemism. It now forms one of 35 biodiversity forest regions in the world (the 'Forests of East Australia' International Biodiversity Hotspot). Although many parts of the GER region are pristine and intact, others are heavily modified and in need of restoration (e.g. reconnecting fragmented landscapes). The consolidated conservation efforts along the Great Dividing Range aim to improve climate change resilience and biodiversity conservation.⁷

Slopes to Summit is a regional biodiversity planning project focused on 'Community working together to protect threatened species and connect important wildlife habitats in the upper Murray River and Billabong Creek catchment' (Slopes to Summit 2010). Partners that steer the project include Murray CMA, the Nature Conservation Trust of NSW, Holbrook Landcare, Charles Sturt University, Australian National University, Albury Wodonga Parklands, NSW Office of Environment and Heritage and CSIRO.⁸ S2S is one of several partnership projects within the GER initiative that aims to improve landscape resilience and connectivity.

⁷ For more information on the GER region, see www.environment.nsw.gov.au/ger

⁸ For more information on S2S, see www.greasternranges.org.au/partnerships/partnerships/slopes-to-summit-s2s

In 2009, the S2S partners identified priority landscapes known to contain significant biodiversity values, such as threatened species. These landscapes were seen as the best opportunities to improve connectivity conservation in the region. They include:

- Jindera and Thurgoona Landscape
- Woomargama Landscape
- Nest Hill to Morgan's Ridge
- Little Billabong
- Billabong Creek
- Woomargama to Murray River
- Upper Murray Link.

Some priority S2S areas have also been captured in the priority Active Management and Repair areas in Figures 4.1 and 4.2.

4.3.5 NSW landscape value mapping

Connectivity considerations are of critical importance to the survival of species and populations, especially where habitat fragmentation has reduced the area available to populations of fauna. In addition, connectivity that favours large-scale movement of native species through preferred habitat is seen as an aid to adapting to possible environmental changes arising from climate change.

In 2010, the NSW Department of Environment and Climate Change mapped landscape value across the eastern and central divisions of NSW to identify priorities for conservation, particularly at the landscape scale and larger (Drielsma et al. 2010). This work was initiated to assist the travelling stock reserve assessment process, but has since expanded to include the GER initiative. The landscape value information could be customised to help allocate catchment management authority conservation incentives and reserve establishment.

The mapping from the landscape value mapping project is not intended to direct management actions to particular locations. Rather, where habitat connectivity needs to be improved or maintained, landscape value mapping guides what to do (i.e. protect, improve or restore), and broadly, which vegetation formations to focus on.

4.3.6 State-scale 'Native Vegetation Management Benefits'

In 2011, OEH conducted a series of four state-scale analyses to show where native vegetation management would contribute the highest benefit to terrestrial biodiversity through improvement in the condition, extent and connectivity of native vegetation. These analyses are combined in a single state-scale map depicting the highest native vegetation management benefits ('NVM Benefits') (OEH, in prep.). The NVM Benefits map in Appendix 4.1 shows the distribution of the top 5–10 per cent of priority areas within the NSW Murray catchment for three types of management:

- 'Revegetate' benefits are cleared areas where re-establishment (through replanting or natural regeneration) of species that previously occurred at the site would contribute to improving the condition of terrestrial biodiversity at the state scale.
- 'Manage/Improve' benefits relate to areas of existing native vegetation that are generally in good condition and where the management emphasis would be on maintaining this high condition. 'Improve' benefits generally comprise the best examples of more heavily altered vegetation types, which nonetheless require some form of active management to improve their condition.
- 'Consolidate' benefits were derived through a different form of analysis to the other three benefit layers, and provide a state-scale cross-regional connectivity analysis. The layer highlights where emphasis on linking, or retaining the current connectivity values of core remnants, would provide greatest benefit. This includes a combination of monitoring and targeted removal of threats (weeds, inappropriate fire regimes, etc.) and revegetation to buffer or link otherwise isolated vegetation remnants.

Individual statewide maps depicting each of these four layers are available from the OEH data download facility: www.environment.nsw.gov.au/research/AncillaryVegetationProductsDataInventory.htm.

The Active Management priority areas in the Murray BMP (Figure 4.1) align primarily with the Consolidate priorities of the NVM Benefits map, and the Repair priority areas (Figure 4.2) primarily align with Revegetate and Manage/Improve priorities.

There are some additional priority investment areas in Figures 4.1 and 4.2, which may be explained by slight differences in priority scores derived from analyses using regional-scale data and consideration of threats to biodiversity.

4.4 Related technical information

The following appendices are available on CD by contacting Murray Catchment Management Authority, or online at www.murray.cma.nsw.gov.au.

Appendix 4.1 Other biodiversity planning strategies and processes relevant to the NSW Murray catchment

Appendix 4.2 The Biodiversity Forecasting Tool

Appendix 4.3 Flow chart of the Biodiversity Forecasting Tool process

Appendix 4.4 Graphical representation of the Biodiversity Forecasting Tool process to identify Active Management and Repair priorities

Appendix 4.5 The area and proportion of the NSW Murray catchment for each quartile of investment priorities for Active Management of remnant vegetation and investment priorities for Repair of native vegetation

Appendix 4.6 Maps of each vegetation formation showing investment priorities for Active Management of remnant vegetation and investment priorities for Repair of native vegetation



5

**Significant
species, populations and
ecological communities
in the NSW Murray
catchment**

5 Significant species, populations and ecological communities in the NSW Murray catchment

Key points

- The NSW Murray catchment is home to more than 120 threatened species, populations and ecological communities. Some of these threatened species and their habitats are protected and managed under various recovery plans.
- The NSW Priorities Action Statement (PAS₁) is a database that lists the recommended recovery actions for each threatened entity. This database will soon be superseded by PAS₂, which will also identify recovery projects for individual threatened species.
- Because PAS₂ is not yet available, the NSW Murray Biodiversity Management Plan instead identified 30 priority management areas and defined recovery management actions for each.
- Many other significant species that are not formally listed as threatened occur in the NSW Murray catchment, including 28 species of migratory birds. These were identified through a matrix of key biodiversity assets, community engagement workshops and expert panels. Broad management actions were identified for these species.

This chapter focuses on species, populations and ecological communities (including threatened entities) that are significant for biodiversity. Many of these species are formally listed as threatened under Commonwealth and/or NSW legislation, and a number were also identified as important by the NSW Murray community.

5.1 Threatened species, populations and ecological communities

At the time of the New South Wales Murray Biodiversity Management Plan's (Murray BMP's) preparation, the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the *Fisheries Management Act 1994* (FM Act) formally listed 128 species, populations and ecological communities within the NSW Murray catchment as threatened. Additionally, 53 species and ecological communities in the NSW Murray catchment were listed as threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Table 5.1 and Appendix 5.2).

Table 5.1 Summary of the status of threatened entities in the NSW Murray catchment (March 2012)

Status	EPBC Act	TSC Act	FM Act
Flora			
Critically endangered	–	6	–
Endangered	6	15	–
Vulnerable	18	18	–
Fauna			
Critically endangered	–	2	2
Endangered	9 terrestrial 3 aquatic	12 1 preliminary listing	5
Vulnerable	9 terrestrial 1 aquatic	55	1
Populations			
Endangered	–	1	2
Ecological communities			
Critically endangered	1	–	–
Endangered	6	8	1

EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth); FM Act = *Fisheries Management Act 1994* (NSW); TSC Act = *Threatened Species Conservation Act 1995* (NSW)

Note: Some species are listed under more than one Act.

Within the NSW Murray catchment, eight terrestrial endangered ecological communities (EECs) are listed under the TSC Act, and the six EECs (one critically endangered) are listed under the EPBC Act. The FM Act lists one aquatic EEC in the catchment. The TSC and EPBC Acts use different terminology to describe similar ecological communities. Appendices 5.2 and 5.3 list the EECs and identify their associated NSW and Australian Government listings.

Most EECs have not been mapped in the catchment; however, Figure 5.1 shows a broadly indicative map. This was generated using information in Roff et al. (2010a) to identify the vegetation communities likely to include each EEC. This map has not been ground validated to confirm the presence of the EECs and should be interpreted with caution.

Appendix 5.6 lists websites that contain more information on individual species, populations and ecological communities.



Brown treecreeper (top), pied honeyeater, plains-wanderer
Photos: Chris Tzaros, David Parker

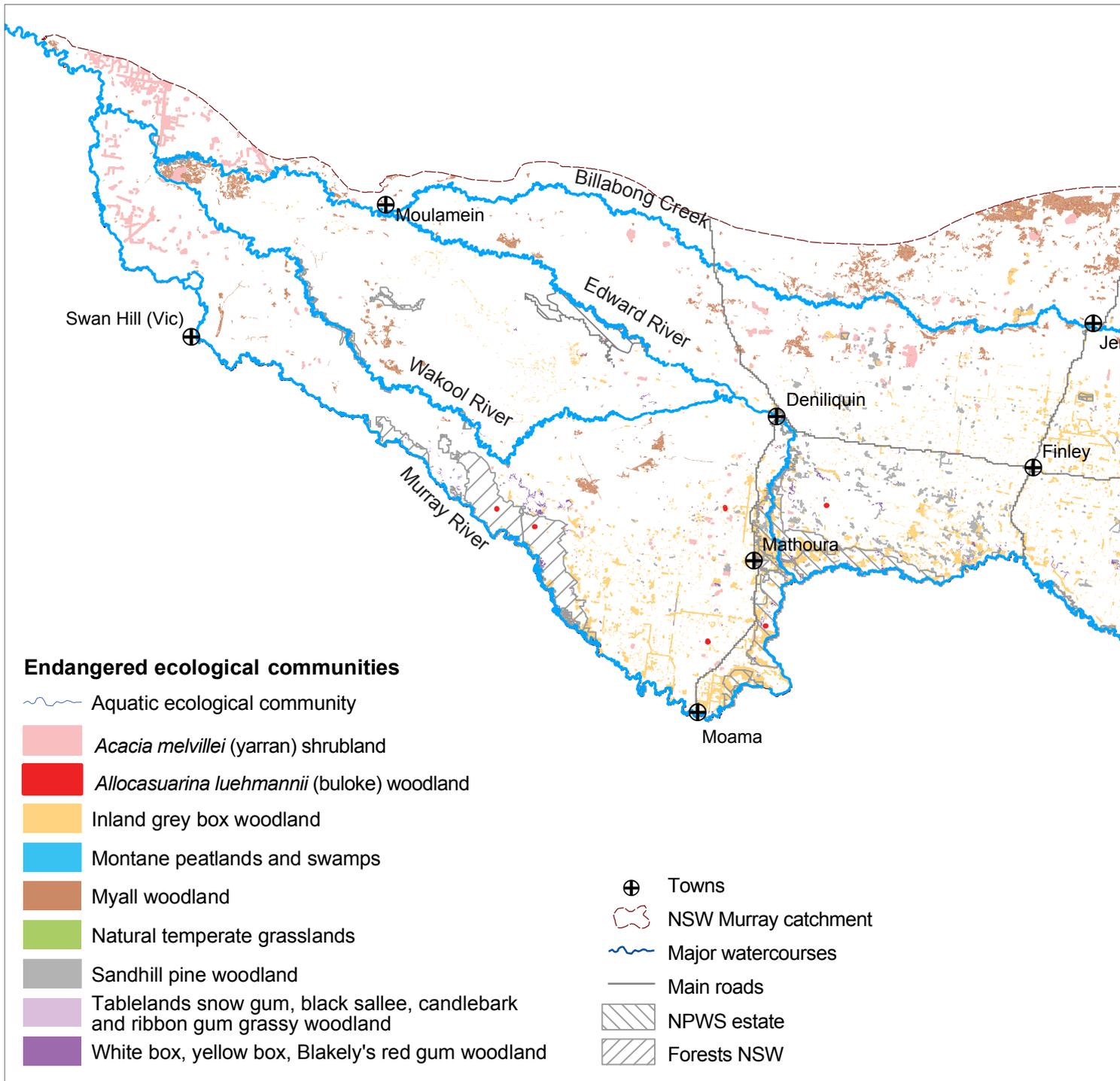
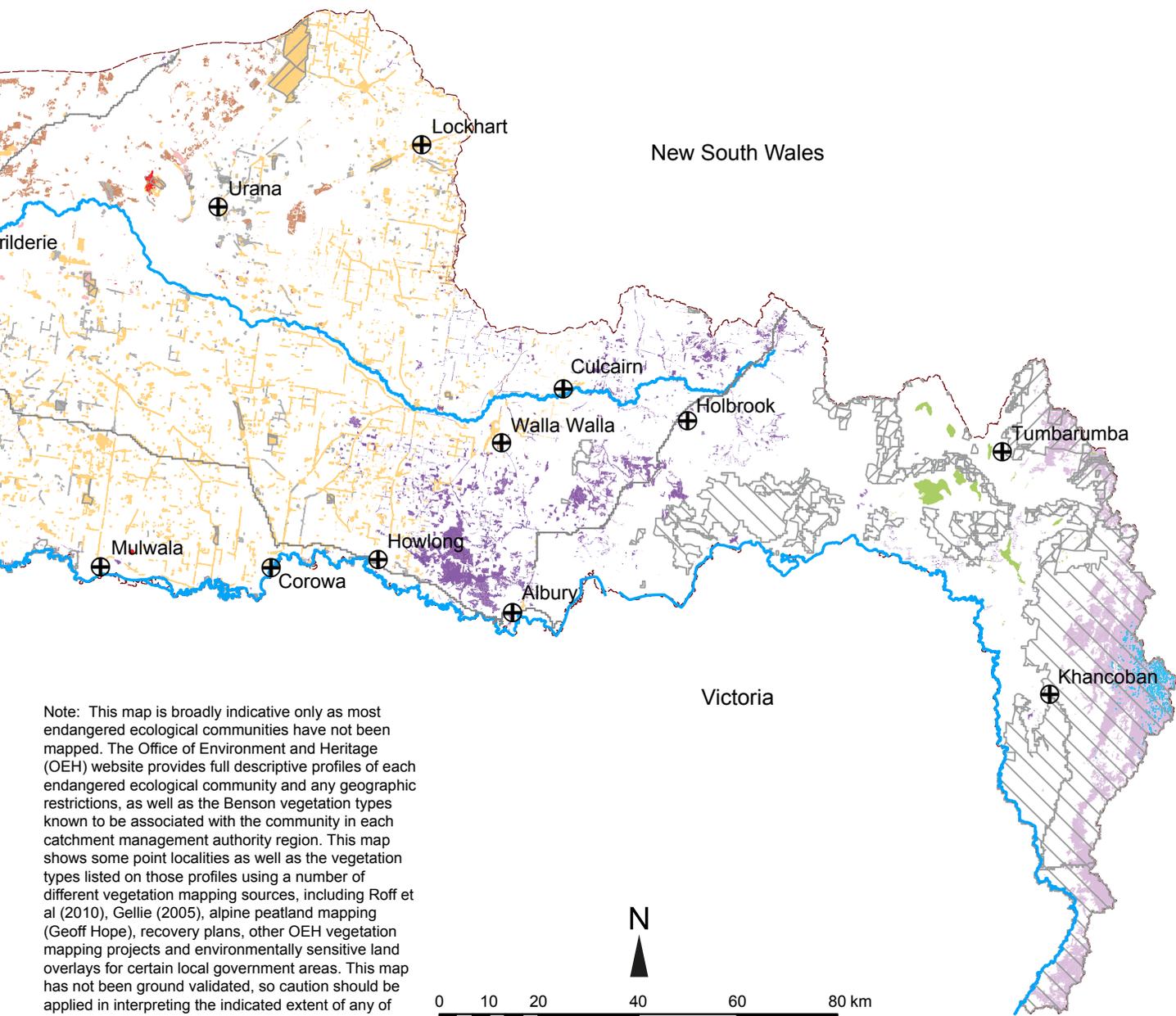


Figure 5.1 Terrestrial endangered ecological communities in the NSW Murray catchment



Note: This map is broadly indicative only as most endangered ecological communities have not been mapped. The Office of Environment and Heritage (OEH) website provides full descriptive profiles of each endangered ecological community and any geographic restrictions, as well as the Benson vegetation types known to be associated with the community in each catchment management authority region. This map shows some point localities as well as the vegetation types listed on those profiles using a number of different vegetation mapping sources, including Roff et al (2010), Gellie (2005), alpine peatland mapping (Geoff Hope), recovery plans, other OEH vegetation mapping projects and environmentally sensitive land overlays for certain local government areas. This map has not been ground validated, so caution should be applied in interpreting the indicated extent of any of these endangered ecological communities.



5.1.1 Threatened species recovery plans and other planning documents

As of March 2012, final or draft recovery plans had been prepared for 32 threatened entities in the NSW Murray catchment. Preparation of single-species recovery plans at the state or national level is no longer considered the best way to manage threatened species. This is due to the time required to prepare plans for an increasing number of threatened entities (currently more than 1000 in NSW). Biodiversity management and threatened species recovery plans are now focusing at the levels of regions, bioregions or ecological communities (P. Latch, Australian Government Department of Sustainability, Environment, Water, Population and Communities, pers. comm.). However, a small number of single-species plans may still be prepared in some circumstances.

The protection and management of threatened species and their habitat is also considered in plans of management for National Parks and Wildlife

Service (NPWS) parks and reserves⁹ and NPWS fire-management strategies.¹⁰ These plans provide specific actions for weed and feral animal control to help manage threatened species. In some instances, fire hazard reduction activities are prescribed specifically to protect threatened species populations. Management actions, such as coordinated fox control, are often undertaken in partnership with park neighbours.

5.1.2 NSW Priorities Action Statement

Since the inception of the TSC and EPBC Acts, many land managers, Landcare and other community groups and individuals have invested in management actions to help recover threatened entities of the NSW Murray catchment. Some of these actions are incorporated into formal recovery plans and plans of management to accommodate the growing list of threatened entities and their associated management actions. Recovery databases, such as the NSW Priorities Action Statement for Threatened Entities (PAS1) database, have been developed that list the recovery actions recommended for each entity. The actions are usually general in description and non-spatial, with some exceptions.¹¹

The NSW Office of Environment and Heritage (OEH), NPWS and some catchment management authorities implemented PAS1 recovery actions and reported through the OEH Threatened Species Recovery Database. This database will soon be superseded by PAS2, which will become publicly available in 2013. PAS2 will include mechanisms to identify whether species under threat require direct action at specific sites, or whether they can be managed as part of broader landscape actions (e.g. improving connectivity between patches of bushland). PAS2 will also identify cost-effective recovery projects with critical recovery actions based on current scientific and expert advice. These projects will be prioritised using cost-benefit information.

⁹ www.environment.nsw.gov.au/parkmanagement/ParkManagementPlans.htm#from-quicknav=Park+management+plans
¹⁰ www.environment.nsw.gov.au/firemanagement/FireManagementPlans.htm
¹¹ For individual actions included in the PAS1 or in recovery plans refer to Appendix 5.3 or visit www.environment.nsw.gov.au/threatenedspecies/

An important step in the PAS2 prioritisation process for threatened species recovery in NSW is categorising all threatened species into one of six management streams. Categorisation depends on a range of factors, such as the amount of information available for a species, how it is valued by the local community, its distribution, and the scale of the threats that affect the species. The management streams will help to identify the most appropriate management for each species. Appendix 5.1 describes the different management streams. Appendix 5.2 identifies the six management streams for threatened species in the NSW Murray catchment.

PAS2 recovery projects will be developed by the end of 2012 for one iconic and 12 site-managed threatened entities in the NSW Murray catchment. Since the time frames for the delivery of PAS2 projects do not align with the Murray BMP, an alternative approach for targeted threatened species management is presented in Section 5.1.3.

5.1.3 Recovery actions for regionally iconic and priority threatened species in the NSW Murray catchment

The Murray BMP and many previous planning exercises (e.g. Slopes to Summit, NSW Murray Catchment Biodiversity Action Plan (Miles 2001)) have identified numerous important sites and areas across the NSW Murray catchment in which threatened and regionally iconic species occur. However, finite management resources restrict the number of priority management areas. The OEH, Murray Catchment Management Authority (Murray CMA) and external experts identified thirty sites, areas or landscapes with threatened, regionally iconic or other significant flora and fauna species, which they considered to be priorities for future investment (Figure 5.2). Recovery management actions for the areas identified in Figure 5.2 are shown in the tables following the figure. Reference to future PAS2 site-managed species projects that may occur within the 30 management areas is also provided in the tables.



Pobblebonk frog (left), long-neck turtle (top), bearded dragon
 Photos: Natasha Lappin, Elisa Tack

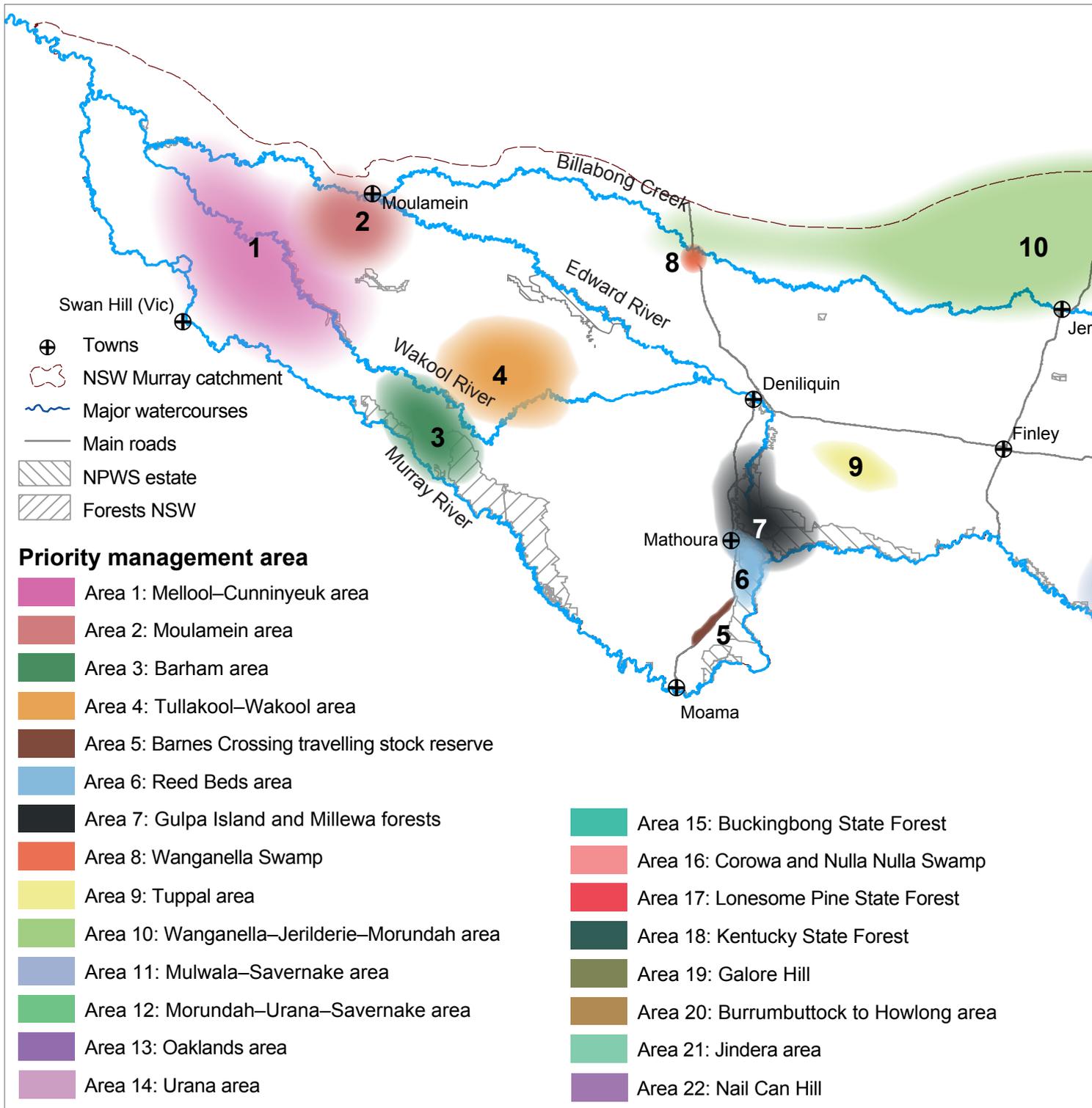
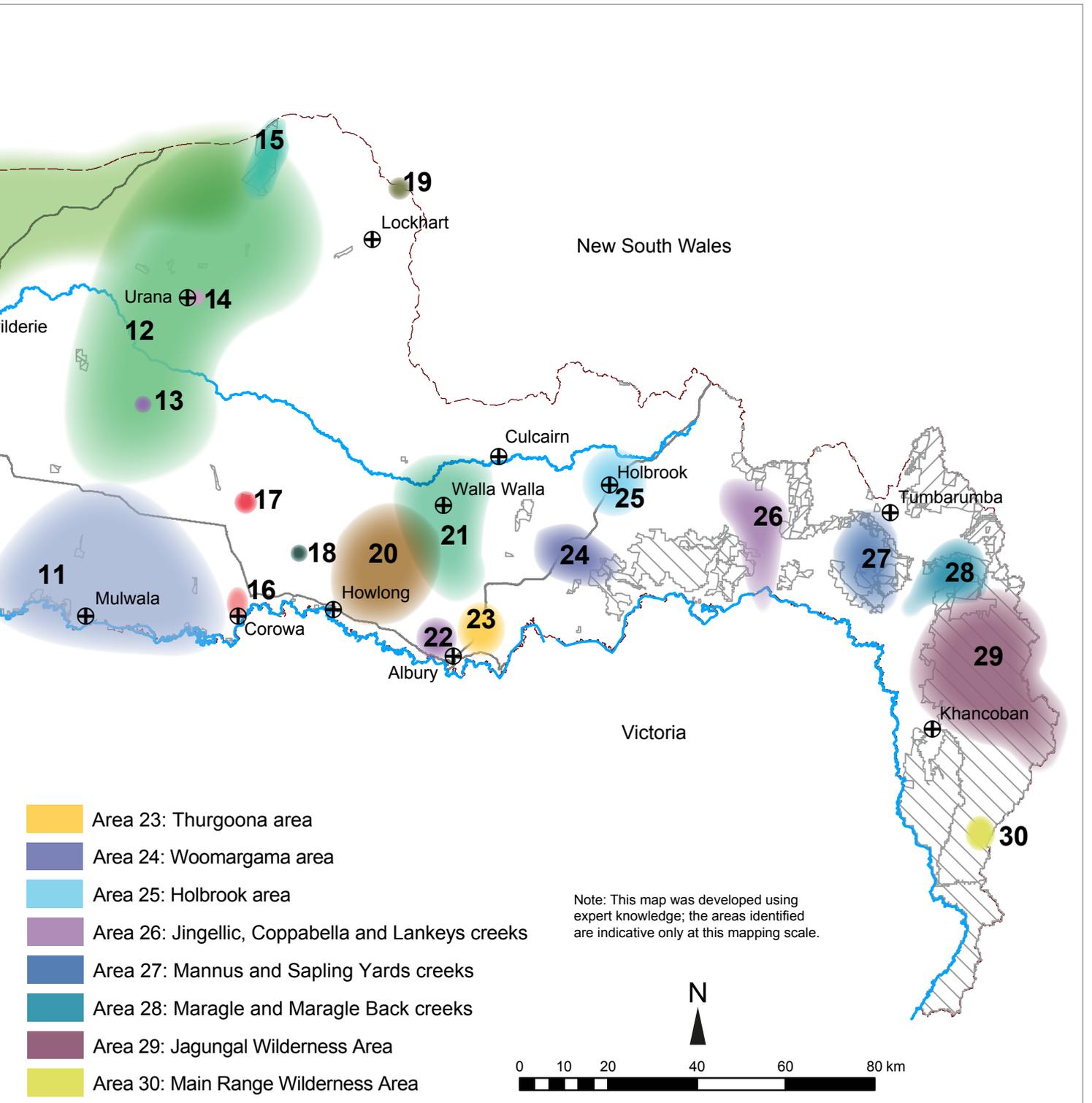


Figure 5.2 Indicative management areas for potential investment in iconic and threatened species in the NSW Murray catchment



Area 1: Mellool–Cunninyeuk area

Iconic, threatened and significant species	Southern bell frog (threatened) Painted snipe (threatened)
Endangered ecological communities	Inland grey box woodland, myall woodland, sandhill pine woodland
Habitat types	Wetlands, dams and irrigation areas
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with landholders and groups at known southern bell frog sites and potential painted snipe sites to ensure that sensitive wetland management is undertaken • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Use water allocation licence arrangements to divert sufficient water into known bell frog sites and potential painted snipe sites to allow breeding • Encourage landholders to minimise impacts of grazing stock on bell frog and potential painted snipe sites. If possible, exclude stock from all or part of water bodies with bell frogs or potential painted snipe habitat • Eradicate pest species such as feral pigs that may be degrading potential southern bell frog or painted snipe habitat • Avoid fires around water bodies and through ephemeral wetlands when dry • Maintain fallen coarse woody debris, rocks, leaf litter, and emergent aquatic and fringing vegetation etc., particularly within a 1-kilometre radius of permanent water bodies and throughout ephemeral wetlands • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the southern bell frog and painted snipe in the Mellool–Cunninyeuk area
Performance criteria	<ul style="list-style-type: none"> • Increase the number of sites and area of habitat managed for the southern bell frog and painted snipe in the Mellool–Cunninyeuk area • Increase the size of local populations of the southern bell frog and painted snipe at managed sites in the Mellool–Cunninyeuk area

Area 2: Moulamein area

Iconic, threatened and significant species	Bush stone-curlew (iconic, threatened) Grey-crowned babbler (threatened)
Endangered ecological communities	Inland grey box woodland, myall woodland, sandhill pine woodland
Habitat types	Black Box Woodlands, Riparian Forest and Grasslands
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with landholders and groups and provide resources and extension to increase awareness and improve habitat management on private properties in the Moulamein area • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Maintain and improve woodland and grassland habitat condition and extent through sympathetic grazing management for biodiversity using various funding mechanisms such as stewardship payments • Conduct integrated and coordinated fox and cat control • Conduct captive breeding and reintroduction to supplement local populations of bush stone-curlews • Conduct long-term population monitoring to measure success of reintroductions
Recovery objectives	Promote the local recovery of the bush stone-curlew and grey-crowned babbler in the Moulamein area
Performance criteria	<ul style="list-style-type: none"> • Increase the number of sites and amount of habitat managed for bush stone-curlew and grey-crowned babbler in the Moulamein area • Increase the size of local populations of bush stone-curlew and grey-crowned babbler at managed sites in the Moulamein area



Wetlands (left), Gilbert's whistler
Photos: Natasha Lappin, Chris Tzaros

Area 3: Barham area

Iconic, threatened and significant species	Bush stone-curlew (iconic, threatened) Grey-crowned babbler (threatened) Gilbert's whistler (threatened) Yellow gum (threatened)
Endangered ecological communities	Inland grey box woodland, sandhill pine woodland
Habitat types	Open Grassy Woodlands, Riparian Forest and Grasslands
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with private landholders and groups and provide resources and extension to increase awareness and improve habitat management on private properties in the Barham area • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Maintain and improve woodland and grassland habitat condition and extent through sympathetic grazing management for biodiversity using various funding mechanisms such as stewardships payments • Restore and revegetate woodlands, including yellow gum woodland, and including the use of shrubs in red gum forest for Gilbert's whistler • Conduct integrated and coordinated fox and cat control • Conduct captive breeding and reintroduction to supplement local populations of bush stone-curlews • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the bush stone-curlew, grey-crowned babbler, Gilbert's whistler and yellow gum in the Barham area
Performance criteria	<ul style="list-style-type: none"> • Increase the number of sites and amount of habitat managed for bush stone-curlew and grey-crowned babbler in the Barham area • Increase the size of local populations of bush stone-curlew, grey-crowned babbler, Gilbert's whistler and yellow gum at managed sites in the Barham area

Area 4: Tullakool–Wakool area

Iconic, threatened and significant species	Southern bell frog (threatened) Painted snipe (threatened)
Endangered ecological communities	Myall woodland
Habitat types	Wetlands, dams and irrigation areas
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with landholders and groups at known southern bell frog sites and potential painted snipe sites to ensure that sensitive wetland management is undertaken • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Use water allocation licence arrangements to divert sufficient water into known bell frog sites and potential painted snipe sites to allow breeding • Encourage landholders to minimise impacts of grazing stock on bell frog and potential painted snipe sites. If possible, exclude stock from all or part of water bodies with bell frogs or potential painted snipe habitat • Eradicate pest species such as feral pigs that may be degrading potential southern bell frog or painted snipe habitat • Avoid fires around water bodies and through ephemeral wetlands when dry • Maintain fallen coarse woody debris, rocks, leaf litter, and emergent aquatic and fringing vegetation etc., particularly within a 1-kilometre radius of permanent water bodies and throughout ephemeral wetlands • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the southern bell frog and painted snipe in the Tullakool–Wakool area
Performance criteria	<ul style="list-style-type: none"> • Increase the number of sites and amount of habitat managed for southern bell frog and painted snipe in the Tullakool–Wakool area • Increase the size of local populations of southern bell frog and painted snipe at managed sites in the Tullakool–Wakool area



Black Box Woodland (left),
southern bell frog

Photos: David Parker, David Hunter

Area 5: Barnes Crossing travelling stock reserve

Iconic, threatened and significant species	<i>Prasophyllum</i> sp. 'Moama' (threatened) Turnip copperburr (threatened) Lowly greenhood (threatened)
Endangered ecological communities	Inland grey box woodland, <i>Allocasuarina luehmannii</i> (buloke) woodland, natural grasslands of the Murray valley plains
PAS2 project site	Turnip copperburr
Habitat types	Riverine Grassland and Black Box Woodland
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Maintain and improve grassland habitat condition and extent through sympathetic grazing management for biodiversity using various funding mechanisms such as paying for agistment fees for grazing rights on travelling stock reserves • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Control annual weeds using grazing and burning • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the recovery of the three threatened plant species at Barnes Crossing travelling stock reserve
Performance criteria	<ul style="list-style-type: none"> • Maintain optimal habitat structure for survival of threatened plants at Barnes Crossing travelling stock reserve • Maintain the local population size of <i>Prasophyllum</i> sp. 'Moama' and turnip copperburr and increase the population size of the lowly greenhood at Barnes Crossing travelling stock reserve

Area 6: Reed Beds area

Iconic, threatened and significant species	Australasian bittern (threatened) Little bittern (significant) White-bellied sea eagle (significant)
Habitat types	Wetland surrounded by Red Gum Forest
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Use water allocation licences and other arrangements to provide sufficient water levels in the reed swamp to allow bitterns and other waterbirds to breed • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Control feral predators • Use fire as a management tool to maintain the diversity of reeds and rushes habitat and monitor outcomes of fire management for the Australian bittern and other wetland species • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the recovery of the Australasian and little bitterns and the white-bellied sea eagle in the Reed Beds area
Performance criteria	<ul style="list-style-type: none"> • Maintain and improve the quality of suitable wetland habitat for Australasian and little bittern in the Reed Beds area • Increase the size of local populations of the Australasian and little bittern in the Reed Beds area

Area 7: Gulpa Island and Millewa forests

Iconic, threatened and significant species	Superb parrot (iconic, threatened) Gilbert's whistler (threatened)
Endangered ecological communities	Inland grey box woodland, myall woodland, sandhill pine woodland
Habitat types	River Red Gum Forest and Fringing Box Woodlands
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Increase the amount of superb parrot foraging habitat through management and restoration on private land adjoining the Gulpa Island and Millewa forests. • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Use water allocation licences and other arrangements to provide flows and flooding regimes that will maintain and improve superb parrot breeding and foraging habitat in river red gum forest and allow recruitment of new breeding habitat trees • Protect known nest trees during park management activities • Maintain and improve woodland and grassland habitat condition and extent through sympathetic grazing management for biodiversity using various funding mechanisms such as stewardships payments • Survey and monitor nest sites to provide long-term population estimates, nest tree mortality and new nest trees • Restore and revegetate sandhill woodlands including shrub species such as wattles • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the recovery of the superb parrot and Gilbert's whistler in the Gulpa Island and Millewa forests
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of superb parrot foraging habitat through management and restoration on private land in the Gulpa Island and Millewa forests • Increase the extent and condition of Gilbert's whistler habitat on reserves in the Gulpa Island and Millewa forests • Increase the size of local breeding populations of superb parrot and Gilbert's whistler on private and reserve land in the Gulpa Island and Millewa forests



Flooded River Red Gum Forest
Photo: David Parker

Area 8: Wanganella Swamp

Iconic, threatened and significant species	Australasian bittern (threatened) Brolga (iconic, threatened) Painted snipe (threatened)
Endangered ecological communities	Sandhill pine woodland
PAS2 project site	Brolga
Habitat types	Natural Wetland
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with landholders and groups to ensure that Wanganella Swamp is not overgrazed • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Use water allocation licence arrangements to divert sufficient water into Wanganella Swamp to allow waterbirds to breed • Control pigs, foxes and cats to reduce impact, including predation on chicks and eggs • Avoid using fire as a hazard control measure, except when Cumbungi/reeds become too thick and suitable habitats are affected • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the recovery of the Australasian bittern, brolga and painted snipe at Wanganella Swamp
Performance criteria	<ul style="list-style-type: none"> • Maintain and increase the amount of suitable habitat for threatened waterbirds at Wanganella Swamp • Increase the size of local populations of the Australasian bittern, brolga and painted snipe at Wanganella Swamp

Area 9: Tuppal area

Iconic, threatened and significant species	Bush stone-curlew (iconic, threatened) Diamond firetail (threatened) Superb parrot (iconic, threatened)
Endangered ecological communities	Inland grey box woodland, sandhill pine woodland, <i>Allocasuarina luehmannii</i> (buloke) woodland, natural grasslands of the Murray valley plains
Habitat types	Black Box and Sandhill Pine Woodland
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with landholders and groups and provide resources and extension to increase awareness and improve habitat management on private properties in the Tuppal area • Maintain and improve woodland and grassland habitat condition and extent through sympathetic grazing management for biodiversity using various funding mechanisms • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Conduct integrated and coordinated fox and cat control • Conduct captive breeding and reintroduction to supplement local populations of bush stone-curlews • Assess the potential impact of noisy miners on woodland bird populations and implement appropriate noisy miner management actions • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the bush stone-curlew, diamond firetail and superb parrot in the Tuppal area
Performance criteria	<ul style="list-style-type: none"> • Increase the number of sites and total area with sympathetic management of threatened woodland bird habitat in the Tuppal area • Increase the size of local populations of the bush stone-curlew, diamond firetail and superb parrot in the Tuppal area

Area 10: Wanganella–Jerilderie–Morundah area

Iconic, threatened and significant species	<p>Riverine Grassland flora (threatened): <i>Austrostipa wakoolica</i>, <i>Brachyscome papillosa</i>, <i>Lepidium monoplocoides</i>, <i>Leptorhynchos orientalis</i>, <i>Maireana cheelii</i>, <i>Swainsona murrayana</i>, <i>Swainsona plagiotropis</i>, <i>Swainsona sericea</i></p> <p>Plains-wanderer (threatened)</p> <p>Red-chested button-quail (significant)</p> <p>Hooded scaly-foot (significant)</p> <p>Curl snake (significant)</p>
Endangered ecological communities	Inland grey box woodland, myall woodland, sandhill pine woodland, natural grasslands of the Murray valley plains
PAS2 project sites	Brolga, plains-wanderer, red Darling pea, claypan daisy, chariot wheels, turnip copperburr
Habitat types	Riverine Grasslands
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with landholders and groups to maintain and improve grassland habitat condition and extent, including the management of rye grass, through sympathetic grazing management for biodiversity using various funding mechanisms such as stewardship payments and the <i>OEH Plains-wanderer habitat management guide</i> (Parker & Oliver 2007) • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Conduct integrated and coordinated fox and cat control for the plains-wanderer and other ground-dwelling grassland fauna • Conduct captive breeding programs to research potential effects of locust control insecticides on plains-wanderers • Control weeds in areas where threatened grassland plants are at risk • Assess the potential impact of noisy miners on woodland bird populations and implement appropriate noisy miner management actions • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of threatened Riverine Grassland flora, plains-wanderer and other grassland fauna species in the Wanganella–Jerilderie–Morundah area
Performance criteria	<ul style="list-style-type: none"> • Increase the number of sites and total area with sympathetic management of Riverine Grassland vegetation in the Wanganella–Jerilderie–Morundah area • Increase the size of local populations of threatened Riverine Grassland flora and plains-wanderer in the Wanganella–Jerilderie–Morundah area



Riverine Grassland north of Conargo (left), *Swainsona murrayana*
Photos: David Parker, Sandra Walpole

Area 11: Mulwala–Savernake area

Iconic, threatened and significant species	<p>Brolga (iconic, threatened)</p> <p>Superb parrot (iconic, threatened)</p> <p>Grey-crowned babbler (threatened)</p> <p>Hooded robin (threatened)</p> <p>Scarlet robin (threatened)</p> <p>Flame robin (threatened)</p> <p>Carpet python (significant)</p>
Endangered ecological communities	Inland grey box woodland, <i>Allocasuarina leebmannii</i> (buloke) woodland, sandhill pine woodland
PAS2 project sites	Brolga
Habitat types	Wetlands, Grasslands, dams and Grassy Box Woodlands
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with private landholders at known brolga breeding sites to ensure that sensitive wetland management is undertaken • Increase awareness of the importance of retaining mature trees across agricultural landscapes for the superb parrot and other hollow-dwelling fauna • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management. • Use water allocation licences and other arrangements to provide sufficient water levels at known brolga breeding sites to allow breeding • Encourage landholders to minimise impacts of grazing stock at brolga breeding sites • Control feral predators at brolga breeding sites and around known carpet python habitat • Support rabbit control programs, particularly around known carpet python habitat • Encourage landholders to maintain large logs on the ground, particularly in riparian areas and along creek lines • Avoid using fire as a hazard reduction measure • Use incentives and other funding mechanisms to reward landholders for retaining paddock trees and using regeneration or replanting to ensure that these will replace paddock trees when they are gone • Use existing and new information (Biodiversity Forecasting Tool priority Active Management and Repair area mapping) to identify key habitat areas for Active Management and Repair, with an emphasis on improving connectivity across the landscape for the superb parrot • Look for opportunities to increase the condition and extent of superb parrot foraging habitat by protecting or planting areas of native food plant species (e.g. eucalypts, wattles, native grasses) • Assess the potential impact of noisy miners on woodland bird populations and implement appropriate noisy miner management actions • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of brolga, superb parrot, grey-crowned babbler, hooded robin, scarlet robin and flame robin in the Mulwala–Savernake area
Performance criteria	<ul style="list-style-type: none"> • Increase the number of sites and total area with sympathetic management of habitat of the brolga, superb parrot, grey-crowned babbler, hooded robin, scarlet robin and flame robin in the Mulwala–Savernake area • Increase the size of local populations of the brolga, superb parrot, grey-crowned babbler, hooded robin, scarlet robin and flame robin in the Mulwala–Savernake area

Area 12: Morundah–Urana–Savernake area

Iconic, threatened and significant species	<p>Brolga (iconic, threatened)</p> <p>Riverine Grassland flora: <i>Lepidium monoplacoides</i> (threatened), <i>Swainsona murrayana</i> (threatened), <i>Leptorhynchus orientalis</i> (threatened), <i>Picnosaurus picumnus</i> (significant)</p> <p>Plains-wanderer (threatened)</p>
Endangered ecological communities	Inland grey box woodland, myall woodland, natural grasslands of the Murray valley plains
PAS2 project sites	Brolga, plains-wanderer, Oaklands diuris, red Darling pea, claypan daisy, sand hill spider orchid
Habitat types	Wetlands, Grasslands, and irrigation areas
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with private landholders at known brolga breeding sites to ensure that sensitive wetland management is undertaken • Work with landholders and groups to maintain and improve grassland habitat condition and extent, including the management of rye grass, through sympathetic grazing management for biodiversity using various funding mechanisms such as stewardship payments and the <i>OEH Plains-wanderer habitat management guide</i> (Parker & Oliver 2007) • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Use water allocation licences and other arrangements to provide sufficient water levels at brolga breeding sites to allow breeding • Encourage landholders to minimise impacts of grazing stock at brolga breeding sites • Control feral predators at brolga breeding sites • Avoid using fire as a hazard reduction measure • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of threatened Riverine Grassland flora, brolga, plains-wanderer and other grassland fauna species in the Morundah–Urana–Savernake area
Performance criteria	<ul style="list-style-type: none"> • Increase the number of sites and total area with sympathetic management of Riverine Grassland vegetation and wetlands in the Morundah–Urana–Savernake area • Increase the size of local populations of threatened Riverine Grassland flora, brolga and plains-wanderer in the Morundah–Urana–Savernake area

Area 13: Oaklands area

Iconic, threatened and significant species	Oaklands diuris orchid (<i>Diuris</i> sp. 'Oaklands') (threatened)
Endangered ecological communities	White box–yellow box–Blakely’s red gum woodland
Habitat types	White Cypress Pine Woodland
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with local community to protect and manage the Oaklands diuris population • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Maintain fencing for site protection and stock grazing management • Control weeds if required • Use ex situ reintroduction to increase viability and survival of local populations • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the recovery of the Oaklands diuris in the Oaklands area
Performance criteria	<ul style="list-style-type: none"> • Increase the population size of the Oaklands diuris in the Oaklands area

Area 14: Urana area

Iconic, threatened and significant species	Sand-hill spider orchid (threatened) Oaklands diuris orchid (<i>Diuris</i> sp. 'Oaklands') (threatened)
Endangered Ecological Communities	Inland grey box woodland, myall woodland, sandhill pine woodland, natural grasslands of the Murray valley plains
PAS2 project sites	Brolga
Habitat types	Open grassy White Cypress Pine Woodland
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Continue to work with private landholders and local government to ensure local populations are protected from overgrazing • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Control weeds if required, using non-chemical control • Use ex situ reintroduction to increase viability and survival of local populations • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the sand-hill spider orchid and Oaklands diuris in the Urana area
Performance criteria	<ul style="list-style-type: none"> • Increase the size of local populations of the sand-hill spider orchid and Oaklands diuris in the Urana area

Area 15: Buckingham State Forest

Iconic, threatened and significant species	<p>Sand-hill spider orchid (threatened)</p> <p>Oaklands diuris orchid (<i>Diuris</i> sp. 'Oaklands') (threatened)</p> <p>Diamond firetail (threatened)</p> <p>Hooded robin (threatened)</p>
Endangered ecological communities	Inland grey box woodland, white box–yellow box–Blakely's red gum woodland
PAS2 project sites	Brolga, claypan daisy, sand hill spider orchid
Habitat types	White Cypress Pine Woodland
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Negotiate with Forests NSW to protect orchid habitat from timber harvesting operations • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Reduce impacts of grazing by excluding domestic and feral herbivores • Control weeds as required • Monitor pollination and seed-set of threatened orchids • Conduct ex situ propagation and reintroduction of threatened orchids • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the sand-hill spider orchid, Oaklands diuris, diamond firetail and hooded robin within Buckingham State Forest
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat managed for threatened species within Buckingham State Forest • Increase the population sizes of the sand-hill spider orchid, Oaklands diuris, diamond firetail and hooded robin in Buckingham State Forest

Area 16: Corowa and Nulla Nulla Swamp

Iconic, threatened and significant species	<p>Sloane's froglet (threatened)</p> <p>Brolga (iconic, threatened)</p> <p>Painted snipe (threatened)</p> <p>Magpie goose (threatened)</p>
Endangered ecological communities	Inland grey box woodland
PAS2 project sites	Brolga
Habitat types	Natural and artificial wetlands
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with the local community and Corowa Shire to protect identified important wetland sites for Sloane's froglet and minimise impacts from future development and infrastructure maintenance (e.g. mowing, grading) • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Exclude grazing from Nulla Nulla Swamp • Use water allocation licences and other arrangements to provide sufficient water levels at Nulla Nulla Swamp for Sloane's froglet and other wetland fauna • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of Sloane's froglet, brolga, painted snipe and magpie goose in Corowa and Nulla Nulla Swamp
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat managed for Sloane's froglet, brolga, painted snipe and magpie goose in Corowa and Nulla Nulla Swamp • Increase the population sizes of Sloane's froglet, brolga, painted snipe and magpie goose in Corowa and Nulla Nulla Swamp

Area 17: Lonesome Pine State Forest

Iconic, threatened and significant species	Sand-hill spider orchid (threatened) Threatened woodland birds: grey-crowned babbler (threatened), diamond firetail (threatened), speckled warbler (threatened)
Endangered ecological communities	Inland grey box woodland, white box–yellow box–Blakely’s red gum woodland
PAS2 project sites	Brolga, sand hill spider orchid
Habitat types	White Cypress Pine Woodland
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Negotiate with Forests NSW to protect orchid habitat from timber harvesting operations • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Reduce impacts of grazing by excluding domestic and feral herbivores • Control weeds as required • Monitor pollination and seed-set of threatened orchid • Conduct ex situ propagation and reintroduction of threatened orchid • Assess the potential impact of noisy miners on woodland bird populations and implement appropriate noisy miner management actions • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the sand-hill spider orchid and threatened woodland birds within Lonesome Pine State Forest
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat managed for threatened species in Lonesome Pine State Forest • Increase the population sizes of the sand-hill spider orchid and threatened woodland birds in Lonesome Pine State Forest

Area 18: Kentucky State Forest

Iconic, threatened and significant species	Hooded robin (threatened) Speckled warbler (threatened) Diamond firetail (threatened) Grey-crowned babbler (threatened)
Endangered ecological communities	Inland grey box woodland, white box–yellow box–Blakely’s red gum woodland
PAS2 project sites	Brolga
Habitat types	White Cypress Pine Woodland
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with Forests NSW to reduce stock grazing and retain coarse woody debris in hooded robin habitat • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Identify key woodland bird habitat within Kentucky State Forest and develop a local population management plan, which includes an annual monitoring program • Assess the potential impact of noisy miners on woodland bird populations and implement appropriate noisy miner management actions
Recovery objectives	Promote the local recovery of threatened woodland birds, including the hooded robin, speckled warbler, diamond firetail and grey-crowned babbler, in Kentucky State Forest
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat managed for threatened species within Kentucky State Forest • Increase the size of local populations of threatened woodland birds, including the hooded robin, speckled warbler, diamond firetail and grey-crowned babbler, in Kentucky State Forest

Area 19: Galore Hill

Iconic, threatened and significant species	Glossy black cockatoo (iconic, threatened) Grey-crowned babbler (threatened) Speckled warbler (threatened)
Endangered ecological communities	Inland grey box woodland
Habitat types	Drooping she-oak woodland on rocky hills Mature hollow-bearing trees
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work in partnership with Land and Property Management Authority, Lockhart Shire and the local community to manage the drooping she-oak woodland and other native vegetation on Galore Hill • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Reduce impacts of grazing by goats using fencing and other methods • Control weeds • Identify and protect mature hollow-bearing trees on and in the local Galore Hill area • Manage St John's wort on lower slopes of Galore Hill • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the glossy black cockatoo, grey-crowned babbler and speckled warbler at Galore Hill
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat and number of sites managed for threatened woodland birds on Galore Hill and the surrounding area • Increase the number of hollow-bearing trees protected for glossy black cockatoo breeding habitat in the Galore Hill area • Increase the size of local populations of the glossy black cockatoo and other threatened woodland birds in the Galore Hill area



Bush stone-curlew (left), Grassy Box Woodlands
Photos: Rosie Smith, Natasha Lappin

Area 20: Burrumbuttock to Howlong area

Iconic, threatened and significant species	<p>Squirrel glider (iconic, threatened)</p> <p>Carpet python (significant)</p> <p>Threatened woodland birds: brown treecreeper (threatened), grey-crowned babbler (threatened), diamond firetail (threatened), speckled warbler (threatened)</p>
Endangered ecological communities	Inland grey box woodland, white box–yellow box–Blakely’s red gum woodland
PAS2 project sites	Brolga
Habitat types	Grassy Box Woodlands
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Continue to work with local community and landholders to increase awareness and participation in squirrel glider management actions • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Use existing and new information (Biodiversity Forecasting Tool priority Active Management and Repair area mapping) to identify key habitat areas for Active Management and Repair • Use incentives and other funding mechanisms to undertake habitat protection and restoration and to reward landholders for long-term management of squirrel glider habitat • Control feral predators, particularly foxes, around known carpet python habitat • Encourage the active management and buffering of rocky outcrops, which provide important carpet python habitat • Encourage local landholders to use ‘glider friendly’ plain top wire in new and existing fencing • Assess the potential impact of noisy miners on woodland bird populations and implement appropriate noisy miner management actions • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of threatened woodland birds and squirrel gliders in the Burrumbuttock to Howlong area
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat and number of sites managed for the squirrel glider, carpet python and threatened woodland birds in the Burrumbuttock to Howlong area • Increase the number of fencing agreements that use plain top wire in the Burrumbuttock to Howlong area • Increase the size of local populations of the squirrel glider, carpet python and threatened woodland birds in the Burrumbuttock to Howlong area

Area 21: Jindera area

Iconic, threatened and significant species	Bush stone-curlew (iconic, threatened) Regent honeyeater (iconic, threatened)
Endangered ecological communities	Inland grey box woodland, white box–yellow box–Blakely’s red gum woodland
PAS2 project sites	Brolga
Habitat types	Open Grassy Woodland
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with landholders and groups and provide resources and extension to increase awareness and improve habitat management on private properties in the Jindera area • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Maintain and improve woodland and grassland habitat condition and extent through sympathetic grazing management for biodiversity using various funding mechanisms such as stewardships payments • Conduct integrated and coordinated fox and cat control • Conduct captive breeding and reintroduction to supplement local bush stone-curlew population • Assess the potential impact of noisy miners on woodland bird populations and implement appropriate noisy miner management actions • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the bush stone-curlew and regent honeyeater in the Jindera area
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat and number of sites managed for the bush stone-curlew and regent honeyeater in the Jindera area • Increase the size of local populations of the bush stone-curlew and regent honeyeater in the Jindera area

Area 22: Nail Can Hill

Iconic, threatened and significant species	<p>Crimson spider orchid (threatened) Pink-tailed worm-lizard (threatened) Striped legless lizard (threatened) Threatened woodland birds: diamond firetail (threatened), speckled warbler (threatened)</p>
Endangered ecological communities	White box–yellow box–Blakely’s red gum woodland
PAS2 project sites	Crimson spider orchid
Habitat types	Grassy Box Woodlands
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with Department of Primary Industries Catchments and Lands, Albury City and local community to ensure habitat protection from human recreational activities • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Control weeds as required • Conduct ex situ propagation and reintroduction of threatened flora • Develop, fund and implement a monitoring program to measure the success of these management actions, including pollination and seed-set
Recovery objectives	Promote the local recovery of the crimson spider orchid, pink-tailed worm-lizard, striped legless lizard and threatened woodland birds in the Nail Can Hill area
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat and number of sites managed for the crimson spider orchid, pink-tailed worm lizard, striped legless lizard and threatened woodland birds in the Nail Can Hill area • Increase the size of local populations of the crimson spider orchid, pink-tailed worm lizard, striped legless lizard and threatened woodland birds in the Nail Can Hill area

Area 23: Thurgoona area

Iconic, threatened and significant species	Squirrel glider (iconic, threatened) Threatened woodland birds: regent honeyeater (iconic, threatened), swift parrot (threatened), speckled warbler (threatened), Sloane's froglet (threatened)
Endangered ecological communities	Inland grey box woodland, white box–yellow box–Blakely's red gum woodland
Habitat types	Grassy Box Woodlands, urban ironbark plantings, natural and artificial wetlands
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with Thurgoona community, Albury City, Albury Conservation Company and the Land and Property Management Authority to improve the condition, extent and landscape connectivity of environmental-zoned lands • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Adhere to recommended threatened species management actions within the Thurgoona and Albury Threatened Species Conservation Strategies • Encourage Thurgoona residents to be responsible companion animal owners • Protect identified important wetland sites for Sloane's froglet and protect from future development and infrastructure maintenance (e.g. mowing, grading) • Assess the potential impact of noisy miners on woodland bird populations and implement appropriate noisy miner management actions • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the squirrel glider, Sloane's froglet and threatened woodland birds in the Thurgoona area
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat and number of sites managed for the squirrel glider, Sloane's froglet and threatened woodland birds in the Thurgoona area • Increase the size of local populations of the squirrel glider, Sloane's froglet and threatened woodland birds in the Thurgoona area

Area 24: Woomargama area

Iconic, threatened and significant species	Brown treecreeper (threatened) Gang-gang cockatoo (iconic, threatened)
Endangered ecological communities	White box–yellow box–Blakely’s red gum woodland
Habitat types	Grassy Box Woodlands
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Work with private landholders with known and potential brown treecreeper habitat to become involved in management of local populations under a local population management plan • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Encourage landholders to retain coarse woody debris throughout woodland habitats • Reward landholders for protecting and improving the condition and extent of brown treecreeper habitat • Conduct annual monitoring to measure the outcomes of implementing the local population management plan • Work with Roads and Maritime Services to ensure that offsets areas for the Hume Highway duplication are managed to maintain and improve the local populations of brown treecreepers
Recovery objectives	Promote the local recovery of threatened woodland birds, including the brown treecreeper and gang-gang cockatoo, in the Woomargama area
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat and number of sites managed for threatened woodland birds, including the brown treecreeper and gang-gang cockatoo, in the Woomargama area • Increase the size of local populations of threatened woodland birds, including the brown treecreeper and gang-gang cockatoo, in the Woomargama area

Area 25: Holbrook area

Iconic, threatened and significant species	Squirrel glider (iconic, threatened) Threatened woodland birds: brown treecreeper (threatened), grey-crowned babbler (threatened), diamond firetail (threatened), speckled warbler (threatened), regent honeyeater (iconic, threatened)
Endangered ecological communities	Inland grey box woodland, white box–yellow box–Blakely’s red gum woodland
Habitat types	Grassy Box Woodlands
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Continue to work with local community and landholders to increase awareness and participation in squirrel glider and woodland bird management actions • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Use existing and new information (Biodiversity Forecasting Tool priority Active Management and Repair mapping) to identify key habitat areas for Active Management and Repair • Use incentives and other funding mechanisms to undertake habitat protection and restoration and to reward landholders for long-term management of squirrel glider and woodland bird habitat • Control feral predators • Encourage local landholders to use ‘glider friendly’ plain top wire in new and existing fencing • Encourage landholders to retain coarse woody debris throughout woodland habitats • Assess the potential impact of noisy miners on woodland bird populations and implement appropriate noisy miner management actions • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the squirrel glider and threatened woodland birds in the Holbrook area
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat and number of sites managed for the squirrel glider and threatened woodland birds in the Holbrook area • Increase the size of local populations of the squirrel glider and threatened woodland birds in the Holbrook area



Grassy Box Woodland
Photo: Martin Driver

Area 26: Jingellic, Coppabella and Lankeys creeks

Iconic, threatened and significant species	Booroolong frog (iconic, threatened)
Habitat types	Permanent rocky streams and rivers
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Continue to work with local landholders and community groups to help with the management of local Booroolong frog populations • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Control blackberry and exotic willows • Improve grazing stock management in riparian zones • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the Booroolong frog in the Jingellic, Coppabella and Lankeys creeks
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat and number of sites managed for the Booroolong frog in the Jingellic, Coppabella and Lankeys creeks • Increase the size of local populations of the Booroolong frog in the Jingellic, Coppabella and Lankeys creeks

Area 27: Mannus and Sapling Yards creeks

Iconic, threatened and significant species	Booroolong frog (iconic, threatened)
Habitat types	Permanent rocky streams and rivers
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Continue to work with local landholders and community groups to help with the management of local Booroolong frog populations • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Control blackberry and exotic willows • Improve grazing stock management in riparian zones • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the Booroolong frog in the Mannus and Sapling Yards creeks
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat and number of sites managed for the Booroolong frog in the Mannus and Sapling Yards creeks • Increase the size of local populations of the Booroolong frog in the Mannus and Sapling Yards creeks

Area 28: Maragle and Maragle Back creeks

Iconic, threatened and significant species	Booroolong frog (iconic, threatened)
PAS2 project sites	Broad-toothed rat
Habitat types	Permanent rocky streams and rivers
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Continue to work with local landholders and community groups to help with the management of local Booroolong frog populations • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Control blackberry and exotic willows • Improve grazing stock management in riparian zones • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the Booroolong frog in the Maragle and Maragle Back creeks
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat and number of sites managed for the Booroolong frog in the Maragle and Maragle Back creeks • Increase the size of local populations of the Booroolong frog in the Maragle and Maragle Back creeks



Booroolong frog (left), spotted tree frog survey
 Photos: David Hunter, Stuart Cohen

Area 29: Jagungal Wilderness Area

Iconic, threatened and significant species	<p>Alpine Bogs and Swamps endangered ecological community (threatened)</p> <p>Southern corroboree frog (iconic, threatened)</p> <p>Alpine tree frog (threatened)</p> <p>Alpine she-oak skink (threatened)</p> <p>Broad-toothed rat (threatened)</p> <p>Alpine flora (threatened): <i>Ranunculus anemoneus</i>, <i>Erythranthera pumila</i>, <i>Carex raleighii</i>, <i>Euchiton nitidulus</i></p>
Endangered ecological communities	Alpine sphagnum bogs and associated fens
PAS2 project sites	Broad-tooth rat, Raleigh sedge
Habitat types	Alpine Bogs and Fens
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Eradicate orange hawkweed • Reduce the numbers of feral pigs and horses • Facilitate southern corroboree frog disease resistance through selective breeding and reintroduction • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	<p>Promote the local recovery of the Alpine Bogs and Swamps endangered ecological community and associated threatened flora and fauna species in the Jagungal Wilderness Area</p> <p>Eradicate orange hawkweed from the Jagungal Wilderness Area</p>
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat and number of sites managed for the Alpine Bogs and Swamps endangered ecological community and associated threatened flora and fauna in the Jagungal Wilderness Area • Increase the extent and condition of the Alpine Bogs and Swamps endangered ecological community and the local population sizes of associated threatened flora and fauna species in the Jagungal Wilderness Area • Eradicate orange hawkweed from the Jagungal Wilderness Area

Area 30: Main Range Wilderness Area

Iconic, threatened and significant species	Mountain pygmy-possum (iconic, threatened)
Endangered ecological communities	Alpine sphagnum bogs and associated fens
PAS2 project sites	Broad-tooth rat, Raleigh sedge
Habitat types	Alpine and subalpine boulder fields and heathlands
Management actions in the NSW Murray catchment	<ul style="list-style-type: none"> • Conduct integrated cat and fox control at known sites and surrounding landscape • Minimise damage to known sites and habitat from potential future developments • Work with Aboriginal stakeholders to develop projects that contribute to the reintroduction of traditional land management practices and that allow for physical and spiritual input into biodiversity management • Develop, fund and implement a monitoring program to measure the success of these management actions
Recovery objectives	Promote the local recovery of the mountain pygmy-possum in the Main Range Wilderness Area
Performance criteria	<ul style="list-style-type: none"> • Increase the amount of habitat and number of sites managed for the mountain pygmy-possum in the Main Range Wilderness Area • Increase the local population size of mountain pygmy-possum in the Main Range Wilderness Area

5.2 Non-threatened significant species in the NSW Murray catchment

5.2.1 Migratory and international convention species

Twenty-four bird species are listed as migratory under the EPBC Act. These species are also listed under various international conventions and agreements (Appendix 5.4). Eighteen of these migratory species rely on the sensitive management of riverine and wetland environments across the NSW Murray catchment; in some cases, these species are infrequent vagrants that select very specific wetlands. The immense distances travelled by the other six migratory species present challenges to managing native vegetation and habitats at specific sites. Land management practices that maintain and improve native vegetation extent and condition will assist the survival of these species. At a more localised scale, protecting and improving known breeding and foraging habitat for the nomadic regent honeyeater in the Thurgoona, Jindera and Holbrook areas is a key recovery action (see Section 5.1.3) that will also benefit other woodland fauna species.

5.2.2 Significant species identified in the biodiversity assets and threats matrix

As part of the process of identifying key threats to biodiversity across the NSW Murray catchment (see Chapter 3), a matrix of key biodiversity assets (species, communities, assemblages) and their likely threats was developed by staff from OEH and Murray CMA (Appendix 3.3). In addition to the 124 listed threatened entities in the NSW Murray catchment (all of which were identified in the matrix), 144 non-threatened plants, animals, aquatic species and ecological communities were identified as significant.

5.2.3 Species of significance to the NSW Murray community

In the community workshops in 2010 and 2011, participants were asked to nominate significant biodiversity assets (see Chapter 2). People who attended asset identification workshops nominated 61 plants, animals, aquatic species or ecological

communities as significant to them (Appendix 5.5). Six of these species were specifically identified by members of the Aboriginal community. Of these assets, 11 were also species or ecological communities that are formally listed as threatened.

Appendix 5.5 only captures information from people who were able to attend meetings and expert panels, and it does not cover all important plants and animals in the NSW Murray catchment. Further opportunities should be made for people to provide input to biodiversity management by identifying additional assets in the future.

5.2.4 Significant species of the NSW Murray catchment identified by experts

A series of workshops and interviews were held with ecological and land management experts from the OEH and Murray CMA, and several professional consultants and retired professional biologists, in late 2010 and early 2011. A total of 76 species and ecological communities were nominated by experts, including 39 that are formally listed as threatened (Appendix 5.5).

5.2.5 Management actions for non-threatened significant species

The presence of significant species increases the biodiversity value of an area. No specific management actions are identified for the many non-threatened but significant species identified in the Murray BMP. However, the management actions recommended in Section 5.1 for threatened and iconic species will also benefit non-threatened species in these areas. A number of broad management actions that will help maintain and improve the population status and habitat of significant species have been previously identified in similar biodiversity planning processes (e.g. NSW Murray Biodiversity Action Plan (Miles 2001)). These actions include:

- retaining existing native vegetation
- encouraging natural regeneration to increase the extent of native vegetation
- strategically replanting to provide connectivity and increase the extent of native vegetation
- managing grazing

- controlling weeds
 - controlling feral pest animals
 - restoring natural hydrological cycles
 - retaining dead standing and falling timber, leaf litter, snags and bush rock
 - protecting mature paddock trees and considering enhancement plantings (replacing fallen trees) to ensure long-term persistence of trees in the landscape
 - managing overabundant native wildlife
 - ecological burning.

5.3 Related technical information

The following appendices are available on CD by contacting Murray Catchment Management Authority, or online at www.murray.cma.nsw.gov.au.

Appendix 5.1 NSW Priorities Action Statement 2 (PAS2) threatened species management streams

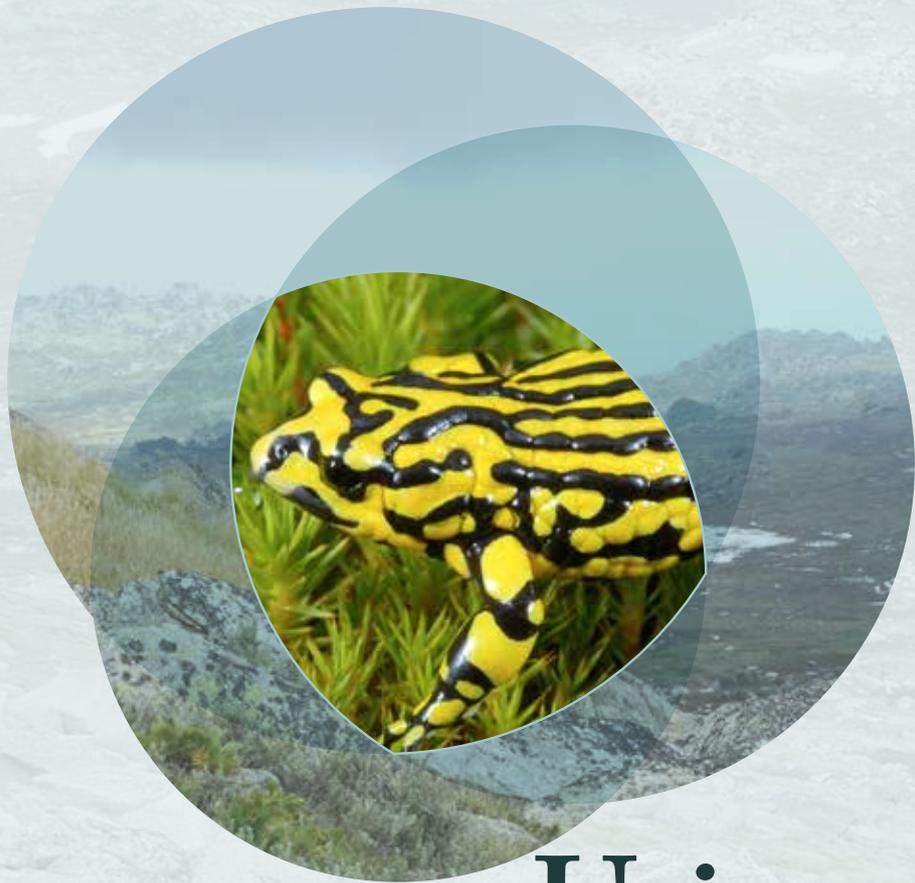
Appendix 5.2 Threatened entities in the NSW Murray catchment (as of March 2012)

Appendix 5.3 Threatened species, populations and ecological communities of the NSW Murray catchment: actions included in the NSW Priorities Action Statement 1 and recovery plans

Appendix 5.4 Migratory bird species of the NSW Murray catchment listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) and international conventions and agreements

Appendix 5.5 Plants, animals, aquatic species and ecological communities identified as significant in community workshops

Appendix 5.6 Websites for information on species, populations and ecological communities



6

**Using the NSW
Murray Biodiversity
Management Plan
to guide biodiversity
investment**

6 Using the NSW Murray Biodiversity Management Plan to guide biodiversity investment

The NSW Murray Biodiversity Management Plan (Murray BMP) aims to help investors prioritise biodiversity management actions across the NSW Murray catchment. It contains information to help assess the relative biodiversity values of a site or local landscape. Table 6.1 lists the steps for determining

important attributes from the site scale to the catchment scale.

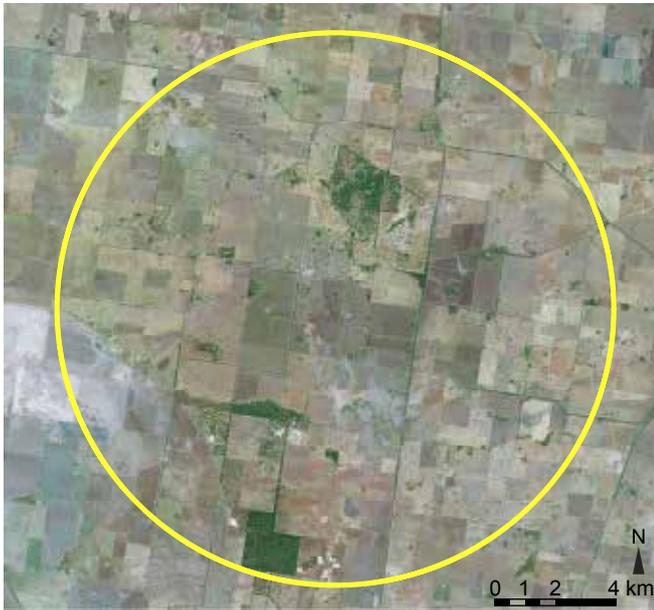
The following case studies illustrate how the information in the Murray BMP can be used for a variety of purposes.

Table 6.1 Recommended steps for assessing biodiversity values and sources of information

Step	Scale	Biodiversity value/cue	Source
Step 1	Site	Ecological principles	Section 4.1
		Land capability	www.environment.nsw.gov.au/soils/publications.htm
		Land use	Chapter 2 (Figure 2.7)
		Vegetation community mapping	Chapter 2 (Figure 2.5)
		Vegetation condition mapping	Chapter 2 (Figure 2.6)
		VCA vegetation type	Appendix 2.9
		Threats probability Threats consequence	Section 3.4
		Threatened species records	Atlas of NSW Wildlife
		Migratory species records	www.environment.gov.au/cgi-bin/sprat/public/publicshowmigratory.pl
		Assets identified by local community and by experts	Chapter 2
Threatened/significant species management area	Chapter 5 (Figure 5.2)		
Step 2	Validation of site/area/local landscape	Key local-scale habitat values (e.g. native ground cover, hollow-bearing trees)	Section 4.1.1
Step 3	Local landscape	Ecological principles	Section 4.1.2
		Vegetation community mapping	Chapter 2 (Figure 2.5)
		Vegetation condition mapping	Chapter 2 (Figure 2.6)
		VCA vegetation type	Appendix 2.9
		Threats probability Threats consequence	Section 3.4
		Assets identified by local community and by experts	Chapter 2
		Freshwater wetlands	www.environment.gov.au/epbc/protect/wetlands.html
		Local priority landscapes	Appendix 4.1

Step 3 (cont.)	Local landscape (cont.)	Draft Murray Regional Strategy high-conservation-value areas	Appendix 4.1
		Important bird areas	Appendix 4.1
		Local environmental plan environmental protection zoning	Local environmental plans
		Threatened species management area	Section 5.1.2 (Figure 5.2)
Step 4	Catchment	Active Management and Repair priority investment areas	Chapter 4 (Figures 4.1–4.4), and specific priority investment maps for each vegetation formation (Appendix 4.6)
		Vegetation community mapping	Chapter 2 (Figure 2.5)
		Vegetation condition mapping	Chapter 2 (Figure 2.6)
		VCA vegetation type	Appendix 2.9
		Threats probability	Section 3.4
		Threats consequence	
		Slopes to Summit priority corridors and areas	Section 4.3.4
		National reserve system and public land (e.g. travelling stock reserves) with biodiversity values	Chapter 2 (Figure 2.8)
		NSW landscape value	Section 4.3.5
		State-listed endangered ecological communities	Chapter 5 (Figure 5.1) www.environment.nsw.gov.au/threatenedspecies/
Step 5	State	‘Overcleared’ vegetation community	Chapter 2 (Table 2.2)
		Overcleared ‘Mitchell landscape’	Appendix 4.1
		‘Native Vegetation Management Benefits’	Section 4.3.6 www.environment.nsw.gov.au/research/AncillaryVegetationProductsDataInventory.htm
		Statewide landscape value (corridors)	Section 4.3.5
		Great Eastern Ranges initiative	Section 4.3.4
		National wildlife corridors	Section 4.3.3 www.environment.gov.au/biodiversity/wildlife-corridors
Step 6	National	Nationally listed threatened species, populations and communities	Chapter 5 (Figure 5.1) www.environment.gov.au/biodiversity/threatened/index.html
		Nationally listed migratory species	www.environment.gov.au/cgi-bin/sprat/public/publicshowmigratory.pl

Case study 1 Optimising biodiversity outcomes from carbon plantings

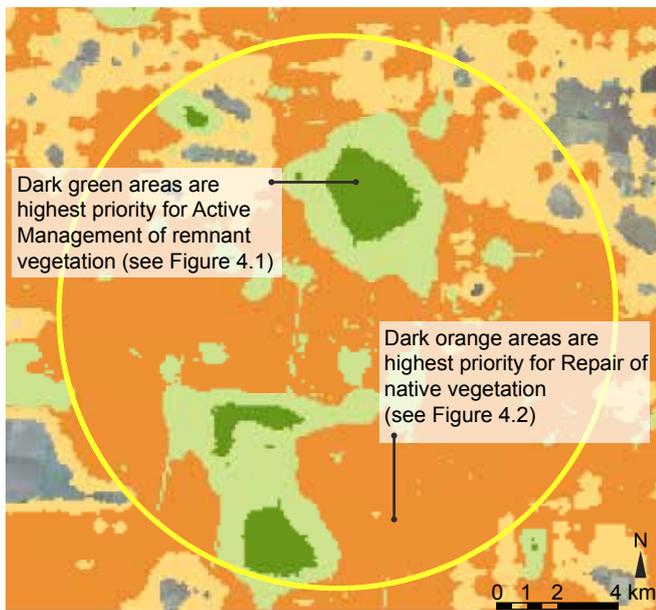


View 1: Local landscape

Carbon markets have the potential to be significant drivers for ecological restoration. Carbon forest plantings can mitigate climate change impacts and improve an ecosystem’s resilience to climate change at the same time. If properly designed and located, carbon plantings may generate income for landholders for carbon sequestration services, as well as increase the site’s existing biodiversity values by improving landscape connectivity and increasing the extent, condition and connectivity of native vegetation. These actions will also contribute to increasing climate change resilience in Repair priority landscapes.

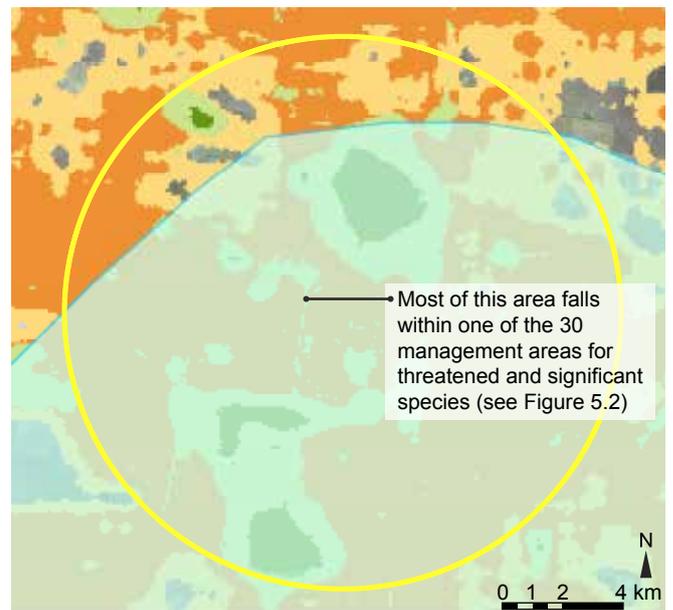
The following sequence of views shows a hypothetical example of how the mapping information in the Murray BMP could be used to optimise carbon forest plantings for biodiversity benefits in a fragmented local landscape.

View 1 shows a SPOT 5 satellite image of a fragmented local landscape in the NSW Murray catchment with small patches of native vegetation scattered across farming country.



- Very high priority for Active Management
- High priority for Active Management
- Very high priority for Repair
- High priority for Repair
- Moderate–low priorities

View 2: Priority areas for Active Management (green) and Repair (orange) in local landscape



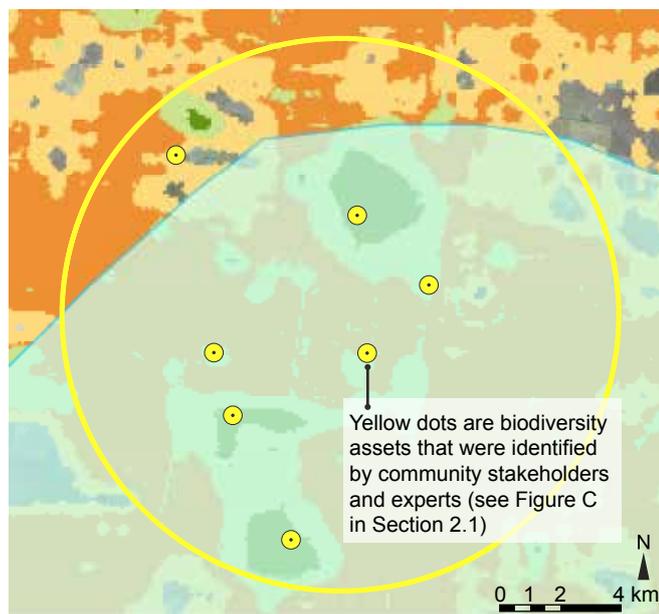
- Management area for threatened or significant species
- Very high priority for Active Management
- High priority for Active Management
- Very high priority for Repair
- High priority for Repair
- Moderate–low priorities

View 3: Management area for threatened and significant species in the local landscape

View 2 shows the priority areas in the local landscape for Active Management of remnant vegetation and Repair of native vegetation. Repair areas are potential candidates for carbon forest plantings that will contribute to biodiversity. Priority Active Management areas are unlikely to be appropriate areas for carbon plantings, because they are intact remnants. However, carbon plantings that use appropriate local tree and shrub species can improve the extent and connectivity of these intact remnants.

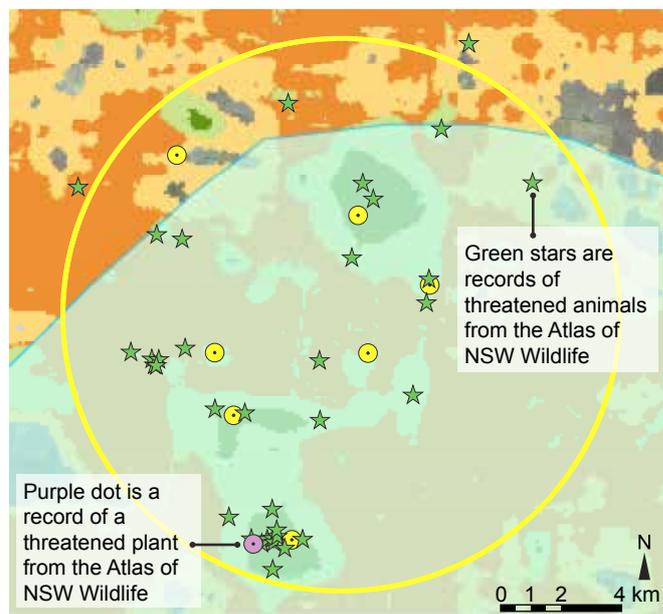
View 3 identifies a management area for threatened and significant plants and animals within the local landscape. Any management actions (including carbon forest plantings) need to consider the recommended actions for the management area, so that they can provide additional benefits for threatened or significant species. For example, carbon plantings could use a mixture of local plant species to fulfil specific habitat requirements of local fauna (e.g. nectar-bearing trees for regent honeyeaters, swift parrots and squirrel gliders).

View 4 shows biodiversity assets or sites that were identified by stakeholders and experts, and View 5 shows records of threatened plants and animals in the local landscape. This fine-scale information is useful to guide and refine planning for carbon plantings, particularly when determining the appropriate location and types of planting that will benefit these species and assets.



- Expert and community assets
- Management area for threatened or significant species
- Very high priority for Active Management
- High priority for Active Management
- Very high priority for Repair
- High priority for Repair
- Moderate–low priorities

View 4: Biodiversity assets in the local landscape



- ★ Threatened flora
- Threatened fauna
- Expert and community assets
- Management area for threatened or significant species
- Very high priority for Active Management
- High priority for Active Management
- Very high priority for Repair
- High priority for Repair
- Moderate–low priorities

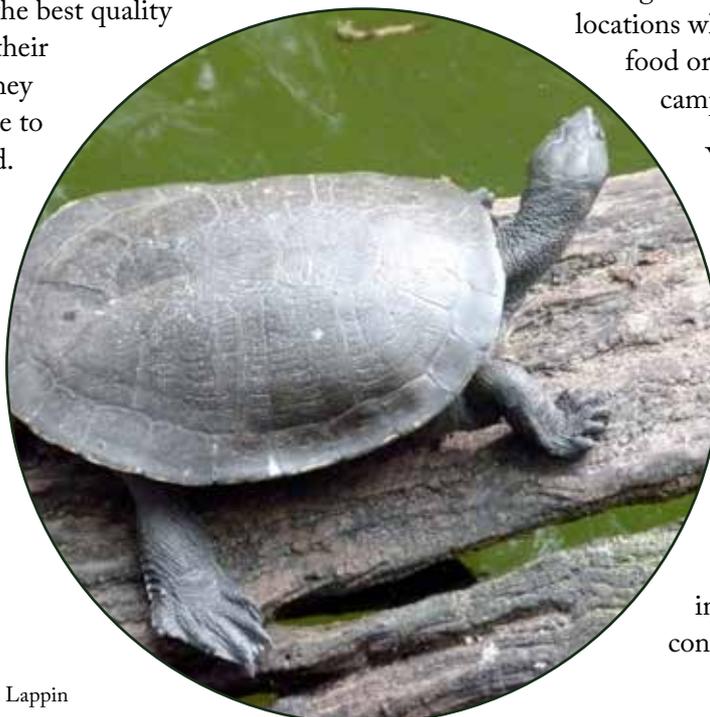
View 5: Threatened species records in the local landscape

Case study 2 Traditional ecological knowledge: connecting with totems

Many Aboriginal people have a totem that connects them to their ancestors and creation stories. A totem can be an animal, plant, rock, hill, river or other type of landform. For example, the totem for Wamba Wamba women is the nightjar owl; for Wamba Wamba men, it is the magpie. Aboriginal art has strong connections with the imagery of totems. Part of Aboriginal people's duty as custodians of the land is to look after their totems and the environment on which those totems depend.

The broad-shelled turtle is one of the totems of the Yorta Yorta Nation. This turtle's habitat has undergone major changes in the last century, which is particularly concerning for the Yorta Yorta people. To support their connection to this totem, the Yorta Yorta Nation, in partnership with the Arthur Rylah Institute, undertook a survey of the Barmah–Millewa Forest to record the living and dead populations of broad-shelled turtles. The survey connected children with their traditions and established the foundation for future projects to maintain and improve the habitat of this important species.

Yorta Yorta people continue to survey the viability and health of turtle populations, and work to improve turtle habitat. The Murray BMP can be a useful tool for Aboriginal communities to identify the best quality habitat for their totems so they can continue to be protected.



Murray turtle
Photo: Natasha Lappin

Case study 3 Traditional ecological knowledge: Yorta Yorta Nation linking Aboriginal and Western spatial systems

Aboriginal people have lived within the landscape of the NSW Murray catchment 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. No single map can depict this connection to Country and the custodial role that Aboriginal people have to care for Country. However, the Yorta Yorta Nation is 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 is based on the approach adopted by some First Nations in North America. It can be used to map generational changes of land use due to environmental changes, such as fragmentation of native vegetation, declining populations of native animals and changing flow regimes of waterways.

This approach to mapping captures an individual's life—how they have occupied their traditional land and how they have used the resources of the land during their lifetime. For example, maps may include locations where a person has harvested plants for food or medicinal purposes, fishing spots, or camping areas.

Yorta Yorta people pioneered land use and occupancy mapping in Australia in 2008. They have started to take the next steps in linking Aboriginal and Western spatial systems through collaborative partnerships with other First Nations and supporting institutions. The Murray BMP—through its mapping of the extent and quality of biodiversity—can be a practical tool to inform current and future land use and occupancy mapping, supporting Aboriginal people in the continuation of their traditions and connection to Country.

The following sequence of views provides a hypothetical example of how Aboriginal people could use the information in the Murray BMP for future projects on Country.

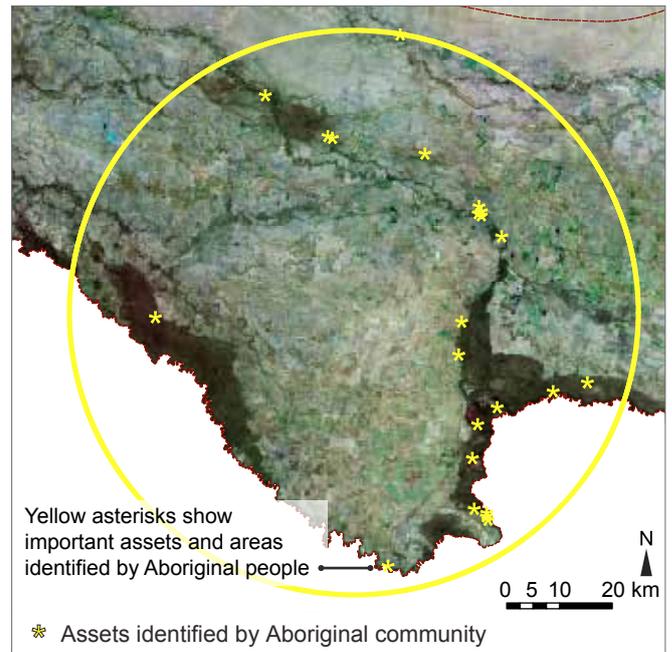
View 1 shows important cultural sites, areas and assets nominated by Aboriginal people at workshops in the western NSW Murray catchment.

View 2 shows areas of public lands—including national parks, the Werai group of forests—which could be potential areas for future projects undertaken by Aboriginal people in the western NSW Murray catchment.

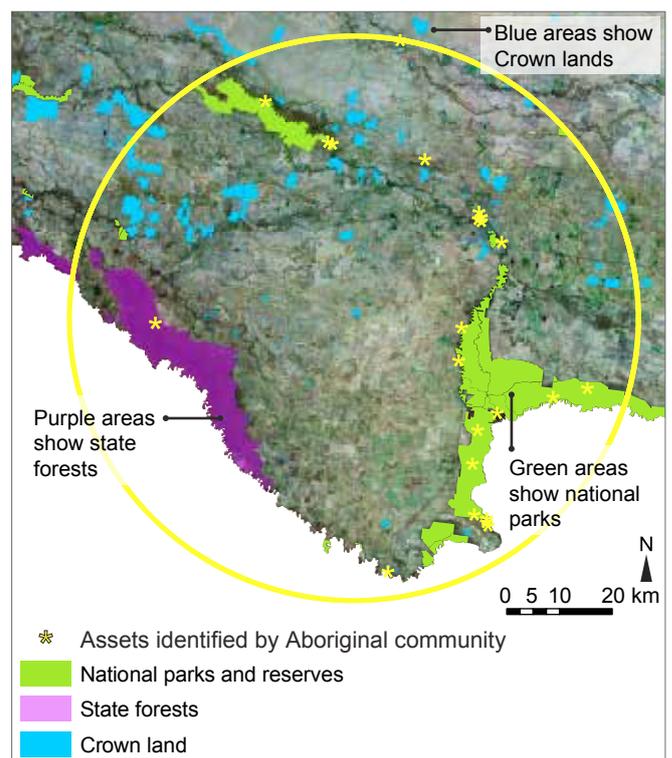
View 3 shows locations of high-conservation-value travelling stock reserves that were identified by stakeholders and Livestock Health and Pest Authority staff at workshops. These sites could also be potential areas for Aboriginal community projects.

View 4 shows the priority areas for Active Management and Repair in the western NSW Murray catchment. These can help to prioritise areas for biodiversity management actions that are part of Aboriginal cultural land management projects.

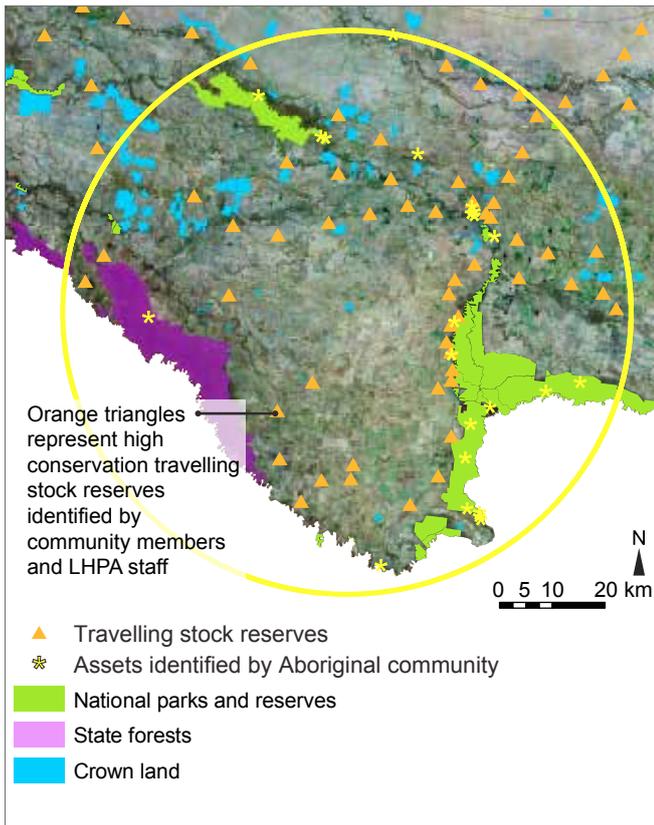
View 5 shows the records for freshwater turtles from the Atlas of NSW Wildlife. This type of information may help Aboriginal people locate sites for projects to protect and manage their totems.



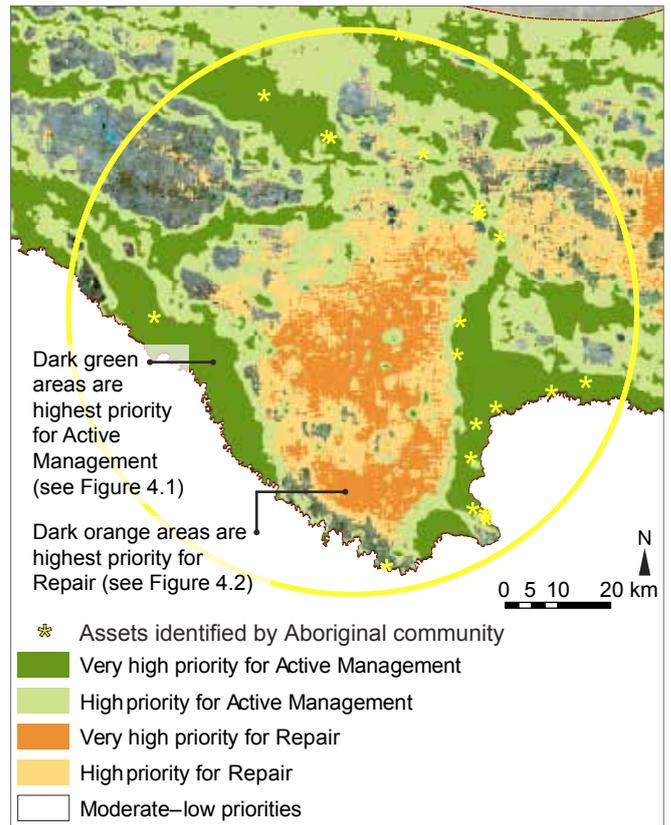
View 1: Assets and areas identified by Aboriginal people in the western NSW Murray catchment



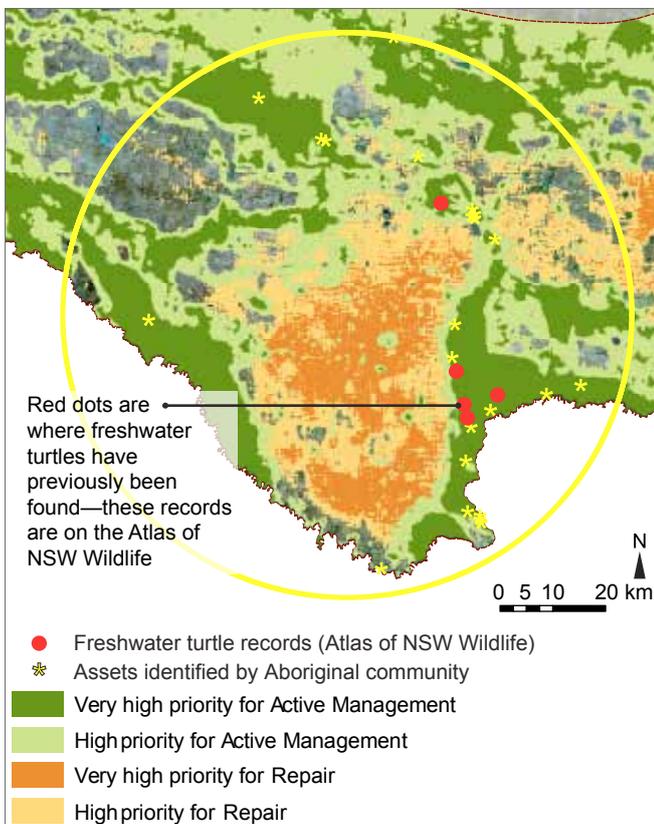
View 2: Areas of public land in the western NSW Murray catchment



View 3: Locations of high conservation value travelling stock reserves in the western NSW Murray catchment



View 4: Priority Active Management and Repair areas in the western NSW Murray catchment



View 5: Records of freshwater turtles in the western NSW Murray catchment

Case study 4 Weed control and threat management in National Parks and Wildlife Service estates

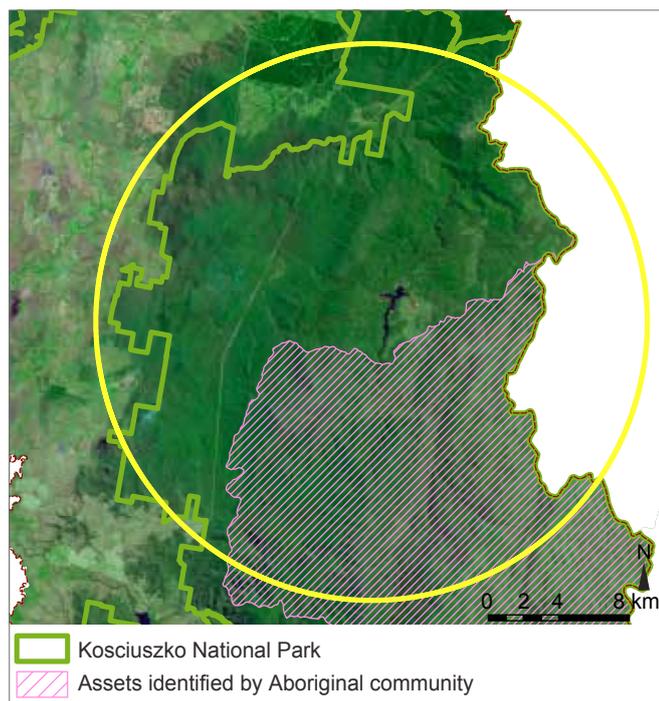
One of the key challenges for land managers, including the National Parks and Wildlife Service (NPWS), is managing threats to biodiversity, such as pest animals and weeds. Significant weed threats are emerging in the reserve system—particularly orange hawkweed and oxide daisy in Kosciuszko National Park (see Chapter 3 for information on threats and their management).

The following sequence of views shows how the NPWS could use the information in the Murray BMP to target weed control in the Jagungal Wilderness Area, where orange hawkweed is already a significant biodiversity management issue.

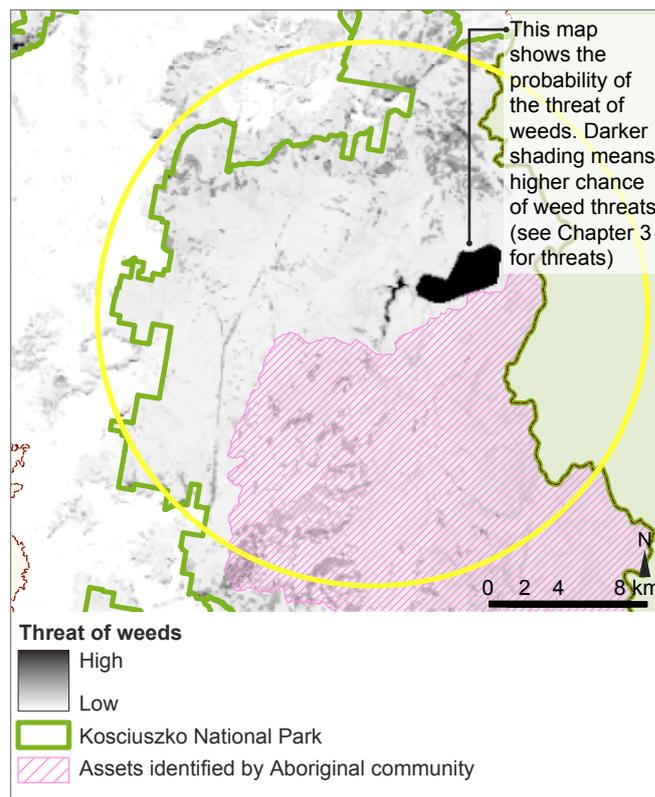
View 1 shows a SPOT 5 satellite image of Kosciuszko National Park including the Jagungal Wilderness Area.

View 2 displays the threats probability mapping layer for terrestrial weeds (see Chapter 3 for further details) in the Jagungal Wilderness Area. The darker the shading appears, the higher the likelihood that weeds will affect the biodiversity of the area. The significant orange hawkweed infestation is shown as an isolated dark patch.

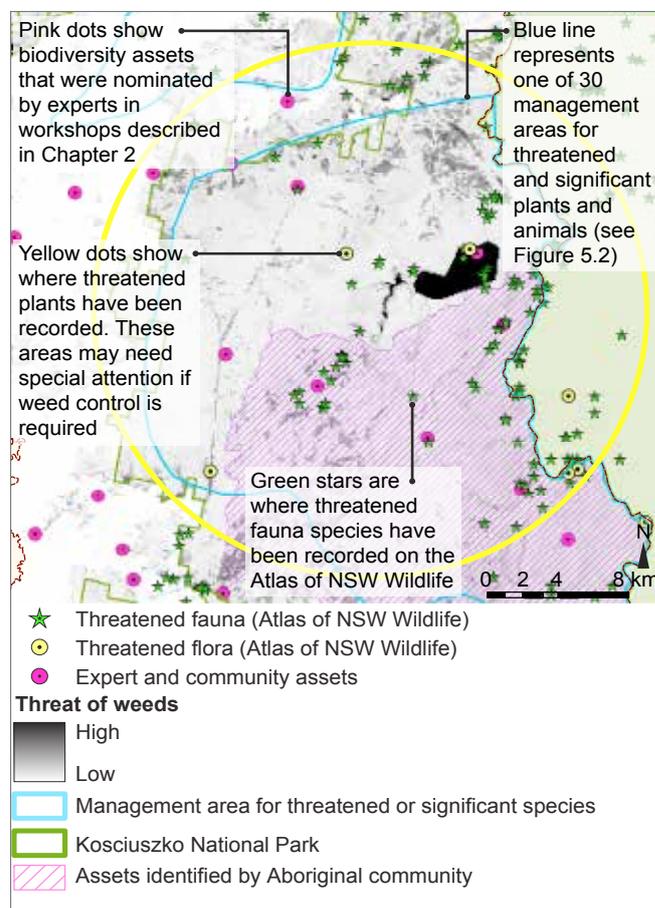
View 3 overlays records of threatened plants, animals and biodiversity assets on the weed threats mapping layer to indicate areas that may require sensitive weed management.



View 1: Jagungal Wilderness Area



View 2: Probability mapping of weed threat in the Jagungal Wilderness Area



View 3: Records of threatened plants and animals, biodiversity assets and location of the management area for threatened and significant species in the Jagungal Wilderness Area

Case study 5 Local government: natural resource management planning

Implementing community strategic plans

The amendments to the *Local Government Amendment (Planning and Reporting) Act 2009* (NSW) have provided a new framework for local government to meet its statutory obligations. The community strategic plans formed under this amendment call for action-based delivery plans that link with the operational plans and annual reports of local government, and are developed under the four pillars of social, economic, environmental and civic leadership.

The Murray BMP can be a tool to guide resourcing and reporting on activities in local government areas under sections 403 and 404 of the *Local Government Act 1993* (NSW). Local information, needs and activities identified within the four pillars of community strategic plans can relate to broader priorities identified in the Murray BMP.

The Murray BMP can also inform State of Environment reporting in local government areas. The Murray BMP contains biodiversity information that can inform the three indicator areas of local government: control (core business, statutory response), influence (advocacy, education, collaboration and communication) and concern (awareness and understanding). These links provide an opportunity for greater partnership opportunities between local governments.

Roadside vegetation and reserve management

The Murray BMP contains new spatial information that can assist local governments in their natural resource assets and management planning at an operational level. The new data includes:

- vegetation extent (mapped by vegetation type)
- vegetation condition
- catchment-scale priorities for biodiversity Active Management and Repair investment.

New vegetation condition data can be used to identify and update local government maps of environmental assets, such as vegetation in high condition

(i.e. vegetation that is ‘near-natural’ and valued as habitat for native plants and animals, as a seed source for future revegetation works, and as an area of high aesthetic value). Local government can use the information in the Murray BMP to update roadside vegetation management plans and inform management recommendations.



Remnant Grassy Woodland roadside vegetation
Photo: Lisa Smallbone

Scenario: Checks and balances to minimise damage to high-value environmental assets

A new pipeline is to be installed along a road verge, requiring trenching and potentially disturbing existing native vegetation.

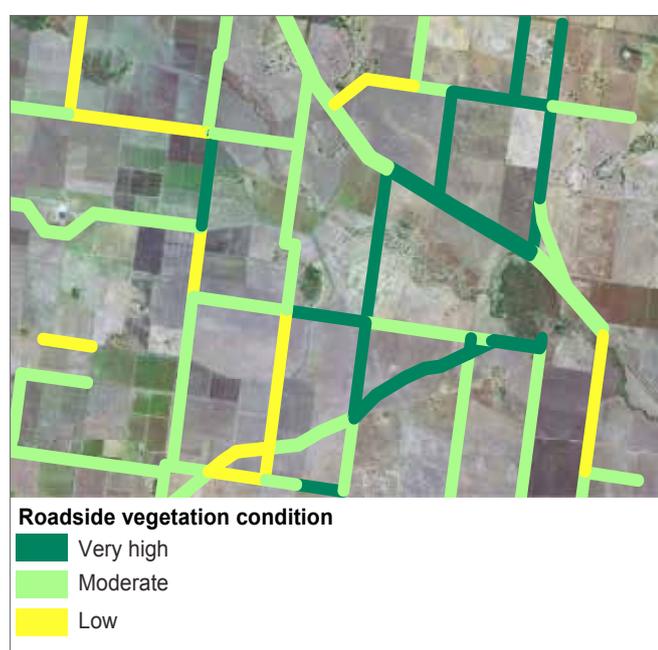
To minimise biodiversity impacts from the pipeline, local government staff used information in the Murray BMP for pre-development planning. Biodiversity values such as the presence of nominated biodiversity and cultural assets (Chapter 2), threatened or significant plants and animals (Chapter 5), and rare or threatened vegetation (Chapters 2 and 5) should be considered before developments proceed.

For this scenario, the most relevant local-scale information can be found in Chapter 2, in which many patches of roadside vegetation—particularly travelling stock reserves—have been ranked by their biodiversity values.

The Active Management and Repair priority maps in Chapter 4 can be used to identify a site’s contribution to regional biodiversity values, and determine if it is a high priority for Active Management due to its condition and connectivity. Narrow roadside reserves

that are surrounded by degraded vegetation are expected to be at greater risk from weed invasion than roadsides that are part of larger areas of intact remnant vegetation. Disturbance by the pipeline construction may require some follow-up weed management in Active Management areas.

The information in the Murray BMP may assist in relocating or reconfiguring the pipeline to adjacent land that has lower biodiversity values than the road verge, or may help in the development of appropriate management strategies after the construction (see View 1 below). This may include replanting in a Repair priority area to balance out the disturbance of the development.



View 1: This view shows how information about roadside vegetation condition can help local government staff to assess the relative biodiversity values of roadside vegetation

Scenario: Prioritising on-ground works for vegetation management and restoration

The spatial mapping information in the Murray BMP may assist and inform local government planning for roadside vegetation management. The priority investment maps in Chapter 4 can be used to:

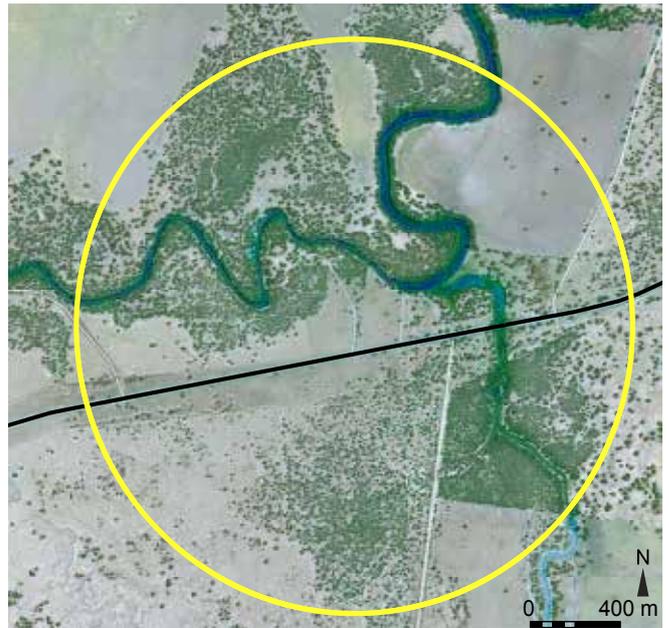
- prioritise weed and pest control works in roadsides that are mapped as priority areas for Active Management. By scheduling annual inspections of these areas, weeds can be identified before they become a problem
- identify priority Repair areas that are most suitable for restoration and enhancement works (such as revegetation of the shrub layer, weed control and placement of fallen timber) that will contribute the most to biodiversity at the regional scale. This information could be used to support funding applications and guide the implementation of local natural resource management plans.

By inspecting priority areas for Active Management and identifying threats such as weeds, pests or human impacts early on, control costs can be minimised. Priority area maps can help shift roadside management from ‘reactive’ (where problems are addressed when they are already significant) to ‘active’ (where there is an emphasis on preventive action and prioritisation of works).

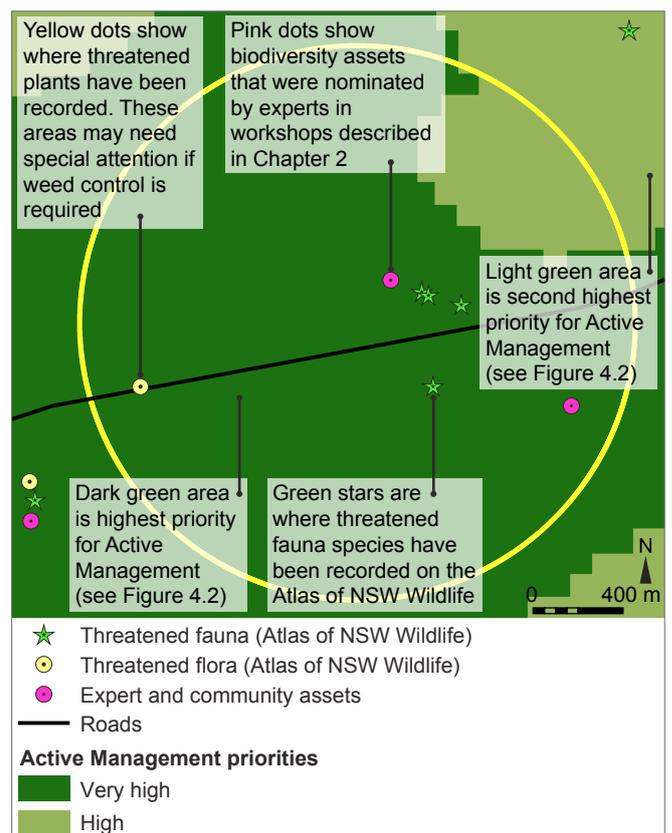
The following hypothetical scenario of an area of roadside vegetation in the central northern NSW Murray catchment provides an example of how mapping information in the Murray BMP can be used to plan management actions.

View 1 shows a SPOT 5 satellite image of roadside vegetation in the north-central area of the NSW Murray catchment.

View 2 shows that this area has very high Active Management values, as well as records of threatened plants and animals, and biodiversity assets nominated by stakeholders or experts. This area has multiple biodiversity values at the site and catchment scale that will help to guide management actions such as weed and grazing management and feral pest control.



View 1: SPOT 5 satellite view of roadside vegetation in north-central NSW Murray catchment



View 2: Priority Active Management areas, threatened species records and biodiversity assets

Case study 6 Informing the Murray Catchment Management Authority's investment in biodiversity

Ranking projects in a catchment-wide incentives program

Murray Catchment Management Authority (Murray CMA) runs a range of programs to protect and improve biodiversity on private and public lands in the Murray catchment. Participation in Murray CMA programs is voluntary, so a financial incentive (i.e. funding for eligible on-ground works and ongoing management) is provided to increase landholder involvement.

Through the Murray CMA's annual Biodiversity Incentives program, landholders are invited to submit proposals for projects that will improve biodiversity management. Projects are ranked according to their biodiversity benefit and value for money, and funded by rank within the constraints of the project budget.

Under this program model (a mixed market-based instrument), Murray CMA can prioritise its investment programs to maximise their overall biodiversity benefit and cost-effectiveness. Criteria that are considered when assessing a project's biodiversity benefit include:

- project size (area of vegetation that is actively managed for its biodiversity value)
- vegetation condition
- connectivity value
- threats to the site posed by neighbouring land uses
- proposed duration of management contract
- whether the project contains wetlands or riparian areas
- whether the project falls within a priority area.

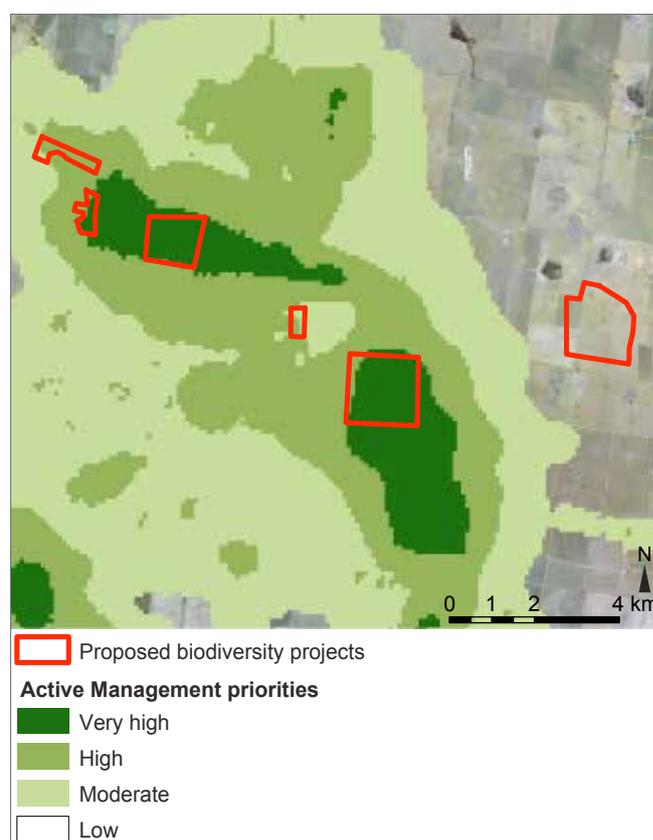
Previously, priority areas have been defined by investor preferences (e.g. protecting endangered ecological communities, or improving connectivity within identified landscape-scale corridors). Investor preferences will continue to be a major influence on the direction of biodiversity investment in the Murray catchment, alongside the standard project criteria listed above.

New priority area maps will enable a more rigorous and consistent evaluation of a project's relative contribution to regional biodiversity value. The images below show how priorities for Active Management can be used to compare project proposals for improved biodiversity management. In this example, project proposals within dark green shaded zones (high-priority Active Management areas) would be expected to contribute more to conservation of regional biodiversity values than areas outside the Active Management priorities.



Travelling stock reserve incentive site

Photo: Shanna Rogers



Using Repair priority-area mapping to identify preferred sites for restoration and revegetation of Grassy Woodlands

Murray BMP Repair priority-area maps can maximise benefits to biodiversity when investment programs have specific objectives, such as targeting threatened or 'overcleared' vegetation communities. Under a model of voluntary participation, Murray CMA or other funding bodies could use the priority area maps to apply differential incentive funding for landholders. This may encourage greater participation in areas where restoration management actions, such as revegetation and promoting natural regeneration, will be most beneficial. It may also guide more targeted project promotion.

Similarly, priority area maps can maximise benefits within the investment area when investor preferences target funding towards areas of interest, specific themes, or issues of concern. These may include local government areas, management zones, endangered ecological communities or the ranges of threatened species.

The following sequence of views shows how spatial mapping information in the Murray BMP can be used to identify priority areas within Grassy Woodlands for repair activities.

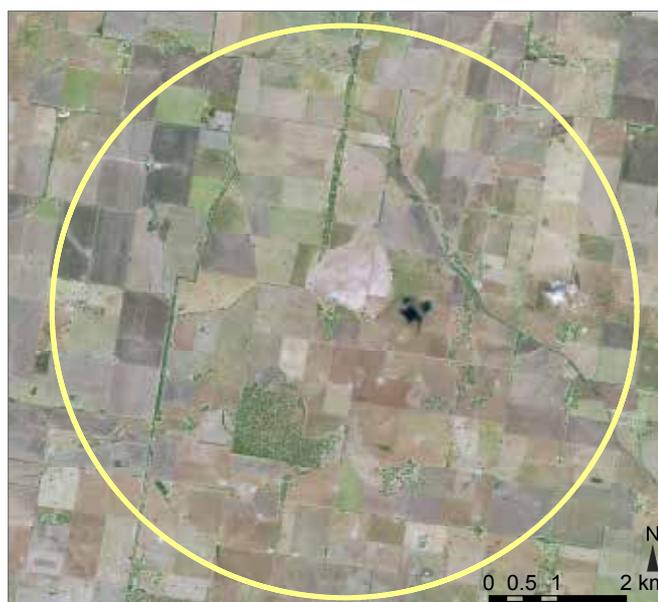
View 1 shows a local landscape in the South Western Slopes of the NSW Murray catchment that is primarily agricultural with scattered remnants of native vegetation.

View 2 shows that the local landscape contains remnants of Grassy Woodland and small patches of Semi-arid Woodland (Roff et al. 2010a,b, see Figure 2.5). Grassy Woodlands have been extensively cleared in the past, and some ecological communities are now listed as endangered under state and Commonwealth legislation. These communities are considered as a priority for funding management actions.

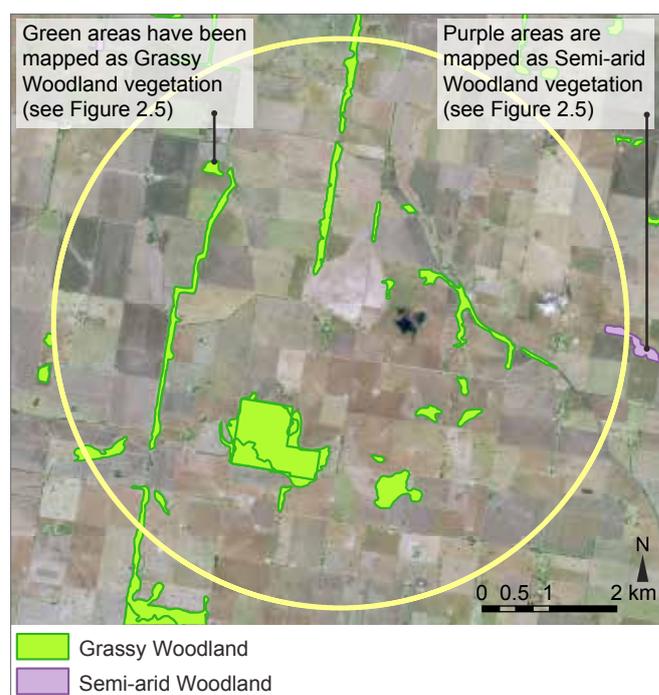
View 3 illustrates that this local landscape is ranked in the Murray BMP as a priority for Repair. This could include management activities such as revegetation using plantings and natural regeneration.

View 4 illustrates that this area is also primarily a priority Repair area for Grassy Woodland vegetation formations.

View 5 shows that parts of this landscape fall within the top five per cent of Repair priorities in the Grassy Woodland formation, and may be highly ranked areas for future voluntary management agreements.



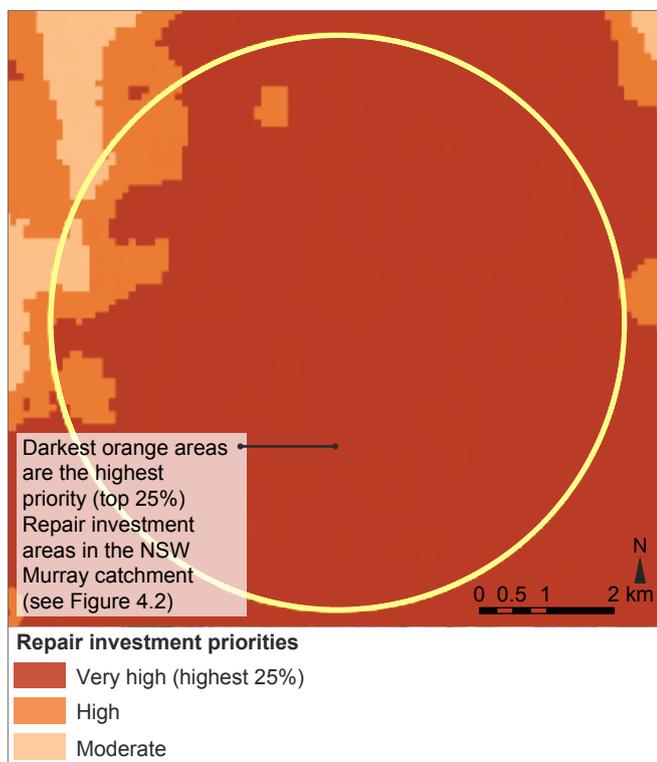
View 1: SPOT 5 satellite image of local landscape in South Western Slopes of NSW Murray catchment



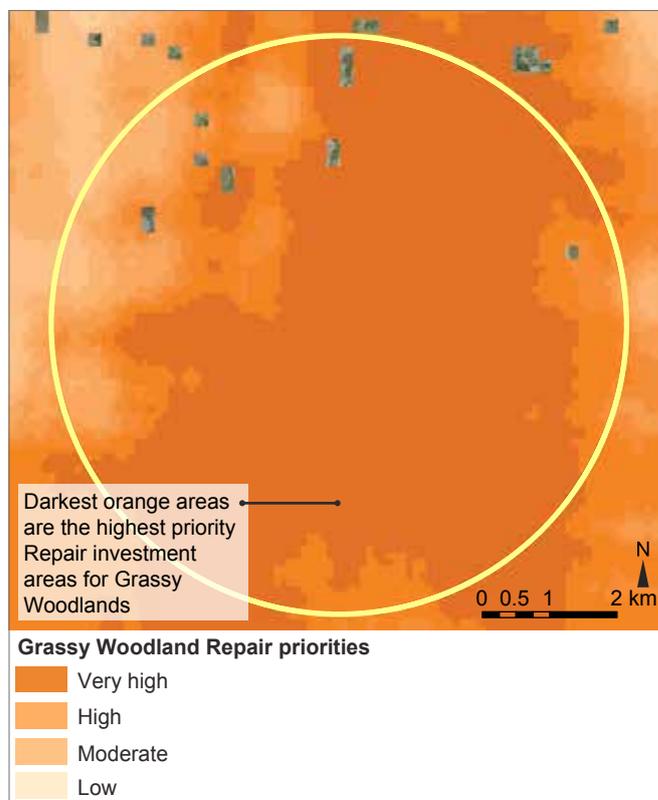
View 2: Vegetation formation mapping (Roff et al. 2010a,b)

View 6 shows that the local landscape also contains threatened fauna and biodiversity assets. These may

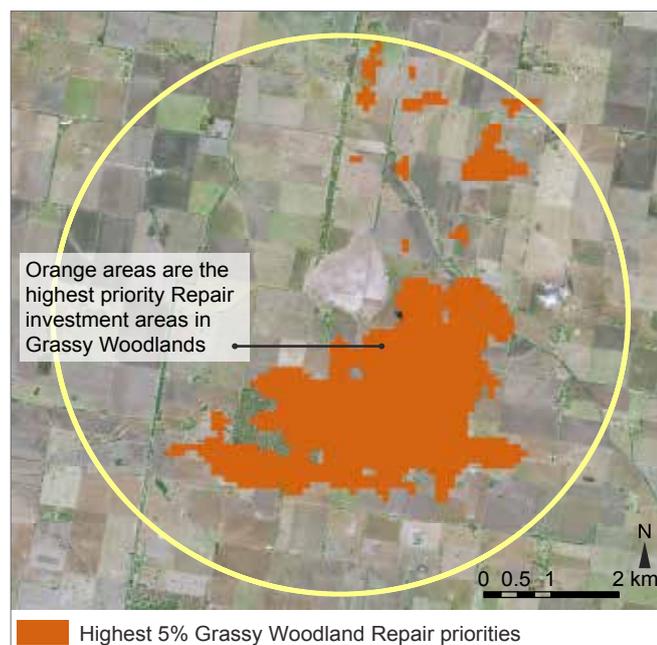
increase the overall biodiversity ranking of this area for future investment.



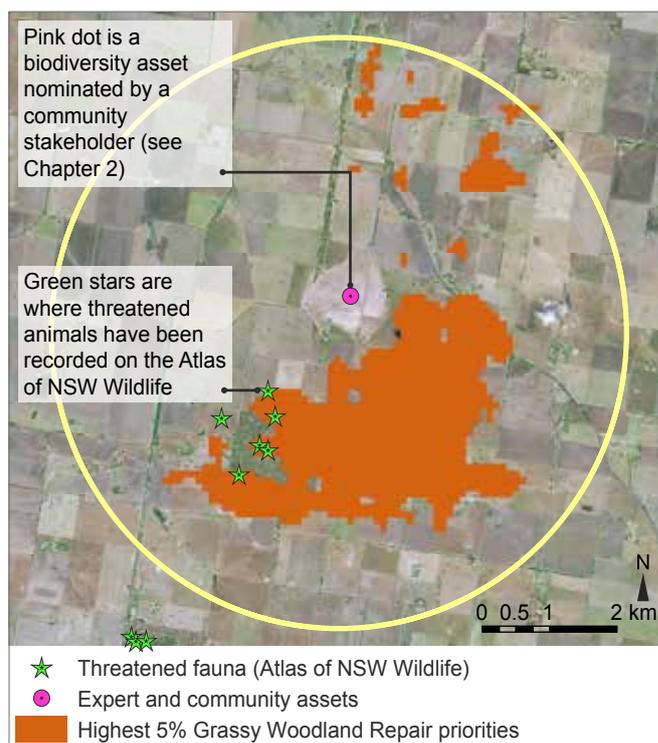
View 3: Priority Repair mapping values for the NSW Murray catchment



View 4: Priority Repair mapping values for Grassy Woodland vegetation formation



View 5: Highest 5 per cent of Repair mapping values for Grassy Woodland vegetation formation



View 6: Threatened fauna and biodiversity assets records

Using threats maps to identify where threat-specific actions are best targeted

Threat consequence maps (Appendix 3.5) identify areas at the greatest risk of biodiversity decline due to the impacts of specific threats. By identifying the major contributing threats in different parts of the catchment, investment programs can be tailored to the nature of the threat and targeted to the areas where they will be of greatest benefit. Threat abatement programs could include funding on-ground works to provide infrastructure or materials to improve demonstration sites, or formal training or general awareness raising to improve landholder knowledge and capacity to manage the threat.

Specific examples could include workshops, training programs and educational materials to increase landholders' capacity to manage native pastures where loss of native diversity due to pasture improvement is a major threat. Education programs can raise awareness of the importance of paddock trees to biodiversity on farms, particularly in cropping zones where paddock tree loss and decline is most notable.

Capacity building plays an important role in improving biodiversity management.



Milkmaids (top), everlasting daisy (left), woodland field day
Photos: Alison Skinner, Stuart Cohen

Glossary

Active Management	Active Management priority investment areas include vegetation that, if lost, would have the greatest impact on the biodiversity of the NSW Murray catchment. These areas are generally in high condition and well connected, but require on-ground management to address existing or potential threats (such as weeds or pests) that would affect the biodiversity values of that area.
biodiversity	The variety of all life forms, including different plants (from the smallest mosses, herbs and grasses, to shrubs and tall trees), animals (invertebrates, fish, amphibians, reptiles, birds and mammals) and fungi; the genes they contain; and the ecosystems in which they live.
Biodiversity Forecasting Tool (BFT)	A computer modelling program that uses a range of GIS-based data to assess the contribution of local-scale patches of vegetation to the future health of a catchment's biodiversity. In the past decade, the BFT has been applied to terrestrial biodiversity assessment and planning activities across many areas of NSW.
endangered ecological community (EEC)	An ecological community is an assemblage of two or more populations of different species that occupy the same geographical area. An endangered ecological community faces a very high risk of extinction in the future. Threatened ecological communities are listed as endangered under the <i>Threatened Species Conservation Act 1995</i> (NSW), <i>Fisheries Management Act 1994</i> (NSW), or the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cwlth).
enhancement planting	Planting trees to provide replacements for mature trees when they fall down and to add structural complexity to habitats.
National Parks and Wildlife Service (NPWS) estate	Includes all formal reserves managed by the NSW NPWS (Office of Environment and Heritage), as well as lands vested in the Minister for the Environment and intended for future transfer to an Aboriginal landholding body (under Part 11 of the <i>National Parks and Wildlife Act 1974</i>).
NSW Murray catchment	The NSW section of the Murray catchment from the headwaters of the Murray River to the confluence of the Murray and Murrumbidgee rivers. This is also known as the Murray Catchment Management Authority area.
Repair	Repair priority investment areas have low-condition vegetation in small, fragmented and isolated remnants. These areas need revegetation (replanting and promoting natural regeneration) and restoration management to improve their biodiversity values.
significant species	Plants and animals that are not formally listed as threatened, which are either listed as migratory species or were nominated as important by community stakeholders or species experts.
threatened species	Plants and animals that face the likelihood of future extinction if threats that affect their survival are not managed. Species are listed as critically endangered, endangered or vulnerable under the <i>Threatened Species Conservation Act 1995</i> (NSW), <i>Fisheries Management Act 1994</i> (NSW), or the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cwlth).

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