Perup

draft management plan

2011

Department of
Environment and Conservation

Conservation
Commission
WESTERN AUSTRALIA

Perup

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Conservation Commission of Western Australia

Acknowledgments

Planning team

This management plan was prepared by a department planning team consisting of Paul Roberts, Peter Keppel, John Gillard, Roger Hearn, Dr Lachie McCaw, Tim Foley, Brad Barton, Rod Simmonds and Ian Michael.

The planning team acknowledges individuals past and present for their involvement and input while preparing this management plan, and those who contributed submissions during the preparation of this plan. The planning team would like to thank the many other department staff that contributed to the preparation of, and commented on, the management plan, particularly Paul McCluskey, Ian Wilson, Adrian Wayne, Beverly Gardiner, Amanda van Loon, Cathy Birch, Laura Sinclair, Trevor Howard, Roger Armstrong, Michael Coote and Ken Wallace.

Conservation Commission

Carol Lacroix, formerly from the Conservation Commission, was an observer for this plan.

Community involvement

Many individuals and organisations made valuable contributions to the development of this document. The planning team would especially like to acknowledge the contributions of Mr Ray Curo (Shire of Manjimup), Mr Dion Steven (Shire of Boyup Brook, Bridgetown-Greenbushes and Manjimup), Cassandra Stipanicev (Shire of Cranbrook), Leonie Banks (WA Recreational Horserider's Association), Justin Bellanger (South Coast NRM), R. Crosby, Tom Devries, Jenny Dewing (Blackwood Environment Society), Cheryl Hamence (Blackwood Valley Landcare), Bessel Hanekamp, Emily Lewis (Warren Catchments Council), Ian Moore (Moore Mapping), Bob Morgan (Fire for Life), Geraldine Muir, Graham Muir, Mark Muir, Kelum Pape, Alida Parke, Bev Parke, Les Parke, Keith Prosser, Kim Redman (Bridgetown-Greenbushes Friends of the Forest), June Roberts, Andy Russell, Erica Shedley (Birds Australia WA), Peter Taylor (Birding South West), Helen Tuckett (Tonebridge Progress Association), Noreen Tuckett (Boyup Brook Tourist Bureau), Katherine and Kevin Waddington (Outback Heritage Horse Association of WA).

Aboriginal people

The contribution of Nyoongar people to the preparation of this plan is recognised. Any information presented that has been handed down should not be used outside the context of this management plan.

The term 'Nyoongar' refers to Aboriginal people who live in the south-west corner of Western Australia (WA), between Jurien Bay and Esperance. The word 'Nyoongar' can be spelt in different ways, and spelling in this form should also be seen to encompass the Noongar, Nyungar, Noongah and Nyungah spellings.

Funding and support

The preparation of this management plan has been partly funded and supported by the Australian Government Department of the Environment, Water, Heritage and the Arts.

Images

Main cover photo: Numbat (*Myrmecobius fasciatus*)
Other cover photos: Australian shelduck (*Tadorna tadornoides*) photo by Peter Taylor
The 'Cottage' located at *Perup – Nature's Guesthouse* photo by Tim Foley
Header photo: Migratory waders and other waterbirds at Lake Unicup, photo by Peter Taylor

Invitation to comment

The *Perup draft management plan* is an opportunity to provide information, express your opinion, suggest alternatives and have your say on how the parks and reserves covered by the plan will be managed during the next 10 years.

Make your comments count

What to consider

In making your submission, it is important to understand that legislation and policy imposes certain obligations on the Department of Environment and Conservation (the department) to manage lands and waters vested with the Conservation Commission of Western Australia (Conservation Commission) and that there may be little room to manage some issues outside of these constraints and responsibilities. Nevertheless, it is important to hear from the public about the management of these issues. There are also some issues that may have a number of management options during the life of the plan, or where the department has developed a proposal and wants to gauge public opinion about management.

Issues and proposed actions that the department and the Conservation Commission would particularly like to seek feedback on during the public comment period of this draft management plan include:

- key performance indicators mentioned through various sections of the plan
- the size, structure and general readability of this plan
- the addition of proposed reserves to the conservation estate
- proposed names for the unofficially named Greater Kingston National Park, Lake Muir National Park, Tone-Perup Nature Reserve, Cobertup Nature Reserve and Quindinup Nature Reserve
- the upgrading of Alco, Cowerup, Quindinup and Wilgarrup nature reserves to ‘class A’ reserves
- progressive assessment, removal and rehabilitation of exotic tree species trial plots
- assessment of the invasiveness, distribution and environmental impact of invasive plants and animals in the planning area, particularly feral pigs (*Sus scrofa*), red deer (*Cervus elaphus*), goats (*Capra hircus*) and horses (*Equus caballus*)
- identification and protection of ‘protectable areas’ not infested by *Phytophthora cinnamomi*
- proposed visitor management settings
- development of day-use and camping sites
- development of trails, particularly bushwalking and horseriding trails
- the assessment of waterskiing on Lake Unicup
- the renewal of Lease 1337/40 for a dam site (water) in Greater Kingston National Park
- the exclusion of beekeeping from the planning area.

How to make effective comments

It is important to indicate those strategies and recommendations you agree with as well as those with which you disagree. Each submission is important. However, those that give reasons for concerns, give support where fitting and offer information and constructive suggestions are most useful.

If you prefer not to write your own submission you could make a joint submission with others. To ensure your submission is as effective as possible:

- make it clear and concise
- list your points according to the subject sections and page numbers in the plan
- describe briefly each subject or issue you wish to discuss
- say whether you agree or disagree with any or all of the aims or strategies within each subject or just those of specific interest to you – clearly state your reasons (particularly if you disagree) and provide supportive information where possible
- suggest alternatives to deal with issues with which you disagree.

Where to send your comments

Submissions are welcome for two months after the release date of the draft management plan and can be made online at: www.dec.wa.gov.au or by writing to:

Planning Coordinator
Perup draft management plan
Department of Environment and Conservation
Locked Bag 104
BENTLEY DELIVERY CENTRE WA 6983

How your comments will be considered

All submissions will be summarised according to topics discussed. The management plan will then be reviewed in the light of submissions, according to established criteria (see below). A summary of the submissions will be prepared along with the final management plan, including an indication of how the plan was amended or not amended in response to the submissions:

1. The draft management plan will be amended if a submission:
   (a) provides additional information of direct relevance to management
   (b) provides additional information on affected user groups of direct relevance to management
   (c) indicates a change in (or clarifies) government legislation, management commitment or management policy
   (d) proposes strategies that would better achieve management objectives
   (e) indicates omissions, inaccuracies or a lack of clarity.

2. The draft management plan will not be amended if a submission:
   (a) clearly supports proposals in the plan
   (b) makes general statements and no change is sought
   (c) makes statements already in the plan or were considered during the plan preparation
   (d) addresses issues beyond the scope of the plan
   (e) is one among several widely divergent viewpoints received on the topic, but the text/strategies in the plan are still considered the preferred option
   (f) contributes options that are not feasible (generally due to conflict with existing legislation, government policy, lack of resource capacity or lack of research knowledge to make decisions)
   (g) is based on unclear, factually incorrect information
   (h) provides details that are not fitting or necessary for inclusion in a document aimed at providing long term management direction.

Contents

Introduction

1. Management plan area

This draft management plan has been prepared by the department on behalf of the Conservation Commission. The plan covers two national parks (Greater Kingston National Park and Lake Muir National Park) and 17 nature reserves (including Lake Muir Nature Reserve and Tone-Perup Nature Reserve) totalling about 106,889 hectares in the Perup area[1] north and east of Manjimup (Map 1, Table 1). The parks and reserves, henceforth referred to as the 'planning area', lie within the local government areas of Manjimup, Bridgetown-Greenbushes, Boyup Brook and Cranbrook (Map 1).
This management plan will be the first plan for all the parks and reserves in the planning area.

Table 1: Existing reserves in the planning area

Reserve Name/ Tenure	Reserve No.	Class	Area (ha)	Purpose	Created[3]
Alco Nature Reserve	32142	Other[2]	191.2	Conservation of flora and fauna	July 1973
Bokarup Nature Reserve	14739	A	146.1	Water and conservation of flora and fauna	June 1978
Cobertup[1] Nature Reserve	26681	A	151.0	Water and conservation of flora and fauna	October 1978
Cowerup Nature Reserve	33455	Other[2]	270.5	Conservation of flora and fauna	July 1975
Galamup Nature Reserve	6549	A	221.8	Conservation of flora and fauna	March 1978
Greater Kingston[1] National Park	47662	A	21,092.0	National park	December 2004
Kodjinup Nature Reserve	26678	A	626.0	Water and conservation of flora and fauna	October 1978
Kulunilup Nature Reserve	26677	A	612.0	Water and conservation of flora and fauna	October 1978
Lake Muir Nature Reserve	31880	A	11,310.8	Water and conservation of flora and fauna	August 1978
Lake Muir[1] National Park	47886	A	9625.0	National park	December 2004
Noobijup Nature Reserve	26680	A	183.1	Water and conservation of flora and fauna	October 1978
Pindicup Nature Reserve	26679	A	281.0	Water and conservation of flora and fauna	October 1978
Pinticup Nature Reserve	26682	A	75.5	Water and conservation of flora and fauna	October 1978
Quindinup[1] Nature Reserve	25506	Other[2]	2653.0	Conservation of flora and fauna	October 1985
Tone-Perup[1] Nature Reserve	47879	A	55,935.0	Conservation of flora and fauna	December 2004
Unicup Nature Reserve	25798	A	3296.0	Conservation of flora and fauna	December 1960
Wilgarrup Nature Reserve	12381	Other[2]	84.6	Conservation of flora and fauna	November 1985
Yarnup Nature Reserve	29601	A	61.6	Water and conservation of flora and fauna	November 1978
Un-named nature reserve	46478	A	72.8	Conservation of flora and fauna	February 2001
Total area			106,889		

[1] Name of reserve is only provisional. [2] Other than class A reserves. [3] Gazettal date for the current purpose.

[1] *See the Conservation Commission's* '2009 Review of management planning' *at www.conservation.wa.gov.au.*

2. Key values and threats

Key values

The planning area has importance for the following specific key values:

- the internationally significant 'Muir-Byenup system' Ramsar-listed wetland (Muir-Byenup Ramsar wetland system) (Map 1)
- the nationally and regionally significant system of wetlands that is one of few in the state in a near pristine condition, and contains rare peat swamps and the biggest natural sedgelands in WA
- extensive jarrah (*Eucalyptus marginata*) old-growth forest
- a high diversity of native plant and animal species in a big undisturbed and intact biological refuge that is contiguous with substantial nearby areas of state forest and national park
- ten threatened flora species
- fourteen threatened fauna species, including one of the last remaining strongholds of the woylie (*Bettongia penicillata ogilbyi*), numbat, tammar wallaby (*Macropus eugenii derbianus*), Muir's corella (*Cacatua pastinator pastinator*), Australasian bittern (*Botaurus poiciloptilus*) and Balston's pygmy perch (*Nannatherina balstoni*), the biggest remaining non-coastal population of the ngwayir or Western ringtail possum (*Pseudocheirus occidentalis*), the biggest known wambenger or brushtail phascogale (*Phascogale tapoatafa* ssp. [WAM M434]) population in WA, one of the most abundant chuditch (*Dasyurus geoffroii*) populations
- many big areas that have a high probability of not being infested by *Phytophthora cinnamomi*
- Aboriginal sites of mythological, ceremonial, cultural and spiritual significance, and non-Indigenous sites associated with early settlement and the agricultural and forestry industries
- regionally-significant visitor facilities at *Perup – Nature's Guesthouse* and Lake Muir Observatory
- an accumulation since the 1970s of long-term ecological research knowledge on a range of species, habitats and threatening processes.

Woylie. Photo – Bert and Babs Wells

Rain clouds over Lake Muir. Photo – Paul Roberts

Ecological character[2]

The 10,630 hectare Muir-Byenup Ramsar wetland system (Map 1) was included on the List of Wetlands of International Importance under the Ramsar Convention (see Legislative and Policy Framework) in January 2001 on the basis of meeting four of the original six qualifying criteria[3] of:

- **Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.** Three wetland-dependent orchids (*Caladenia christineae*, *Caladenia harringtoniae* and *Diuris drummondii*) are listed as 'vulnerable' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and occur at the site in appreciable numbers. These plants mainly occur on seasonally inundated areas or wetland margins, which have been extensively cleared for agriculture elsewhere in south WA. However, the Ramsar site also supports the 'endangered' woylie and the 'vulnerable' Balston's Pygmy Perch, Muir's corella, forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*), chuditch, numbat and quokka (*Setonix brachyurus*).
- **Criterion 4: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.** The open lakes of the site regularly support moulting by thousands of Australian shelducks, which is one of the most important moulting sites in south WA. Lake Muir is used as a drought refuge by tens of thousands of waterbirds. However, the site also supports ten species identified under international migratory species agreements (see *Legislative and Policy Framework* and *Native Animals and Habitats*), and is also an important breeding site for the little bittern (*Ixobrychus minutus*), spotless crake (*Porzana tabuensis*), Australasian bittern, black swan (*Cygnus atratus*) and Eurasian coot (*Fulica atra*).
- **Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.** Up to 52,000 waterbirds have been counted in a full Lake Muir. The annual data on water depth suggest conditions are suitable for use by 20,000 waterbirds at least several times within a 25 year period, which in the context of wetland availability in WA is considered sufficient evidence of regular use by 20,000 waterbirds.
- **Criterion 6: A wetland should be considered internationally important if it regularly supports one per cent of the individuals in a population of one species or subspecies of waterbird.** At least five, possibly 10, Australasian bitterns occur regularly and possibly breed in the sedge swamps of the site, which constitutes more than one per cent (i.e. five) of the south WA population (Wetlands International 2006). The site contains the core component of a wider suite of wetlands that constitutes one of the five remaining refuges for the south WA population of this globally threatened species.

The ecological character of the Muir-Byenup Ramsar wetland system (Table 2) has been described by Cook and Farrell (2009).

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[2]The 'ecological character' is the combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time. Within this context, ecosystem benefits are defined in accordance with the variety of benefits to people (i.e. ecosystem services). Ecosystem services are defined as 'the benefits that people receive from ecosystems' (Ramsar Convention 2005, Resolution IX.1 Annex A). The phrase 'at a given point in time' refers to resolution VI.1 paragraph 2.1, which states that 'It is essential that the ecological character of a site be described by the Contracting Party concerned at the time of designation for the Ramsar List, by completion of the Information Sheet on Ramsar Wetlands' (as adopted by recommendation IV. 7).

[3]The Ramsar criteria are contained in the Ramsar Information Sheet for this site (see www.environment.gov.au/water/publications/environmental/wetlands/database/index.html).

Table 2. Summary of the ecological character of the Muir-Byenup Ramsar wetland system.

Component	Summary description
Geology	Tertiary alluvial flats (Lake Muir) and Tertiary plateau and flat (Byenup Lagoon system).
Hydrogeology	Fresh to saline groundwater. Groundwater pH 5.2–6.3. Acidity is due to soluble metals. Potential acidity is present in the form of pyrite (metallic sulphide).
	Lake Muir
Hydrology	Major sink water – almost exclusively internally draining. Naturally saline wetland – shallow evaporating basin (dry nine years 1998–2008).
Water quality	Saline (0.58–96 parts per thousand). pH 6.2–9.9. Lower pH is associated with low water levels.
Flora (habitat)	Salt tolerant macrophytes. Fringing vegetation includes *Gahnia trifida* sedgelands, low shrublands (samphires) and wetland scrub. Flat-topped yate (*Eucalyptus occidentalis*) occurs at higher elevations. Notable flora includes wetland-dependent orchids and endemic[4] species.
Aquatic invertebrates	No information available.
Fish	No information available.
Frogs and reptiles	No comprehensive surveys. Likely to be rich in reptiles, including oblong tortoises (*Chelodinea oblonga*) and tiger snakes (*Notechis scutatus*).
Mammals	Believed to contain many species found in adjacent Tone-Perup Nature Reserve, including woylies and chuditch. Also contains suitable habitat for the boodie (*Bettongia lesueur lesueur*), dalgyte (*Macrotis lagotis*) and water rat or rakali (*Hydromys chrysogaster*).
Waterbirds	Regularly supports 20,000 waterbirds. Up to 52,000 waterbirds in 1989. Five species listed under international migratory agreements. Used as a drought refuge by big numbers of waterbirds. Black swans, silver gulls (*Larus novaehollandiae*) and Australasian shoveler (*Anas rhynchotis*) breed at Lake Muir.
	Byenup Lagoon System
Hydrology	Surface water area and depth varies seasonally. Coorinup Swamp acts as a shallow evaporating basin (primary saline lake). Byenup Lagoon permanent, other wetlands permanent or near permanent and minor swamps inundated and/or waterlogged winter/spring. Areas of peat in Byenup, Tordit-Gurrup and Poorginup dry out seasonally.
Water quality	Poorginup Swamp fresh (0.1–1.6 parts per thousand), other wetlands brackish to saline (Tordit-Gurrup 0.65–15.2 and Byenup 1.38–42.2 parts per thousand). Poorginup Swamp acidic (pH 5–6.6). Other wetlands pH 7–9. Higher nutrient concentrations related to low water levels and peat drying. Wetlands do not behave as eutrophic.

Component	Summary description
Acidification	Poorginup Swamp has acid sulfate soils, formed during seasonal drying and re-wetting. Vegetation decline on Byenup Lagoon may be due to acidity and interactions with heavy metal release from sediments. Vegetation decline also evident in recent aerial photos of north Tordit-Gurrup.
Flora (habitat)	Macrophytes include *Ornduffia submersa* and *Schoenus natans*. Fringing vegetation includes *Baumea* sedgelands and shrublands with jarrah/ yate (*Eucalyptus cornuta*) or flooded gum (*E. rudis*) woodlands at higher elevations.
Aquatic invertebrates	DeHaan (1987) recorded 103 invertebrate taxa in Tordit-Gurrup Lagoon, Byenup Lagoon and Poorginup Swamp. Tordit-Gurrup Lagoon had the highest richness and Poorginup the lowest. Insects accounted for 73 per cent of invertebrates. Eleven *Hydracarina taxa* (water mites) (six in Poorginup swamp). Storey (1998) found 219 taxa, 32 endemic to south-western Australia (most in Poorginup Swamp). Greater than 78 species of ostracods and copepods, with six ostracods and one cyclopoid only known in the Muir/ Unicup recovery catchment. New species within Rotifera and Cladocera families and two new dytiscids. *Hygrobia wattsii* sp. n (Byenup Lagoon) appears restricted to peat wetlands.
Fish	Seven fish species, six endemic to south-west WA such as Western pygmy perch (*Edelia vittata*), Balton's pygmy perch, nightfish (*Bostockia porosa*), Western minnow (*Galaxias occidentalis*), black-stripe minnow (*Galaxiella nigrostriata*) and mud minnow (*G. munda*) and the introduced mosquito fish (*Gambusia holbrooki*). Poorginup Swamp had the greatest number of native fish species. Balston's pygmy perch listed as vulnerable (EPBC Act), black-stripe and mud minnows listed as lower-risk, near-threatened (IUCN[5] Red List 2009[6]).
Frogs and reptiles	No comprehensive surveys. Likely to be rich in reptiles, including oblong tortoises and tiger snakes.
Mammals	Believed to contain many species found in adjacent Tone-Perup Nature Reserve, including woylies and chuditch. Also contains suitable habitat for boodies, dalgytes and rakalis.
Waterbirds	Tordit-Gurrup used as a drought refuge by big numbers of waterbirds. Open water important for Australian shelduck moulting (more than 12,000 in 1992). Non-vegetated beaches (Tordit-Gurrup and Byenup) provide habitat for waders, ducks and swans. Poorginup Swamp contains critical habitat for Australasian bitterns (endangered IUCN red list). Little bittern, spotless crake, Australasian bitterns, black swans and Eurasian coots breed at the site. Local knowledge suggests grebes, swamp harrier (*Circus approximans*), blue-billed duck (*Oxyura australis*), cormorants, sea-eagles and spoonbills also breed at the site (P Taylor, pers. comm.).

[4]Flora or fauna that is confined in its natural occurrence to a particular region.

[5]International Union for Conservation of Nature and Natural Resources.

[6]See www.iucnredlist.org (accessed 2009).

Key threats

The major threats in the planning area that have potential to significantly affect the key values include:

- altered hydrological regimes and processes, particularly altered water flows and increasing salinity/acidity
- *Phytophthora cinnamomi* dieback plant disease, and potentially pathogenic organisms affecting the woylie
- invasive plants and animals, particularly foxes (*Vulpes vulpes*), cats (*Felis catus*), pigs, deer, goats and horses
- inappropriate/extreme fire regimes, particularly infrequent, big and intense bushfires and frequent fires that are intense enough to kill fire regime specific species.

3. Management directions

Vision

The unique natural and cultural heritage values of the internationally significant Perup area, such as the Ramsar wetlands, threatened species and old-growth forests, and our knowledge of them, are conserved and enhanced for present and future generations.[7]

This vision will be supported by the department's implementation of strategic objectives (DEC 2007) of:

- conserving biodiversity
- managing natural resources and promoting sustainable practices
- leading climate change actions
- creating a world class parks system
- maintaining community involvement and support
- improving the way we do business.

Specific desired outcomes and objectives for managing the parks and reserves in the planning area to achieve these strategic objectives, and how these will be achieved and measured, are detailed throughout the plan.

Key directions of this management plan include:

- protecting the Muir-Byenup Ramsar wetland system
- protecting sizable areas of vegetation free of *Phytophthora cinnamomi*
- gaining local knowledge about and controlling invasive species
- maintaining or improving water balances
- ensuring management is consistent with the Lake Muir/Unicup recovery catchment plan
- managing species of conservation significance and impacts upon them to maintain long-term viability of populations
- fostering and improving community understanding of, and involvement in, management of key values.

[7]*The vision of this plan is derived from community input and reflects the key values of the planning area.*

Management purpose

4. Legislative and policy framework

The department administers inter alia the *Conservation and Land Management Act 1984* (CALM Act), which provides for the management of lands and waters vested with the Conservation Commission, and the *Wildlife Conservation Act 1950* (WC Act), which provides for specific protection of native flora and fauna on all state lands and waters. Other state and federal legislation may be referred to throughout this plan. This management plan also conforms to other statutory policies and policies of the department.

Australia is a signatory to a number of important international conservation agreements (for example Ramsar Convention[8] , Bonn Convention[9] , and JAMBA, CAMBA and ROKAMBA migratory bird agreements[10]), which affect management of the planning area. State and federal agencies collaborate in providing the legislative and policy framework for management and reporting of wetlands listed under the Ramsar Convention. The *Australian Ramsar Management Principles* (Regulation 10.02 of the EPBC Act) state general standards for Ramsar wetlands in Australia, including requirements for management, management planning, and environmental impact assessment and approval.

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance, such as (i) wetlands of international importance (listed under the Ramsar Convention), (ii) threatened species and ecological communities, and (iii) migratory species protected under international agreements, need approval from the responsible Australian government minister, in addition to any approval that may be needed in WA. In terms of (i) above, the matter protected under the EPBC Act is the 'ecological character' of a Ramsar wetland, not just features of the wetland located within the site boundary.

Parts of the planning area also lie within the Lake Muir/Unicup 'Natural Diversity Recovery Catchment' (Lake Muir/Unicup recovery catchment) (Map 1), which under the State Salinity Strategy's 'Natural Diversity Recovery Catchment' program (State Salinity Council 2000) helps recover and protect significant natural areas, particularly wetlands, from salinity.

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[8] The official title of the convention is the Convention on Wetlands of International Importance especially as Waterfowl Habitat. The use of the title 'The Convention on Wetlands', or the 'Ramsar Convention' after the Iranian town in which the treaty was developed in 1971, is commonly accepted. The convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

[9] Australia became a contracting party to the 'Convention on the Conservation of Migratory Species of Wild Animals' (Bonn Convention) in 1991.

[10] CAMBA = China-Australia Migratory Bird Agreement, JAMBA = Japan-Australia Migratory Bird Agreement, ROKAMBA = Republic of Korea-Australia Migratory Bird Agreement.

Australian shelduck (*Tadorna tadornoides*) photo by Peter Taylor

Memorandums of understanding relevant to the planning area include:

- the Department of Regional Development and Lands in relation to the management of the non-townsite unallocated Crown land (UCL) and unmanaged reserves
- the South West Aboriginal Land and Sea Council Aboriginal Corporation in relation to access and cooperative management agreements between the department and Aboriginal people
- the Outback Heritage Horse Association of WA in relation to the cooperative humane removal of horses with identified heritage value.

Desired outcome

- The management plan is consistent with relevant legislation, policy and national and international obligations.

Objective

4.1 Increase the size of the Muir-Byenup Ramsar wetland system listed under the Ramsar Convention during the life of the plan.

Strategies

1. Ensure management is consistent with Australia's obligations under the Ramsar Convention, and promote the management of the Muir-Byenup Ramsar wetland system in accordance with the *Australian Ramsar Management Principles*.
2. Increase the size of the Muir-Byenup Ramsar wetland system by proposing additions of contiguous areas that have become vested with the Conservation Commission since the site's Ramsar listing.
3. Ensure management is consistent with WA's obligations under the State Salinity Strategy for the management of the Lake Muir/Unicup recovery catchment.

Banded stilts (*Cladorhynchus leucocephalus*) at Lake Unicup. Photo – Peter Taylor

Key performance indicator

Performance measure	Target	Reporting requirements
4.1 The size of the Muir-Byenup Ramsar wetland system	4.1 An increase in the size of the Muir-Byenup Ramsar wetland system	After five years

5. Performance assessment

The Conservation Commission will measure the success of this plan in accordance with section 19(1)(g)(iii) of the CALM Act by using selected key performance indicators that target key components of the plan, and other mechanisms as appropriate. The EPBC Act, through the Environment Protection and Biodiversity Conservation Regulations 2000, regulates the reporting of sites in Australia listed under the Ramsar Convention.

6. Administration

The day-to-day implementation of the management plan is the responsibility of the department's district manager, who coordinates within allocated budgets and other resources the operational management of parks and reserves in the planning area. The planning area lies mainly within the Donnelly District of the Warren Region (Map 1).

7. Term of the plan

This management plan is for a period not exceeding 10 years and comes into operation from the date that a notice is published in the Gazette. However, the plan shall remain in force until it is revoked and a new plan is approved and substituted for it. At any time, the plan may be amended.

Jarrah forest in flower. Photos– Tim Foley

Managing the natural environment

8. Physical environment

This chapter describes the natural values of the planning area, the threats to these values and strategies proposed by the department to mitigate the threats.

Climate

The planning area has a Mediterranean climate with cool wet winters and hot dry summers. Annual rainfall ranges from 700–900 millimetres per year, has a strong declining gradient in rainfall variation from south to north and falls mostly during the winter months. As a consequence, the area is prone to bushfires. Annual evaporation ranges from 1400–1600 millimetres per year and has a less marked gradient than rainfall. Mean monthly maximum and minimum temperatures recorded at Rocky Gully over the past 14 years range from 27.4–6.5 degrees Celsius.

Climate affects the hydrology of the Muir/Unicup recovery catchment. Rainfall influences groundwater aquifer[11] recharge, which maintains the wetlands, and surface water hydrology. Annual evaporation (1400–1600 millimetres) influences wetlands in the short term through seasonal changes in salinity, and in the long term through increasing groundwater salinity as evaporation exceeds precipitation. A slight gradient of increasing groundwater salinity from south to north reflects the patterns of evaporation and rainfall (Storey 1998).

Many plant and animal species of conservation significance (for example orchids, aquatic invertebrates, fish, waterbirds) depend on rainfall and other aspects of the climate in their life cycles and/or the maintenance of critical habitat (for example wetlands). Climate change may have significant impacts on the key values and, while there is limited knowledge of the resilience of natural systems to anticipated climate changes and uncertainty on how to appropriately respond to the effects of climate change, protecting the natural environment can help to improve the resilience of biodiversity and decrease its vulnerability to climate change.

Wetland-dependent orchid (*Caladenia harringtoniae*).
Photo – Tim Foley

[11] *An aquifer is a layer of rock that holds and allows water to move through it, and from which water can be extracted.*

Geology, landforms and soils

The planning area is located within the Yilgarn Craton and the Albany-Fraser Orogen, which are partly overlain by sediments of the Eucla Basin. The Manjimup Lineament[12] divides the Archaean Yilgarn Craton in the north (Kingston and Perup areas – 2.4 billion years old) from the Proterozoic Albany-Fraser Orogen in the south (Lake Muir area – 1.2 billion years old). The planning area spans across the Darling Plateau (greater than 300 metres elevation) and the Ravensthorpe Ramp (less than 200 metres elevation) regional geomorphic units in broadly undulating country consisting of plateau tops, creek valleys and river courses, and lowlands and plains. Geology and geomorphology strongly influence catchment hydrology by affecting the development of aquifers, seepage points, discharge zones and drainage patterns.

Climatic conditions, slow water movement and a shallow lake basin have resulted in the accumulation of peat deposits in Byenup Lagoon, Tordit-Gurrup Lagoon, Poorginup Swamp and a number of un-named swamps in the Lake Muir/Unicup recovery catchment. These peat swamps, which are rare in Australia and in particular WA, strongly influence water quality and provide an effective filter and buffering capacity and an important habitat for native plants and animals. Organic soils and peat swamps have the potential to become acid sulfate soils[13].

Hydrology

The planning area is located within the Blackwood, Deep, Frankland, Lake Muir and Warren catchments. Well-defined surface water drainage in the north drains into the Wilgarrup, Yerraminnup, Perup, Tone, Donnelly and Blackwood rivers (Map 1). The Lake Muir/Unicup recovery catchment (Map 1) is a big flat area of internal drainage consisting of a suite of partly inter-connected small to big (Lake Muir is 4600 hectares) lakes, swamps and floodplains of varied salinity (saline to fresh), permanence (permanent to seasonal) and substrate (peat and inorganic) (Smith 2003). While the Lake Muir/Unicup recovery catchment is one of 13 inland natural wetland complexes in WA, it is the only wetland complex of its type in near pristine condition.

Wetlands occurring in the lowlands of the Lake Muir/Unicup recovery catchment vary from lakes through to sumplands and damplands, some creeks, palusplains and floodplains and, depending on their position in the landscape, may belong to perched groundwater systems overlying poorly conductive clays or may be ‘windows’ to deeper regional aquifers (P Taylor in Smith 2003). Most of the wetlands have partly cleared catchments and fringing vegetation of varying width. Wetlands possibly contribute to maintenance of groundwater in the catchment, but little is known about the interactions between the shallow and deep groundwater systems and the interaction of these with the surface water systems. Groundwater movement is controlled by geology and topography, with most groundwater slowly discharged from shallow flow systems into dissecting drainages or lakes. Lake Muir and Unicup Lake are surface expressions of the groundwater. Water recharge of wetlands occurs as a result of precipitation, rising groundwater, local discharge from springs or surface run-off. Seasonal rainfall generally determines wetland water levels and variations in wetland salinity. Inflow surface water is channeled into Lake Muir from northern and eastern wetlands and, while Lake Muir is the final sink for water in the catchment (acting as a big shallow evaporating basin that usually dries up to a salt pan in summer) (Smith 2003), water can also move into the Tone, Deep and Frankland catchments under certain conditions.

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[12]A lineament is a long, straight (or only slightly bowed) fracture that subdivides the Precambrian bedrock.

[13]Acid sulfate soils are naturally occurring soils and sediments containing iron sulfides, most commonly pyrite. When acid sulfate soils are exposed to air the iron sulfides in the soil react with oxygen and water to produce a variety of iron compounds and sulfuric acid. Initially a chemical reaction, the process is accelerated by soil bacteria. The resulting acid can release other substances, including heavy metals, from the soil and into the surrounding environment.

Water quality monitoring has been undertaken at Byenup, Lake Muir, Poorginup, Tordit-Gurrup, Unicup, Yarnup and other local wetlands since the late 1970s (Lane et al. 2009). The department and Department of Water monitor one water gauging station and 184 groundwater bores at 115 sites in the catchment, as well as about 40 surface water sites. More drilling and installation of water monitoring bores, as well as the installation of gauging stations, weirs and other water sampling points, will occur. Aquatic biodiversity in streams is also being monitored annually at several locations in the planning area as part of a project linked to key performance indicator 20 of the *Forest management plan 2004–2013* (Conservation Commission 2004).

Desired outcome

- The area's geological features, landforms and soils are protected, and the natural surface and groundwater hydrological regimes are maintained.

Objective

8.1 Increase knowledge of the natural surface and groundwater hydrological regimes for the reserves in the Lake Muir/Unicup recovery catchment within five years of the plan being gazetted.

Strategies

1. Protect geological features, landforms and soils (such as alluvial soils) vulnerable to environmental disturbance.
2. Establish guidelines for sound earthwork practices and implement these for development works.
3. Maintain information on surface and groundwater hydrological regimes, including the integration of all hydrological data and survey information as a consolidated base for more investigations and monitoring.
4. Develop and calibrate a natural surface and groundwater hydrological model for the reserves in the Lake Muir/Unicup recovery catchment.
5. Describe and quantify the natural variation in hydrological parameters used in the model to facilitate increased accuracy of system thresholds.
6. Protect water sources, wetlands and hydrological processes from damage or disturbance that may affect water quality or quantity.
7. Assess all development proposals for their potential adverse impacts on geological and hydrological features, landforms, soils, surface water movement, and groundwater quality and quantity, and referring proposals that may impact on key values.
8. Appropriately rehabilitate disturbed areas and monitor to progress restoration of these to a stable condition resembling as close as possible the natural ecosystem function.
9. Where fitting, map occurrences of peat and organic soils in the planning area, consistent with the nature conservation plan for the Warren Region.
10. Consider the potential for acid sulfate soils in planning and operations (for example fire, earthworks, rehabilitation and/or planting), and avoid disturbance, compaction or displacement of saturated soils at risk.

Water monitoring at Red Lake. Photo – Roger Hearn

11. Monitor hydrological regimes through the measurement of water parameters taken at bores, gauging stations, weirs and other water sampling points.
12. Install more bores, gauging stations, weirs and other water sampling points as necessary.
13. Encourage fencing to prevent stock from private property encroaching on the wetlands.

Key performance indicator

Performance measure	Target	Reporting requirements
8.1 A wetlands hydrological information system for the Lake Muir/Unicup recovery catchment is developed	8.1 Establish a wetlands hydrological information system for the Lake Muir/Unicup recovery catchment within 5 years of the plan being gazetted	After five years

9. Biological environment

Native plants and plant communities

The planning area is recognised as a major centre of plant biodiversity and contains about 925[14] and 497 native vascular[15] and non-vascular species, respectively. Nature reserves in the Lake Muir/Unicup recovery catchment (totalling 19,888 hectares) alone contain 862 native species in comparison to the 27,000 hectare Lesueur National Park that contains 821 species (Gibson and Keighery 2000).

The planning area contains many plant species of conservation significance, such as:

- seven threatened species listed under the EPBC Act – the endangered *Caladenia dorrienii, Verticordia densiflora var. pedunculata* and *Verticordia plumosa var. vassensis*, and the vulnerable *Caladenia christineae, Caladenia harringtoniae*, *Diuris drummondii* and *Meziella trifida*
- nine threatened species or 'rare flora' declared and listed under the WC Act – the critically endangered *Andersonia annelsii* and *Grevillea acropogon*, endangered *Caladenia christineae, Caladenia dorrienii*, *Verticordia densiflora var. pedunculata* and *Verticordia plumosa var. vassensis*, and vulnerable *Caladenia harringtoniae*, *Diuris drummondii* and *Meziella trifida*
- forty six priority[16] species
- eighteen locally endemic[17] species (for example *Astartea* sp. Lake Muir, *Eryngium* sp. Lake Muir, *Tribonanthes* sp. Lake Muir and *Wurmbea* sp. Cranbrook) (Hearn *et al*. 2003)
- fourteen relictual[18] species (Hearn *et al*. 2003).

[14] Records obtained in 2008 from the Western Australian Herbarium. There may be variations in the data due to incorrect geo-coding and taxonomic errors.

[15] Plants that have a specialised circulatory or conducting system.

[16] Priority flora and fauna species (i) may be threatened but there is insufficient survey data available to accurately determine their true status (Priority 1 to 3), (ii) are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened list for other than taxonomic reasons (Priority 4), or (iii) are conservation dependant (Priority 5).

[17] Flora or fauna with a distribution that ranges less than 150 kilometres.

[18] Pertaining to an archaic form in an otherwise extinct taxon.

The planning area lies predominantly within the Menzies botanical sub-district of the Darling Botanical District, a division of the South West Botanical Province. Plant communities mainly comprise medium forest and woodlands of jarrah, marri (*Corymbia calophylla*), yate, *Eucalyptus decipiens* and wandoo (*E. wandoo*) in various combinations; low woodlands and closed forests of paperbarks; scrublands; tea-tree, mohan (*Melaleuca viminea*) and heartleaf poison (*Gastrolobium bilobum*) thickets; sedgelands, reed swamps and lakes (Gibson and Keighery 1999). Vegetation within the Muir-Byenup Ramsar wetland system has been mapped by Gibson and Keighery (2000) (Map 2). There are 11 forest ecosystems in the planning area. Permanently wet areas support big dense stands of jointed rush (*Baumea articulata*) and other sedges, and reserves in the Lake Muir/Unicup recovery catchment have some of the biggest areas of natural sedgelands in WA. There has been no change in the vegetation of most of the 27 wetlands in the Lake Muir/Unicup recovery catchment during a five year period from 1997 (Gibson *et al*. 2004).

Desired outcome

- Species and plant communities of conservation significance are identified, protected and conserved.

Objectives

9.1 Maintain the baseline extent and condition of vegetation communities in the Muir-Byenup Ramsar wetland system during the life of the plan.

9.2 Maintain or improve the population size[19] of rare flora species from 2011 levels.

Heartleaf poison (*Gastrolobium bilobum*) thicket in Tone-Perup Nature Reserve. Photo – Paul Roberts

[19] *Population size is defined under the nature conservation plan for the Warren Region as the number of mature/reproducing plants.*

Strategies

1. Identify native plants and plant communities that may need special protection, and implement appropriate strategies to minimise the impacts from threatening processes such as climate change, environmental weeds, pest and problem animals, inappropriate fire regimes and proposed developments.
2. Assess and, where necessary, propose statutory protection for species of conservation significance.
3. Assess all proposed operations and developments for potential impacts.
4. Manage species of conservation significance consistent with the nature conservation plan for the Warren Region and Hearn *et al*. (2008).
5. Where fitting, develop and implement recovery and translocation plans for species of conservation significance consistent with the nature conservation plan for the Warren Region.
6. Implement condition monitoring programs for rare flora species, consistent with the nature conservation plan for the Warren Region.
7. Establish baseline information of the extent and biomass of phytoplankton vegetation communities across the Muir-Byenup Ramsar wetland system and the macrophyte vegetation community of Lake Muir.
8. Monitor the extent and condition of phytoplankton, macrophytes, samphire, *Gahnia* sedgeland and fringing shrubs and trees within the Muir-Byenup Ramsar wetland system (Map 2).
9. Apply the proposed hydrological model for predicting potential change in the extent and health of vegetation with various water regime scenarios.

Key performance indicators

Performance measure	Target	Reporting requirements
9.1 Baseline areal extent and condition of vegetation communities in the Muir-Byenup Ramsar wetland system	9.1 Maintain baseline areal extent and condition during the life of the plan	After five years
9.2 The population size of rare flora species	9.2 Maintain or improve the population size of rare flora species from 2011 levels	After five years, or as per recovery plans if applicable

Native animals and habitats

The planning area is recognised as one of the most important areas for native fauna conservation in southern WA being one of the last natural refuges for many threatened species. The planning area also has a rich diversity of native animals containing 30 mammals, 130 birds, 26 reptiles, 13 frogs, six fish, and 488 aquatic invertebrate species (Halse *et al*. 2004). Wetlands in the Muir/Unicup recovery catchment have equivalent or slightly greater aquatic invertebrate species richness than other wetlands of south-west Australia (Storey 1998).

The planning area contains many fauna species of conservation significance, such as:

- eight threatened species listed under the *2009 IUCN Red List of Threatened Species* – the critically endangered woylie, the endangered numbat, Australasian bittern, Baudin's cockatoo (*Calyptorhynchus baudinii*) and Carnaby's cockatoo (*Calyptorhynchus latirostris*), and the vulnerable ngwayir, quokka and malleefowl (*Leipoa ocellata*)
- nine threatened species listed under the EPBC Act – the endangered Carnaby's cockatoo and the vulnerable chuditch, numbat, ngwayir, quokka, Muir's corella, Baudin's cockatoo, malleefowl and Balston's pygmy perch

- 14 threatened species listed under the WC Act – the endangered woylie, Muir's corella, Baudin's cockatoo and Carnaby's cockatoo, and the vulnerable numbat, chuditch, wambenger, ngwayir, quokka, Australasian bittern, forest red-tailed black cockatoo, malleefowl, Balston's pygmy perch and mud minnow (*Galaxiella munda*)
- 35 migratory bird species on the national *List of Migratory Species* under the EPBC Act, such as red-necked stint (*Calidris ruficollis*), that are listed under international agreements (for example JAMBA, CAMBA and ROKAMBA Migratory Bird Agreements and the Bonn Convention)
- 13 priority species
- six endemic native fish species, 32 endemic macroinvertebrate species and six macroinvertebrate species locally endemic species including Doeg's watermite (*Pseudohydraphantes doegi*) and the Poorginup Swamp watermite (*Acercella poorginup*) (Storey 1998)
- some invertebrate species are considered to be relictual species (for example *Huitfeldtia* sp. nov).

Wetlands in the Lake Muir/Unicup recovery catchment are important to the survival of many waterbird species, and the presence and abundance of species is strongly influenced by local and regional water availability. Eight species of waterbirds breed in the wetlands, such as little bittern, spotless crake, Australian shelduck, silver gull and Australasian bitterns. Some species congregate in big numbers on undisturbed waters within the Lake Muir/Unicup recovery catchment during moulting and in 1989 up to 52,000 waterbirds were observed on Lake Muir alone with the most abundant species being Pacific black duck (*Anas superciliosa*) (18,500), grey teal (*Anas gracilis*) (16,000), Eurasian coot (10,000), black swan (4,000) and Australian shelduck (3,500).

The planning area is uniquely important to the conservation of fauna species and assemblages. The diversity of vertebrate fauna is relatively complete compared with what is known to have occurred about the time of settlement by Europeans. Only the 'presumed extinct' Leeuwin's rail (*Rallus pectoralis clelandi*), and the endangered boodie and dalgyte are known to have become locally extinct within the planning area. The planning area now supports critically important or key populations of several species that have been lost from much of their former range (for example woylie, numbat and tammar wallaby).

Western ringtail possum.

Chuditch. Photos – DEC

Perup is a particularly important area for critical weight range[20] mammals (Burbidge and McKenzie 1989). Many of the reserves in the planning area also have remnant and linkage value as they adjoin the wheatbelt to the east, which has been extensively cleared for agriculture. A 400 hectare predator-free enclosure in Tone-Perup Nature Reserve (i.e. the 'Perup Sanctuary') is being constructed to protect an emergency colony of up to 500 endangered woylies and will enable ongoing scientific research into factors associated with woylie population dynamics. The planning area is also potentially valuable for re-introductions or translocations of fauna, such as the malleefowl, boodie and dalgyte.

Recovery plans exist for the chuditch, ngwayir, woylie, Muir's corella, Baudin's cockatoo, Carnaby's cockatoo, forest red-tailed black cockatoo and malleefowl.

Some habitats are particularly important for the survival and persistence of species. Extensive thickets of heartleaf poison have contributed to the existence and value of the conservation reserves for protecting critical weight range mammals from predation by the introduced predators the fox (*Vulpes vulpes*) and cat (*Felis catus*) (Christensen et al. 1985). Thickets of mohan, which have a lifespan of about 20 years, provide shelter for the tammar wallaby. Open water, mudflats, *Baumea* and *Gahnia* sedgelands, samphire, *Melaleuca* and *Eucalyptus* habitats in the Muir-Byenup Ramsar wetland system are important for macroinvertebrates, fish and waterbirds (foraging, nesting, roosting and protection from predators).

Desired outcome

- Fauna species and their habitats are identified, protected and conserved.

Objectives

9.3 Maintain the baseline composition and abundance of fauna communities in the Muir-Byenup Ramsar wetland system during the life of the plan.

9.4 No adverse change in the conservation status of threatened and priority animal species from 2011 levels.

Strategies

1. Identify native animals that may need special protection, and implement appropriate strategies to minimise the impacts from threatening processes such as climate change, environmental weeds, pest and problem animals, inappropriate fire regimes and proposed developments.
2. Assess and, where necessary, propose statutory protection for species of conservation significance.
3. Assess all proposed operations and developments for potential impacts.
4. Manage species of conservation significance consistent with the nature conservation plan for the Warren Region.
5. Develop and implement recovery and translocation plans for species of conservation significance.
6. Identify knowledge gaps relating to fauna composition, abundances and distributions, such as under-studied taxa (for example invertebrates and bats) and areas (for example isolated reserves), and undertake, support or encourage systematic fauna surveys.
7. Establish baseline information on the composition and abundance of invertebrates, frogs, fish, waterbirds and mammals of Lake Muir, and frogs, waterbirds and mammals of other wetlands in the Muir-Byenup Ramsar wetland system.
8. Monitor the composition and abundance of invertebrates, frogs, fish, waterbirds and mammals within the Muir-Byenup Ramsar wetland system.
9. Survey and monitor threatened species and their habitat, consistent with the nature conservation plan for the Warren Region, to assess the effectiveness of management and identify regional trends through space and time (for example abundance changes of greater than 30 per cent within a period of one-to-two years).
10. Maintain a predator-proof enclosure in Tone-Perup Nature Reserve for the establishment, protection and recovery of sustainable populations of the woylie and other species of conservation significance.

[20]*Mammals weighing between 35 grams and 5.5 kilograms.*

Key performance indicators

Performance measure	Target	Reporting requirements
9.3 Baseline composition and abundance of fauna communities in the Muir-Byenup Ramsar wetland system	9.3 Maintain baseline composition and abundance during the life of the plan	After five years
9.4 The conservation status of threatened and priority animal species located in the planning area	9.4 No adverse change in the conservation status of threatened and priority animal species from 2011 levels	After five years, or as per recovery plans if applicable

Ecological communities

There are no records of threatened or priority ecological communities in the planning area. Other ecological communities of conservation significance in the area include (i) the 'aquatic invertebrate communities of peat swamps', (ii) primary saline wetlands, (iii) claypans with shrubs over herbs, and (iv) flat-topped yate association (May and McKenzie 2003).

The planning area contains 19,828 hectares of jarrah old-growth forest[21] , principally within Tone-Perup Nature Reserve (10,860 hectares) and Lake Muir National Park (6430 hectares), which represents about 19 per cent of the planning area, and six per cent of the old-growth forest in the south-west of WA.

Desired outcome

- Ecological communities of conservation significance are identified, protected and conserved.

Strategies

1. Identify ecological communities that may need special protection, and implement appropriate strategies to minimise the impacts from threatening processes such as climate change, environmental weeds, pest and problem animals, inappropriate fire regimes and proposed developments.
2. Assess and, where necessary, propose statutory protection for ecological communities of conservation significance.
3. Assess all proposed operations and developments for potential impacts.
4. Undertake an assessment of the conservation status of, and threats to, the 'aquatic invertebrate communities of peat swamps' ecological community and, where fitting, implement a condition monitoring and evaluation program for this ecological community consistent with the nature conservation plan for the Warren Region.

10. Protecting the natural environment

Conservation reserve system

The planning area lies within the 'Jarrah Forest' IBRA[22] bioregion, and specifically within the central part of the 'Southern Jarrah Forest' IBRA sub-region. About 14 per cent (637,238 hectares) of the 'Jarrah Forest' IBRA region is protected within conservation reserves and 17 per cent (441,076 hectares) of the 'Southern Jarrah Forest' IBRA sub-region is protected within conservation reserves (of which 24 per cent is protected within the planning area).

[21] *Ecologically mature forest where the effects of unnatural disturbance are now negligible.*

[22] *Interim Biogeographic Regionalisation for Australia (Thackway and Cresswell 1995).*

Creation of a conservation reserve system that is comprehensive, adequate and representative[23] helps meet obligations under the International Convention on Biological Diversity[24] and *Australia's Strategy for the National Reserve System 2009–2030* (National Reserve System Task Group 2009). Proposed additions to existing reserves in the planning area are listed in Table 3. Proposed additions to the planning area will increase the amount of WA's jarrah forest IBRA region in conservation reserves. As proposed additions become vested with the Conservation Commission, they will be managed in accordance with this management plan. Any reserve additions, or changes in the classification of existing reserves or the category of land, will be subject to usual government consideration and determination.

Table 3. Proposed additions to the planning area

Proposed additions	Current tenure	Proposed tenure	Proposed class	Area (ha)	Comments
Recommendations from the *Forest management plan 2004–2013*					
Wournbelup / Chowerup UCL	UCL	nature reserve	A	2,147.0	ID 168
reserve 27925	other reserve	nature reserve	A	8.7	ID168, vested with Shire of Boyup Brook for purpose of 'gravel'.
reserve 30214	unmanaged	nature reserve	A	4.3	ID 168
Dingup	state forest	conservation park	A	230.0	ID 180
reserve 10504	other reserve	nature reserve	A	80.0	ID 194, vested with Shire of Manjimup for purpose of 'Parkland rehabilitation gravel and water'.
reserve 10391	other reserve	national park	A	37.5	ID 196, vested with Shire of Manjimup for purpose of 'Parkland rehabilitation gravel and water'.
Bokarup UCL	UCL	nature reserve	A	155.8	ID 202
reserve 35307	other reserve	nature reserve	A	324.2	ID 202
Chitelup	state forest	national park	A	310.0	ID 235

[23]*The terms comprehensive, adequate and representative together describe the attributes of an ideal conservation reserve system. These terms are defined in the Australian and New Zealand Environment and Conservation Council's Guidelines for Establishing the National Reserve System as:*

- *comprehensiveness – inclusion of the full range of ecosystems recognised at an appropriate scale within and across each bioregion*
- *adequacy – the maintenance of the ecological viability and integrity of populations, species and communities and*
- *representativeness – the principle that those areas that are selected for inclusion in reserves reasonably reflect the biotic diversity of the ecosystems from which they derive.*

[24]*Australia signed the 'Convention on Biological Diversity' (Rio Convention) at the United Nations Conference on Environment and Development (also known as the 'Rio Earth Summit') in Rio de Janeiro, Brazil in 1992.*

Proposed additions	Current tenure	Proposed tenure	Proposed class	Area (ha)	Comments
Other proposed additions					
Red Lake and Cowerup Swamp	UCL	nature reserve	A	560.0	Exclusive of the current tenements.
Department of Water freehold	freehold land	nature reserve	A	3,986.0	10 locations adjoining Bokarup, Kodjinup, Kulunilup and Unicup nature reserves
Total area				**7,843.5**	

Desired outcome

- Protection of the values of the planning area.

Objective

10.1 Increase the area of jarrah forest IBRA region in conservation reserves.

Strategies

1. Implement the tenure recommendations as outlined in Table 3, subject to usual government consideration and determination.
2. Where fitting, seek to incorporate adjoining or nearby land, if identified as having high conservation significance, and subject to usual government consideration and determination.
3. Manage any proposed reserve additions in the Perup area that become vested with the Conservation Commission in accordance with this management plan.
4. Upgrade Alco, Cowerup, Quindinup and Wilgarrup nature reserves to 'class A' reserves, subject to usual government consideration and determination.
5. Establish official reserve names for all provisionally named conservation reserves in Table 1.

Key performance indicator

Performance measure	Target	Reporting requirements
10.1 Incorporation of areas identified in Table 3 into the planning area.	10.1 All identified areas have been incorporated into the planning area.	After five years

Altered hydrological regimes

Alterations to the natural groundwater and surface water regimes may have a significant impact on wetland values, and are often inter-related with other threats such as invasive plants and animals, diseases, inappropriate fire regimes, and acid sulfate soils.

Changes in the watertable levels and altered seasonal patterns, and the quantity and timing of water draining into the catchment and reserves can have adverse direct or indirect impacts on aquatic ecosystems in the planning area. Recent historic variation in mean annual water depths has been recorded for Lake Muir (0–1.31 metres), Byenup Lagoon (0.4–2.8 metres), Tordit-Gurrup Lagoon (0.15–3.1 metres) and Poorginup Swamp (0–0.72 metres). Rising groundwater in parts of the Lake Muir/Unicup recovery catchment is increasing salinity and affecting vegetation and aquatic ecosystems, and rising watertables, which can adversely affect habitat condition. Declining groundwater in other parts of the catchment is exposing acid sulfate soils with subsequent acidification of wetlands, waters and soils.

Changes in surface water flows through artificial drainage can also exacerbate existing impacts (Gibson and Keighery 1999, Cook and Farrell 2009). Proposals to alter drainage on or into lands managed by the department are assessed in accordance with the Conservation Commission's Policy A4 – *Drainage*, and may be acceptable if (i) drainage will not be detrimental to reserve values, (ii) drainage is an essential part of a longer term permanent and whole-of-catchment solution, and (iii) no alternative sites or routes exist.

Potential acid sulfate soils are associated with freshwater peat wetlands in Byenup Lagoon System (because of land clearing and rising watertables associated with plantation harvesting) and Poorginup Swamp (where acid sulfate soils have formed during seasonal drying, although installed artificial drains are causing the swamp to dry out earlier than other wetlands). Cowerup Swamp, which has acid sulfate soils with a pH between 3.4 and 4.9, has been mined for peat, and acidic water drains via artificial drainage channels and Red Lake into Lake Muir. Peat swamps are also at risk of burning during drier parts of the year, exposing acid sulfate soils that then release acid and associated heavy metals into surrounding waters and soils.

A number of physical and chemical properties and processes, such as salinity, acidification, eutrophication, turbidity and levels of dissolved oxygen, have adverse direct or indirect impacts on aquatic ecosystems in the planning area, and are particularly important in the monitoring of water in the Muir-Byenup Ramsar wetland system (Cook and Farrell 2009). Recent historic variation in pH levels has been recorded for Lake Muir (6.2–9.9), Byenup and Tordit-Gurrup lagoons (6.8–9.3) and Poorginup Swamp (4.6–8.3), and in salinity (parts per thousand) levels has been recorded for Lake Muir (0.58–125), Byenup Lagoon (1.38–42.2), Tordit-Gurrup Lagoon (0.65–15.2) and Poorginup Swamp (0.1–1.6). However, knowledge and available data is insufficient at this time to propose water parameter indicators for monitoring alterations to the natural groundwater and surface water quality and hydrological regimes, and more hydrological investigations are needed.

The majority of naturally fresh water wetlands in the Byenup Lagoon system have shown significant, progressive salinisation since 1996–97. Salinisation has adverse direct and indirect impacts on jointed rush (which is characteristic of and responsible for the thick peat deposits), freshwater-adapted fringing and emergent *Melaleuca* and *Eucalyptus* vegetation, the composition and richness of freshwater aquatic invertebrate communities, the survival of several native fish species, and waterbird feeding and/or nesting.

Increased release of nutrients (via drainage) can occur from mining, agriculture and forestry activities, as well as from the drying of peat (which particularly releases organic nitrogen), which has caused algal blooms in Byenup Lagoon and has changed invertebrate composition.

A recovery plan is in preparation for the Lake Muir/Unicup recovery catchment that will consider a range of long term strategies, such as revegetation with local native plant species, for maintaining wetland values and ecological health of reserves in the planning area.

Desired outcome

- Minimal alterations to the natural groundwater and surface water quality and hydrological regimes.

Objective

10.2 Increase the knowledge of hydrological, hydro-geological and hydro-ecological parameters and relationships of the Lake Muir/Unicup recovery catchment during the life of the plan.

Strategies

1. Protect water sources, wetlands and hydrological processes from damage or disturbance that may affect water quality or quantity.
2. Assess all management activities and development proposals for their potential adverse impacts on surface and groundwater quality and quantity, and refer proposals that may impact on natural, cultural or socio-economic values.

3. Appropriately rehabilitate disturbed areas and monitor to progress restoration of these to a stable condition resembling as close as possible the natural ecosystem function.
4. Investigate hydrological, hydro-geological and hydro-ecological parameters of the Lake Muir/ Unicup recovery catchment.
5. Develop and implement a recovery plan for the Lake Muir/Unicup recovery catchment.
6. Establish baseline information of the lake and aquifer levels within the Muir-Byenup Ramsar wetland system.
7. Monitor the change in lake and aquifer levels and water quality parameters of the Muir-Byenup Ramsar wetland system.
8. Develop and implement condition monitoring program for the Muir-Byenup Ramsar wetland system, consistent with the nature conservation plan for the Warren Region.
9. Where fitting, continue with revegetation programs on reserves in the planning area.

Key performance indicator

Performance measure	Target	Reporting requirements
10.2 A hydrological, hydro-geological and hydro-ecological investigation of the Lake Muir/ Unicup recovery catchment	10.2 Completed report on the Lake Muir/Unicup recovery catchment	After five years

Invasive[25] plants and animals

Environmental weeds

About 143 species of environmental weeds[26] occur in the planning area. Weeds that are current priorities for control include the 'declared'[27] Cape tulip (*Moraea flaccida*), as well as bullrush (*Typha orientalis*), watsonia (*Watsonia* spp.), Victorian tea tree (*Leptospermum laevigatum*) and introduced wattles (*Acacia* spp.).

Exotic pines and eastern states eucalypt species occur in numerous locations including 16 trial plots. Some weeds such as bridal creeper (*Asparagus asparagoides*), which is a declared plant and a Weed of National Significance (Commonwealth of Australia 2009), and taylorina (*Psoralea pinnata*) are located on adjacent lands.

[25] *Invasive species are plants and animals that, as a result of human activities, occur beyond their accepted normal distribution and which threaten valued environmental, agricultural or other social resources by the damage they cause. Invasive species can be either native species that are impacting on natural or agricultural values or introduced species (e.g feral animals) that have become established as wild or naturalised populations. 'Invasiveness' is a species' ability to invade terrestrial and/or aquatic environments, and depends on factors such as reproduction rates and dispersal ability.*

[26] *Environmental weeds are defined under the* Environmental Weed Strategy for Western Australia *(CALM 1999) as unwanted plant species growing in natural ecosystems that modify natural processes, usually adversely, resulting in the decline of the communities they invade.*

[27] *'Declared' plants (and animals) are those that are declared pests under the* Agriculture and Related Resources Protection Act 1976 *until such time as the* Biosecurity and Agriculture Management Act 2007 *is fully proclaimed.*

Introduced and other problem animals

The most significant introduced animals in the planning area are the fox, cat, pig, red deer, goat, horse and cattle (*Bos taurus*).

A long-established 1080 baiting program for the control of foxes and wild dogs under the department's *Western Shield* covers most of the planning area, which has reduced fox and wild dog numbers to the extent that native mammal numbers have increased substantially (Morris *et al*. 2000). The timing of fox control programs is critical to successfully controlling foxes.

Feral cats are a serious predator of native birds and animals, and cats have been identified as the main predator of woylies in association with the recent woylie declines (Ward *et al*. 2008). Cat control is not readily achieved by conventional 1080 baiting or trapping, and additional targeted programs may be needed (Denny and Dickman 2010).

Feral pigs have substantially impacted wetlands where diggings have disturbed populations of rare flora and affected water quality (through increased turbidity). It is also thought that pigs are detrimental to local quokka populations (Christensen *et al*. 2008). Annual trapping, baiting and shooting programs are undertaken in association with other land managers and local community groups (for example Lake Muir-Denbarker Pig Eradication Group and the Sporting Shooters Association of Australia). Illegal release of feral pigs for hunting occurs in the area, which sustains local populations (Higgs and Lyons 2006). Trained domestic dogs aid in the control of feral pigs by locating and flushing feral pigs from thick vegetation (Higgs and Lyons 2006).

Wandoo Woodland. Photo – Paul Roberts

Deer, goats and cattle have been reported in various locations across the planning area, and represent significant threats to local biodiversity (DEWHA 2008).

Wild horses have been present in the Lake Muir area for some time and, despite occasional illegal release of horses, may have bloodlines that are considered historically important according to the Outback Heritage Horse Association of WA.

Mosquito fish are common in wetlands of the planning area (Storey 1998), and can (i) directly affect native fish species by fin-nipping and other antagonistic behaviours and (ii) prey on a wide range of food sources such as fish larvae, 'grazing' invertebrates (such as *Daphnia*) and young tadpoles.

The marri spitfire (*Perga* sp.), gum leaf skeletoniser (*Uraba lugens*), Helena gum moth (*Opodiphthera helena*) and the bulls-eye borer (*Phoracantha acanthocera*) can often impact jarrah and marri forest, but do not appear to be a serious threat to the long-term maintenance of biodiversity in healthy and robust ecosystems.

The department is aware of the significant social and economic impacts that several native animals can and do have on local communities. Western grey kangaroo (*Macropus fuliginosus*) and emu (*Dromaius novaehollandiae*) (declared under the BAM Act) and the tammar wallaby may periodically cause damage to fences and feed on crops on adjoining agricultural land. Muir's corella (declared under the BAM Act) aggregates in big flocks around the Lake Muir, Frankland and Rocky Gully area causing significant noise and damage to crops, grain stockpiles and remnant vegetation. While the Western grey kangaroo and emu can be controlled by shooting programs (licensed and regulated under the WC Act), the tammar and Muir's corella are fauna of conservation significance and control of impacts are limited to non-lethal methods.

Desired outcomes

- An improved understanding of the distribution and impacts of invasive plants and animals.
- Minimal impacts of invasive plants and animals on natural, cultural and socio-economic values.
- Prevention of new established invasive plant and animal populations.

Bullrush (*Typha orientalis*) in a Muir/Unicup peat-based wetland. Photo – Ian Wheeler

Objectives

10.3 Decrease in the area and number of populations of Cape tulip, bullrush, Watsonia, Victorian tea tree and introduced wattles from 2011 levels.

10.4 Decrease in the distribution and numbers of foxes, feral pigs, deer, goats and horses from 2011 levels.

Strategies

1. Maintain information on invasive plants and animals including presence, abundance and distribution, relevant biological information and history of control.
2. Assess the invasiveness, distribution and environmental impact of invasive plants and animals in the planning area, particularly feral pigs, deer, goats and horses, consistent with the regional weed and feral animal control plans.
3. Control invasive plants and animals by appropriate methods in accordance with the species, its impact and the resources available, consistent with regional invasive weed and feral animal control plans.
4. Eradicate new populations of invasive plants and animals before they become established.
5. Limit the opportunity for weeds to be introduced and established by (i) applying appropriate hygiene practices to machinery, (ii) minimising disturbance of soil during management activities, and (iii) importing soil from only sources with strict soil quarantine.
6. Progressively assess and remove exotic trees, including their wildings, and rehabilitate affected areas.
7. Continue *Western Shield* introduced predator control, and investigate, monitor and review its effectiveness, including:
   - adequate documentation and timely delivery of the fox control program
   - cooperation and coordination between the department and other land-holders and parties undertaking predator control on and around the planning area
   - monitoring introduced predator activity and/or abundances in association with the control program
   - monitoring key native fauna to verify that conservation goals are being successfully achieved and sustained.
8. Permit the use of dogs to facilitate hunting of feral pigs, with appropriate authorisation and training.
9. Where fitting, humanely control feral horses in association with the Outback Heritage Horse Association of WA.
10. Investigate and control uncontrolled cattle grazing in accordance with department policy and guidelines.

Key performance indicators

Performance measure	Target	Reporting requirements
10.3 The area and number of populations of Cape tulip, bullrush, Watsonia, Victorian tea tree and introduced wattles	10.3 Decrease in the area and number of populations of Cape tulip, bullrush, Watsonia, Victorian tea tree and introduced wattles from 2011 levels	After five years
10.4 The distribution and abundance of foxes, cats, feral pigs, deer, goats and horses	10.4 Decrease in the distribution and abundance of foxes, cats, feral pigs, deer, goats and horses from 2011 levels	After five years

Diseases

The most significant plant pathogen in the planning area is *Phytophthora cinnamomi*, which kills susceptible plants (Shearer *et al*. 2004) and can irreversibly change the composition of many plant and animal communities (Shearer *et al*. 2009, Wilson *et al*. 1994) including jarrah forest and woodlands, flats and swamps. *P. cinnamomi* infestation (strongly related to vegetation, the presence of watercourses and other water gaining sites, and access) is most common where human activities have taken place in the absence of an effective hygiene regime. Feral pigs may also spread *P. cinnamomi*.

The department's Policy 3 – *Dieback* provides guidance for managing *P. cinnamomi*. Disease risk areas[28] cover 48 per cent of the planning area, and the department manages a conditional permit system for entry into disease risk areas. A regional dieback management plan is being developed, which will examine (i) priorities for protection, (ii) ways to reduce the rate of vectored spread and the incidence of initiation of new centres of infestation, and (iii) the suitability of disease risk areas. Big areas of forest have a high probability of being uninfested, which may be important for the long-term survival of some species and the maintenance of biodiversity, particularly in the face of other landscape-scale threatening processes such as invasive plants and animals and inappropriate fire regimes.

Other (endemic) plant diseases may also occur, such as *Armillaria luteobubalina*, other species of *Phytophthora*, gall rust (*Uromycladium tepperianum*) and common aerially dispersed canker-causing fungi (*Botryosphaeria ribis* and *Cryptodiaporthe melanocraspeda*), which can have significant localised impact, but do not appear to be a serious threat to the long-term maintenance of biodiversity in healthy and robust ecosystems.

As part of the investigation into the causes of recent woylie declines, a number of potentially pathogenic organisms (for example *Trypanosoma* sp. nov. and *Toxoplasma neospora*) have been identified in some mammal species (Smith *et al*. 2008, Thompson *et al*. 2008). Diseases can be exposed to, and spread within, animal populations through the transportation, trapping and handling of animals, and transferred to and from humans and stock. The department's Administrative Instruction No. 67 *Animal Welfare Act and Animal Ethics Committee* provides guidance for appropriate hygiene and quarantine protocols.

Desired outcomes

- No introduction of new plant and animal diseases.
- Minimal impact and spread of existing plant and animal diseases.
- A better understanding of plant and animal diseases and their significance to species of conservation significance.

Strategies

1. Implement management responses as appropriate for any outbreaks of new plant and animal diseases.
2. Implement appropriate hygiene measures for *P. cinnamomi* consistent with the regional response plan for *P. cinnamomi*, including hygiene management plans before commencing any operation that needs soil or plant material movement, and inclusion of disease management specifications in contract documents and job prescriptions.
3. Identify, evaluate and, where practical, implement effective and efficient measures for the maintenance and/or restoration of significant *P. cinnamomi* infested areas, including (i) treating priority sites of threatened species and communities with phosphite, and (ii) rehabilitating badly affected areas using appropriate local dieback resistant species.
4. Identify and establish 'protectable areas', consistent with the regional response plan for *P. cinnamomi*.

[28] *Disease risk areas are any area of public land where the director general considers that the earth, soil or trees may be, or may become infected with a forest disease.*

5. Where fitting, undertake more detailed mapping of *P. cinnamomi* occurrence and/or the probability of infestation by *P. cinnamomi*, consistent with the nature conservation plan for the Warren Region.
6. Review the aptness of existing disease risk areas in the planning area.
7. Where knowledge gaps exist and the importance to conservation is high, investigate plant and animal diseases and their significance to species or ecosystems/habitats of conservation significance, such as determining the role of disease in the decline and limitations of recovery of the woylie or other species where fitting.

Fire

The department's management of fire, including prescribed fire and bushfire prevention and suppression, is regulated by legislation (for example *Bush Fires Act 1954*, CALM Act and precedents established under common law) and guided by the department's Policy No. 19 – *Fire management policy*. Fire management (through the use of the 'master burn plan' process) will aim to:

- conserve biodiversity by implementing ecologically appropriate fire regimes based on best available knowledge
- reduce the threat that bushfire presents to life and community assets by prescribed burning, fire prevention and fire suppression measures
- increase knowledge through fire research, operational experience and by monitoring and evaluating representative fire regimes across parts of the planning area.

Implementing ecologically appropriate fire regimes will be based on:

- **Vital attributes and life histories[29] of fire regime specific species and communities**. While many species and communities are resilient to a range of fire intensities and fire regimes, some depend on a particular combination of fire interval, frequency, season and intensity for their persistence. For plants, these are species or communities that are readily killed[30] by fire but often depend on fire to stimulate germination, have long juvenile periods and which store seeds in the canopy. For animals, these are usually species that have specific habitat requirements such as a spatial mosaic of seral stages ranging from long unburnt to recently burnt, or specific vegetation structure requirements that are influenced by fire. Fire regime specific species and communities are typically associated with less flammable parts of the landscape such as rock outcrops, riparian zones, broad valley floors and some wetlands, especially those with peat substrates. Knowledge of the vital attributes and life histories of fire regime specific species and communities can inform how and when to use fire at landscape scales to protect or appropriately manage these communities. For example, specific fire management guidelines have been prepared to accommodate the needs of fire regime specific communities in the planning area (for example granite outcrops, peat swamps, watercourse reeds and rushes).

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[29] *Vital attributes and life history traits are critical physical characteristics of plants and animals that determine their ability to survive different fire intervals. For plants, it mainly relates to (i) methods of persistence (seeders or sprouters), (ii) conditions to establish and grow to maturity following, and (iii) timing of life stages, such as juvenile period and viable seed set. For animals, it relates to (i) ability to survive fire and early post-fire period (type of refuge, mobility, scale and intensity of fire), (ii) habitat requirements (seral stage(s) of the vegetation), and (iii) fecundity and dispersal characteristics.*

[30] *Species that are readily killed by low intensity fire and rely on seed for regeneration are usually understorey plants with thin bark or with canopies relatively close to the ground and which are obligate seeders and which have relatively long juvenile periods.Some species are sensitive to fire, but may survive low intensity fire.*

- **Vital attributes and life histories of threatened species and communities**. Protecting threatened species and communities from big, intense bushfires and using planned fire to maintain habitat quality and to regenerate threatened plants is fundamental to the ongoing conservation of these species. Understanding the vital attributes and life histories of threatened species, which often have specific fire regime requirements, such as the tammar wallaby that needs fire-regenerated thickets with certain structural characteristics (Christensen 1980), is particularly important. Specific fire management guidelines have been prepared to accommodate the needs of a range of threatened species in the planning area (for example ngwayir, tammar wallaby, black cockatoos and malleefowl).
- **Creating and maintaining a diversity of post-fire vegetation ages (seral stages) across each Landscape Conservation Unit[31]**. Planned and unplanned fires since the early 1970s have created patchiness in the age of the vegetation. A mosaic of vegetation and habitats representing a range of fire intervals, intensities, seasons and scales, provides habitat heterogeneity of different ages, which benefits biodiversity at landscape scales (Burrows 2008). A greater diversity of seral stages result in a greater level of biodiversity, and the most stable form of relationship between proportion of the landscape and seral stage is one that approximates a negative exponential fuel age distribution (Burrows and Abbott 2003, Burrows 2008).
- **Reducing heavy fuel loads and maintain a network of strategic fuel-reduced buffers**. A bushfire in 1950 burnt almost the entire planning area, and where lightning strikes or other ignitions coincide with severe fire weather and heavy fuel accumulation, then extensive, damaging bushfires occur. This strategy will reduce the severity and extent of bushfires, providing safer conditions for firefighters, neighbours and visitors as well as protection of biodiversity and community assets. Assets in the planning area considered to be of particularly high-value that should be specifically considered in fire management plans include *Perup – Nature's Guesthouse* and Lake Muir Observatory, peat swamps, threatened species (especially fauna) and long-term research sites.

Ongoing research in the planning area is improving knowledge and understanding of fire regimes and the vital attributes of local species and ecosystems. The *Perup fire effects* study in Yackelup (DEC 2009), established in 1986, is examining the long-term effects of different fire regimes on the floristic and structural composition of jarrah forest and on forest productivity measured through tree health and growth. Ten fire exclusion reference areas[32] occur in the planning area.

Wurmbea sp. Cranbrook at Byenup Lagoon. Photo – Roger Hearn

[31] *Diversity and variability in fire regimes at the landscape scale helps maintain biodiversity (Burrows and Abbott 2003). Management of fire at this scale is based on landscape conservation units, and the planning area contains seven landscape conservation units.*

[32] *Fire exclusion reference areas deliberately exclude fire to provide reference sites for scientific studies of the effects of fire on the environment.*

Desired outcomes

- Biodiversity and natural values at the landscape scale are maintained and protected.
- No impact on human life and community assets.

Objective

10.5 Limit the potential run (extent) of bushfires to less than 10 kilometres during the life of the plan.

Strategies

1. Apply prescribed fire to establish and maintain a mosaic of vegetation structure (post-fire seral stages) with a modal grain size of about 250 hectares.
2. Apply prescribed fire in strategic locations to limit the potential fire run (extent) of bushfires, without intersecting low fuel areas, to less than 10 kilometres.
3. Apply and maintain the master burn plan process consistent with the fire management and nature conservation plans for the Warren Region.
4. Use specific fire management guidelines to protect and conserve fire regime specific species and ecosystems.
5. Maintain a diversity of post-fire fuel ages across each landscape conservation unit by approximating a negative exponential fuel age distribution.
6. Encourage cooperative fire management arrangements between relevant agencies, local government, local bushfire brigades and neighbouring land managers.
7. Maintain a representative network of fire exclusion reference areas, consistent with the department's guidelines for management of these areas.

Key performance indicator

Performance measure	Target	Reporting requirements
10.5 The extent of fire runs of bushfires	10.5 No bushfire runs of more than 10 kilometres without intersecting low fuel areas	Annually

Melaleuca viminea thicket in Tone-Perup Nature Reserve that is home to the tammar wallaby. Photo – Paul Roberts

11. Cultural heritage

The planning area contains two registered sites and nine interim sites on the Commonwealth's *Register of the National Estate*, with the Tone-Perup, Lake Muir and Quindinup nature reserves listed in recognition of their conservation significance.

Management of Aboriginal and non-Indigenous cultural heritage in the planning area is guided by WA's *Aboriginal Heritage Act 1972, Heritage of Western Australia Act 1990* and department Policy 18 – *Recreation, tourism and visitor services*. Ten Aboriginal sites in the planning area (and three on the Red Lake/Cowerup Swamp UCL) are registered with the Department of Indigenous Affairs, and one non Indigenous heritage site (Grevillea Fire Tower) is registered on the WA 'Register of Heritage Places' database. Grevillea Fire Tower is the only site on a 'Municipal Inventory' (Shire of Bridgetown-Greenbushes Municipal Inventory) in the planning area. The department has 13 sites of cultural heritage significance listed on its Recreation and Tourism Information System database. Other sites may occur that are not registered.

Aboriginal heritage

The planning area lies within the traditional occupancy of the Kaneang people (north), the Minang people (south) and the Pibelmen people (west). The wetlands in the planning area attracted Aboriginal people because of the abundant water supply and variety of edible plants and animals. Most of the registered mythological, burial, quarry/artefact scatters, kangaroo traps and camping/hunting sites are associated with rivers, lakes and swamps. Only two archeological and ethnographical surveys have been undertaken, mainly associated with Lake Muir and other nearby reserves.

Bokarup Swamp. Photo – Roger Hearn

Traditional custodians have a strong desire to care for country and practise customary activities according to their traditional laws and customs, to be involved in the cooperative management of conservation reserves in WA and to strengthen cultural ties to the land. Working with Aboriginal people to care for the land will be beneficial to the preservation of natural and cultural heritage, as well as enriching cross-cultural awareness. The involvement of traditional custodians in the cooperative management of conservation estate also provides a suite of cultural, spiritual and economic benefits to Aboriginal people. While it is possible that management arrangements with Aboriginal people may change during the life of the management plan, the department will continue to recognise the interests of Aboriginal people on reserves where native title has been extinguished and their desire to continue cultural activities and customs in these areas.

The Conservation Commission and the department acknowledge the aspirations of Aboriginal people to obtain native title across their traditional lands and waters under the provisions of the federal government's *Native Title Act 1993* (Native Title Act). The South West Aboriginal Land and Sea Council Aboriginal Corporation is the representative Aboriginal body[33] appointed under Native Title Act for the planning area which represents native title holders and other Aboriginal people in the south-west of WA.

There are three registered native title claims across the planning area: Southern Nyoongar (WC96/109), Wagyl Kaip (WC98/70) and South West Boojarah 2 (WC06/4), although no native title determination has been made. The Native Title Act requires native title claimants and representative bodies to be advised when major public works[34] are undertaken and when a management plan is being prepared. The department will continue to recognise the interests of Aboriginal people and their desire to continue cultural activities and customs in the planning area.

Grevillea Tower. Photo – Paul Roberts

[33] The role of native title representative Aboriginal bodies is to help Aboriginal groups or individuals to make applications for native title, help resolve disagreements between groups making applications, and help groups and individuals by representing them in native title negotiations and proceedings.

[34] Major public works include buildings or fixed structures, roads, railways, bridges, water bores or wells or any major earthwork.

Non indigenous heritage

The planning area has a rich cultural heritage associated with early settlement, and the agricultural and forestry industries. The area was first explored by Dr Thomas Braidwood Wilson in 1829, who was then followed by Captain Bannister in 1832, Lieutenant Preston, William Nairne Clarke in 1841 and surveyor Augustus Charles Gregory in 1852.

The area was first settled in the 1850s after Thomas and Robert Muir set off from the Hay River, discovered and named Lake Muir in 1852, continued along the Perup River almost to the Wilgarrup junction, then moved their flocks to and established properties in the area in 1856. Significant sites associated with early settlement and the agricultural industry include settlers camp and well in Galamup Nature Reserve, Bokarup Homestead in Bokarup Nature Reserve, and sheep pens in Yarnup Nature Reserve.

Timber mills (for example Unicup Mill in Kodjinup Nature Reserve) were opened up in the area as the timber industry spread south and eastward in the early 1900s. From 1921–58 timber was hauled to the Palgarup mill via an extensive network of 126 kilometres of railway formations extending north and east (for example into Greater Kingston National Park). Grevillea fire tower in Greater Kingston National Park, constructed in 1940 and in operation until 1975, was the world's tallest all timber fire lookout tower at a height of 42.7 metres.

Desired outcome

- Cultural heritage is conserved and protected.

Objective

11.1 No disturbance to known or identifiable heritage sites without consultation with relevant stakeholders and formal approval during the life of the plan.

Strategies

1. Protect and maintain cultural heritage to ensure threatening processes do not have an adverse impact.
2. Liaise with the Department of Indigenous Affairs, Heritage Council of WA, local government, Aboriginal people, South West Aboriginal Land and Sea Council and other relevant organisations, and the local community regarding the appropriate protection and management of cultural heritage.
3. As needed, notify relevant native title claimants and representative Aboriginal bodies when undertaking works as defined in section 24J of the Native Title Act.
4. Ensure that the cultural values of the traditional custodians inform and guide all management actions.
5. Foster connection to country by allowing customary activities.
6. Encourage training, employment and economic development through cooperative management arrangements.
7. Support or encourage surveys of cultural heritage.

Key performance indicator

Performance measure	Target	Reporting requirements
11.1 Protection of known or identifiable heritage sites	11.1 No disturbance without consultation with relevant stakeholders and formal approval	Annually

Managing visitor use

12. Visitor opportunities and planning

Regional recreational context

The natural attributes, unspoiled environment and remote feel of the parks and reserves are the principal qualities that appeal to visitors to the planning area. In comparison with other parts of the Warren Region, visitor numbers and experiences in the planning area are relatively limited and low-key, which may be attributed to (i) distances to and/or from surrounding towns, (ii) few recreational water features[35], (iii) the relative remoteness and reduced level of access, and (iv) lower levels of visitor demand in the area. However, the planning area contains regionally significant wildlife viewing, educational and developed accommodation experiences, although the area is not well known or promoted by the tourism industry. The main recreation sites in the planning area are *Perup – Nature's Guesthouse* and Lake Muir Observatory, which in 2008–09 attracted 3000 visits and 15,588 visits, respectively. The unique *Perup – Nature's Guesthouse* is one of only a few tourism facilities in the region that provides a forest experience, accommodates groups of 15 or more visitors and provides visitors with activities to take part in (Tourism WA 2007). Other nearby recreation sites and/or facilities on neighbouring lands (for example Tonebridge, Tone River Wilderness Cottages/Camp at Strachan, Chindilup Pool and Frankland bridge) are limited and low-key.

There are valuable opportunities to provide nature-based recreation based on the area's unique native flora and fauna, ecological communities and hydrological values that complement existing opportunities and meet new demands. However, the primary focus of management of the parks and reserves will remain on the natural environment, and recreational development and management will be mainly low-key, with minimum facilities provided and minimum-impact activities promoted.

Birdwatching. Photo – Ian Wheeler

[35] *Recreational water features tend to be popular visitor destinations.*

Visitor planning

Planning for visitor use is needed in order to manage issues of visitor risk, environmental impacts, social benefit, equity, public demand and potential economic benefit. Visitor management settings (Map 3) provide the greatest range of recreation opportunities in a given area, while limiting unintended incremental development and minimising visitor impacts. More detailed precinct, master plan or site planning may be needed before the development of recreation sites and to manage more specific visitor use issues. Recreation planning will continue to be generally low-key outside of *Perup – Nature's guesthouse* and Lake Muir Observatory, although more planning may be needed for potential camping and day-use sites, horseriding and interpretation, particularly in the Lake Muir/Unicup recovery catchment.

The planning area has significant visual landscape values in the distinctive vegetation and open views associated with watercourses, wetlands and lakes. The department's *Visual resource management Guidelines* should be adhered to in all aspects of land management, particularly the planning and implementation of new facilities, buildings, recreation sites, signs and infrastructure.

Visitor interpretation and education

The provision of consistent and accurate information by internal and external providers is important in protecting the key values and achieving effective communication. The department provides a variety of information on the planning area (for example facilities, activities and access) through a variety of means (for example signage, printed materials, the department's website and department staff). *Perup – Nature's Guesthouse* and Lake Muir Observatory are the key interpretive sites in the planning area, and will each serve as a 'hub' for the principle interpretive stories about:

- the Muir-Byenup Ramsar wetland system, wetland waters and wildlife, and their relationship to the recovery catchment
- threatened fauna, particularly critical weight range mammals, and their relationship to the forests and woodlands.

Perup – Nature's Guesthouse provides a unique and ideal base for education programs for specific user groups (particularly local schools) to facilitate learning through interpretive programs, walktrails and trapping and/or spotlighting activities, and foster greater appreciation and understanding of the area's key values.

Entrance sign and Homestead at *Perup – Nature's Guesthouse*. Photos – Tim Foley

Visitor safety

Risks to visitors (for example adverse weather conditions, falling limbs, bushfire, poisonous snakes and becoming lost) are often present and are managed through a visitor risk management program under the department's Policy 53 – *Visitor risk management*. Many visitor risks can be overcome through attention to personal safety (including the registration of trip details with friends or family), appropriate maintenance of facilities by department staff, and appropriate risk warning signage.

Desired outcome

- Community awareness, understanding and appreciation of key values through the planning and provision of a range of safe and minimal-impact nature-based recreation and tourism opportunities based on visitor demand and trends.

Objectives

12.1 Maintain or increase visitor satisfaction with the general visitor experience at *Perup – Nature's Guesthouse* from 2011 levels.

12.2 No change to the extent of visitor management settings from 2011 levels.

Strategies

1. Provide visitor services, facilities and experiences in the planning area consistent with the department's Policy 18 – *Recreation, tourism and visitor services*.
2. Ensure existing and future recreation and tourism developments and visitor activities remain consistent with visitor management settings (Map 3), and refer any proposed changes to visitor management settings to the Conservation Commission.
3. Ensure existing and potential recreation and tourism developments and visitor activities minimise environmental, cultural, visual and social impacts and, where relevant, are designed, developed and maintained to department standards.
4. Monitor the levels of change and impacts of visitor use on recreation areas and facilities, and modify recreation and tourism management where fitting.
5. Provide appropriate information, interpretation and education opportunities for visitors to increase their knowledge, appreciation and understanding of (i) key values and management issues, and (ii) the Muir-Byenup Ramsar wetland system and threatened fauna.
6. Undertake formal risk assessment of all recreation sites and facilities as part of the visitor risk management program and in addition to that which occurs on a day-to-day basis, and undertake appropriate action as necessary.
7. Develop a visitor satisfaction survey for *Perup – Nature's Guesthouse*.
8. Monitor visitor numbers, visitor satisfaction and feedback at *Perup – Nature's Guesthouse*, and use visitor data to improve management consistent with the recreation framework plan for the Warren Region.

Key performance indicators

Performance measure	Target	Reporting requirements
12.1 Visitor satisfaction with the general visitor experience at *Perup – Nature's Guesthouse*	12.2 Maintain or increase visitor satisfaction with the general visitor experience at *Perup – Nature's Guesthouse*	After five years
12.2 The extent of visitor management settings	12.1 No change to the extent of visitor management settings	After five years

13. Visitor access

Most road and track access on department-managed lands ('CALM Act roads') is managed by the department, except dedicated public roads[36], which remain a separate Crown land road reserve managed by either Main Roads WA or relevant local government authorities (for example Muirs Highway and Boyup Brook-Cranbrook Road). A small number of unused Crown road reserves are scattered across the planning area. Management of the parks and reserves often needs access to be temporarily, permanently or seasonally closed to the public, and in the planning area a significant proportion of access is 'management access only'[37] because it lies within disease risk areas. A road management policy is being developed that will be used to guide future management of access. Some 'CALM Act roads' are the only viable public access to private property that may be surrounded by department-managed lands, and these roads and/or tracks will continue to remain open. Inappropriate vehicle access, which has resulted in the degradation of some wetland shorelines and disturbance to nesting waterbirds at Lake Muir and Lake Unicup, will be controlled through a variety of techniques for managing visitor impacts.

Desired outcome

- Provision and maintenance of safe and effective access that facilitates visitor appreciation of, and minimises significant adverse impacts on, natural, cultural and socio-economic values.

Strategies

1. Provide and maintain strategic road and track access (as shown in Map 3) for management and public use consistent with appropriate visitor management settings, protection of key values, department standards and in consultation with visitors and relevant stakeholders.
2. Only permit vehicles driving off dedicated roads, CALM Act roads and tracks with approval from the regional or district manager.
3. Temporarily, permanently or seasonally close management access roads or tracks to the public, subject to approval by the regional or district manager, and signpost 'management access only' accordingly.
4. Ensure Crown road reserves are best located to protect the natural and landscape values and meet public access needs, and negotiate with appropriate authorities to cancel unnecessary or unused road reserves adding them to the planning area.
5. Close and, where fitting, rehabilitate access that is poorly located, in poor condition, difficult to maintain, unsuitable for recreation and conservation purposes, no longer needed or where there is an adverse and unacceptable impact on the environment.
6. Where fitting, improve access to services, information and facilities for people with disabilities.

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[36] *Dedicated public roads are defined under the* Land Administration Act 1997 *as "land dedicated at common law or reserved, declared or otherwise dedicated under an Act as an alley, bridge, court, lane, road, street, thoroughfare or yard for the passage of pedestrians or vehicles or both".*

[37] *Roads and tracks that are designated as 'management access only' will be signposted and/or physically closed by a gate, drain or felled tree.*

14. Visitor activities and use

Bushwalking

Existing walktrails are mainly associated with developed facilities (for example the short raised platform walk at Lake Muir Observatory, and *Perup – Nature's Guesthouse*) (Map 1). A limited number of additional (longer-distance) walktrails may be developed around these sites, where fitting.

Visitor accommodation

Perup – Nature's Guesthouse is an accommodation and education complex in Tone-Perup Nature Reserve. The self-contained 'Cottage' is mainly used by couples or families, and the 'Scientists Cottage' for visiting researchers. The 'Homestead' and 'Bunkhouse' offer shared accommodation for bigger groups of 10 to 30 people and, with the 'Classroom', are often used for conferences, meetings and studies. A caretaker lives on-site, and fees and bookings apply for these facilities.

There are no designated camping sites in the planning area, and camping is generally low-key and often confined to overnight travellers passing through the area or individuals seeking solitude, inspiration or self-reliant recreation. *Perup – Nature's Guesthouse* may be developed as a designated camping site to cater for a small number of overnight travellers requiring minimal camping facilities. Old Heartlea Settlement may be developed as an overnight, low-key designated camping site.

Day use and picnicking

Day-use sites at Lake Muir Observatory, Lake Unicup and Old Heartlea Settlement provide opportunities for picnicking and barbecuing, lookouts, interpretation, and other nature-based leisure activities such as scenic driving, bushwalking and nature observation. Red Lake (once it becomes vested with the Conservation Commission) and Grevillea Fire Tower may be developed as low-key day-use sites to enhance recreational and interpretive experiences.

Horseriding

Horseriding in bush settings is part of the cultural heritage of the south-west, and still occurs along some roads and tracks, although the demand, use and location often changes. Horseriding trails on some roads and tracks open to the public, with associated facilities and trails, will be investigated and, where permitted, monitored for the prevalence of weeds, erosion, degradation of vegetation and *P. cinnamomi*.

Picnic area outside homestead at *Perup – Nature's Guesthouse*. Photo – Tim Foley

Water-based activities

There are few water-based activities in the planning area because many of the water bodies are relatively shallow and environmentally sensitive. Waterskiing has historically occurred in Unicup Nature Reserve on Lake Unicup, and the lake was gazetted as a water ski area on 25 October 1991. Waterskiing occurs on two alternate nearby gazetted water ski areas at Lake Poorarecup and Lake Nunijup, which are 43 kilometres and 63 kilometres to the east, respectively.

Wildlife viewing

Perup – Nature's Guesthouse provides a unique and regionally-significant wildlife viewing and interaction experience with some of Australia's rarest mammals (for example chuditch, numbat, woylie and tammar) in their natural habitat, and is the focus for guided nature activities associated with jarrah and wandoo forests. Lake Muir Observatory is also a regionally-significant facility for visitors to observe waterbirds that visit and inhabit Lake Muir. Other sites in the Lake Muir/Unicup recovery catchment may also be suitable for wetland wildlife viewing (for example Red Lake).

Desired outcome

- A range of recreational activities appropriate to the environment and management settings that facilitates visitor enjoyment and appreciation of key values.

Objective

14.1 Maintain or increase visitor satisfaction with facilities and activities at *Perup – Nature's Guesthouse* from 2011 levels.

Strategies

1. Provide and maintain a range of recreation opportunities consistent with appropriate visitor management settings (Map 3), adequate protection and maintenance of key values, recreational development criteria, site capability, safety standards, and the rights and enjoyment of other visitors.
2. Monitor the impacts of, and demand for, recreational activities, and control activities in liaison with users where impacts become significant or unacceptable through appropriate visitor management techniques.
3. Maintain built accommodation in order to maintain the visitor experience.
4. Not permit dogs in the planning area, except (with appropriate authorisation) guide dogs and dogs needed for emergency search and rescue and management purposes.
5. Develop more, preferably longer-distance, walktrails in association with key stakeholders, within close proximity of *Perup – Nature's Guesthouse* and Lake Muir Observatory, as the need arises.
6. Maintain a fee and booking system for accommodation at *Perup – Nature's Guesthouse*.
7. Investigate the establishment of horseriding trails on roads and tracks open to the public, consistent with the purpose of the land and, where established, monitor to minimise adverse impacts (for example *P. cinnamomi*).
8. Where fitting, develop a scenic drive in the Lake Muir/Unicup recovery catchment in association with key stakeholders to interpret hydrological regimes, wetlands, waterbirds and Ramsar values.
9. Assess natural, cultural and socio-economic values and the impacts and safe operation of waterskiing at Lake Unicup, and discuss options for management with local communities and relevant stakeholders.

Key performance indicator

Performance measure	Target	Reporting requirements
14.1 Visitor satisfaction with facilities and activities at *Perup – Nature's Guesthouse*	14.1 Maintain or increase visitor satisfaction with facilities and activities at *Perup – Nature's Guesthouse* from 2011 levels	After five years

15. Tourism and commercial operations

There are no recreation and tourism leases[38] in the planning area, although there is one other lease for water from a dam site (see *Public Utilities and Services*). Commercial tour operators interact with visitors on a regular basis and play a significant role in disseminating information. However, at present only one commercial tour operator has a licence[39] for the planning area.

Desired outcome

- Extension of the range of services, facilities and experiences available through the involvement of private enterprise, consistent with other management objectives.

Strategies

1. Evaluate proposals for licences and commercial tourism leases and permit their establishment, where fitting, in accordance with department policy.
2. Monitor tour operator compliance with licence and lease conditions, and the level and impact of operator use to ensure commercial operations are sustainable.

Lake Muir observatory. Photos – Paul Roberts

[38] *Leases are formal agreements that allow exclusive use of land as a means of providing security to protect significant investments.*

[39] *Licences allow private tour operators conducting commercial tourist activities to access and use department-managed lands, and enables the department to monitor and regulate access and use to ensure key values are maintained.*

Managing resource use

Mineral and petroleum exploration and development

Parts of the planning area have mineral prospectivity for gold, silver, lead, zinc, tungsten and bauxite, and have been, and continue to be, subject to mineral exploration. Current mining tenements[40] in the planning area are E70/3112, E70/3256, E70/3395 and E70/3474. The mining tenement M70/1158 for access to peat covers a small swamp to the northwest of Cowerup Swamp within the Red Lake and Cowerup Swamp UCL.

Basic raw materials, principally gravel, continue to be in demand by local governments and Main Roads WA for maintenance to major roads traversing the area. The determination of gravel needs from within the planning area should be assessed within the framework of the State Gravel Supply Strategy[41]. The extraction of gravel can result in the loss of vegetation and the introduction and spread of dieback and weeds, as well as having visual impacts. There is a presumption against accessing basic raw materials on conservation reserves, and any application will be assessed on a case-by-case basis. Proposed reserves 10391 and 10504 (Map 1, Table 3) are vested with the Shire of Manjimup and will only become vested with the Conservation Commission once the reserves are no longer needed for road making materials.

Public utilities and services

A number of Western Power transmission lines and Telstra service lines traverse the planning area. Utility providers need permission from the relevant district manager for access and the conditions of entry and operation for the maintenance of infrastructure (including during emergencies). If at any stage utilities and services are no longer needed, the infrastructure will be removed and the land rehabilitated. The only agreement, licence or lease within the planning area is Lease 1337/40 in Greater Kingston National Park for water from a dam site.

Exotic pines within species trail plots in Tone-Perup Nature Reserve. Photo – Paul Roberts

[40] *A mining tenement under the* Mining Act 1978 *means a prospecting licence, exploration licence, retention licence, mining lease, general purpose lease or a miscellaneous licence granted or acquired under this Act or by virtue of the repealed Act.*

[41] *The State Gravel Supply Strategy is a strategic and coordinated approach to assessing future gravel supply and demand for the wider region.*

Forest produce

Forest produce[42] may be generated from licenses issued under section 99A(1) of the CALM Act for (i) use for therapeutic, scientific or horticultural purposes, (ii) essential works[43], and (iii) the taking or removal of exotic trees (for example *Pinus* and eastern states eucalypt species trial plots), honey, beeswax or pollen (by apiary site permit). Firewood collection and the extraction and sale of craftwood[44] from national parks and nature reserves are not permitted. Under section 33(1)(cb) of the CALM Act, forest produce obtained through the carrying out of necessary operations[45] (on nature reserves) or compatible[46] operations (on national parks or conservation parks) can be used for the purpose of making improvements to the land, where it is consistent with the reserve purpose. Forest produce obtained in this manner may be used by the department for management purposes.

Water resources

Three public drinking water source areas[47] occur in the planning area: (i) Donnelly River Water Reserve, (ii) Warren River Water Reserve, and (iii) Deep River Water Reserve none of these have drinking water source protection plans. The Department of Water needs access to these public drinking water source areas to conduct investigations into alternate water supplies, and to surface, ground and meteorological monitoring sites in the planning area for data collection and asset maintenance. The department uses watering points located throughout the planning area for fire control, and these will continue to be maintained.

Beekeeping

There no current or available apiary sites on existing or proposed reserves in the planning area. Of the eight sites that lie adjacent to the planning area, site 4418 is 'conditional' and site 5681 (which is vacant) will be closed.

Desired outcomes

- Minimal impact of resource use on natural, cultural and socio-economic values.
- Disturbances to the natural environment from resource use are appropriately rehabilitated and/or restored.

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[42] *Forest produce includes trees, parts of trees, timber, sawdust, chips, firewood, charcoal, gum, kino, resin, sap, honey, seed, bees-wax, rocks, stone and soil as per section 3 of the CALM Act.*

[43] *Essential works as defined in section 99A(2) of the CALM Act includes works that are needed to establish or re-establish access to land or to provide fire containment lines.*

[44] *Traditionally, craftwood has been restricted to Banksia nuts, Xanthorrhoea bases, sheoak and jarrah timber offcuts, although burls are not craftwood.*

[45] *Necessary operations are activities conducted by the department that are necessary for the preservation or protection of persons, property, land, waters, flora or fauna, or for the preparation of a management plan.*

[46] *Compatible operations are activities conducted by the department that are approved by the Minister for Environment as being compatible with the purposes for which the park or management area is managed under the CALM Act.*

[47] *Public drinking water source areas are proclaimed/gazetted under the* Metropolitan Water Supply, Sewerage, and Drainage Act 1909 *or the* Country Areas Water Supply Act 1947 *as a water reserve, catchment area or underground water pollution control area to define the boundary and protect the water quality of these drinking water sources.*

Strategies

1. Assess the impacts of proposed resource use, referring proposals to the EPA where necessary or fitting, and permitting proposed uses only where (i) they are consistent with the CALM Act and government policy, (ii) there are no viable alternatives, and (iii) they minimise adverse impacts on department operations and key values.
2. Monitor existing resource use/activities to ensure compliance with pre-determined conditions and/or department needs, and ensure areas of disturbance from resource use/activity are appropriately rehabilitated and/or restored in accordance with the department's Policy 10 – *Rehabilitation of disturbed land.*
3. In accordance with department and Conservation Commission policies, permit access to basic raw materials where:
    - the use of the material helps in the protection and management of the area
    - a more environmentally acceptable alternative is not available
    - the material is used within the boundaries or enclaves of the planning area
    - the environmental cost to the conservation estate on balance is neutral
    - extraction is consistent with this management plan and purpose and tenure of the area.
4. Encourage resource users to be responsible for management of environmental problems, particularly the introduction and spread of weeds and disease.
5. Where necessary, excise land containing utility and service infrastructure and reserve these areas as CALM Act section 5(1)(h) reserves.
6. Recognise the continued access by agencies and utilities to department-managed lands for the maintenance of existing assets.
7. Permit the removal of forest produce, such as trial plots, only where it is consistent with the CALM Act and where a licence is granted by the director general (i) for therapeutic, scientific or horticultural purposes, (ii) as a result of essential works, or (iii) as a result of the removal of exotic trees.
8. Liaise with Department of Water regarding the management of water resources to ensure sufficient environmental flows are maintained for rivers in the planning area and to ensure that environmental impacts are minimised.
9. As needed, issue a CALM Act water removal permit for the abstraction (taking) of water from the planning area after (i) consultation with the Conservation Commission and approval of the Minister for Environment, (ii) approval by Department of Water, and (iii) appropriate assessment by the EPA.
10. Cancel apiary site 5681, in consultation with relevant stakeholders.

Little Unicup Lake. Photo – Paul Roberts

Involving the community

16. Community involvement and off-reserve management

A key objective for the department is to maintain and promote community involvement in, and support for, the protection and conservation of the state's natural environment (DEC 2007), which can be achieved through:

- public participation and involvement opportunities and programs
- managing cross-boundary issues
- liaising and partnering with other agencies, and groups with similar interests
- expansion of off-reserve conservation that complements management of the reserve system.

Public participation and involvement opportunities

There are numerous opportunities for public participation and involvement in management activities of the department. Public participation has been a core component of the preparation of this draft management plan, and six workshops were held in 2009 with local community representatives, with an additional two workshops held with Aboriginal native title working groups.

Volunteer activities increase the department's work capabilities and skills base, and also foster communication links and understanding with the community. The department maintains a volunteer database, and during 2008–09 49 volunteers contributed more than 11,500 hours in the department's Donnelly District to activities such as feral animal and weed control. Birds Australia volunteers have been involved with assessments of waterbird usage in reserves of the Lake Muir/Unicup recovery catchment (Jaensch *et al*. 1988). The Friends of Perup is a community-based non-profit organisation that has been actively involved in the management of Tone-Perup Nature Reserve, raising community awareness and interest in the reserve's unique natural values.

The department informs, consults and involves the public on many day-to-day aspects of planning and operational activities including monthly district operations and rolling three-year indicative and annual burn programs.

Management of cross-boundary issues

Management objectives for this plan cannot be achieved in isolation from land management activities on adjoining lands. Catchment, weed and feral animal, threatened species and fire management issues need to be approached from the broader integrated land management perspective to achieve management objectives. Ongoing liaison with neighbours, local communities and agencies will aim to facilitate the effective, coordinated management of cross-boundary issues and minimise adverse impacts on key values. Principles for effective neighbour relations outlined in the department's Policy 65 – *Good neighbour policy* will be fostered through the development of partnerships with the community.

Liaison with land-holders will be important in implementing recovery actions for some threatened species (for example chuditch, Muir's corella, Baudin's cockatoo and forest red-tailed black cockatoo) that are highly mobile and travel across tenures in search of food or nesting sites, particularly in increasing awareness about their conservation status and to provide information on actions that land-holders can undertake to help in the recovery effort.

The Lake Muir/Unicup recovery catchment plan will need the cooperation and integration of activities by all land managers and stakeholders in maintaining wetland values of reserves and surrounding lands in the catchment.

Liaison and partnerships

The department liaises with the relevant federal department administering the EPBC Act concerning the management of the Muir-Byenup Ramsar wetland system, migratory species and threatened plants and animals listed under that Act. Several state government agencies have responsibilities for, or provide advice on, land use practices within the vicinity of the planning area, including drainage and declared invasive species (Department of Agriculture and Food) and water resource use (Department of Water). Liaison with local governments (Boyup Brook, Bridgetown-Greenbushes, Cranbrook and Manjimup) is also particularly important given:

- some proposed reserves identified in Table 3 are vested in local government authorities
- local governments broadly represent the views of local communities within their constituencies
- local governments are able to encourage planning and land management practices that complement management of the reserves through a range of planning instruments (for example town planning schemes and local planning strategies)
- the department maintains working arrangements with local governments, local bush fire brigades and volunteers to provide cooperative and coordinated fire fighting that can deal successfully with the full range of fire emergencies on or near department-managed lands and can achieve complementary fire management on adjoining lands
- local governments share responsibilities in the provision and maintenance of the public road network.

The reserves are a part of the South West and South Coast natural resources management (NRM) regions, which help deliver, in partnership with other governments, Aboriginal groups, land managers and community groups, the Australian government's conservation funding programs. Annual funding programs across sub-catchments, such as the Warren Catchment's Council, will contribute towards the effective management of the planning area, and interaction with NRM groups is important to provide for integrated natural resource management.

Muir's corella count at Unicup Hall. Photo – Lee Fontanini

Perup workshop. Photo – DEC

Off-reserve conservation

Off-reserve conservation complements management of the reserve system through the protection and management of natural values directly (for example rare or under-represented species or ecological communities) and indirectly (for example waterways or other habitats that may link to or enhance nearby conservation reserves). Several properties lie adjacent or close to the planning area that are covered by covenant and voluntary management schemes (for example the department's Nature Conservation covenant and Land for Wildlife schemes, Department of Agriculture and Food's Agreement to Reserve covenant, and National Trust [WA] covenant), which provide protection and linkage benefits for natural values as well as support and advice for land-holders.

Desired outcome

- Effective involvement and support of, and liaison and partnership with, organisations, statutory bodies and the local community.

Strategies

1. Liaise with and encourage neighbours, local authorities, relevant agencies and other stakeholders to facilitate off-reserve conservation and the effective, coordinated management of cross-boundary issues.
2. Continue to support, promote and provide opportunities for public participation and community involvement in management activities associated with management of the planning area, including the naming of unofficially named or un-named parks and reserves.
3. Maintain the department's volunteer database.

Research and monitoring

The planning area is one of the most important areas for long term ecological research in WA. An extensive body of knowledge on critical weight range mammals (for example woylie, tammar and ngwayir) has been built up since the 1970s. Studies in the Kingston area continue to examine the impact of forest practices on the jarrah forest ecosystem. The Lake Muir/Unicup recovery catchment has a long history of water, vegetation, invertebrate and waterbird research and monitoring. The planning area will continue to be an important focus for long term ecological research in WA given (i) the relatively intact flora and fauna, (ii) the presence and relatively high abundance of many rare animals, (iii) the knowledge base from which to develop more investigations, (iv) the ecological and international importance of Muir-Byenup Ramsar wetland system, and (v) the extent and impact of threatening processes.

Broad direction for research and monitoring in the planning area is provided by (i) the department's *Science Division 2008 strategic plan* for research, (ii) May and McKenzie (2003), (iii) species recovery plans, (iv) nature conservation plan for the Warren Region, and (v) Cook and Farrell (2009). Major projects in the area that will continue through the life of this plan (to varying degrees) (DEC 2009), include:

- monitoring of selected vertebrate communities in Tone-Perup Nature Reserve
- *Perup fire effects* study
- woylie conservation research project
- State Salinity Strategy wetland monitoring
- Kingston project
- FORESTCHECK[48].

Radiotracking. Photo – Adrian Wayne

[48]*FORESTCHECK is the department's integrated monitoring system developed to provide information about any changes and trends in key forest organisms, communities and processes associated with a variety of forest management activities.*

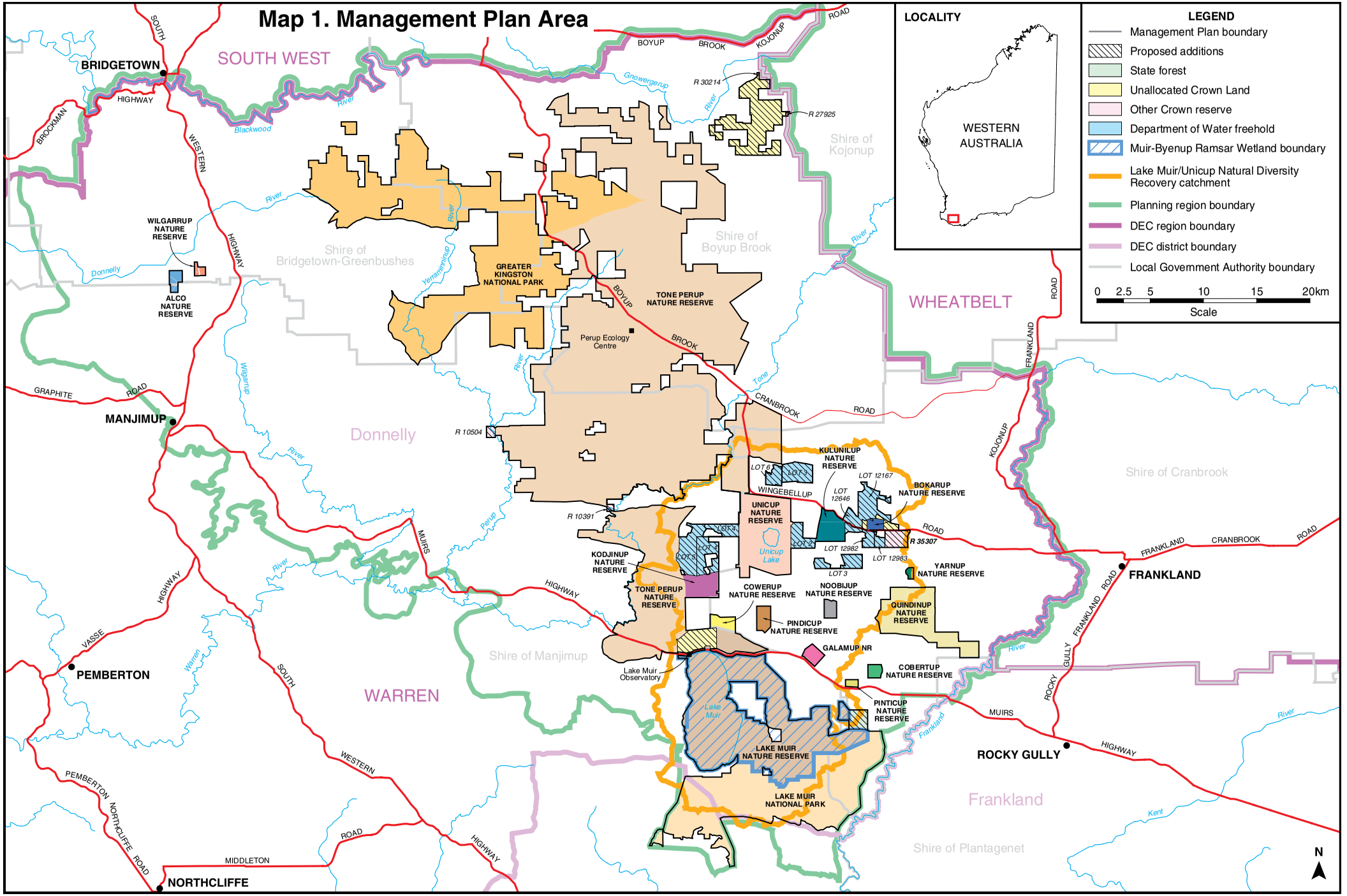
Desired outcomes

- Knowledge and understanding of natural, cultural and socio-economic values is increased through research and monitoring.
- Any adverse change in the state of the Muir-Byenup Ramsar wetland system's ecological character is monitored and understood.

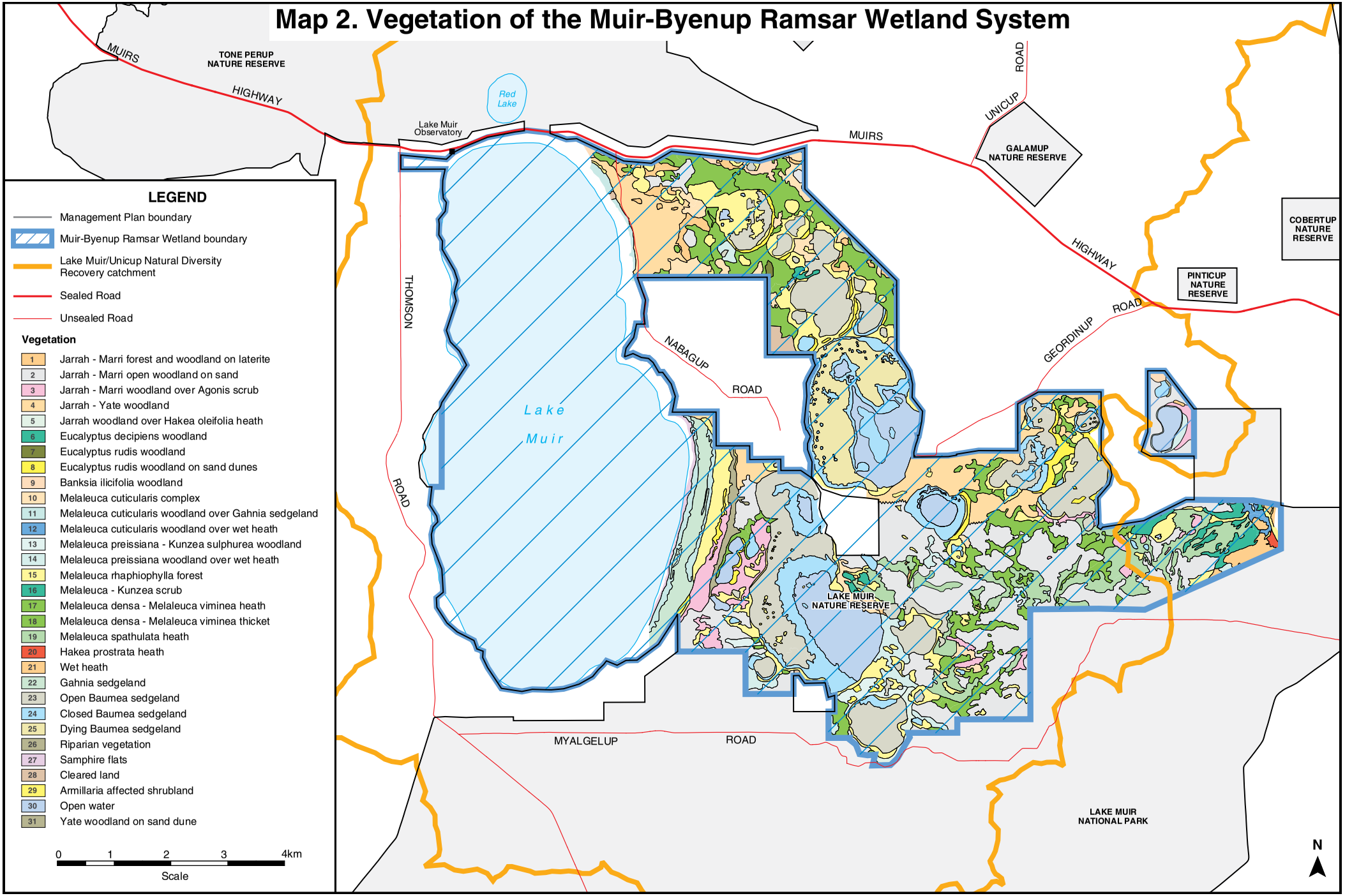
Strategies

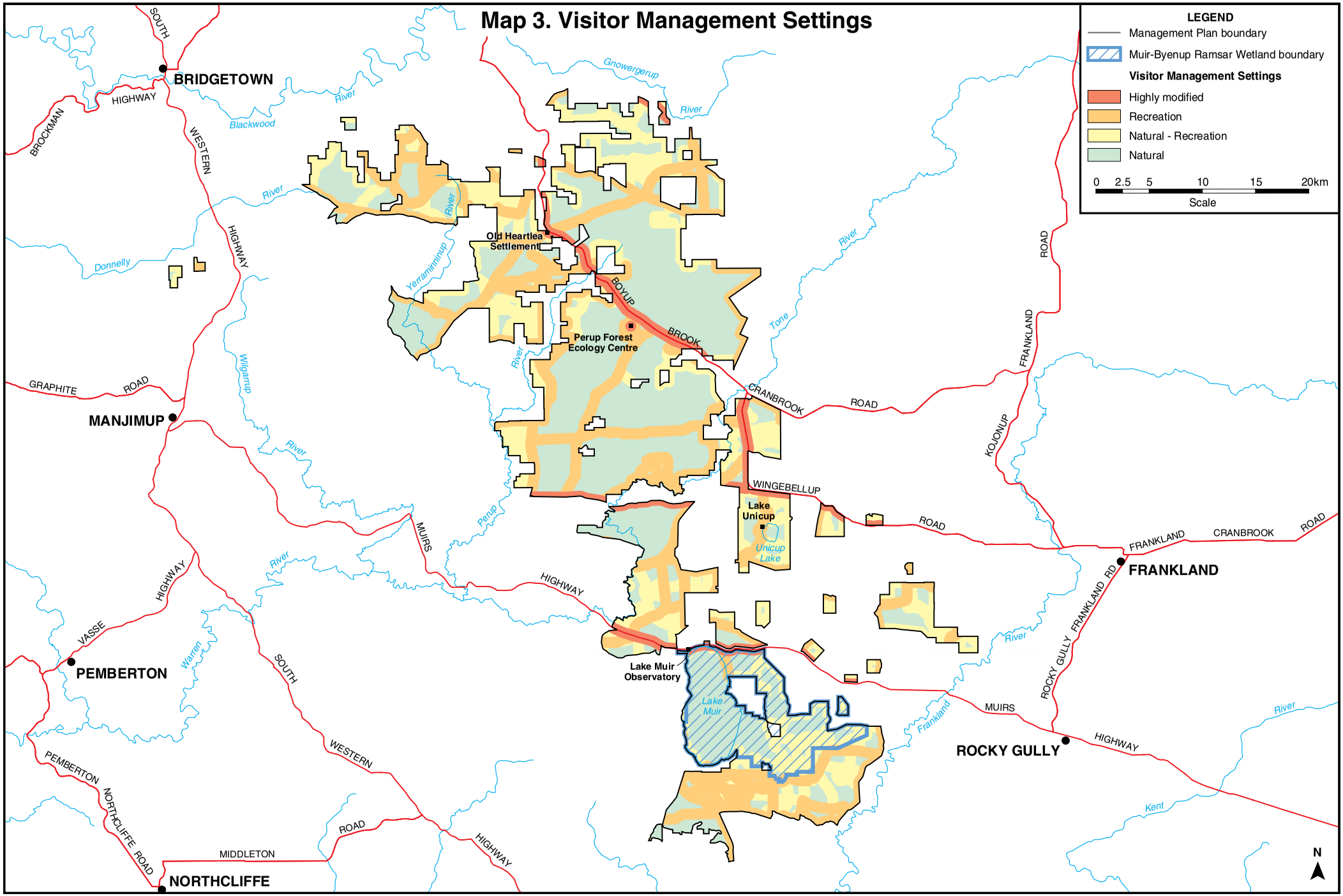
1. Develop and implement an integrated program of survey, research and monitoring aimed at meeting key performance indicators, facilitating management of the planning area, and developing a sound understanding of key values and the significance of threatening processes upon these.
2. Incorporate research and monitoring findings into operational management and interpretive and/or educational material where fitting.
3. Encourage and support volunteers, educational institutions and other organisations where their research contributes directly to department strategies or the implementation and auditing of this management plan.
4. Monitor sites in the reserves of the Lake Muir/Unicup recovery catchment that are subject to detailed biological surveys.
5. Collate water quality data for reserves in the Lake Muir/Unicup recovery catchment, analyse trends and develop and apply hydrological model(s) in the management of hydrological regimes.
6. Continue monitoring critical weight range and other vertebrate fauna in long term ecological research/monitoring sites in the Tone-Perup Nature Reserve.
7. Undertake detailed vegetation/floristic mapping and assessment of Tone-Perup Nature Reserve in the context of a statewide vegetation information system and mapping project.
8. Encourage research that links plant community coverage, distribution and condition/health to changes in acidity, salinity and surface metal concentrations and other hydrological regimes.
9. Continue monitoring the state of the Muir-Byenup Ramsar wetland system's ecological character.

DEC researchers and volunteers with a captured woylie for woylie research in Tone-Perup Nature Reserve. Photo – Keith Morris


Map 1. Management Plan Area
LOCALITY
WESTERN AUSTRALIA
LEGEND
Management Plan boundary
Proposed additions
State forest
Unallocated Crown Land
Other Crown reserve
Department of Water freehold
Muir-Byenup Ramsar Wetland boundary
Lake Muir/Unicup Natural Diversity Recovery catchment
Planning region boundary
DEC region boundary
DEC district boundary
Local Government Authority boundary
0 2.5 5 10 15 20km
Scale
SOUTH WEST
WHEATBELT
WARREN
Frankland
BRIDGETOWN
MANJIMUP
PEMBERTON
NORTHCLIFFE
FRANKLAND
ROCKY GULLY
Shire of Bridgetown-Greenbushes
Shire of Kojonup
Shire of Boyup Brook
Donnelly
Shire of Cranbrook
Shire of Manjimup
Shire of Plantagenet
WILGARRUP NATURE RESERVE
ALCO NATURE RESERVE
GREATER KINGSTON NATIONAL PARK
TONE PERUP NATURE RESERVE
Perup Ecology Centre
KULUNILUP NATURE RESERVE
BOKARUP NATURE RESERVE
UNICUP NATURE RESERVE
Unicup Lake
KODJINUP NATURE RESERVE
TONE PERUP NATURE RESERVE
COWERUP NATURE RESERVE
NOOBIJUP NATURE RESERVE
YARNUP NATURE RESERVE
PINDICUP NATURE RESERVE
QUINDINUP NATURE RESERVE
GALAMUP NR
COBERTUP NATURE RESERVE
PINTICUP NATURE RESERVE
LAKE MUIR NATURE RESERVE
LAKE MUIR NATIONAL PARK
Lake Muir
Lake Muir Observatory
R 30214
R 27925
R 10504
R 10391
R 35307
WINGEBELLUP
LOT 6
LOT 3
LOT 12167
LOT 12646
LOT 12982
LOT 12983
LOT 5
LOT 4
LOT 2
LOT 1
BOYUP BROOK ROAD
CRANBROOK ROAD
FRANKLAND ROAD
GRAPHITE ROAD
MIDDLETON ROAD
PEMBERTON NORTHCLIFFE ROAD
ROCKY GULLY FRANKLAND ROAD
KOJONUP ROAD
SOUTH WESTERN HIGHWAY
BROCKMAN HIGHWAY
MUIRS HIGHWAY
VASSE HIGHWAY
WESTERN HIGHWAY
Blackwood River
Gnowergerup River
Donnelly River
Yerraminup River
Wilgarup River
Tone River
Perup River
Warren River
Frankland River
Kent River
MUIRS
ROCKY GULLY
N

Map 2. Vegetation of the Muir-Byenup Ramsar Wetland System




Map 3. Visitor Management Settings
LEGEND
Management Plan boundary
Muir-Byenup Ramsar Wetland boundary
Visitor Management Settings
Highly modified
Recreation
Natural - Recreation
Natural
0 2.5 5 10 15 20km
Scale
BRIDGETOWN
MANJIMUP
PEMBERTON
NORTHCLIFFE
FRANKLAND
ROCKY GULLY
Old Heartlea Settlement
Perup Forest Ecology Centre
Lake Unicup
Unicup Lake
Lake Muir Observatory
Lake Muir
BROCKMAN HIGHWAY
WESTERN HIGHWAY
SOUTH WESTERN HIGHWAY
GRAPHITE ROAD
VASSE HIGHWAY
PEMBERTON NORTHCLIFFE ROAD
MIDDLETON ROAD
MUIRS HIGHWAY
CRANBROOK ROAD
WINGEBELLUP ROAD
FRANKLAND CRANBROOK ROAD
FRANKLAND RD
ROCKY GULLY FRANKLAND RD
KOJONUP ROAD
BOYUP BROOK
Blackwood River
Donnelly River
Gnowergerup River
Yerraminnup River
Wilgarrup River
Perup River
Warren River
Tone River
Frankland River
Kent River
N

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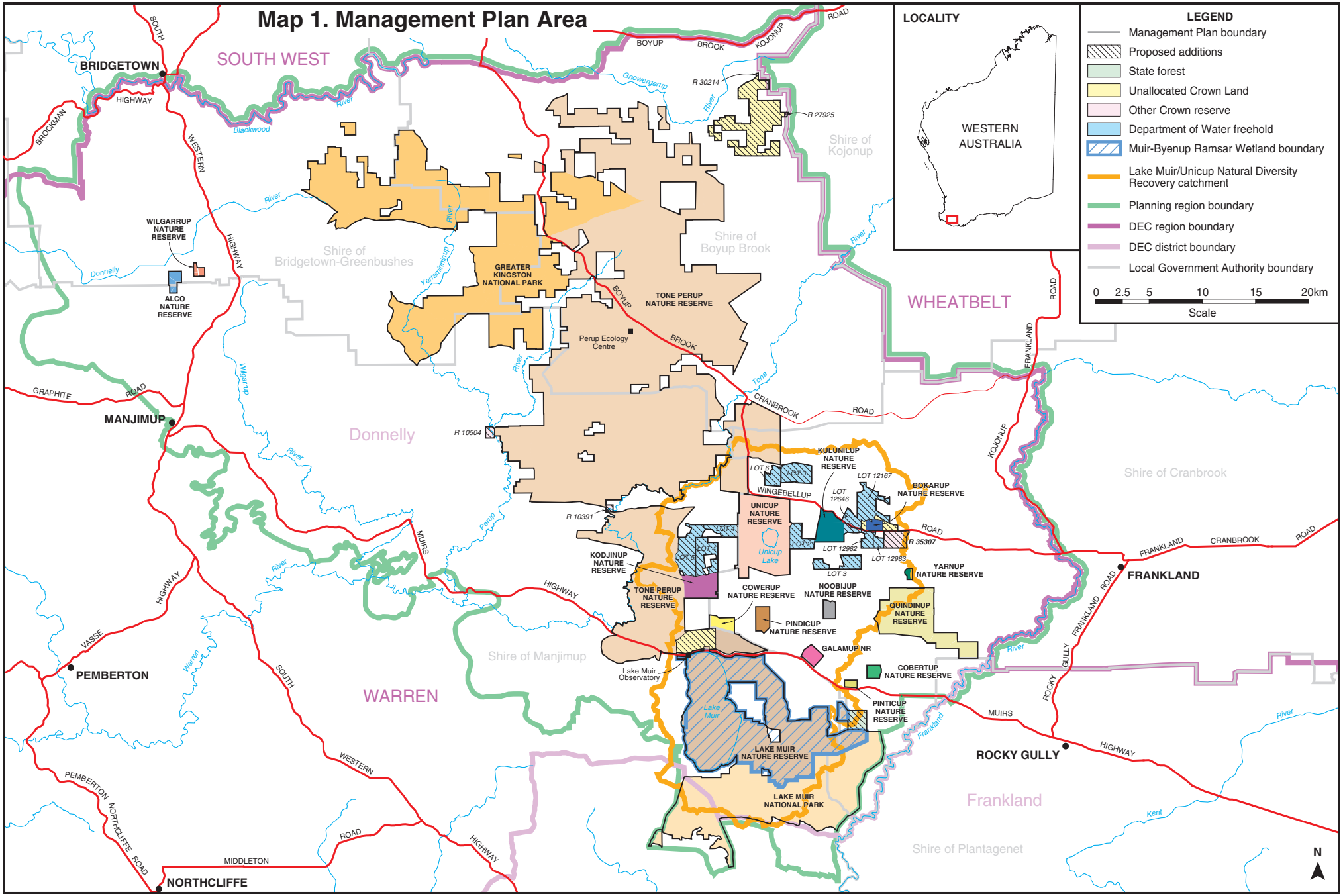
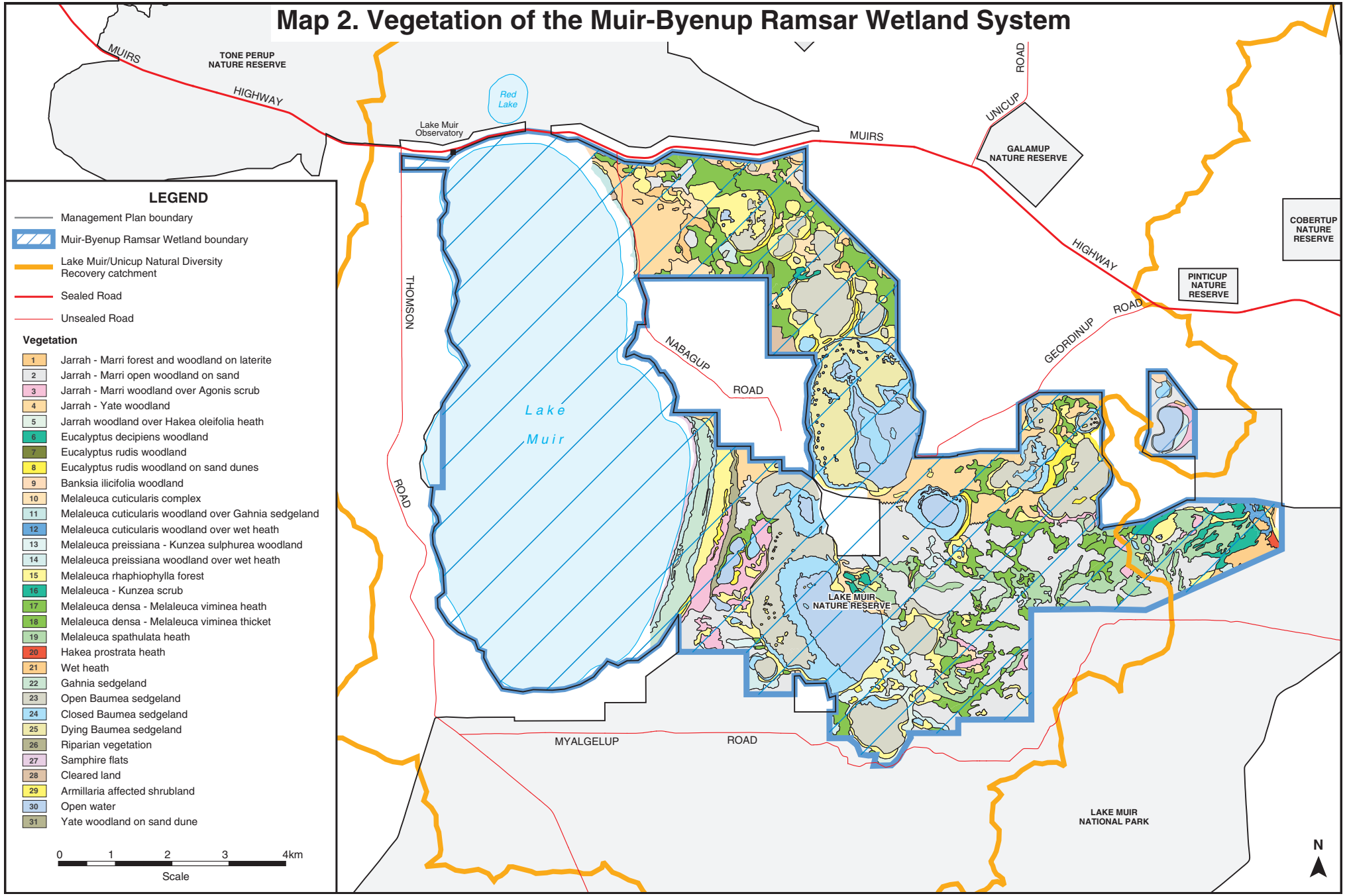
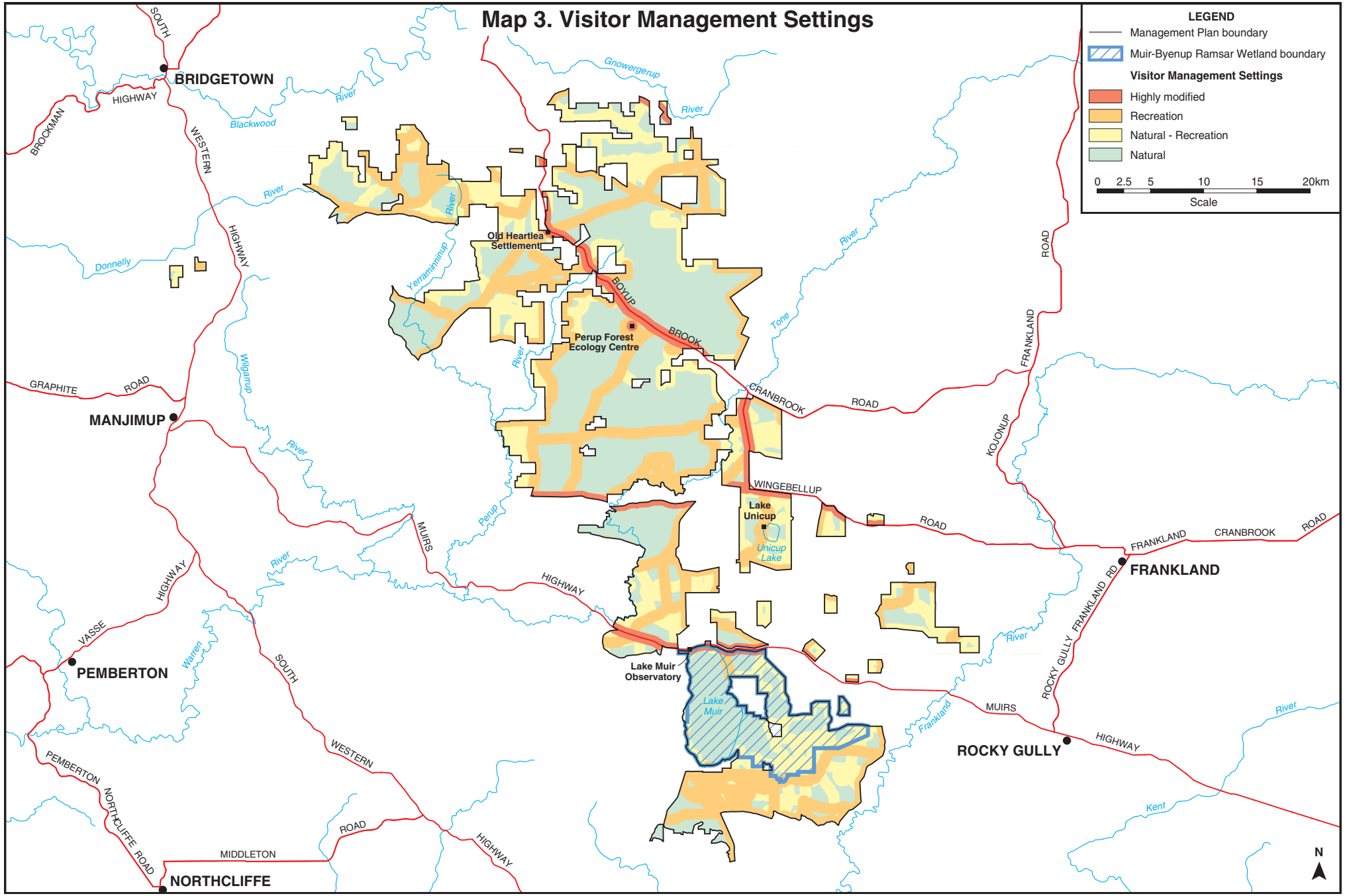

Map 1. Management Plan Area
LOCALITY
WESTERN AUSTRALIA
LEGEND
Management Plan boundary
Proposed additions
State forest
Unallocated Crown Land
Other Crown reserve
Department of Water freehold
Muir-Byenup Ramsar Wetland boundary
Lake Muir/Unicup Natural Diversity Recovery catchment
Planning region boundary
DEC region boundary
DEC district boundary
Local Government Authority boundary
0 2.5 5 10 15 20km
Scale
SOUTH WEST
WHEATBELT
WARREN
BRIDGETOWN
MANJIMUP
PEMBERTON
NORTHCLIFFE
FRANKLAND
ROCKY GULLY
Shire of Bridgetown-Greenbushes
Shire of Kojonup
Shire of Boyup Brook
Donnelly
Shire of Manjimup
Shire of Cranbrook
Frankland
Shire of Plantagenet
WILGARRUP NATURE RESERVE
ALCO NATURE RESERVE
GREATER KINGSTON NATIONAL PARK
TONE PERUP NATURE RESERVE
Perup Ecology Centre
R 30214
R 27925
R 10504
R 10391
R 35307
KULUNILUP NATURE RESERVE
WINGEBELLUP
UNICUP NATURE RESERVE
Unicup Lake
BOKARUP NATURE RESERVE
KODJINUP NATURE RESERVE
TONE PERUP NATURE RESERVE
COWERUP NATURE RESERVE
NOOBIJUP NATURE RESERVE
YARNUP NATURE RESERVE
QUINDINUP NATURE RESERVE
PINDICUP NATURE RESERVE
GALAMUP NR
COBERTUP NATURE RESERVE
PINTICUP NATURE RESERVE
LAKE MUIR NATURE RESERVE
LAKE MUIR NATIONAL PARK
Lake Muir
Lake Muir Observatory
LOT 6
LOT 3
LOT 12167
LOT 12646
LOT 12982
LOT 12983
LOT 1
LOT 2
LOT 4
LOT 5
BOYUP BROOK ROAD
KOJONUP ROAD
CRANBROOK ROAD
FRANKLAND ROAD
GRAPHITE ROAD
MUIRS HIGHWAY
SOUTH WESTERN HIGHWAY
BROCKMAN HIGHWAY
VASSE HIGHWAY
PEMBERTON NORTHCLIFFE ROAD
MIDDLETON ROAD
ROCKY GULLY ROAD
Blackwood River
Gnowergerup River
Donnelly River
Yerramimup River
Wilgarup River
Tone River
Perup River
Warren River
Frankland River
Kent River
N

Map 2. Vegetation of the Muir-Byenup Ramsar Wetland System




Map 3. Visitor Management Settings
LEGEND
Management Plan boundary
Muir-Byenup Ramsar Wetland boundary
Visitor Management Settings
Highly modified
Recreation
Natural - Recreation
Natural
0 2.5 5 10 15 20km
Scale
BRIDGETOWN
MANJIMUP
PEMBERTON
NORTHCLIFFE
FRANKLAND
ROCKY GULLY
Old Heartlea Settlement
Perup Forest Ecology Centre
Lake Unicup
Unicup Lake
Lake Muir Observatory
Lake Muir
SOUTH WESTERN HIGHWAY
BROCKMAN HIGHWAY
GRAPHITE ROAD
VASSE HIGHWAY
PEMBERTON NORTHCLIFFE ROAD
MIDDLETON ROAD
BOYUP BROOK
CRANBROOK ROAD
WINGEBELLUP ROAD
FRANKLAND CRANBROOK ROAD
FRANKLAND RD
FRANKLAND ROAD
KOJONUP ROAD
ROCKY GULLY FRANKLAND RD
MUIRS HIGHWAY
Gnowergerup River
Blackwood River
Donnelly River
Yerraminnup River
Wilgarrup River
Perup River
Tone River
Warren River
Frankland River
Kent River
N