Perup Forest
Lake Muir Nature Reserve
Unicup Nature Reserve

Draft Management Plan

1998

Department of Conservation and Land Management

National Parks and Nature Conservation Authority

Lands and Forest Commission

DRAFT MANAGEMENT PLAN

Perup Forest

and

Lake Muir/Unicup Nature Reserves

Department of Conservation and Land Management
for the
National Parks and Nature Conservation Authority
and the
Lands and Forest Commission
Perth, Western Australia, 1998

WHAT DO YOU THINK ?

We want to know what you think of the proposals in this draft management plan. Have you thought about writing a submission ?

WHY WRITE A SUBMISSION ?

It is an opportunity to provide information, express your opinion, suggest alternatives and have a say on how we are proposing to manage the Perup Forest and Lake Muir/Unicup Nature Reserves over the next 10 years.

If you prefer not to write your own submission you could make a joint submission with others.

WHAT MAKES AN EFFECTIVE SUBMISSION ?

To ensure your submission is as effective as possible:

- make it concise and clear.
- 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 objectives or recommendations within each subject or just those of specific interest to you; clearly state your reasons (particularly if you disagree) and give sources of information where possible.
- suggest alternatives to deal with any issue with which you may disagree.

It is important to indicate those strategies and recommendations you agree with as well as those with which you disagree.

Each submission is important in its own right but those that give reasons for concerns, give support where appropriate and offer information and constructive suggestions are most useful.

WHAT HAPPENS TO YOUR SUBMISSION ?

All submissions will be summarised according to the topics discussed. The draft management plan will then be reviewed in the light of submissions, according to established criteria (see over). An analysis of the submissions will be published, including an indication of whether the plan was or was not amended in response to the comments and justification for the decisions. All submissions are confidential. If you do not want your name appearing in the analysis of submissions please note this on your submission.

WHAT CRITERIA WILL BE USED IN ASSESSING YOUR SUBMISSION ?

1. The draft management plan *will* be amended if a submission:
   (a) provides additional resource 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 goals and objectives; or
   (e) indicates omissions, inaccuracies or a lack of clarity.

2. The draft management plan *will not* be amended if:
   (a) there is clear support for the draft proposals;
   (b) a neutral statement is offered or no change is sought;
   (c) the submission addresses issues beyond the scope of the plan;
   (d) the submission makes points which are already in the plan or were considered during plan preparation;
   (e) existing strategies and recommendations appear to be the most practical, where submissions are in conflict with others or where resources are limited;
   (f) the submission contributes options which are not feasible (generally due to conflict with existing legislation, or Government or departmental policy).

DEADLINE

Submissions are welcome for two months following the date of release of the plan. Please ring (09) 334 0594 or (097) 71 7988 for enquiries.

WHERE DO YOU SEND YOUR SUBMISSION ?

Written submissions should be sent to:

Executive Director
Department of Conservation and Land Management
P.O. Box 104
COMO W.A. 6152

Attn: Plan Coordinator
Perup Forest and Lake Muir/Unicup Nature Reserves Draft Management Plan

PREFACE

Management plans set out the strategies and guidelines for the management of an area for ten years. Plans are the responsibility of the Lands and Forest Commission (LFC) for State forest and timber reserves, and of the National Parks and Nature Conservation Authority (NPNCA) for nature reserves, national parks and conservation parks. The Department of Conservation and Land Management (CALM) prepares plans on behalf of these bodies. The LFC and NPNCA issue draft plans for public comment and provide final plans for the approval of the Minister for the Environment.

This area management plan is for the Perup Forest and for the Lake Muir/Unicup complex of Nature Reserves which include Bokarup, 'Cobertup', Cowerup, Galamup, Kodjinup, Kulunilup, Lake Muir, Mordalup, Noobijup, Pindicup, Pinticup, 'Quindinup', Unicup and Yarnup Nature Reserves. Perup Forest is currently State Forest but is in the process of being converted to a nature reserve to be vested in the NPNCA (see Section 3.1 Boundaries and Land Tenure). The reference to 'the reserves' in the draft management plan refers to the Perup Forest and the Lake Muir/Unicup complex of natures.

Changes of purpose to the reserves have been proposed in this draft management plan and these will have to be approved before recommendations depending on this change in status are able to be implemented.

According to the CALM Act (1984), management plans must contain:

- a statement of the policies or guidelines proposed to be followed; and
- a summary of operations proposed to be undertaken for a specified period not exceeding 10 years.

In accordance with Section 55 of the Act, the term of this plan will be 10 years but a review may take place within the term of the plan.

ACKNOWLEDGEMENTS

This plan was prepared by the Perup Forest and Lake Muir/Unicup Nature Reserves project team, comprising Aminya Ennis - Coordinator, Rod Simmonds - District Manager, Jim Lane - Principal Research Scientist, Dr Per Christensen - Senior Principal Research Scientist, and Ben Rose - Agriculture Western Australia. The contributions of John Lloyd, to the early drafts of the plan and Tania Jackson, in the finalising the draft are acknowledged.

Many people have provided valuable assistance in the preparation of this plan, particularly staff of:

- CALM's Southern Forest Region and Manjimup District,
  Land Information Section, Environmental Protection Branch, and Planning Section.
- Agriculture Western Australia (Manjimup); and
- the Water and Rivers Commission.

NOMENCLATURE

Inclusion of a name in this publication does not imply its approval by the relevant nomenclature authority.

CONTENTS

Following Page

MAPS

TABLES

INTRODUCTION

1.0 OVERVIEW

1.1 Brief Description

The Perup Forest and the Lake Muir/Unicup Nature Reserves are located near the south coast of Western Australia, about 65 km south-east of the town of Manjimup (see Map 1). The reserves are part of CALM's Manjimup District which is part of the Southern Forest Region. This plan complements the Southern Forest Region Regional Management Plan (CALM, 1987) and the Forest Management Plan 1994-2003.

The area experiences a moderate Mediterranean climate of warm, dry summers and cold, wet winters. Most of the average annual 700-900 mm of rain falls between May and August. Mean monthly maximum and minimum temperatures range from 26°C to 5°C.

The reserves contain a diversity of fauna species. Perup Forest is one of the most important reserves for mammals in Western Australia, containing three threatened species. The Lake Muir/Unicup wetlands are particularly important for waterbirds. Lake Muir is a major moulting area for thousands of Australian shelduck (*Tadorna tadornoides*) in spring and summer and is periodically a major drought refuge for waterfowl. The vegetated buffer around the wetlands is an important nesting and foraging habitat for birds such as the little bittern and the threatened Australasian bittern.

The vegetation of the reserves is a mosaic of Jarrah and marri forest, wandoo woodlands, paperbark low forest and rush swamps. Two species of declared rare flora occur in the Perup Forest and three species of declared rare flora occur in the Lake Muir/Unicup Nature Reserves.

The Lake Muir/Unicup Region is one of 13 inland natural wetland complexes in Western Australia. The system is unique in that it is the only wetland complex of its type in near pristine condition.

Peat deposits underlie many of the Lake Muir/Unicup wetlands. Peat swamps are rare in Australia and in particular Western Australia and they, and the flora and fauna they support, are of special value for scientific research. The Lake Muir/Unicup peat wetlands are an important representative of a rare habitat.

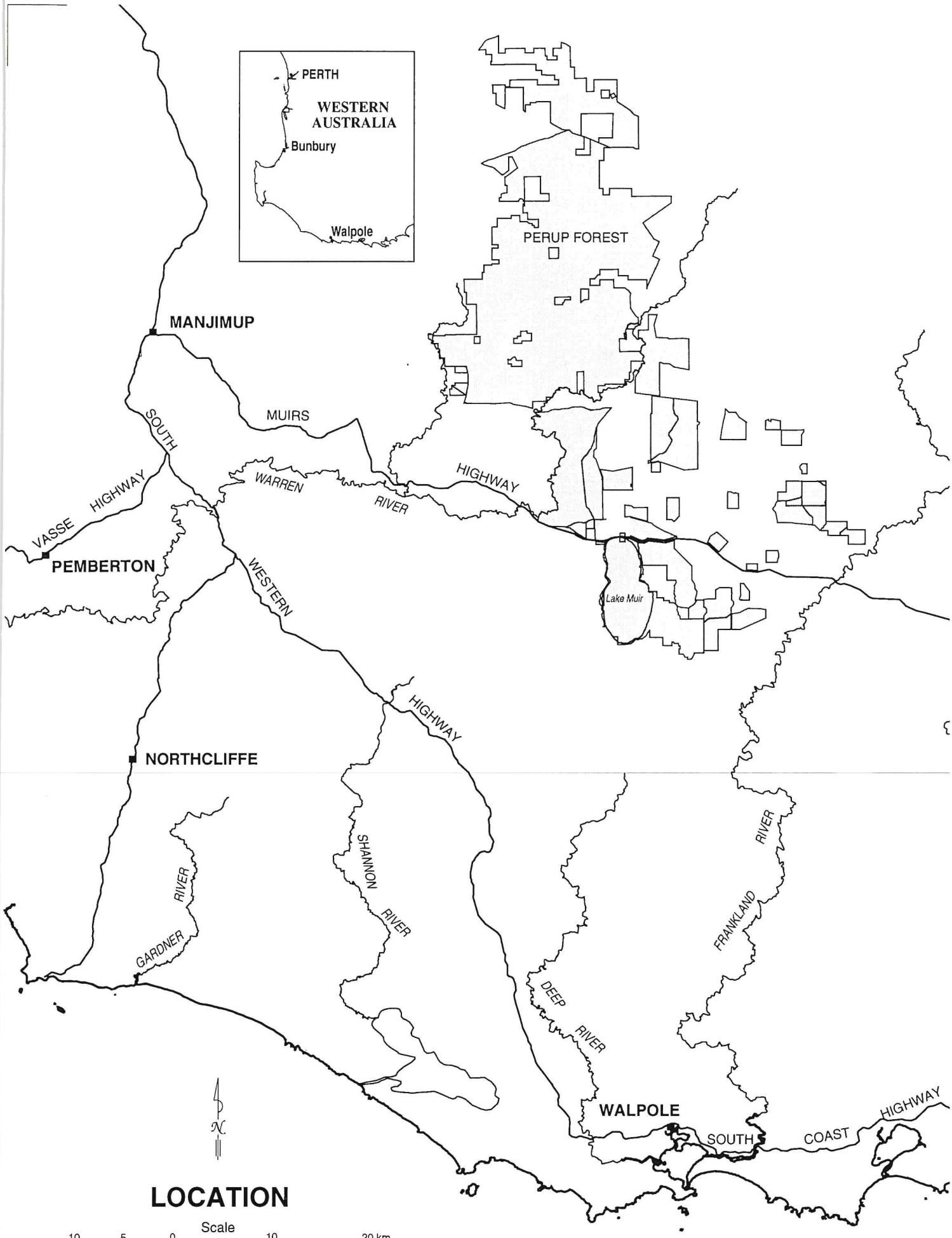
The reserves have important scientific and educational values. Perup Forest has potential for nature based tourism based at the Perup Forest Ecology Centre. The location of the Ecology Centre provides a unique opportunity to view some of Australia's rarest animals in their natural habitat and provides a base for interpretive and wilderness experiences in the forest. The extensive wetlands, waterbirds, and hydrology of the area also provide opportunities for public education.

The Perup Ecology Centre provides an ideal base for research into the relationships between fire, vegetation and fauna. The complex hydrology of the Lake Muir/Unicup Nature Reserves, threats from salinisation and rising watertables, rare peat swamps and important habitats for waterbirds all provide opportunities for important research.

The major threats to the wetland ecosystems of the reserves are rising watertables and increased run-off and salt loads resulting from clearing in the catchments. This management plan proposes strategies to ensure the reserves' values are protected and maintained. As a result of their high nature conservation values, the Lake Muir/Unicup wetlands have been identified as a high priority area for action in the catchment under the Western Australian (WA) Government's Salinity Action Plan (1996).

1.2 Primary Values

- Perup Forest contains three threatened mammal species.
- The Lake Muir/Unicup wetlands are important for waterbirds such as the little bittern and the threatened Australasian bittern.
- Perup Forest contains two species of declared rare flora and the Lake Muir/Unicup Reserves contain three species of declared rare flora.
- The Lake Muir/Unicup wetlands system is one of few wetlands in the State in a near natural condition.
- The Lake Muir/Unicup Reserves contain rare peat swamps.
- The reserves have important educational values such as the potential for nature-based tourism based at the Perup Ecology Centre.
- The reserves have important scientific values.


PERTH
WESTERN AUSTRALIA
Bunbury
Walpole
PERUP FOREST
MANJIMUP
SOUTH
MUIRS
HIGHWAY
WARREN
RIVER
HIGHWAY
VASSE
HIGHWAY
PEMBERTON
WESTERN
Lake Muir
HIGHWAY
NORTHCLIFFE
RIVER
GARDNER
SHANNON
RIVER
RIVER
FRANKLAND
DEEP
RIVER
WALPOLE
SOUTH
COAST
HIGHWAY
N
LOCATION
Scale
10 5 0 10 20 km
Study area of Management Plan
SOUTHERN OCEAN

Map 1

1.3 Official Recognition

In addition to their reservation under Western Australian legislation, the importance of the Perup Forest and Lake Muir/Unicup Nature Reserves has also been recognised in other ways.

Register of the National Estate

Perup Forest and Lake Muir and 'Quindinup' Nature Reserves are listed on the Register of the National Estate in recognition of their significance for conservation. Perup Forest is listed for its importance for threatened fauna and undisturbed vegetation communities and its importance as a research, teaching or reference site. It is also listed for exhibiting an unusual richness of fauna and providing habitat for certain faunal processes, including the potential for the conservation of viable populations of rare and restricted species. Lake Muir Nature Reserve is listed for its importance for rare, endangered or uncommon flora, undisturbed vegetation and wetland systems, and the high aesthetic value of its wetlands. Quindinup Nature Reserve is listed for its important remnant forest habitats within a large tract of cleared agricultural land and for important undisturbed vegetation communities.

Wetlands of National Significance

Lake Muir and the Byenup Lagoon System are included in the Directory of Important Wetlands in Australia (ANCA, 1996). The lakes were included in the Directory on the basis of representativeness or rarity of wetland type, special ecological/hydrological values, rarity of species and communities, and recognised scientific values.

Ramsar Listing

The Lake Muir/Unicup wetlands also meet a number of the criteria specified for listing as Wetlands of International Importance under the Ramsar Convention. The Ramsar Convention is an intergovernmental treaty which provides the framework for international cooperation for the conservation of wetland habitats. The wetlands were considered in 1989 for possible inclusion on the List of Wetlands of International Importance but were not nominated for the List due to the proposal for peat mining in the wetlands. The mining tenements over the wetlands have since been cancelled. The Government is now giving consideration to the nomination of the Lake Muir complex under the Ramsar Convention.

Salinity Action Plan

The Lake Muir/Unicup wetlands have been identified as a high priority area for attention under the WA Governments Salinity Action Plan.

1.4 Public Participation

Public participation in the preparation of this management plan has been extensive and included seeking pre-draft submissions, holding a public workshop and arranging meetings with individuals and groups.

Pre-draft Submissions

Three submissions were received after a call for comment was advertised in local and Statewide newspapers, and after a pamphlet was circulated to the community, organisations and other Government departments announcing preparation of the management plan.

Workshop

CALM held a workshop in June 1995 at the Perup Ecology Centre as part of the program to involve the community in preparing the draft management plan. Organisations and individuals involved or interested in the reserves attended.

Meetings

A number of meetings were held with interested groups and individuals, including local landholders, Agriculture Western Australia, the Ministry for Planning, and the Water and Rivers Commission.

PRINCIPAL MANAGEMENT DIRECTIONS

2.0 MANAGEMENT GOALS AND OBJECTIVES

2.1 Primary Objectives

CALM's primary objective in managing nature reserves, as defined in Section 56 of the CALM Act (1984), is to:

> maintain and restore the natural environment, and to protect, care for, and promote the study of indigenous flora and fauna, and to preserve any feature of archaeological, historic or scientific interest.

Perup Forest and the Lake Muir/Unicup complex of nature reserves will be managed with this primary objective. Other more specific objectives are detailed in individual sections of this plan.

In the case of conservation parks, the primary objective is to:

> fulfil so much of the demand for recreation by members of the public as is consistent with the proper maintenance and restoration of the natural environment, the protection of indigenous flora and fauna, and the preservation of any feature of archaeological, historic or scientific interest.

The proposed area of conservation park at Unicup Lake (see Section 3.1 Boundaries and Land Tenure) will be managed with this primary objective. Other more specific objectives are detailed in individual sections of this plan.

2.2 NPNCA and CALM Management Policies

This draft management plan is based on current National Parks and Nature Conservation Authority (NPNCA) and Department of Conservation and Land Management (CALM) policies. These policies are derived from legislation, principally the CALM Act (1984), and associated regulations. Policies are published and distributed throughout CALM as policy statements and are available to the public on request.

2.3 Management Goals

The statement of mission adopted in CALM's Strategic Plan is:

TO CONSERVE WESTERN AUSTRALIA'S WILDLIFE AND MANAGE LANDS AND WATERS ENTRUSTED TO THE DEPARTMENT FOR THE BENEFIT OF PRESENT AND FUTURE GENERATIONS.

CALM's management goals and objectives for the Perup Forest and the Lake Muir/Unicup complex of nature reserves, consistent with CALM's mission statement, are:

Conservation

- Conserve biological, physical, cultural and landscape resources, particularly the primary values of the reserves as identified in Section 1.2 Primary Values.

Recreation and Tourism

- Facilitate recreation and tourism in a manner compatible with conservation and other goals.

Community Relations

- Promote informed appreciation of the area's natural and cultural values, and facilitate integrated catchment management by the community to protect these values.

Commercial and Other Uses

- Manage commercial and other uses in a manner that minimises impact on other values.

Knowledge

- Seek a better understanding of the natural and cultural environments, and the impacts of visitor use and management activities.

2.4 Key Issues for Future Management

All issues relevant to management of the reserves are considered in this draft management plan, however, the following are considered to be key issues (which are not in order of priority).

- Catchment management - salinity, drainage and rehabilitation
- Fire protection
- *Phytophthora* dieback
- Weeds and feral animals, particularly pigs and foxes
- Adjacent land use
- Threatened fauna and flora
- Use of the reserves.

3.0 LAND TENURE

3.1 Boundaries and Land Tenure

The objective is to ensure that the gazetted purpose, vesting and tenure of the reserves reflect their values and use.

Bokarup Nature Reserve
Bokarup Nature Reserve comprises Reserve No. 14739 which was gazetted in 1913 as a 'C' class reserve for the purpose of 'Water'. The Reserve is now gazetted as an 'A' class reserve for the purpose of 'Water and Conservation of Flora and Fauna'. It has an area of 146.1 ha and is vested in the NPNCA.

'Cobertup' Nature Reserve
'Cobertup' Nature Reserve comprises Reserve No. 26681 which was gazetted in 1963 for the purpose of 'Conservation of Flora and Fauna'. The Reserve is now gazetted as an 'A' class reserve for the purpose of 'Water and Conservation of Flora and Fauna'. It has an area of 151 ha and is vested in the NPNCA. The name of the reserve is not yet gazetted but this is proposed in the plan.

Cowerup Nature Reserve
Cowerup Nature Reserve comprises Reserve No. 33455 which was gazetted in 1975 as a 'C' class reserve for the purpose of 'Conservation of Flora and Fauna'. It has an area of 270.5 ha and is vested in the NPNCA.

It is proposed that Cowerup Nature Reserve be upgraded from 'C' to 'A' class nature reserve.

Galamup Nature Reserve
Galamup Nature Reserve comprises Reserve No. 6549 which was gazetted in 1899 as a 'C' class reserve for the purpose of 'Water'. The Reserve is now gazetted as an 'A' class reserve for the purpose of 'Conservation of Flora and Fauna'. It has an area of 221.8 ha and is vested in the NPNCA.

Kodjinup Nature Reserve
Kodjinup Nature Reserve comprises Reserve No. 26678 which was gazetted in 1963 for the purpose of 'Conservation of Flora and Fauna'. The Reserve is now gazetted as an 'A' class reserve for the purpose of 'Water and Conservation of Flora and Fauna'. It has an area of 626 ha and is vested in the NPNCA.

Kulunilup Nature Reserve
Kulunilup Nature Reserve comprises Reserve No. 26677 which was gazetted in 1963 for the purpose of 'Conservation of Flora and Fauna'. The Reserve is now gazetted as an 'A' class reserve for the purpose of 'Water and Conservation of Flora and Fauna'. It has an area of 612 ha and is vested in the NPNCA.

Lake Muir Nature Reserve
Lake Muir Nature Reserve comprises Reserve No. 31880 which was gazetted in 1974 as a 'C' class reserve for the purpose of 'Conservation of Flora and Fauna'. The Reserve is now gazetted as an 'A' class reserve for the purpose of 'Water and Conservation of Flora and Fauna'. It has an area of 11 310.8 ha and is vested in the NPNCA.

Mordalup Nature Reserve
Mordalup Nature Reserve comprises Reserve No. 30018 which was gazetted in 1969 as a 'C' class reserve for the purpose of 'Conservation of Flora and Fauna'. The Reserve is now gazetted as an 'A' class reserve for the purpose of 'Conservation of Flora and Fauna'. It has an area of 42.5 ha and is vested in the NPNCA.

Noobijup Nature Reserve
Noobijup Nature Reserve comprises Reserve No. 26680 which was gazetted in 1963 for the purpose of 'Conservation of Flora and Fauna'. The Reserve is now gazetted as an 'A' class reserve for the purpose of 'Water and Conservation of Flora and Fauna'. It has an area of 183.1 ha and is vested in the NPNCA.

Pindicup Nature Reserve
Pindicup Nature Reserve comprises Reserve No. 26679 which was gazetted in 1963 for the purpose of 'Conservation of Flora and Fauna'. The Reserve is now gazetted as an 'A' class reserve for the purpose of 'Water and Conservation of Flora and Fauna'. It has an area of 281 ha and is vested in the NPNCA.

Pinticup Nature Reserve
Pinticup Nature Reserve comprises Reserve No. 26682 which was gazetted in 1963 for the purpose of 'Conservation of Flora and Fauna'. The Reserve is now gazetted as an 'A' class reserve for the purpose of 'Water and Conservation of Flora and Fauna'. It has an area of 75.5 ha and is vested in the NPNCA.

'Quindinup' Nature Reserve
'Quindinup' Nature Reserve comprises Reserve No. 25506 which was gazetted in 1960 for the purpose of 'Timber Settlers Requirements'. The Reserve is now gazetted as a 'C' class reserve for the purpose of 'Conservation of Flora and Fauna'. It has an area of 2 653 ha and is vested in the NPNCA. The name of the reserve is not gazetted.

It is proposed that Quindinup Nature Reserve be upgraded from 'C' class to 'A' class nature reserve and that the name of the reserve be gazetted.

Unicup Nature Reserve
Unicup Nature Reserve comprises Reserve No. 25798 which was gazetted in 1960 as an 'A' class reserve for the purpose of 'Conservation of Flora and Fauna'. It has an area of 3 296 ha and is vested in the NPNCA.

Waterskiing occurs on Unicup Lake within the nature reserve. A day use recreation site, associated with use of the lake for waterskiing, is located on the north west bank of the lake. Under the current tenure of Unicup Lake, waterskiing is not consistent with the reserve's purpose.

It is proposed that an area of Unicup Lake be changed to a Conservation Park and its status remain as 'A' class vested in the NPNCA. The remaining area of the reserve will stay as nature reserve. This proposed tenure change allows for waterskiing in a gazetted area in the Conservation Park and for associated recreational use while still protecting conservation values.

Yarnup Nature Reserve
Yarnup Nature Reserve comprises Reserve No. 29601 which was gazetted in 1969 for the purpose of 'Conservation of Flora and Fauna'. The Reserve is now gazetted as an 'A' class reserve for the purpose of 'Water and Conservation of Flora and Fauna. It has an area of 61.6 ha and is vested in the NPNCA.

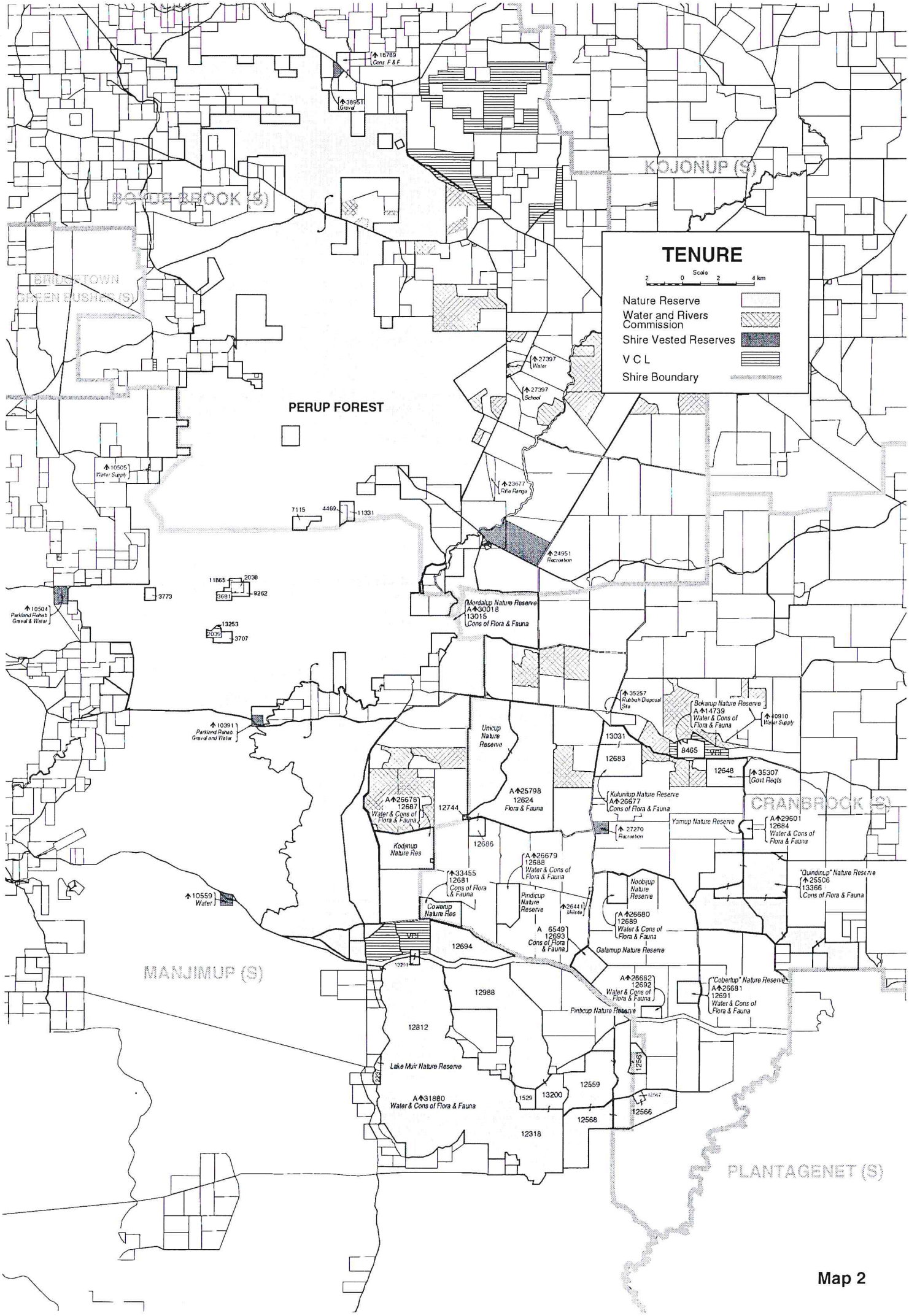
Perup Forest
Perup Forest is currently State forest vested in the LFC but is in the process of being converted to a nature reserve to be vested in the NPNCA. Parliament gave its approval in April 1994 for 32 863 hectares to be excised from the State forest estate to allow the creation of a nature reserve under the Land Act. The latter task is currently with the Department of Land Administration, with roading issues to be resolved amongst others, before reservation can be completed.

The General Working Plan for State forests in Western Australia (working plan No. 87, 1982) produced by the then Forests Department indicated the Perup Forest area to be a management priority area for 'flora, fauna and landscape' and 'catchment protection'.

This management emphasis, which caused the area to be managed as if it were a conservation reserve from 1972, was reflected in the Southern Forest Region Management Plan 1987-1997. The Plan indicated the Perup State forest should be converted to a nature reserve to be vested in the NPNCA. Management which was by then the responsibility of CALM continued to be as if the area was already a conservation reserve.

The 1987 plan was revised by way of the Forest Management Plan 1994-2003 which re-affirmed the intention to convert the Perup State forest area to a nature reserve. This management plan and the Government Gazette notice of 22 March 1994 met the requirements of section 9(2)(b) and 60(3)(a) of the CALM Act 1984 with regard to a proposal to amend the purpose of State forest.

The area of State forest agreed to be cancelled by Parliament to form the basis of Perup Nature Reserve has been separated from the remainder of State forest No. 37 and 38 by way of the 1994 plan and the 22 March 1994 State forest purposes Gazette notice.


TENURE
Scale
2 0 2 4 km
Nature Reserve
Water and Rivers Commission
Shire Vested Reserves
V C L
Shire Boundary
KOJONUP (S)
BOYUP BROOK (S)
BRIDGETOWN
GREEN BUSHES (S)
MANJIMUP (S)
CRANBROOK (S)
PLANTAGENET (S)
PERUP FOREST
Mondalup Nature Reserve
A 30018
13015
Cons of Flora & Fauna
Unicup Nature Reserve
A 25798
12624
Flora & Fauna
Bokarup Nature Reserve
A 14739
Water & Cons of Flora & Fauna
Kulunilup Nature Reserve
A 26677
Cons of Flora & Fauna
Yamup Nature Reserve
A 29601
12684
Water & Cons of Flora & Fauna
"Quindinup" Nature Reserve
25506
13366
Cons of Flora & Fauna
A 26678
12687
Water & Cons of Flora & Fauna
Kodjinup Nature Res
A 26679
12688
Water & Cons of Flora & Fauna
33455
12681
Cons of Flora & Fauna
Pindicup Nature Reserve
Cowerup Nature Res
Noobijup Nature Reserve
A 26680
12689
Water & Cons of Flora & Fauna
A 6549
12693
Cons of Flora & Fauna
Galamup Nature Reserve
A 26682
12692
Water & Cons of Flora & Fauna
"Cobertup" Nature Reserve
A 26681
12691
Water & Cons of Flora & Fauna
Pinbcup Nature Reserve
Lake Muir Nature Reserve
A 31880
Water & Cons of Flora & Fauna
Parkland Rehab Gravel & Water
Water Supply
Rifle Range
Recreation
Rubbish Disposal Site
Govt Reqts
Water
School
Gravel
Cons F & F
12744
12686
12694
12988
12812
12318
12559
12568
12566
13200
1529
8465
12648
13031
12683
2039
3707
3681
9262
3773
7115
4469
11331

Map 2

Table 1
PROPOSED CHANGES TO CURRENT STATUS OF NATURE RESERVES

Land/Reserve	Area (ha)	Proposed Actions
Reserve No. 26681 Cobertup Nature Reserve	151	Gazette the name of the reserve.
Reserve No. 33455 Cowerup Nature Reserve	270.5	Upgrade to 'A' class nature reserve.
Reserve No. 25506 Quindinup Nature Reserve	2 653	Upgrade to 'A' class nature reserve and gazette the name of the reserve.
Reserve No. 25798 Unicup Nature Reserve	3 296	Change an area of the reserve (Unicup Lake) to 'A' class Conservation Park.

RECOMMENDATION

1. Implement the changes to tenure and nomenclature proposed in Table 1.

3.2 Surrounding Land

The objectives are to:

- *seek to incorporate appropriate lands within the reserves.*
- *encourage owners of nearby lands to manage their properties in a way that is sympathetic with management of the reserves.*

Various land tenures surround the reserves, including private property, leasehold land, vacant Crown land and other reserves (see Map 2). The management objectives for the reserves cannot be achieved in isolation. There must be complementary management of these surrounding areas. Catchment, disease and fire management, in particular must be approached from the broader perspective in order to achieve specific protection objectives for the reserves. Ongoing liaison with neighbouring land managers and responsible agencies is essential for implementing mutually beneficial management arrangements. Of particular importance are:

- neighbouring landowners;
- Shires of Boyup Brook, Cranbrook and Manjimup;
- Water and Rivers Commission;
- Agriculture Western Australia;
- Bush Fires Board; and
- Main Roads Western Australia.

In order to maximise the reserves' protection, rationalise their administration and management, particularly through boundary changes, and minimise future land conflicts, it may be appropriate to investigate reserve excisions or additions (eg. an excision from the reserves for a land exchange which is beneficial to the reserve system). Table 2 includes a summary of tenure proposals outlined below.

- Vacant Crown land (VCL) to the north of Lake Muir is currently leased for the mining of peat. Red and Cowerup Lakes, located within the area, are used by waterbirds and would provide a significant link between Lake Muir Nature Reserve and Perup Forest. The mining leases expire in 2003 and 2004. The area should be vested in the NPNCA as 'A' class nature reserve on expiration of the leases.

- The Regional Management Plan for the Southern Forest Region (CALM, 1987) proposes that an area of VCL surrounding Bokarup Nature Reserve be vested in the NPNCA as part of the 'A' class Bokarup Nature Reserve.

- The Regional Management Plan for the Southern Forest Region (CALM, 1987) proposes that Reserve No. 35307 (Government Requirements), 324.2 ha, be vested in the NPNCA as 'A' class nature reserve.

During the term of this plan other areas may become available as suitable additions to, or excisions from, the reserves. Proposed additions may be sought through vesting of public lands in the NPNCA, normal real estate transactions in the case of private property, or by other appropriate means. Their conservation values will be assessed as they become available. Excisions from the reserves will be assessed on their merits.

Table 2
CROWN RESERVES FOR POSSIBLE INCLUSION IN THE RESERVES

Land/Reserve	**Area (ha)**	**Proposed Actions**
VCL - Red and Cowerup Lakes (mining leases)	-	Vest in NPNCA as 'A' class nature reserve on expiration of the mining leases.
VCL - Bokarup	-	Incorporate into Reserve No. 14739 Bokarup Nature Reserve as proposed in the Regional Management Plan for the Southern Forest Region.
Reserve No. 35307 Government Requirements	324.2	Amend to 'A' class nature reserve vested in NPNCA as proposed in the Regional Management plan for the Southern Forest Region.

RECOMMENDATIONS

1. **Implement the proposed actions detailed in Table 2.**

2. **Incorporate where appropriate other adjoining land, such as Water and Rivers Commission land, if identified as having high conservation significance.**

3. **Continue liaison with reserve neighbours to establish cooperative management, particularly in regard to catchment, fire and dieback management, control of introduced animals and landscape management.**

MANAGEMENT FOR CONSERVATION

4.0 GEOLOGY, GEOMORPHOLOGY AND HYDROLOGY

The objective is to protect and conserve the geological and hydrogeological features, landforms and soils.

Climate

The reserves experience a Mediterranean climate, with winter rainfall and summer drought. The area experiences a strong gradient in rainfall variation from south to north, with 900 mm annual rainfall occurring to the south of Lake Muir, and 700 mm annual rainfall occurring to the north of Lake Unicup. The annual evaporation is about 1600 mm, with a less marked gradient than rainfall. In terms of climate, the southern parts of the area may be classed as humid, while the northern parts are subhumid, grading into semi-arid climates further north.

The combined effects of abundant rainfall, the north-south gradient of increasing rainfall, and the degree of evaporation in the Lake Muir/Unicup area are as follows:

- generally the wetlands are freshwater systems;
- large water bodies perched above relatively impermeable layers are subject to evaporation and hence increase in salinity to become point sources of saline water;
- rainfall decreases from south to north resulting in a general increase of salt in groundwater regionally;
- the gradient in increase of salt in groundwater regionally means that river headwaters in the region are draining into saltier terrains and groundwaters as they incise further and further to the north (V and C Semeniuk Research Group, 1996, unpublished).

Geology

The geology of the region is described within a framework of two main units:

- the Precambrian rocks which underlie all the area; and
- the Cenozoic regolith materials.

The Western Australian Precambrian Shield in this part of Australia is comprised of the ancient Archaean Yilgarn Craton (formerly referred to as the Yilgarn Block), composed mainly of granitic rocks and gneisses (3340-2420 million years in age), and the relatively younger Proterozoic rocks of the Albany-Fraser Orogen, composed of a variety of metamorphic rocks, granites, and gneisses (*circa* 2200-1800 million years in age). The boundary between the two is located on the Manjimup Lineament to the east. The Perup Forest is in the area of the Yilgarn Craton and the Lake Muir/Unicup Nature Reserves are located within the terrain of the Albany-Fraser Province.

There are two aspects of the Precambrian geology that have direct and indirect influence on the geomorphology and hydrology of the wetlands. These are:

- the deep weathering of Precambrian rock to yield saprolite that acts to perch water; and
- the Manjimup and Pemberton Lineaments, which may have influenced the development and location of the upwarp flexure termed the Jarrahwood Axis, formed when Australia rifted from Antarctica.

Cenozoic materials are of Tertiary, Pleistocene and Holocene age, and constitute the regolith (weathered materials and sedimentary cover over the Precambrian bedrock).

The most important materials that help control the disposition of landforms and wetlands are laterite, which forms a hill-capping resistant sheet of hard duricrust, and saprolite, which is instrumental in the local perching of groundwater in the region. All other Cenozoic materials are generally of a passive-fill nature, and lie low in the landscape (V and C Semeniuk Research Group, 1996, unpublished).

Geomorphology

At a regional scale, the area has been subdivided into two main geomorphic units (Wilde and Walker, 1984; Fairbridge and Finkl, 1979):

- the Darling Plateau, a region of relatively high plateau more than 300 m above MSL, and underlain by the Archaean Yilgarn Craton; and
- the Ravensthorpe Ramp, a region of terrain inclination towards the coast, 200 m or less in height, and underlain by the rocks of the Proterozoic Albany-Fraser Province.

Perup Forest is located partly within the Darling Plateau and partly within the Ravensthorpe Ramp, and the Lake Muir/Unicup wetlands are located within the Ravensthorpe Ramp.

Perup Forest is largely a simple system of dissected plateau, consisting of plateau tops, creek valleys and river courses. Within this system there is a "High Plateau" and a system of "Young Rivers". The lowlands of the Lake Muir/Unicup Nature Reserves are more complicated in that there are two excavation basins in addition to units of High Plateau and Young Rivers.

The main regional geomorphic units in the area are:
- the High Plateau;
- the Old Basin;
- the Young Basin; and
- the Young Rivers.

The High Plateau is the undulating landscape, with relatively low internal relief of around 20 m, composed of plains, shallow drainage lines, interconnected basins and drainage lines, and scattered circular wetlands. In the area of the reserves the High Plateau is underlain by saprolite, or a sheet of laterite, or yellow aeolian sand. The High Plateau has been formed by prolonged fluvial erosion, where the terrain has become subdued, the watersheds vague, and the fluvial courses shallow and broad. Slow drainage rates and local ponding resulted in the development of basin wetlands within the broad/shallow valley tract, and under former arid to semi-arid climatic conditions, results in the formation of isolated, round, beachridge-ringed wetlands.

The Old Basin is the older of two such excavation structures. The location and form of the Old Basin corresponds to the Tertiary Alluvial Flats of Wilde and Walker (1984). The Old Basin is located at *circa* 180-200 m AHD, and is bordered peripherally by the High Plateau. The terrain of the Old Basin is relatively flat, though there are local hills of bedrock protruding. The terrain is underlain mainly by saprolite, and some quartz sand reworked from the excavation margins. The margins of the High Plateau are incised by consequent streams that cut back into the High Plateau.

The Old Basin was formed by Tertiary age arid zone aeolian and salt-flat weathering driven by near-watertable conditions, leading to the excavation of a basin into the High Plateau. Once the basin was excavated, its margins have undergone consequent stream erosion (incising into the High Plateau), and later partial fill by aeolian and fluvial sediment from the margins.

The Young Basin is the younger of two such excavation structures. The Young Basin is oval with its margins moderately modified on its southern shore by consequent drainage. The location and form of the Young Basin corresponds to Lake Muir. The Young Basin is located at *circa* 160 m AHD, and is bordered peripherally to the west by the High Plateau, and on all other sides by the Old Basin. The floor of the Young Basin is flat and its margins are commonly cliffed. The southern margin of the Young Basin is incised by consequent streams that cut back into the High Plateau.

The Young Basin was formed by Quaternary age arid zone aeolian and salt-flat-weathering driven by near-watertable conditions, leading to the excavation of a basin into the Old Basin and the High Plateau. Since the Young Basin is a relatively recent excavation, its margins have not undergone extensive consequent stream erosion, nor fill by aeolian and fluvial sediment.

The Young Rivers are the incised drainage lines that are cutting into all the other units. The Young Rivers have weakly meandering to straight main channels with dendritic tributary channels. The main channels are incised into the High Plateau. The sediments within the main channels are sands and muds. The tributaries are broad and shallow, varying to steeply incised channels that cut into a variety of materials at their headwaters. The sediments within the tributaries are veneers of sand and mud.

The Young Rivers are drainage lines cut into the Ravensthorpe Ramp, and formed subsequent to the formation of the Ramp. The ongoing headwater erosion of these rivers has cut and is cutting into the terrain of the High Plateau, Old Basin and Young Basin (V and C Semeniuk Research Group, 1996).

Hydrology

Groundwater in the Lake Muir/Unicup area occurs within four aquifer systems;

1. saturated horizons within the totally weathered rock or lateritic profile; primarily the saprock (decomposed bedrock) horizon overlying the crystalline basement;
2. Saturated open fractures and joints (fractured rock aquifers) within the crystalline basement;
3. Saturated Tertiary sediments; and
4. Perched groundwater (perched aquifers).

The most important feature of the groundwater system in the Lake Muir/Unicup area is the presence of sand aquifers of Tertiary age. The goundwater flow regimes of these aquifers are controlling factors in the hydrology of the lake systems.

The Tertiary sediments occur in broad valleys, structurally controlled by major northwest-southeast trending faults, between granite outcrops. Drilling has shown that these sediments, consisting of sand, clay and carbonaceous clay, extend up to a depth of 50 m. Groundwater is present within saturated sand beds which are semi-confined, depending on the presence of thick clay layers. The salinity of groundwater in these aquifers usually varies from 3,600 mg/L to 16,000 mg/L. However locally, for example just north of the Muir Highway, groundwater is fresh (270 mg/L) and bore yeilds are sufficient for irrigation.

In the fractured and totally weathered rock aquifers, the occurrence of groundwater is mainly dependant on the permeability of the weathered profile and intensity and openness of fractures within the moderately weathered

basement. Granite, the major rock type in the study area, tends to weather into a sand rich profile conducive to the development of aquifers within the totally weathered rock or lateritic profile. Both fractured rock and totally weathered rock aquifers are generally unconfined to semiconfined. Groundwater salinity is generally high, ranging from 3,000 mg/L to 6,000 mg/L, with fresh groundwater primarily located in recharge areas situated in the upper portions of the catchment. Groundwater in valleys and depressions underlain by shallow basement rocks tends to be more saline. Groundwater salinity distribution is governed by the ratio of ranfall/evaporation, depth to water level and groundwater flow patterns.

Perched aquifers are a good source of fresh groundwater. This groundwater generally occurs within saturated sand layers, of eolian and fluvial origin, which overlie impermeable clay derived from weathering the crystalline basement.

RECOMMENDATIONS

1. **Consider the vulnerability of geological and hydrogeological features, landforms, soils and surface water movement in all management operations, such as new access, firebreaks and site developments.**

2. **Encourage and facilitate further hydrogeological and landform studies in the catchments to map and describe features affecting ground and surface hydrology.**

5.0 WETLANDS, CATCHMENTS AND DRAINAGE

The objectives are to:

- *Maintain and restore as appropriate the natural hydrological regimes, water quality and groundwater levels of the reserve wetlands.*
- *Prevent and reverse groundwater rise and salinisation of the reserves.*
- *Protect and conserve the quality and quantity of surface water and groundwater in reserves where these are unchanged.*

Wetlands, Rivers and Streams

The Lake Muir/Unicup complex of reserves is surrounded by the Tone, Deep and Frankland Rivers. Perup Forest lies within the headwaters of the Perup and Tone Rivers, tributaries of the Warren River (see Map 3).

There are 20 named wetlands in the area as well as many unnamed permanent and ephemeral wetlands. The wetlands occurring in the area are described in two settings: that of the Perup Forest, set mainly in the High Plateau, and that of the Lake Muir Lowlands.

Wetlands in the Perup Forest are mainly creeks, with some associated basin wetlands. Wetlands occurring in the lowlands of the Lake Muir/Unicup area vary from true lakes, through to sumplands and damplands, some creeks, and palusplains and floodplains

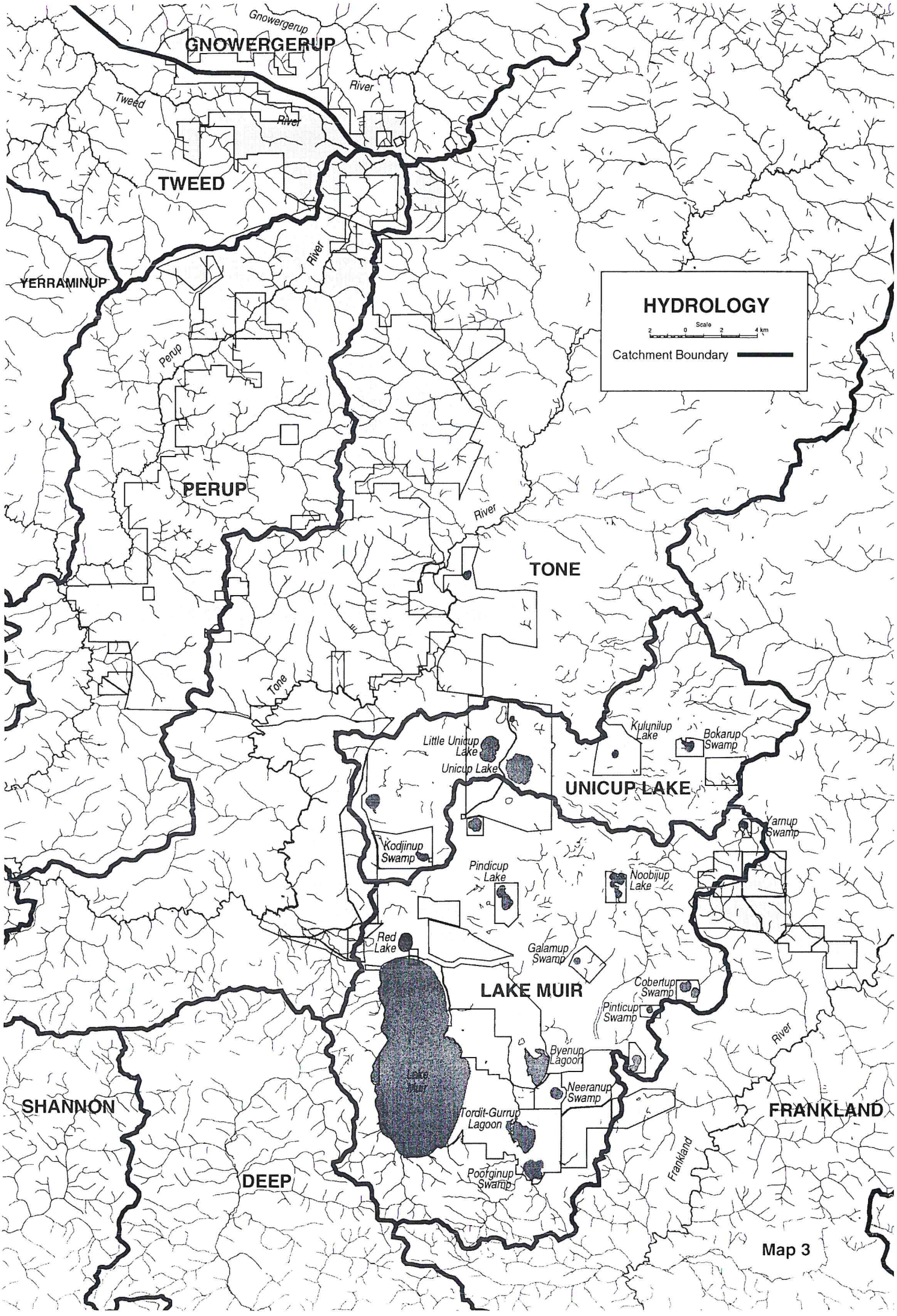
The wetlands of the Lake Muir area are basins or flats. Basins are oval to round to irregular depending on setting. Basins within the Old Basin are filled with peat, clay or sand. Their salinity is variable from fresh to saline, and their water maintenance is also variable. The wetland within the Young Basin is Lake Muir. This wetland is at present a sumpland and is naturally saline (brackish) (V and C Semeniuk Research Group, 1996, unpublished). Most of the lakes have partly cleared catchments. The wetlands have buffering vegetation of varying width.

Lake Muir and the Byenup Lagoon System are included in the Directory of Important Wetlands in Australia (ANCA, 1996). These wetlands include Lake Muir, Byenup Lagoon, Kulunilup Lake, Bokarup Swamp, Little Unicup Lake, Unicup Lake, Yarnup Lake, Kodjinup Swamp, Noobijup Lake, Pindicup Lake, Galamup Swamp, Cobertup Swamp, Pinticup Swamp, Neeranup Swamp, Wimbalup Swamp, Tordit-Gurrup Lagoon and Poorginup Swamp. These lakes were included in the Directory on the basis of representativeness or rarity of wetland type, special ecological/hydrological values, rarity of species and communities, and recognised scientific values.

Peat deposits underlie many of the Lake Muir/Unicup wetlands. Peat swamps are rare in Australia and in particular Western Australia. Peat provides a very effective filter and buffering capacity, and the area and volume of peat has a strong influence on water quality (EPA, 1990). Peat also provides an important habitat for flora and fauna. In drier times the peat is still wet and provides moist conditions for invertebrates and stands of sedges.

Surface Water Quality

CALM has been recording the depth, salinity, pH and total phosphorus for the Muir, Byenup, Tordit-Gurrup, Poorginup, Unicup, Yarnup and Red Lake wetlands for varying periods since the late 1970's. The Mordalup Lakes and Kodjinup Swamp have been monitored by Agriculture Western Australia since 1991. The salinity of the wetlands increases seasonally during summer as the depth decreases due to evaporation. This cycle is most noticeable in Lake Muir which dries


Gnowergerup
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Tweed
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TWEED
River
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2 0 2 4 km
Catchment Boundary
Perup
PERUP
River
TONE
Tone
Little Unicup Lake
Unicup Lake
Kulunilup Lake
Bokarup Swamp
UNICUP LAKE
Yarnup Swamp
Kodjinup Swamp
Pindicup Lake
Noobijup Lake
Red Lake
Galamup Swamp
LAKE MUIR
Cobertup Swamp
Pinticup Swamp
River
Byenup Lagoon
Lake Muir
Neeranup Swamp
SHANNON
Tordit-Gurrup Lagoon
FRANKLAND
Poorginup Swamp
DEEP
Frankland
Map 3

to a salt pan by April-May in most years. Unicup, Red and Poorginup Lake dry up in low rainfall years.

Threats to the Wetlands

The major threats to the wetland ecosystems are rising watertables and increased run-off and salt loads resulting from clearing in the catchments. Salinity and waterlogging are removing land from agricultural production and beginning to impact on upstream components of the wetland ecosystems. Any alteration of water regimes in a wetland can have effects on the wetland in that water has a different longevity within the system, and may be subject to different amounts of evapo-transpiration.

The natural hydrology and salinity of the individual wetlands in the area vary and management strategies need to consider these differences. The mechanism of potential salinisation and alteration of water regimes needs to be identified for given wetlands (eg. import of salt water from distance sources; or, local exacerbation of naturally saline water; or, local clearing leading to water table rise). Once the mechanisms have been identified management strategies can be designed (eg. revegetation of upland areas; short term drainage of creeks if appropriate).

Other threats to the reserves include the possible eutrophication of the lakes from increased nutrient input into the wetlands from agricultural or plantation land. Some of the wetlands (eg. Byenup) are currently showing signs of nutrient enrichment in the form of algal blooms.

Land-use activities in the catchment areas, that cause the buffering vegetation between adjacent lands and the wetlands to deteriorate, could result in an increase in salt and nutrient loading. Protecting the upland or woodland buffer by excluding stock, managing weed intrusions, fire and other inappropriate uses is also important to maintain this area.

Fire can threaten the vegetation and peat deposits of the wetlands. During summer when water tables are low fire can potentially burn out peat swamps. Fire should be excluded from these habitats (see Section 11.0 Fire Protection).

Vehicle access has resulted in degradation of the shoreline of some wetlands. This needs to be controlled to minimise erosion and degradation of wetland shores in terms of their vegetation and beaches.

If the wetlands are to survive, and the surrounding agricultural lands are to remain viable, long term management strategies need to be put in place in the very near future. Short term strategies may be required to address immediate problems but long term strategies must also be implemented to ensure the maintenance and survival of the wetlands and their catchments in the long term. Management strategies not only need to encompass the reserves but also all surrounding lands and waters in the catchments. There needs to be cooperation and integration of activities by all land managers, landholders and stakeholders. Long term strategies need to include preservation and management of existing remnant vegetation, use of deep-rooted perennial and high water use crops, additional strategically placed high water use trees and protection and revegetation of drainage lines.

Little is currently known of the hydrogeology of the individual wetland catchments. Information that is available and recorded needs to be collated and analysed for trends. Further studies and monitoring are required to determine what is currently happening in the catchment areas, what is expected to happen and action that needs to be taken. This will involve upgrading the existing monitoring networks by installing piezometer bores to groundwaters around the wetlands and permanent flow monitoring equipment on the streams. Studies need to be undertaken to determine the best techniques for reducing salinity and waterlogging.

Agriculture WA, CALM, the Department of Enviromental Protection, and the Water and Rivers Commission have developed a WA Salinity Action Plan (1996) for the Government of WA. The aims of the Action Plan are to: reduce further deterioration and where possible recover salt-affected land; protect and restore key water resources and high value wetlands; maintain natural biodiversity; and protect designated infrastructure affected by salinity.

Under the WA Salinity Action Plan the Government will develop and implement a corordinated Wetlands and Natural Diversity Recovery Program to ensure that critical and regionally significant natural areas, particularly wetlands, are protected in perpetuity. The Lake Muir/Unicup system of wetlands has been identified in the Action Plan as a priority area under this program, which is being coordinated by CALM. A recovery plan will be developed through catchment or sub-catchement approaches and, where necessary, short-term emergency actions will be identified.

Agriculture WA is also currently coordinating the preparation and development of a Catchment Management Plan for the Lake Muir/Unicup catchment area, some members of the Unicup Landcare Group are developing farm plans. This is a very positive and important step towards addressing catchment issues and CALM will encourage and support strategies and monitoring which contribute to the maintenance of wetland values and ecological health.

Catchments

The reserves are within seven catchments. These are the Frankland, Lake Muir, Unicup Lake, Tone, Perup, Tweed and Gnowergorup catchments (see Map 3). The Lake Muir/Unicup catchments have a number of sub-catchments (see Map 4).

Surface Drainage

Pindicup and Noobijup drain south into the Lake Muir-Byenup Lagoon System. Lake Muir is the final sink and acts as a large shallow evaporating basin which usually dries up to a salt pan in summer. Lake Muir overflows very infrequently to the south west through swamps into the Deep River. In average to wet years Neeranup Swamp and Tordit-Gurrup Lagoon overflow to the west into Byenup Lagoon, which in turn overflows to the west via a shallow drainage line, assisted by artificial drainage, entering Lake Muir. To the north of Pindicup Road surface drainage flows west to Unicup Lake and north west to the Tone River from the east. Drainage from the north east is into the Bokarup and Kulunilup wetlands then north west to the Tone River and west to Unicup Lake. The Mordalup Lakes drain south via Kodjinup Swamp then west into the Tone River. From Yarnup Road drainage is east into the Frankland River. These creeks flow 5-7 months of the year via a series of swampy basins and man-made drains.

Perup Forest generally has well defined natural drainage directly to the Tone River. The catchment divide between the Perup and Tone Rivers runs approximately north south through the reserve. This reserve, being on high ground between the two rivers, is not affected hydrologically by the farmland to the east and west.

The Byenup Lagoon usually varies seasonally from 1.5 - 2.5 m in depth and 5 000 to 2 500 mg/L salinity. Tordit-Gurrup usually varies from approximately 2.5 - 3.0 m in depth and 3 000 to 800 mg/L salinity. Both lagoons have lower levels and higher salinities in drier years and neither has dried up during the period of records.

Of the three streams discharging into the Lake Muir system, only the Noobijup has historical flow and salinity data and this is only available for 1979. Members of Unicup Landcare Group have recently commenced monitoring of these streams but this needs to be upgraded and properly analysed.

Groundwater Quality

20 groundwater observation bores of 4 to 8.5 m depths were installed by the Unicup Landcare Group and Agriculture Western Australia in 1995. These are located in the lower slopes and valley floors in the Pindicup and Noobijup sub-catchments. The average groundwater level in these bores was 0.3 m below ground level and in eight of these it was up to 2 m above ground level in September 1995. The average groundwater salinity was 6,200 mg/L.

A study carried out for the Department of Industrial Development (Passmore, 1986) sampled 36 surface pits in their 1986 study and salinities ranged from 210 to 1,500 mg/L, with half of these being fresh, ie. <1000 mg/L. Bores drilled in the upper slopes near granite outcrops usually had higher quality groundwater with salinity <500mSm.

Groundwater quality in the valleys and flats is variable but is generally saline, with salinity probably increasing with depth (Passmore, 1986).

Groundwater recharge comes from rainfall within the local topographic basin, which is closed and has dimensions of about 18 km in the east west direction and 30 km in the north south direction. Initially the water is fresh and gives rise to a fresh shallow groundwater, particularly in the vicinity of granite outcrops and to a lesser extent the laterite outcrops.

In the lower topographic areas the fresh recharge water mixes with more saline water (in lakes, swamps and shallow groundwater) that has been concentrated by evaporation and transpiration (Passmore, 1986).

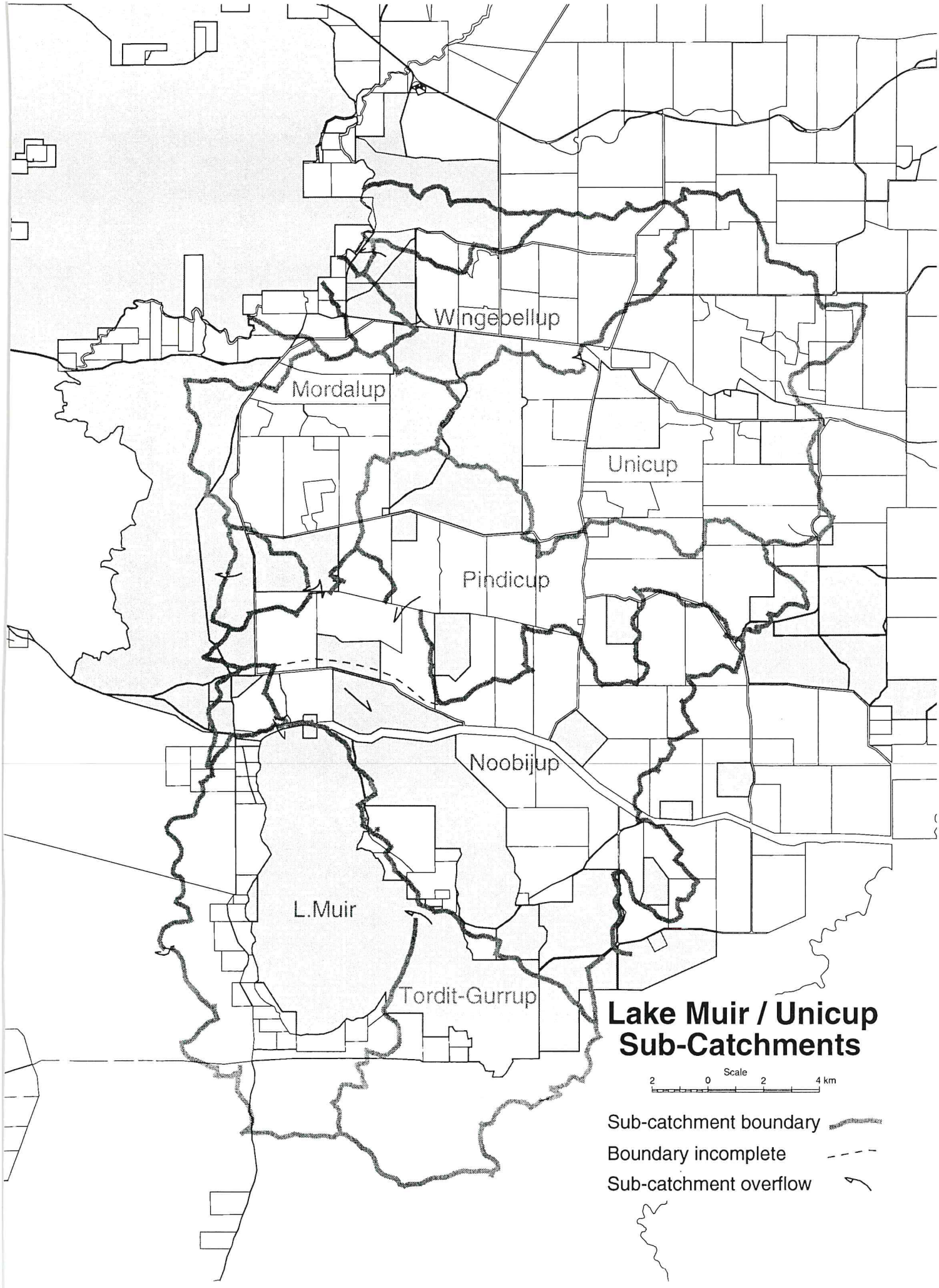
Drainage

Artificial drainage into reserve wetlands will exacerbate the major threats to the wetland ecosystems of rising watertables, and increased run-off, salt and possibly nutrient loads due to catchment clearing. In general terms artificial drainage proposals will adversely affect reserve wetlands and are likely to be refused in all but exceptional circumstances.

Drainage or pumping to or through a particular reserve wetland may be acceptable on a short term basis if it can be demonstrated that it will not be detrimental to reserve values, is an essential part of a longer term permanent solution and alternative sites or routes are not available.

In 1993 the Unicup Landcare Group put forward a detailed proposal to construct a drain within the Kodjinup Reserve to divert saline water from two lakes located upstream from the reserve, to the already saline Tone River. The proposal was approved by the NPNCA and the drain was constructed in 1993. Other drains present in the area are on farmland.

It is likely that other proposals will arise to construct drains within the nature reserves. It is important that the process for formal consideration of drainage proposals and the guidelines that must be addressed in all proposals are both clear to proponents and that development of proposals involves consultation with all stakeholders and neighbours.


Wingebellup
Mordalup
Unicup
Pindicup
Noobijup
L.Muir
Tordit-Gurrup
Lake Muir / Unicup
Sub-Catchments
Scale
2 0 2 4 km
Sub-catchment boundary
Boundary incomplete
Sub-catchment overflow

Map 4

The process of addressing drainage proposals is that a Notice of Intention to Pump or Drain Land (NOI) is submitted to the local district office of Agriculture Western Australia where it is checked for completeness. The NOI together with a report from the relevant Agriculture Western Australia District Leader is forwarded to the Commissioner of Soil and Land Conservation who brings the matter to the attention of appropriate parties such as the relevant Shire Council and Land Conservation District Committee, the Department of Environmental Protection, CALM, Water and Rivers Commission, Main Roads WA, Westrail and Western Power. These bodies then consider the proposal under their own legislation, guidelines and policies. If concerns are raised by neighbours, groups or government agencies the District Land Conservation Officer will meet with the relevant persons, discuss the proposals and report to the Commissioner. If no objections are raised the proponent may be advised by the Commissioner that the proposal can proceed.

A brief summary of legislation and policies that must be considered in any drainage proposals that may affect the reserves follows.

Procedures for the Administration and Assessment of Drainage Regulations (Agriculture Western Australia 1995)

- If the drainage works are to be installed within 5 km upstream of a nature reserve the proposal must be discussed with an officer of the Department of CALM. The date of the discussion and the officer's name should be attached to the notification.
- If the proposed drainage works are within 3 km upstream of a nature reserve it is essential that field staff of the Department of CALM are involved in the initial planning of the proposal.
- The proponent must notify all landholders (private and public) who may be affected by the proposed scheme and obtain written endorsement of the proposal from them in the form of a Statutory Declaration. Statutory Declarations from the two immediate downstream neighbours is a minimum requirement.

Suggested Format for Drainage Proposals:

- Outline of drainage proposal (maps showing location, catchment area).
- Objectives of the proposal.
- The property (catchment plan, revegetation program, fencing of remnant vegetation).
- Expected risk of land degradation (comparative salinities of effluent and receival area, changes to flow rate, on or off-site erosion, siltation, salinity effect on vegetation, known downstream reserves or protected remnant vegetation).
- Agriculture Western Australia District Leader's recommendation.
- Basis for recommendation (eg. the project is a component of a comprehensive catchment management plan, joint proposals of two or more neighbours to transfer effluent to a nearby safe disposal area at a higher salinity than the effluent).

National Parks and Nature Conservation Authority Drainage Policy

The NPNCA will evaluate proposals for drainage affecting land vested in the Authority and:

1. where deemed to be beneficial or neutral to the values of the reserve, the proposals may be supported;
2. where deemed detrimental to these values, the proposals would be opposed;
3. where a short-term detrimental effect is offset by a long-term gain, the proposals may be supported.

Proposals for evaluation by the NPNCA should normally:

- be prepared by an interdisciplinary group
- involve the relevant Land Conservation District Committee (LCDC)
- be based on a catchment approach
- address impacts on the conservation values of the vested land and of the receiving environment
- evaluate a range of alternative solutions
- consider environmental as well as economic values
- consider long term as well as short term options
- consider maintenance as well as construction costs
- fairly allocate costs between the beneficiaries
- be based on proper engineering design
- evaluate effects on existing structures, eg. culverts

In addition to the above already established guidelines the following additional guidelines are proposed for drainage proposals affecting the Perup Forest and Lake Muir/Unicup Nature Reserves.

- Proposals should be mapped, at a minimum, at two different scales - a general view (eg. 1:100 000 or 1:50 000) so that the relationship to other features can be obtained, and a more detailed view (eg. 1:5 000 or 1:10 000) showing remnant vegetation, saline, waterlogged areas and drains.
- Proposals should be screened by Agriculture Western Australia and only when satisfactory be forwarded to CALM or other agencies.
- Drainage should be positioned where it will augment the natural catchment drainage.
- Proposals should state clear goals and include the timeframe over which the proposal is predicted to be effective. The goals should include rainfall events for which the proposed drains will be

effective, and a statement as to what will happen if they are not effective.
- Proposals should comment on the expected changes at the outlet of the drain, alternative ways that waterlogging can be controlled on the property in the long term and the monitoring to be undertaken.

One of the keys to long-term protection and improvement of the natural ecosystems in the Perup, Lake Muir and Unicup catchments is to integrate the management of the plant associations with the characteristics of the underlying aquifer systems. To this end, following collation of relevant hydrological data and vegetation survey monitoring, actions may be identified, refined and taken to minimise nutrient inputs and to prevent further groundwater rise and salinisation within these catchments.

RECOMMENDATIONS

1. **Integrate all hydrological data and vegetation survey information as a consolidated base for further catchment investigations and operational monitoring.**

2. **Follow the NPNCA's Policy Statement on Drainage in regard to drainage proposals affecting the reserves.**

3. **Liaise with adjoining landholders, LCDC's, Landcare Groups, local authorities and Government departments to facilitate the development of integrated management strategies to protect the reserves' catchments from further degradation.**

4. **Encourage and where possible facilitate practices such as the preservation and management of remnant vegetation, use of deep-rooted perennial and high water use crops, strategically located high water use trees and protection and revegetation of drainage lines.**

5. **Encourage and assist landholders, in conjunction with Agriculture Western Australia, to develop and implement a strategic revegetation plan for the whole Unicup/Muir catchment area as part of the development of the Catchment Management Plan for the area.**

6. **Request the Water and Rivers Commission and Agriculture Western Australia to collate existing monitoring data for the catchments and analyse for trends.**

7. **Encourage and assist relevant agencies and landholders to develop and implement a program to further investigate and monitor flow rates, salinity and nutrients in surface and ground waters in the Lake Muir/Unicup catchments to quantify the extent of threats to the wetlands.**

8. **Assess the level of threat posed by current inflows to Byenup Lagoon. Consider the environmental acceptability of diversion and other options where necessary.**

9. **Liaise with adjoining landholders, LCDC's, Landcare Groups, Agriculture Western Australia, the Water and Rivers Commission and the Department of Environmental Protection to identify the actions that need to be taken in the short and long term to prevent further groundwater rise and salinisation of the wetlands catchments.**

10. **Encourage and assist research into water use of intact native vegetation compared with tree plantations.**

11. **Where private property encroaches on the wetlands encourage fencing to prevent stock access.**

12. **Consider potential adverse impacts on surface and groundwater during all management activities within the reserves.**

13. **Provide visitors with information on the hydrology of the wetlands and their catchments.**

6.0 VEGETATION AND FLORA*

The objectives are to:
- *Protect and conserve native plant communities.*
- *Protect and conserve indigenous flora, especially threatened and other priority species.*

* Vegetation refers to plant communities and their structure while flora refers to the plant species present.

Lake Muir/Unicup Nature Reserves

The reserves are near the southern end of the Menzies Sub-district of the Darling Phytogeographic District. Vegetation has been mapped at a scale of 1:1 000 000 by Beard (1981) and a scale of 1:250 000 by Smith (1972).

A detailed vegetation survey of Unicup, Kulunilup and Yarnup Nature Reserves has been conducted by Griffin and Associates (1984). Twenty four vegetation units were defined and mapped for the reserves. Jarrah forest and woodland predominates at Unicup and Yarnup Nature Reserves and shrub and sedge communities dominate at Kulunilup Nature Reserve.

The areas of swamp and lake within the Lake Muir/Unicup Nature Reserves show a complex suite of vegetation units and species complexes related to soil type, moisture status and salinity (Griffin and Associates, 1984). Beard (1981) describes the area covered by these nature reserves as a mosaic of Jarrah and Marri forest, paperbark low forest and rush swamps.

Permantly wet areas support large dense stands of *Baumea articulata* and other sedges. *B. articulata* is well developed on the surface of peat deposits, with the peat providing moist conditions around the roots year-round (EPA, 1990). Such peat based *Baumea* wetlands are very narrowly distributed and are threatened by increased salinity.

Descriptions of wetland-associated plants around Lake Muir, Tordit-Gurrup Lagoon, Lake Unicup and Yarnup Lagoon are given in Halse *et al.* (1993).

Three species of declared rare[1] flora are known to occur in the Lake Muir/Unicup complex of nature reserves. These are *Caladenia christineae, Caladenia harringtoniae* ms, and *Diuris drummondii*. Two Priority 1 species[2] (*Stylidium rhipidium* and *Cryptandra arbutiflora* var. *pygmaea* ms), one Priority 2 species[3] (*Leptocarpus ceramophilus*), and one Priority 4[4] species (*Villarsia submersa*) also occur in the reserves. Kulunilup Nature Reserve has a substantial occurrence of the sedge *Eleocharis sphacelata*, which has a restricted distribution in the Region. The reserves also have some of the largest natural sedgelands in Western Australia.

Perup Forest

Perup Forest is near the southern end of the Menzies Sub-district of the Darling Phytogeographic District. Vegetation has been mapped at a scale of 1:1 000 000 by Beard (1981) and a scale of 1:250 000 by Smith (1972).

Perup Forest consists primarily of an open forest of jarrah (*Eucalyptus marginata*) and marri (*E. calophylla*). Jarrah tends to be dominant on the ridges and the lateritic soils, whereas Marri is more common in the valleys and on the sandier soils. Wandoo (*E. wandoo*) woodlands occur in many of the valleys, especially on clay soils in the northern parts of the reserve.

The understorey over most of Perup is of low clumped scrub species. Species such as *Hakea lissocarpha, Leucopogan capitellatus* and *Bossiaea ornata* are common on the ridges. In lower lying areas, particularly on sandy soils, *Hypocalymma angustifolia* is dominant. In the treeless drainage lines on shallow soils *Hakea prostrata, H. varia* and *Acacia saligna* form tall open thickets. In some areas, particularly along the upper parts of the Perup River, *Melaleuca viminea* forms dense thickets. The Wandoo woodlands have a sparse understorey with occasional shrubs (CALM, unpublished).

A few restricted habitats which occur in the reserve include granite outcrops with *Allocasuarina huegeliana, A. humilis, Hakea cyclocarpa* and *Dryandra armata*, and several peaty swamps with rushbeds of *Cladium reticulatum* surrounded by woodland of *Banksia attenuata*, flooded gum (*Eucaluptus rudis*) and *Melaleuca preissii*.

Several leguminous species form dense thickets following summer fires - *Gastrolobium bilobum* (heartleaf poison), *G. spinosum* (prickly poison) and *Acacia pulchella* (CALM, unpublished). Work has been carried out on the fire ecology of some of the flora of the Perup Forest (Christensen and Kimber, 1975 and Christensen, 1980a), in particular on the thicket forming legume heartleaf (*G. bilobum*) which is the home of the tammar wallaby (Christensen and Maisey, 1987).

Two species of declared rare flora are known to occur in Perup Forest. These are *Caladenia dorrienii* and *Diuris drummondii*. One Priority 1 species (*Synaphia decumbens*), seven Priority 2 species (*Verticordia densiflora* var. *pedunculata, Melaleuca micromera,*

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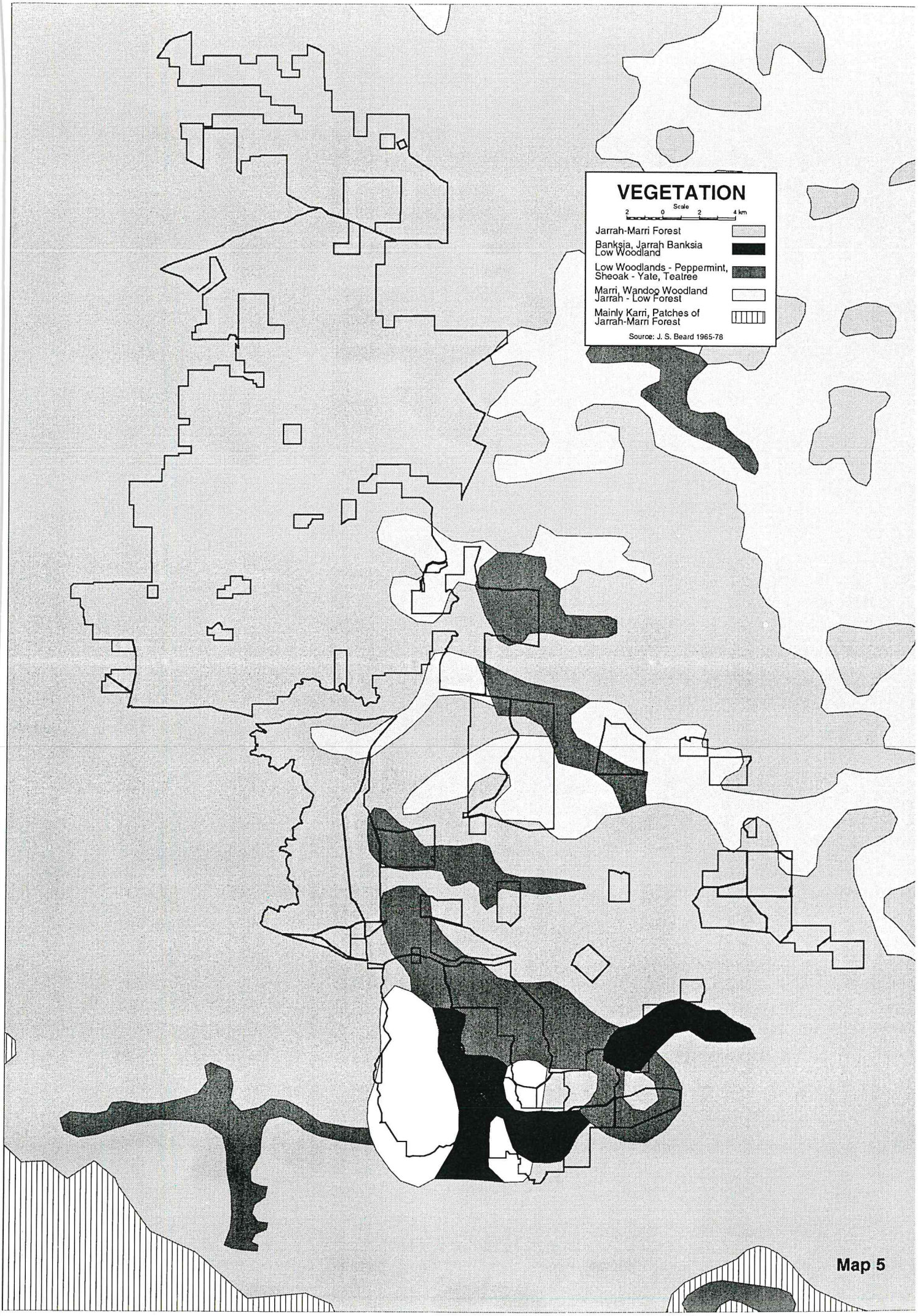
[1] The term "declared rare" is used to mean any plant taxon that is threatened with extinction and declared by the Minister for the Environment under the Wildlife Conservation Act as rare flora, ie. "is likely to become extinct or rare or otherwise in need of special protection".

[2] Priority 1 taxa are known from one or a few (generally <5) populations which are under threat.

[3] Priority 2 taxa are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (ie. not currently endangered).

[4] Priority 4 taxa are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors.


VEGETATION
Scale
2 0 2 4 km
Jarrah-Marri Forest
Banksia, Jarrah Banksia Low Woodland
Low Woodlands - Peppermint, Sheoak - Yate, Teatree
Marri, Wandoo Woodland Jarrah - Low Forest
Mainly Karri, Patches of Jarrah-Marri Forest
Source: J. S. Beard 1965-78

Map 5

Hydatella sessilis ms and *Dampiera orchardii Andersonia annelsii*, *Caladenia luteola* ms), two Priority 3 species[5] (*Dicrastylis glauca* and *Verticordia lindleyii* subsp. *purpurea*), and two Priority 4 species (*Eucalyptus aspersa* and *Caladenia plicata*).

RECOMMENDATIONS

1. **Prepare detailed vegetation maps for all the reserves (with the exception of Unicup, Kulunilup and Yarnup Nature Reserves which have already been mapped).**

2. **Identify and protect vegetation and flora that is rare, unique or in some way warranting special consideration.**

3. **Design facilities and management practices that minimise adverse impacts on flora and vegetation values.**

4. **Protect populations of species that are vulnerable to particular fire regimes by implementing appropriate fire management strategies.**

5. **Provide visitors with information on the area's vegetation, its features and the need to protect it.**

6. **Research the response of plant community types to management regimes, especially fire. Modify practices as necessary.**

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[5] Priority 3 taxa are known from several populations, at least some of which are not believed to be under immediate threat (ie. not currently endangered).

7.0 FAUNA

The objective is to protect and conserve indigenous fauna with an emphasis on threatened and other priority species.

General

The fauna of the Perup Forest is relatively well known. The Lake Muir complex, with the exception of waterbirds, has not been surveyed in detail.

The Perup and Lake Muir/Unicup Reserve System is possibly the richest area for vertebrate fauna in the South West. Situated on the northern edge of the southern forests, it has elements of both the northern and the southern forest faunas. In the wandoo woodlands and jarrah, where there is a clumped understorey, such northern forest species as the numbat (*Myrmecobius fasciatus*) and the woylie (*Bettongia penicillata*) occur. The tammar wallaby (*Macropus eugenii*) occurs in thickets along the valley bottoms in this area also. The red-capped robin (*Petroica goodenovii*) and the gould's snake (*Rhinoplocephalus gouldii*) are also northern species. Species more typical of the southern forest fauna are represented by the southern bush rat (*Rattus fuscipes*) and the red-winged fairy wren (*Malurus elegans*).

The extensive area of diverse wetland habitat in the Lake Muir/Unicup Reserves adds considerably to the total number of species, especially the waterbirds. The other vertebrates in these reserves have not been adequately surveyed and will likely yield further species to the total number known to be present in the area.

Perup Forest

Mammals

Perup Forest is one of the most important reserves for mammals in Western Australia. A total of 22 native species have been recorded within the area, one of the highest numbers recorded in any reserve in the South West. All species in the southern and central forest areas with the exception of the honey possum (*Tarsipes rostratus*) and the quokka (*Setonix brachyurus*) have been recorded in the Perup Forest.

Perup is a particularly important reserve for Critical Weight Range (CWR) species (Burbidge and McKenzie, 1989). Five of these species are in the reserve. Three of these are also listed as threatened (declared 'rare or likely to become extinct') under the Wildlife Conservation Act 1950.

The presence of extensive thickets of heartleaf poison (*Gastrolobium bilobum*) in the reserve contributed to the retention of forest on otherwise suitable land from pastoral grazing and clearing for agriculture.

The same poison plant partially protects the CWR fauna from predation from foxes. Species such as the woylie (*Bettongia penicillata*), the tammar wallaby (*Macropus eugenii*), the common brushtail possum (*Trichosurus vulpecula*) and others which eat the leaves, flowers or seeds of the heartleaf are lethal prey for foxes.

Over thousands of years these native species have built up a high degree of tolerance to sodium fluoracetate, the poison in heartleaf, so that animals which have been feeding on the poison plants are deadly to foxes that eat them. The continued existence of the heartleaf thickets is therefore critical to the survival of CWR species in the reserve.

Threatened and Specially Protected Mammals

Perup Forest contains the largest populations still in existence of the woylie (*Bettongia penicillata*) and also has large populations of the tammar wallaby (*Macropus eugenii*), chuditch (*Dasyurus geoffroii*), the numbat (*Myrmecobius fasciatus*), the western ringtail possum (*Pseudocheirus occidentalis*) and the southern brown bandicoot (*Isoodon obesulus*). The chuditch, numbat and western ringtail possum are listed as threatened under the Wildlife Conservation Act 1950. The woylie, tammar wallaby and southern brown bandicoot have recently been removed from the threatened list and classified as 'Lower Risk, Conservation Dependant', taxa which are the focus of a conservation program, the cessation of which would result in the taxon qualifying for one of the threatened categories.

Birds

The mixture of forest and woodland, with patches of heath and small seasonal swamps with rush beds, provides habitat for a wide range of birds in the Perup Forest. A total of 92 bird species have been recorded in the Forest. None are restricted to the Perup area; all occur more or less widely throughout the southern forests. Threatened species that occur in the area are the western long-billed corella (*Cacatua pastinator pastinator*) and Baudin's cockatoo (*Calyptorhynchus baudinii*). Priority species that occur in the area are the forest red-tailed black cockatoo (*Calytorhynchus magnificus*), and the western shrike-tit (*Falcunculus frontatus*).

Reptiles

With the possible exception of some of the south coastal areas Perup Forest has the most diverse reptile fauna in the southern forests. Four species of snakes, 10 species of skinks and one species of legless lizard have been recorded in Perup.

Perup's position in the low rainfall eastern margins of the forests and its location just outside the typical south coast climate, ensure that a number of skinks which do not occur in the south occur in the area.

Like most of the southern forests there are no dragon lizards, and pygopods (legless lizards) are not well represented in the area. There is only one gecko, the marbled gecko (*Christinus marmoratus*), found in Perup Forest.
Some species which are more common to the north such as the whip snake (*Denisonia gouldi*) are present in the area. Typical southern species such as the short-nosed snake (*Notechis minor*) and the skink (*Glaphyromorhus australis*) do not occur in Perup.

The oblong tortoise (*Chelodina oblonga*) has also been recorded in the area.

Amphibians
A total of eight amphibian species have been recorded in the Perup Forest. The considerable numbers of small swamps throughout the areas of sandy soils contribute to the variety of frogs in the area. The area, however, is not as rich in species as many other similar sized areas further to the south in the higher rainfall zone. No threatened or vulnerable frogs occur in the reserve.

Fishes
The fish fauna of the Perup Forest is known to be depauperate, there being little permanent water in the area with the exception of pools in the Perup River.

Invertebrates
The terrestrial and aquatic invertebrate faunas of the Perup Forest are not well known.

Lake Muir/Unicup Nature Reserves

Mammals
Though systematic surveys have not been undertaken, the Muir/Unicup Reserves are believed to contain many of the mammal species found in the Perup Forest. The woylie (*Bettongia penicillata*) and chuditch (*Dasyurus geoffroii*) have been recorded.

The Lake Muir Nature Reserve is important as one of the few larger reserves where species now extinct in the South West were once known to exist. The reserves contain substantial areas of suitable habitat for the boodie (or burrowing bettong) (*Bettongia lesueur*) and the dalgyte (or bilby) (*Macrotis lagotis*).

The only semi-aquatic mammal occurring in wetlands of south-western Australia is the native water rat (*Hydromys chrysogaster*). Although this animal has not been recorded in the wetland system it possibly occurs there.

Waterbirds
More than 50 species of waterbirds have been recorded on the Muir/Unicup wetlands.

At least nine species are listed under the Japan-Australia or China-Australia migratory bird agreements relating to the protection of migratory birds and birds in danger of extinction. These birds are declared to be fauna in need of special protection.

The number of waterbirds inhabiting the wetlands is strongly influenced by local and regional water availability and varies greatly from year to year.

In March 1989 there were 52 000 waterbirds on Lake Muir alone. The most abundant species were pacific duck (18 500), grey teal (16 000), eurasian coot (10 000), black swan (4 000) and Australian shelduck (*Tadorna tadornoides*) (3 500). Lake Muir was one of few large wetlands in the region still holding water in March of that year. In some years Lake Muir is clearly a major drought refuge for waterfowl.

Water levels also affect other species. In 1986-87, high numbers of waders, egrets and spoonbills, as well as lower numbers of some diving species, such as great crested grebe and blue-billed duck, coincided with below average water depths and increased areas of shallows.

Waterbird use of Byenup Lagoon has been studied more intensively than other Muir/Unicup wetlands. In 1986-87, 80-100 musk ducks were present in each season, making it one of the most significant wetlands in south-western Australia for this species. Crested grebe (*Podiceps cristatus*) are also numerous (10-20) at times.

Numbers of individuals (<200) and species (five) of transequatorial migratory waders recorded for Lake Muir are very low for a lake of such large size and seasonal nature. Further surveys are planned to determine the lake's significance for these species.

At least seven species of waterbirds are known to breed on the Muir/Unicup wetlands. These are the little bittern, spotless crake, Australian shelduck, musk duck, black swan, purple swamphen and silver gull. It is probable that Australasian bitterns also breed here.

The little bittern (*Ixobrychus minutus*) breeds in closed scrub over sedgelands at Yarnup Lagoon, Bokarup Swamp, Kulunilup Swamp and near Byenup Lagoon. The highest number of breeding pairs was recorded at Yarnup Lagoon and this swamp supports the highest recorded density of nesting by the little bittern in Western Australia.

All Australian species of ducks and swans are flightless for a month or so each year while they shed their flight feathers and grow new ones. During this period (usually immediately post breeding) individuals

of some species may congregate in large numbers on undisturbed waters. The Muir/Unicup system is one of a small number of major moult refuges in south-western Australia for the Australian shelduck. In December 1992, more than 12 000 shelduck gathered to moult on Tordit-Gurrup Lagoon. In other years similar or greater numbers may gather to moult on Lake Muir however in December 1992 Lake Muir was too shallow for this purpose due to lower than average rainfall.

Rare and Vulnerable Birds

The Australasian bittern (*Botaurus poiciloptilus*) is on the WA threatened fauna list. It has been recorded in seven wetlands within the Muir/Unicup reserves (Jaensch et al. 1988 and Jaensch and Vervest, 1988a). The highest count (five) was at Kulunilup Swamp in December 1983. Muir/Unicup is believed to be one of the principal refuges for the Australasian bittern in Western Australia.

The only other waterbird on the WA threatened fauna list, the Recherche Cape Barren goose (*Cereopsis novaehollandiae grisea*), has not been recorded on the Muir/Unicup wetlands.

The Western Australian subspecies of Lewin's water rail (*Rallus pectoralis clelandi*) has not been recorded in Western Australia since 1932 and is officially listed as "fauna presumed to be extinct" on the basis of not having been recorded for more than 50 years. There are only four Western Australian records for this species, at Margaret River (two records), King George Sound (Albany) and near Bridgetown. Suitable habitat may exist in the Muir/Unicup reserves and the possibility of rediscovery should not be discounted. No substantial searches aimed specifically at this secretive bird have been conducted in the Muir/Unicup Reserves, or elsewhere in Western Australia.

Threatened species that occur in the area are the western long-billed corella (*Cacatua pastinator pastinator*) and Baudin's cockatoo (*Calyptorhynchus baudinii*).

Buffers of native terrestrial vegetation around the reserved wetlands minimise disturbance to waterbirds and may provide nesting habitat for some species.

Direct threats to waterbirds include feral animals such as foxes and pigs. Indirect threats include raised water levels and salinities, too frequent burning of fringing vegetation and burning of peat and rushbeds.

Reptiles

The reptile fauna of the Lake Muir complex is not well known but it is likely to be comparatively rich because of the presence of areas of open woodland with sandy soils. The oblong tortoise (*Chelodina oblonga*) has been recorded in Tordit-Gurrup and is probably common throughout the wetlands system. Tiger snakes (*Notechis ater*) also occur.

Amphibians

No surveys of the frog fauna of the reserves have been undertaken. It seems likely that these extensive and diverse wetlands may yield a wider variety of amphibians than Perup when surveys are conducted.

Fish

Surveys of the fish of the Muir/Unicup Reserves are currently being undertaken. Several indigenous species are present and the introduced "mosquito fish" (*Gambusia holbrookii*) has also been found at a few sites.

Invertebrates

A survey of aquatic invertebrates was undertaken in some of the wetlands in the Lake Muir/Unicup Nature Reserves in 1987 (DeHaan, 1987). Ninety seven invertebrate taxa were found in the wetland suite comprising Tordit-Gurrup Lagoon (52 taxa), Byenup Lagoon (43 taxa) and Poorginup Swamp (39 taxa). This is a high number compared with other freshwater wetland studies in Western Australia.

Of the nine *Hydracarina* taxa recorded at Poorginup Swamp, six have restricted distributions and some, such as *Pseudohyrophantes* sp. nov., are of considerable zoogeographic interest. One of the new species recorded, *Huitfeldtia* sp. nov., is the second known species of its genus. Its nearest relative is found in North America suggesting it is a relict of 200-250 million years ago when all the continents were joined together in a single land mass. The Poorginup Swamp water-mite *Acercella* sp. has been declared protected throughout the State.

The crustaceans *Cherax preissii* and *C. quinquecarinatus* occur at the wetlands.

Wetland peat deposits are an important habitat for invertebrates. Even in dryer times the peat remains wet and provides an invaluable refuge for invertebrates. A more intensive survey of the invertebrate (and fish) fauna of the Muir/Unicup reserves is currently being undertaken.

RECOMMENDATIONS

1. **Protect fauna habitats from wildfires, pollution and human disturbance.**

2. **Instigate further fauna surveys, particularly on:**
   - **frog, fish and invertebrate faunas of the Muir/Unicup wetlands;**

- **shorebird use of Lake Muir;**
- **fauna of the Perup wetlands;**
- **terrestrial fauna of the Muir/Unicup Reserves; and**
- **terrestrial invertebrates of Perup Forest.**

3. **Manage fire to promote a mozaic of fire ages suitable for a wide range of flora and fauna.**

4. **Continue special fire regimes to promote and maintain tammar wallaby habitat.**

5. **Protect fauna from exotic predators through appropriate baiting regimes.**

8.0 CULTURAL HERITAGE

The objective is to protect and conserve the reserves' cultural heritage and values.

Aboriginal History

Aboriginal people occupied the south-west of Western Australia at least 40 000 years ago. The south-west was occupied by a number of tribal groups collectively known as the Noongars. The Manjimup area was frequented by the Bibelmen and Ganeang tribes of the Noongar cultural group (Tilbrook, 1993).

The wetlands in the reserves attracted Aboriginal people for their variety of edible plants and animals and abundant water supply. At least one Aboriginal site occurs in Lake Muir Nature Reserve and at least 10 sites occur in the general vicinity of the reserves. However, as limited investigations have been conducted, it is possible that other sites exist. These sites include archaeological sites such as artefact scatters, stone arrangements, kangaroo traps and burial sites (Department of Aboriginal Sites, pers. comm. 1995).

All sites are protected by the provisions of the Aboriginal Heritage Act (1972-1980) regardless of whether they are known to the Department of Aboriginal Sites or not. Section 17 of the Act makes it an offence to excavate, destroy, damage, conceal or in any way alter an Aboriginal site without the written permission of the Minister for Aboriginal Affairs.

European History

As early as 1852 pioneers began entering the Warren District. The first person to carry out an exploration in the area was Dr Wilson, who in 1829 traversed the surrounding countryside and gave his report on it. He was followed three years later by Captain Bannister and his companion Mr Smythe, a member of the Surveyor General's Department. Other explorers were Lieutenant Preston, followed by William Clarke in 1841, and surveyor AE Gregory in 1852 (Giles, 1959).

In 1852 Thomos and Robert Muir set off from the Hay River, travelled across country and discovered a lake which they named Lake Muir, then continued along the Perup River almost to the Wilgarrup junction. In 1856 they moved their flocks from the Hay River to the newly discovered area. Properties were established at Perup, Lake Muir, Fernhill, Deeside, Mordalup and Nornalup. The Muirs were followed in 1859 by Rose and Frank Hall (Giles, 1959).

Mills were opened up in the area as the timber industry spread further south and eastward in the early 1900's. Other smaller mills opened up from time to time and in addition were the 'spot' mills which were semi-mobile and moved on to new areas when the old ones were cut out (Hennely, 1951). Remains of the Unicup Mill are located in Kodjinup Nature Reserve.

Historical sites within or adjacent to the nature reserves include the Perup Forest Ecology Centre buildings adjacent to Perup Forest, primary school building (active 1909-1911) in Mordalup Nature Reserve, settlers camp in Galamup Nature Reserve, camp and well in Lake Muir Nature Reserve used by workers when building the Muir Highway, Bokarup Homestead in Bokarup Nature Reserve and sheep pens in Yarnup Nature Reserve.

RECOMMENDATIONS

1. **Liaise with the local Aboriginal community and the Department of Aboriginal Sites concerning the protection of significant Aboriginal sites in the reserves.**

2. **Ensure that visitor and management activities do not adversely impact upon significant historical and cultural sites.**

3. **Where appropriate, incorporate material on historical and cultural sites in interpretive displays and community education programs.**

4. **Continue to compile information on historical sites located in the reserves and maintain an up-to-date database of sites.**

9.0 LANDSCAPE MANAGEMENT

The objective is to protect and where required restore the reserves' natural landscape qualities.

Landscape management can be divided into these main components:

- assessment of landscape values;
- identification of potential or proposed changes;
- development of a plan which manages existing values and proposed changes in an appropriate way.

Landscape values are a measure of the experience associated with people's interaction with the environment. These values may stem from an historic area reflecting past human use, the way people view an area, areas utilised for their resources, or a place to which people attach special meaning, whether they frequent that place or not.

CALM uses a landscape assessment procedure based on the Visual Management System (Williamson & Calder 1979) which focuses on visual values. It involves the description and classification of landscape character, comparative assessment of the significance of places (ie. scenic quality), and determination of levels of public exposure. Three classes of relative scenic quality are recognised - High, Moderate and Low. These three classes for various landscape components-landform, vegetation and waterform- are described in Appendix 1.

The reserves are characterised by their diversity of vegetation (Jarrah forest to shrub and sedge communities) and landforms (granite outcrops to low lying swamps), and their natural wetlands. They are primarily natural, with some roads, few developed recreation sites and little public use. The landscape character is classified as the Darling Uplands in the north-west and Pemberton Slopes in the southwest, which are both sub types of the broader Darling Plateau (CALM 1994).

Significant values lie in the high scenic quality areas of distinctive vegetation associated with watercourses, wetlands and lakes, and the larger granite outcrops. Lake Muir has been listed on the Resister of the National Estate for its high aesthetic and other values.

Public exposure is moderate to high adjacent to the Boyup Brook/Cranbrook Road and Muir Highway. Visibility is generally restricted to foreground areas.

The major threats to landscape values in the reserves are dieback, powerlines, recreation, rubbish, weeds, salinisation and inappropriate developments on neighbouring properties.

Within the CALM managed estate these changes will be planned and managed in a manner which maintains existing landscape values at an appropriate level. Table 3 sets out specific guidelines that should be implemented.

Table 3
GUIDELINES FOR LANDSCAPE MANAGEMENT

Landscape Management Guidelines
• Alterations to the natural landscape should be subtle, remaining subordinate to natural elements by borrowing extensively from form, line, colour, texture and scale found commonly in the surrounding landscape;
• A site development plan, at an appropriate scale, should be completed and approved before any development, maintenance or rehabilitation works are implemented;
• Degraded landscapes, eg. gravel pits and disused vehicular access tracks, should be rehabilitated after use;
• Essential management tracks and firebreaks should follow natural landform, vegetation or landuse patterns/breaks;
• Protection burning, if required, should be done before periods of high vegetation growth (where possible) and incorporate minimal visual impact prescriptions and techniques;
• Previously disturbed areas within areas of high scenic quality should be given the highest priority for rehabilitation until the desired standard of scenic quality is attained; and
• Where environmental and visually destabilising facilities or activities are essential, the degree of resource value lost should be recognised, controlled by management and carefully monitored.

RECOMMENDATIONS

1. Implement CALM Policy No. 34 (Landscape Management) in all aspects of land management of the reserves.

2. Apply the landscape management guidelines set out in Table 3.

3. Encourage neighbours to recognise the importance of landscape management by the sensitive siting of facilities and signs, selection of site-compatible materials and colours, and careful planning and siting of utilities and roads to minimise impacts on the reserves' landscape values.

MANAGEMENT FOR PROTECTION

10.0 PLANT DISEASES

The objective is to prevent introducing plant pathogens into pathogen-free areas and to control their spread where they are already present.

Phytophthora Dieback

Dieback disease is the common term referring to a plant disease caused by a microscopic root rotting fungus *Phytophthora cinnamomi*. It describes the symptoms displayed by infected jarrah (*Eucalyptus marginata*) of a gradual dying back of the healthy crown from the tips. The fungus is widespread in south-western Australia and causes the death of not only jarrah but a wide range of native and introduced plants. Death results from water stress as a result of the fungus infecting the plant roots, causing the roots and stem tissue to rot.

The fungus survives in soil and plant material, and produces small motile spores which are actively spread in water and in films of water in moist soil. The fungus can also spread by active extension through the roots of susceptible host plants.

The spread of *Phytophthora* can also occur by passive dispersal. This passive dispersal occurs when infected soil containing fungal inoculum, or plant tissue is moved from an infected site to a previously uninfected site. People are the main agents of dispersal and their activities are the main agents by which *Phytophthora* has been spread around south-western Australia. The spread of *Phytophthora* is commonly associated with the movement of infected soil or root material in conjunction with road construction and maintenance, or in mud on the wheels and underside of vehicles. However the spread of *Phytophthora* is not limited to areas where machine activity has occurred. It can also be spread by other less obvious means such as in mud on shoes, or on the muddy feet of animals. Feral pigs which dig for food are suspected of being linked to *Phytophthora* spread. Any hoofed animal poses a similar threat.

Cost effective techniques to eradicate the fungus once it is established are not yet available and therefore, every effort must be made to protect dieback-free areas. The only effective measure is to strictly control access in hazardous areas, and to apply stringent disease hygiene to all operations in the reserves.

The most susceptible plant species belong to the families Proteaceae (eg. *Banksia*, *Grevillea*, *Hakea* species), Epacridaceae (southern heath family), Fabaceae (pea family, including genera such as *Daviesia* and *Jacksonia*) and some Myrtaceae (including genera such as *Darwinia* and *Verticordia*).

Phytophthora is known to be present in the reserves but the pattern of distribution in the reserves is poorly known. The reserves are generally in a low dieback hazard area.

The CALM Dieback Disease Hygiene Manual should be used to both guide operations and for the completion of Hygiene Evaluation for all activities which have the potential to spread or intensify the disease.

Most of the Perup Forest is a gazetted Disease Risk Area (DRA) and for roads other than public roads and gazetted open roads, access is controlled by a permit system. This permit system is administered by the CALM Manjimup District under Section 82 of the CALM Act, and Part 16 of the Forest Management Regulations, and using CALM's Policy Statement No. 3 (*Phytophthora* Dieback). This enables CALM staff to authorise or deny entry to DRA, and to specify the roads and tracks to be used as well as a range of conditions for their use. All vehicles and equipment used in DRA must carry a current permit while in DRA.

Further surveys and monitoring of known infections are required to determine the distribution and extent of *Phytophthora* dieback in the reserves.

Armillaria

Armillaria luteobubalina is an indigenous species of mushroom-producing fungus, which causes infection through aerial dispersal of spores, with root to root contact being the main means of infection intensification once established. Species of Proteaceae, Myrtaceae, Papilionaceae, Epacridaceae and Mimosaceae are most susceptible (Shearer, 1994). *Armillaria* is generally common in eastern jarrah and wandoo forests.

RECOMMENDATIONS

1. **Identify priority areas for protection from pathogen introduction and spread based on conservation values, risk of introduction and dieback hazard.**

2. **Develop a broad scale dieback map of the Perup and Lake Muir area and a**

dieback hazard map based on vegetation and landform types.

3. **Inform users of the reserves about plant diseases and their management, and why it is important to prevent their introduction and spread.**

4. **Train staff associated with the area to recognise *Phytophthora* dieback and *Armillaria* and in sampling and management techniques.**

5. **Include disease management specifications in contract documents (including scientific flora collecting licences) and job prescriptions, where appropriate.**

6. **Review the existing road and firebreak network to ensure that the positioning of these does not pose unacceptable risk to special communities or landforms.**

7. **Ensure that additions to the Perup Forest, such as Keninup and Talling blocks, are considered for gazettal as DRA.**

11.0 FIRE PROTECTION

The objectives are to:

- *Protect people, property and conservation values from wildfire.*
- *Provide a fuel age mosaic and apply fire at intervals which will provide for known requirements of communities and species.*
- *Provide an effective education and liaison program to reduce the risk and frequency of human induced fire within or adjacent to the reserves .*

Wildfire Threat Analysis

The Wildfire Threat Analysis is a computerised decision support system which provides an objective and repeatable means of integrating the key factors that contribute to a wildfire threat to an area. These factors are the values at risk, the likelihood of the fire starting, the suppression response that can be mounted and the likely fire behaviour at the site. These factors can be mapped and ranked so that it is possible to determine fire threats. The outputs of this system will be used in conjunction with other management considerations to plan and schedule the fire management activities in the reserves.

Factors Affecting Fire Management

Values which are potentially threatened by fire on or near the reserves include people living near or visiting the areas; the agricultural industry with its homesteads, pasture, crops, stock, buildings and fences; commercial tree plantations (hardwood and softwood); the indigenous flora and fauna such as waterbirds which nest in the wetland fringing vegetation; and sensitive habitats such as peat and wetland areas. It is important to identify these values, and their location, so that they can be considered in the development of fire prevention and fire management strategies. The fuel accumulation rates are relatively slow and litter fuels do not exceed critical levels (8-10 tonnes per ha) for at least 7 years after fire.

In addition to the agricultural industry, other agencies who control land adjoining the reserves include the Water and Rivers Commission and Shires of Boyup Brook, Cranbrook and Manjimup. Ongoing liaison will occur with these agencies in regard to fire protection and prevention associated with the various land uses.

Fire History

Grass tree studies in the Perup area demonstrate that the jarrah/wandoo ecosystems were burnt 3 -4 times every 10 years in the period prior to European settlement. However since European settlement this frequency has altered to the current situation where most of the reserves have been burnt at least once within the last 13 years although a number of areas have been kept free from fire for more than 13

years(see Map 6). The last major wildfire in the Perup Forest occurred in 1950 and burnt almost the entire area. The Lake Muir/Unicup Reserves have a history of numerous wildfires. Fires originating from adjacent farmlands have been the most common source of these fires.

Fire Behaviour

Weather conditions suitable for the ignition and spread of fires typically occur on a regular basis from October until the latter part of April each year. Rainless periods during the cooler months may also provide opportunities for fire spread, particularly in drought years.

Fire behaviour is affected by the amount and type of fuel, air temperature, fuel dryness, wind speed and topography (Sneeuwjagt and Peet, 1985). Different vegetation types accumulate fuel at different rates and have different fire behaviour characteristics, however once the available fuel loads exceed 8-10 tonnes per ha in jarrah or wandoo stands, fire control is very difficult under normal summer conditions. The major fuel types in the reserves are jarrah/marri forest, wandoo woodland, *Melaleuca* and heartleaf thickets, paperbark forest, and reed and peat swamps. The swampy areas are generally very difficult areas in which to suppress fires because of their high flammability and poor ground carrying capability. This often results in very high rates of fire spread and very low rates of fireline production.

The peat swamp associations also pose special problems for fire management because at particular times the peat substrate can ignite and smoulder for long periods, and can lead to a very expensive and difficult manual suppression task. The last significant fire in the peat occurred in 1988 on Lake Tordit-Gurrup following an escape from a private property burnoff.

Fire Ecology

Extended hot dry periods and flammable vegetation ensure that fire has and will continue to occur in the area. Consequently the plants and animals have evolved a variety of physical, physiological and behavioural traits to enable them to persist in this fire-prone environment. While organisms have evolved fire adaptations, some taxa could be susceptible to certain fire regimes, such as very long fire-free periods, frequent summer wildfires or very frequent prescribed fires.

Plant species that are most vulnerable to fire are those that are killed by fire and regenerate only from seed (obligate seeders). Those relying on seed retained on the plant appear to be particularly vulnerable, although some obligate seeders with soil-stored seed are also vulnerable. The critical issue is how quickly these species regenerate and produce adequate seed to replace themselves relative to the periods between burning and fires.

In the absence of detailed fire ecology data, biological indicators such as the juvenile and seed bank dynamics of fire vulnerable plants, and the habitat requirements of the fire sensitive fauna, can be used to set fire frequency, scale and seasonal limits.

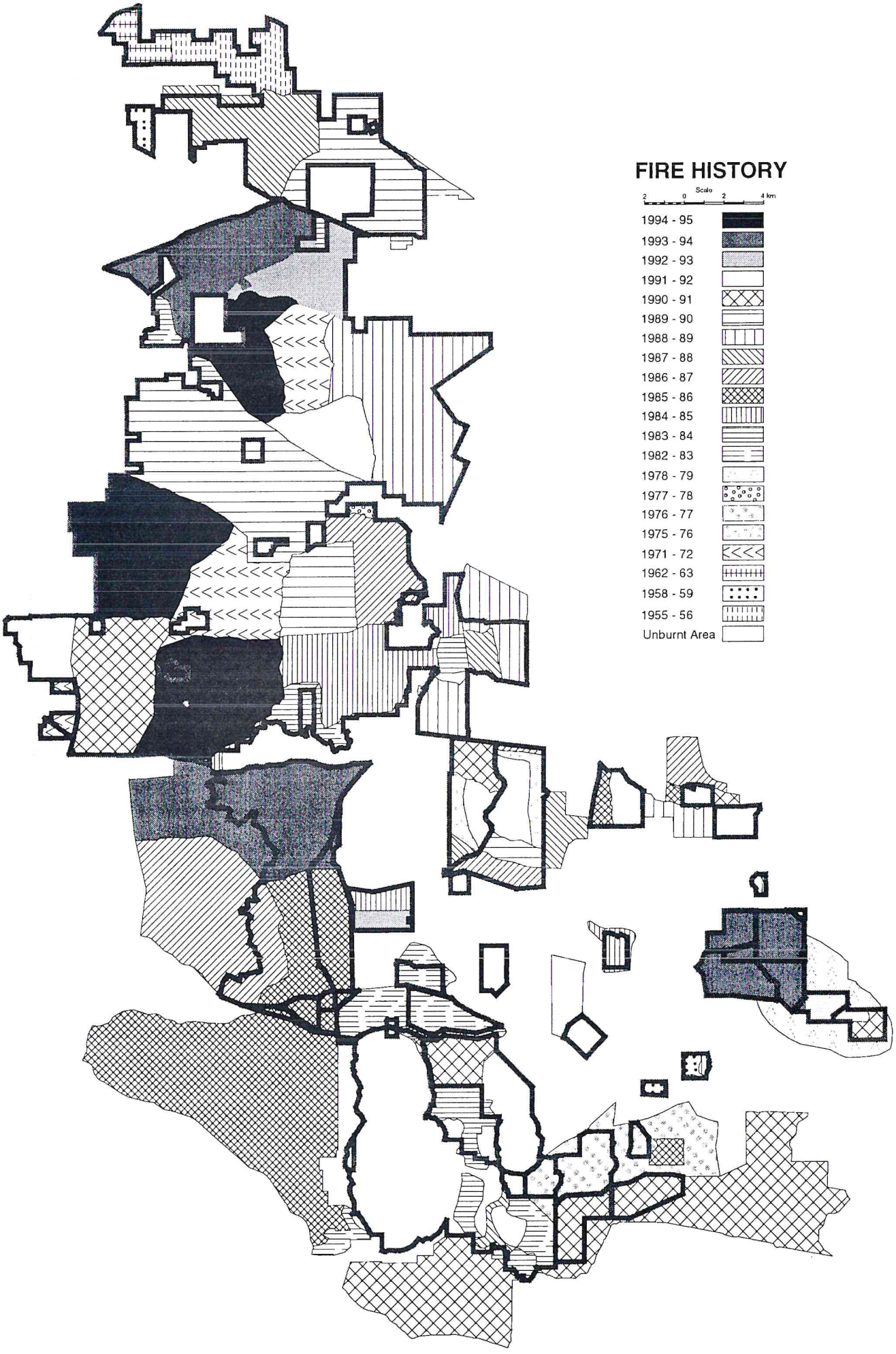
The fire ecology of the Perup area has been studied for more than 25 years (Christensen and Maisey, 1987). Burrows *et al* (1995) have shown that all understorey plants on upland jarrah forest sites flower within four years of fire. On low lying sites such as gullies and broad valley floors, some species take six to seven years to flower after fire (e.g. *Melaleuca viminea*). Doubling the juvenile period to allow for adequate replenishment of seed in seed banks, the minimum interval between fire on upland sites is about eight to nine years, and on lowland sites 12 to 14 years. Generally lowland sites will not burn during cool, moist spring conditions, but will burn ferociously under hot, dry and windy summer conditions.

The plan area contains populations of Declared Rare Flora and priority species. Burning comes within the definition of taking under the Wildlife Conservation Act so Ministerial approval must first be obtained before areas containing Declared Rare Flora can be burnt. Any special requirements of these species are considered in the fire prescription.

Research indicates that the immediate impact of fire on fauna is apparently directly proportional to the scale of the fire, the intensity of the fire, the patchiness of the fire and the interval between fires. This impact will be dramatically modified by the presence of predators, such as foxes and feral cats. It is important that fire regimes are appropriate to the threatened fauna in the reserves.

For example, the tammar wallaby requires scrub thickets with certain structural characteristics, these thickets require periodic intense fires to regenerate successfully as tammar habitat. The scrub thickets in which the tammar lives have a limited life of approximately 20 years, and intense fire, burning under dry conditions, is needed to stimulate seed germination and initiate the development of new thickets. The requirements of the tammar have been the dominant factor in the burning plan for the Perup Forest over the past 25 years. Evidence from the studies of other fauna in the Perup Forest suggests that other threatened species and the remaining fauna and flora are well served by the burning regime which has been largely planned for the tammar (Christensen 1991).

Nesting sites for the uncommon Australasian bittern have been identified in Kulunilup and Yarnup Nature


FIRE HISTORY
Scale
2 0 2 4 km
1994 - 95
1993 - 94
1992 - 93
1991 - 92
1990 - 91
1989 - 90
1988 - 89
1987 - 88
1986 - 87
1985 - 86
1984 - 85
1983 - 84
1982 - 83
1978 - 79
1977 - 78
1976 - 77
1975 - 76
1971 - 72
1962 - 63
1958 - 59
1955 - 56
Unburnt Area

Map 6

reserves. Frequent and intense fire may impact their nesting materials and sites.

The Lake Muir/Unicup Reserves contain a number of peat swamps. Fire in the peat swamps, when water tables are low, can burn through the swamps. The result is that the peat beds are removed down to the level of prevailing summer low water within the peat deposit, potentially changing the wetland from a sumpland to a lake, or from a peat-floored sumpland to a sand or clay-floored lake. This can cause fundamental changes in vegetation and flora (V and C Semeniuk Research Group, 1996, unpublished). Fire can be excluded from these habitats by restricting burns on adjacent land to spring when the swamps are still too wet to burn.

Other Considerations

Phytophthora cinnamomi, commonly referred to as Jarrah Dieback, is a significant plant disease in Western Australia and is present in the reserves. This disease has the capacity to cause a rapid and permanent change in some plant associations.

Road and fireline construction and maintenance using infected machinery can lead to the introduction or spread of dieback, and earthworks can alter the hydrology of an area by impeding drainage. This may result in the intensification of disease expression in some vegetation and landform types.

On this basis it is important that all fire management activities are planned and undertaken with strict hygiene measures in place. This process should include a review of the existing road and firebreak network, with the view to ensuring that the positioning of these does not pose unacceptable risk to special communities or landforms. It should ensure that any new construction or roads or firelines must be carried out under strict hygiene and avoid significant environmental impact.

It is intended that all boundary firebreaks and existing strategic access within the larger reserves will be maintained to ensure safe access for the fire fighting vehicles and permit effective fire containment. In these areas internal tracks are used for management purposes only and may be physically closed to the public in years between burns.

Perimeter areas adjacent to cleared land are vulnerable to weed invasion. This invasion is likely to be exacerbated by any activity which disturbs the vegetation or the soil. Fire is a short term disturbing activity in this respect, and is not expected to be a significant agent of introduction and spread at the proposed frequencies. No special requirements for fire with respect to weeds are proposed, although this can be reviewed if significant impact of invading weeds is detected.

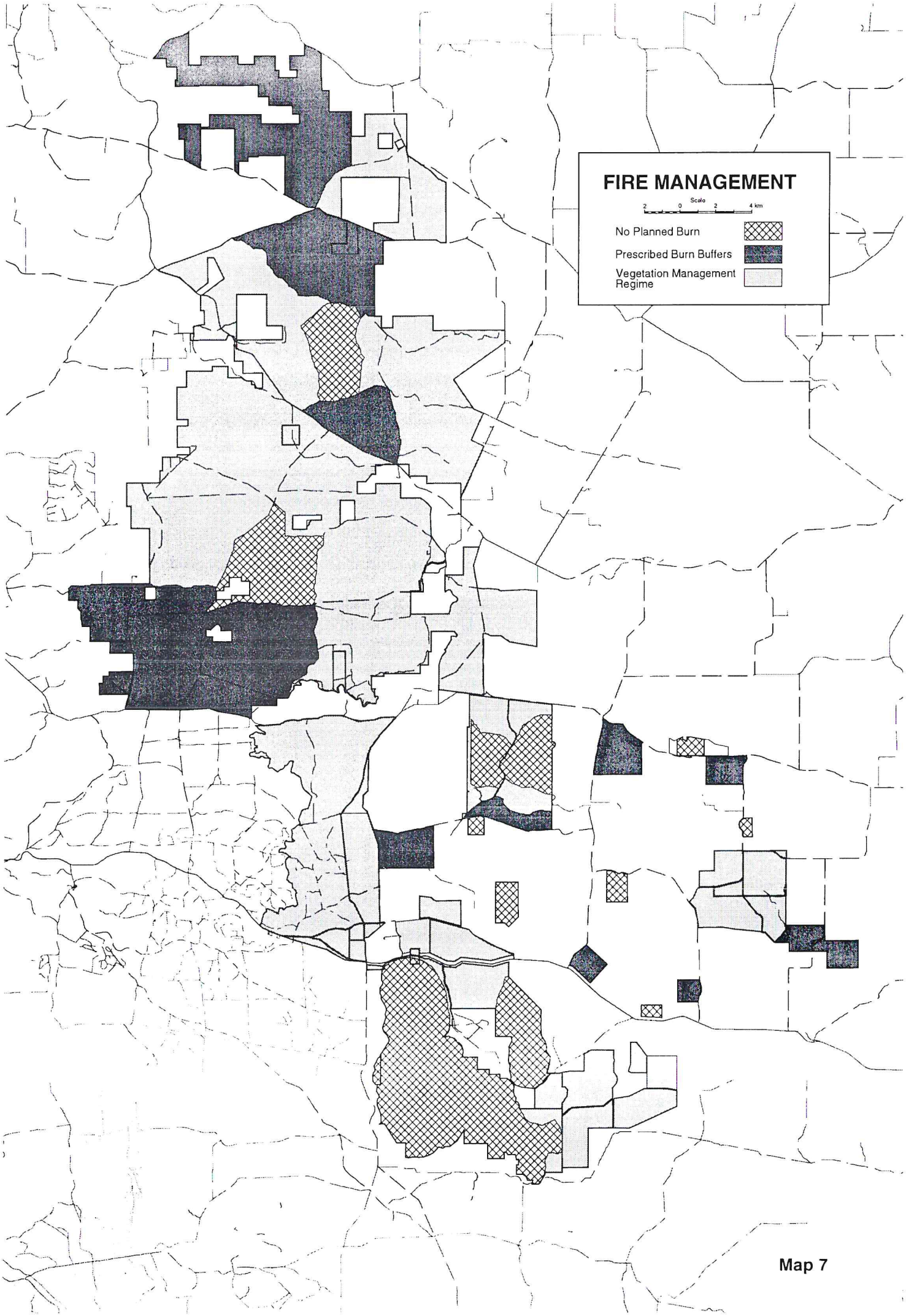
Low key recreation will be permitted in the reserves at the locations identified in Section 14.0. To reduce the risk of wildfires, the use of gas fires only will be permitted in the reserves. Gas fire facilities will be provided at key sites such as the Unicup Lake and Wandoo picnic site (see Section 18.5).

FIRE MANAGEMENT STRATEGY

General

The reserves range in size from 11 300 ha to discrete reserves as small as 70 ha. They currently contain vegetation with a wide range of fuel ages and fuel structures, and the basic strategy is to manage fire to ensure that this mosaic is maintained, and that the values within the reserves are protected from long term damage or loss. The aim of this mosaic is to reduce the likelihood of large tracts of the reserves being burnt at the one time, whilst minimising the risk of wildfires entering and leaving the reserves. The existing network of roads, tracks, and natural features will be used to provide boundaries for fire management activities.

Perup Forest has a burning plan which alternates between spring and autumn burning and incorporates different rotation lengths to create a mosaic of fire ages (see Map 7). This burning plan maximises understorey diversity and includes special burning of tammar thickets. The Lake Muir/Unicup Nature reserves burning plan also alternates between spring and autumn burning.


FIRE MANAGEMENT
Scale
2 0 2 4 km
No Planned Burn
Prescribed Burn Buffers
Vegetation Management Regime

Map 7

Burning Regimes

Three primary burning regimes are to be applied in varying degrees in the each of the reserves in the plan. The combination of theses regimes across the reserves is intended to ensure that we retain and promote a diversity of fuel ages, structures and habitat across the range of vegetation associations.

1. No Planned Burn (NPB)

Sections of the reserves are to be designated 'No Planned Burn'. These areas will not be deliberately burnt for the life of the plan, and some may be retained for reference in the long term. If wildfires should occur in the NPB areas, they will either be immediately attacked to contain them to small size, or they will be allowed to burn to surrounding low fuel buffers or back burning from existing management tracks will be used.

NPB areas may include areas that are known, or likely to be, fire sensitive habitat areas, and areas in which in the absence of adequate biological knowledge and related fire effects must receive conservative fire and other management. Small reserves which contain open waterbodies or wetlands will have a NPB regime in the first instance. This is appropriate since the majority of the reserves would otherwise need to be burnt to provide an adequate buffer.

2. Vegetation Management Regime

Areas which have been assigned this regime are generally those where the adjoining values are not high and where considerable flexibility in the burn rotation is able to be applied. It is proposed to burn these areas in order to provide a mosaic of vegetation structural development and a variety of fauna habitats. The percentage burnt in these areas will vary depending on the fuel types, the season, and the need for burn security. Where possible the total area burnt for each job should exceed about 1000 ha due to possible grazing impacts on small burnt areas.

When appropriate seasonal conditions prevail, it may be possible to burn woodland areas adjacent to rush beds, paperbark thickets and peat swamps without risk of burning these communities. This would ensure retention of nesting sites in rush beds, peat beds and thickets whilst enabling fuel reduction to be performed in the woodland areas. Burning in these sensitive areas will be restricted to spring, with large moisture differential conditions. Such a regime will only proceed if appropriate high moisture conditions prevail. A minimum burn interval of five years will be applied, with the target burn interval being 7-20 years (depending on the vegetation type). It is intended that this opportunistic burning be applied to small and medium sized reserves where their size does not allow the burning of effective strategic fuel reduced buffers.

3. Prescribed Burning Buffers

Broad scale prescribed burning will form the major role in protecting the values within the reserves and adjoining community and private assets. This method of protection has been practised successfully in the reserves since the early 1970's and the management of the reserves and cells within the reserves to maintain a fuel mosaic will be continued. The burns identified for this regime are those which adjoin or protect values within or outside the reserves and where the need to burn to keep fuels within manageable limits is highest. In these areas it is intended that the prescriptions will reflect any special needs such as protection or regeneration of thickets.

Large Reserves / Medium Reserves

Large reserves (>800 ha) and medium reserves (250 - 800 ha) will be burnt under rotation lengths determined according to the rate of fuel accumulation for the predominant vegetation type. In eastern jarrah/marri forest this will normally correspond to a burn rotation of 6-10 years. This will enable fuel quantities to be maintained below 8.5 tonnes/ha, which is the critical level for wildfire control.

Small Reserves

Small reserves (<250 ha) will be burnt only where these are of strategic importance and only when seasonal water levels and fuel moisture conditions allow the reserve to be burnt with minimal risk of burning sensitive thicket habitats or peat swamps. Scrub rolling and burning or protective buffers may be required where values are at risk.

In order to complement the burning on the reserves or to provide protection to areas of the reserves which cannot be burnt (for reasons outlined above), arrangements will be made to facilitate burning of adjoining bushland with the consent of the occupier. This will only be initiated by CALM where it will be of value to the fire protection strategy.

Prescriptions will be prepared for all proposed burns in accordance with CALM's Policy No. 19 (Fire Management). This will also involve the completion of a pre-burn checklist which takes into consideration all potential environmental impacts, especially the need to control dieback, and minimise impacts on landscape and visual resources. All burns carried out by external agencies, i.e. local brigades, will be carried out according to CALM prepared prescriptions. All details will be recorded to check that objectives are

achieved and to increase the knowledge and experience available.

RECOMMENDATIONS

Prescribed Burning

1. Implement the Fire Management Plan for Perup Forest and the Lake Muir/Unicup Nature Reserves (Map 7) which classifies the reserves into 'No Planned Burn', 'Vegetation Management' and 'Prescribed Burning' zones.

2. Identify all peat wetlands in the reserves and where appropriate ensure that they are protected by early spring burns to prevent them being burnt by summer wildfires, which may significantly damage the peat.

3. Monitor the Fire Management Plan annually to take into account major wildfires and completed burning programs. Major modifications to the burn plans must be approved by the Director of Nature Conservation.

4. Modify, relocate or defer burns where planned burns are considered to have a deleterious effect on Declared Rare Flora and Fauna.

5. Undertake Wildfire Threat Analysis to determine prescribed burning priorities if the values in and around the reserves change significantly during the life of the Plan.

Pre-suppression

6. Maintain a network of roads and fire management access tracks, and firebreaks using methods which reduce the risk of introducing, spreading or intensifying dieback, and minimise the risk of soil erosion.

7. Construct and maintain a network of water supply points at strategic locations within or near the reserves.

8. Permit the use of gas fires only at designated recreation sites in the reserves.

Suppression

9. Contain wildfires to the minimum size possible consistent with the regime for each reserve.

10. Minimise use of heavy machinery for fire suppression in small reserves.

Liaison

11. Continue to work closely with local authorities and brigades, adjacent landholders and the Bush Fires Board to ensure an effective fire management force is in place.

Information and Education

12. Work with the Bush Fires Board and local authorities to provide an information and education program on fire safety and survival, the reserves' values and fire risks to neighbours and visitors, to improve their appreciation and support for fire management programs.

Research and Monitoring

13. Continue to monitor the application of Vegetation Management regimes to ensure that these are achieving the prescribed outcomes.

14. Continue research on fire ecology by CALM's Science and Information Division staff and by promoting further research by tertiary institutions.

12.0 INTRODUCED PLANTS AND ANIMALS

The objective is to minimise the impacts of introduced plants and animals on ecosystem values.

Introduced Plants

A bushland or environmental weed can be defined as an unwanted plant species growing in bushland. Weeds displace indigenous plants, particularly in disturbed sites, by competing with them for light, nutrients and water. They can also have a significant adverse impact on other conservation values by altering animal habitats, harbouring pests and diseases, and have the potential to create a fire hazard.

Exotic trees, which may be regarded as weeds, can be removed and where appropriate utilised to provide materials for structures and facilities within the reserves. CALM may also issue a licence to a person to take, remove and sell exotic trees located in the reserves. This requires approval of the Minister for the Environment and the National Parks and Nature Conservation Authority, in accordance with section 99 and 99A of the CALM Act 1984.

Outbreaks of cape tulip (*Homeria flaccida* and *H. miniata*), arum lily (*Zantedeschia aethiopica*) and blackberry (*Rubus fruticosus*) have been found in the reserves. These species, which are declared under the *Agriculture and Related Resources Protection Act 1976,* are controlled with chemicals.

Environmental weeds recorded in the reserves which are not declared under the *Agriculture and Related Resources Protection Act 1976* include:

- watsonia (*Watsonia* sp.)
- tagasaste (*Chamaecytisus proliferus*)
- victorian Ti Tree (*Leptospermun laevigatum*)
- *Pinus radiata*
- *Pinus pinaster*
- Tasmanian Blue Gum (*Eucalyptus globulus*)
- broom bush (*Teline monspessulana*)
- *Robinia pseudoacacia*
- freesias (*Freesia leichtlinii*)
- various Eastern States wattles (*Acacia* species)
- numerous grasses
- *Gladiolus* sp.
- bridal creeper (*Myrsiphyllum asparagoides*)

Methods of weed control, including the use of chemicals, must comply with CALM's Policy Statement No. 14 (CALM's Role in the Management of Bushland Weeds).

The efficiency of control of target species and any effects on non-target species should continue to be assessed, and changes made to procedures if required. Information should be provided to the public on the impacts and control of introduced plants.

Introduced Animals

Non-indigenous animals have a detrimental effect on native animals and plants. Foxes and cats can severely reduce or eliminate native fauna by preying on them or by competing for food and territory. Horses and pigs can cause erosion by destroying native vegetation and can spread *Phytophthohra cinnamomi*, the cause of dieback disease. The management and control of introduced animals varies according to the species and its impact on the environment.

Introduced animals known to occur in the reserves include:

- fox (*Vulpes vulpes*)
- cat (*Felis catus*)
- dog (*Canis familiaris familiaris*)
- pig (*Sus scrofa*)
- rabbit (*Oryctolagus cuniculus*)
- horse (*Equus asinus*)
- house mouse (*Mus musculus*)
- black rat (*Rattus rattus*)
- honeybee (*Apis mellifera*)
- laughing kookaburra* (*Dacelo novaeguineae*)

Control of these animals is implemented by CALM and in some cases Agriculture WA. Methods of control include baiting and trapping programs and opportunistic shooting of foxes, cats, dogs and pigs.

Perup Forest has a long established 1080 baiting program for the control of foxes and feral dogs. The bi-annual baiting program has been successful in reducing fox and dog numbers to the extent that native mammal numbers have increased substantially. Cats are also present in the reserves and could have a similar impact to that of foxes. They appear not to be controlled by the current method of 1080 baiting.

Future baiting of the reserves will be undertaken as part of the Western Shield program. The program is the biggest nature conservation project ever undertaken in Australia to bring back from the brink of extinction native mammal species whose populations have diminished as a result of introduced predators such as the cat. The baits are now distributed over more than 3.4 million hectares of CALM-managed lands.

The presence of feral pigs in the reserves is a major concern. The first official sighting of pigs in the Lake Muir/Unicup Reserves was in 1992. Recent impacts from pigs have been substantial around wetlands and on adjacent farm lands, with diggings occurring

* The laughing kookaburra is not native to Western Australia (it was introduced from the eastern States in 1896) but it is still native Australian fauna and protected under the Wildlife Conservation Act.

through known populations of declared rare flora. Illegal release of feral pigs for the purpose of sport is considered to be the major contributing factor to their recent abundance. The nature of the vegetation types and presence of permanent water make the wetlands a highly suitable area for the ongoing presence of feral pigs and considerable ongoing control work is required.

Rabbits can cause erosion, weed invasion, loss of native plant species by overgrazing, and compete with native fauna for food and shelter. The impact of other introduced animals in the reserves is not well documented.

The efficiency of control of target species and any effects on non-target species should continue to be assessed, and changes made to procedures if required. Information should be provided to the public on the impacts and control of introduced animals.

RECOMMENDATIONS

1. **Develop an inventory of introduced plants and animals and monitor these populations.**

2. **In conjunction with Agriculture WA and adjacent landholders, further develop and implement programs to prevent introduction, and control existing populations of exotic plants and animals, as resources allow.**

3. **Continue and expand the current fox baiting program in Perup Forest under the Western Sheild to include appropriate areas of the nature reserves**

4. **Continue and expand active trapping, shooting and baiting of feral pigs in the reserves.**

5. **Liaise with Agriculture WA, neighbours, local Government and other relevant authorities to encourage an integrated approach to introduced animal and plant management.**

6. **Remove exotic trees where considered necessary. If the trees are to be taken under licence and sold, follow the approval procedures of the CALM Act.**

7. **Monitor the efficiency of control programs on target species and any effects on non-target species and make changes to procedures if required.**

8. **Encourage volunteers, educational institutions and other organisations to participate in research projects related to introduced plant and animal issues in the reserves.**

9. **Inform users of the reserves about the impacts of introduced plants and animals and their management, particularly via the Perup Forest Ecology Centre.**

13.0 REHABILITATION

The objective is to rehabilitate degraded areas to a stable condition resembling the natural environment as closely as possible.

There are a number of disused gravel pits in the nature reserves which require rehabilitation. Sand extraction areas in Perup Forest are being rehabilitated by the lessee following the expiration of leases at the end of 1995.

Degraded sites will be rehabilitated in accordance with CALM Policy Statement No. 10 (Rehabilitation of Disturbed Land) and guidelines. Wherever possible the seeds and cuttings from species in the immediate location will be used and landforms and soil profiles will be rehabilitated to resemble as closely as possible the natural landforms in the vicinity. Rehabilitation will be ongoing and periodically monitored.

RECOMMENDATIONS

1. **Prepare a rehabilitation program.**

2. **Rehabilitate degraded areas in accordance with CALM Policy Statement No. 10 (Rehabilitation of Disturbed Land) and guidelines.**

3. **Review the rehabilitation on an annual basis.**

4. **Provide opportunities for interested individuals and groups to be involved in rehabilitation projects.**

RECREATION AND TOURISM

14.0 RECREATION STRATEGY

The continued enjoyment by visitors of the Perup Forest and Lake Muir/Unicup Nature Reserves can only be assured while these areas are managed to protect their conservation values and to maintain the natural environment.

The management philosophy for the reserves is to meet the needs of visitors seeking nature-based activities. This will be achieved by acknowledging visitor needs and providing, where appropriate, quality recreation experiences. Recreation activities will be managed to protect conservation values and to maintain the natural environment and social values of recreation settings in perpetuity.

PRINCIPLES

Preservation of the Values of the Land Itself
The natural systems (including landscapes, particular sites, biota) should be able to sustain the recreation which is occurring or is proposed. The intensity of recreational activities may need to be controlled to ensure it does not destroy the values and nature of the land.

Consistency of Recreation with Purpose of Vesting
Recreation activities should be compatible with the vested purpose of the reserves. The vested purpose of nature reserves provides for passive recreation and nature appreciation. The proposed purpose change to a small part of Lake Unicup Nature Reserve will allow for recreational use such as waterskiing (see Section 3.1 Boundaries and Land Tenure).

Equity
A range of activities, consistent with purpose, should be allowed in the reserves. However, uses which impair other forms of use or jeopardise safety of other users should be controlled or eliminated. Priority will be given to low impact activities and those that increase awareness, appreciation and understanding of the natural environment.

Management
Activities and facilities should be supervised where conservation values may be impaired. If effective management cannot be provided the activity or facility should be restricted, relocated or eliminated.

15.0 RECREATION OPPORTUNITIES

The objective is to provide a range of minmum impact nature-based recreation opportunities while protecting environmental values and minimising conflicts between user groups.

Perup Forest and Lake Muir/Unicup Nature Reserves are located in CALM's Manjimup District in the Southern Forest Region.

Recreational experiences provided for in the Southern Forest Region are based on the natural environment and require varying degrees of infrastructure and management. The Region is quite sparsely populated, heavily forested, primarily with karri and southern jarrah forests, but with other wide open natural spaces. The coastline is relatively inaccessible and spectacular.

Historically, and for the most part, the recreation focus within the Manjimup District has been in the karri forest at sites on, or close to, the main access roads with only a few key recreation sites in the eastern forest, largely maintained by agencies other than CALM. Manjimup District is the northern gateway to the karri forest and is generally promoted as such by the local tourist bodies and the opportunity to experience karri is reasonably well catered for at a variety of sites.

The eastern 'half' of the District is not as well known or promoted by the local tourist industry yet contains diverse and unique ecosystems, particularly wetlands and mixed jarrah/wandoo forest which are home for a variety of threatened native fauna species. Scope exists to provide a wider range of nature-based recreation and interpretation opportunities within the District that will not duplicate existing opportunities but provide new opportunities and meet new demands. A regional perspective is essential when planning for recreational opportunities in the reserves in order to complement existing opportunities elsewhere in the region.

The reserves will be developed and managed to facilitate mainly low-key recreational pursuits, that is minimum facilities, minimum impact activities. Activities that have minimal or no adverse impact on the environment may be allowed. Activities that are likely to result in extensive or long term disturbance to the natural environment will not be allowed.

RECOMMENDATIONS

1. **Prepare a comprehensive Recreation Plan for the reserves.**

2. **Ensure that Site Development Plans are produced and approved before development works are undertaken.**

3. **Continue to provide education and recreation opportunities in the Perup Forest to complement opportunities available elsewhere on CALM-managed and other public land in the region.**

4. **Ensure a regional perspective is taken by developing education and recreation opportunities in the Lake Muir/Unicup Nature Reserves to complement opportunities available elsewhere on CALM-managed and other public land in the region.**

5. **Provide nature-based recreation opportunities and facilities with minimal environmental impact which will appeal to a wide range of community interests.**

6. **Work with State and local authorities in promoting minimum impact visitor use which is appropriate in the reserves.**

7. **Preserve the unique opportunities and features that attract visitors to the area.**

16.0 ACCESS

The objective is to provide and maintain suitable access while ensuring the reserves' values are not adversely affected.

Tracks within the reserves are numerous. It is proposed to rationalise vehicle access in the reserves. This may involve stabilising and realigning designated tracks, closing and rehabilitating the remainder and permitting seasonal use of some tracks. An area of Perup Forest is proclaimed as a Disease Risk Area (DRA). This means that access to this area of the reserve requires a permit.

Vehicle access has resulted in degradation of the shoreline of some wetlands. Vehicle access along the wetland shorelines needs to be controlled.

Proposed access in the reserves needs to consider:
- dieback;
- access requirements for fire management; and
- safety of visitors.

Lake View Road is a closed road which has been used illegally for some years. This road should be upgraded to an all weather access standard and permitted to be used as an open road. It is also proposed that all weather access be developed into tammar viewing areas in Perup Forest.

Where there is a need to establish or re-establish access in accordance with this management plan or provide fire breaks, forest produce may be ulilised within the reserves or removed and sold under licence. The taking and removal of the forest produce as essential works must benefit the reserves. Where a licence is issued to a person to take and remove forest produce the approval of the Minister for the Environment and the National Parks and Nature Conservation Authority is required. Further, if the forest produce removed is to be sold, the public must be notified at least two weeks in advance in accordance with Section 99A of the CALM Act. Approval is not required if all the forest produce from essential work is used within the reserves.

RECOMMENDATIONS

1. **Rationalise the vehicle access system in the reserves.**

2. **Design and maintain vehicle access to minimise the risk of spreading dieback disease and causing erosion.**

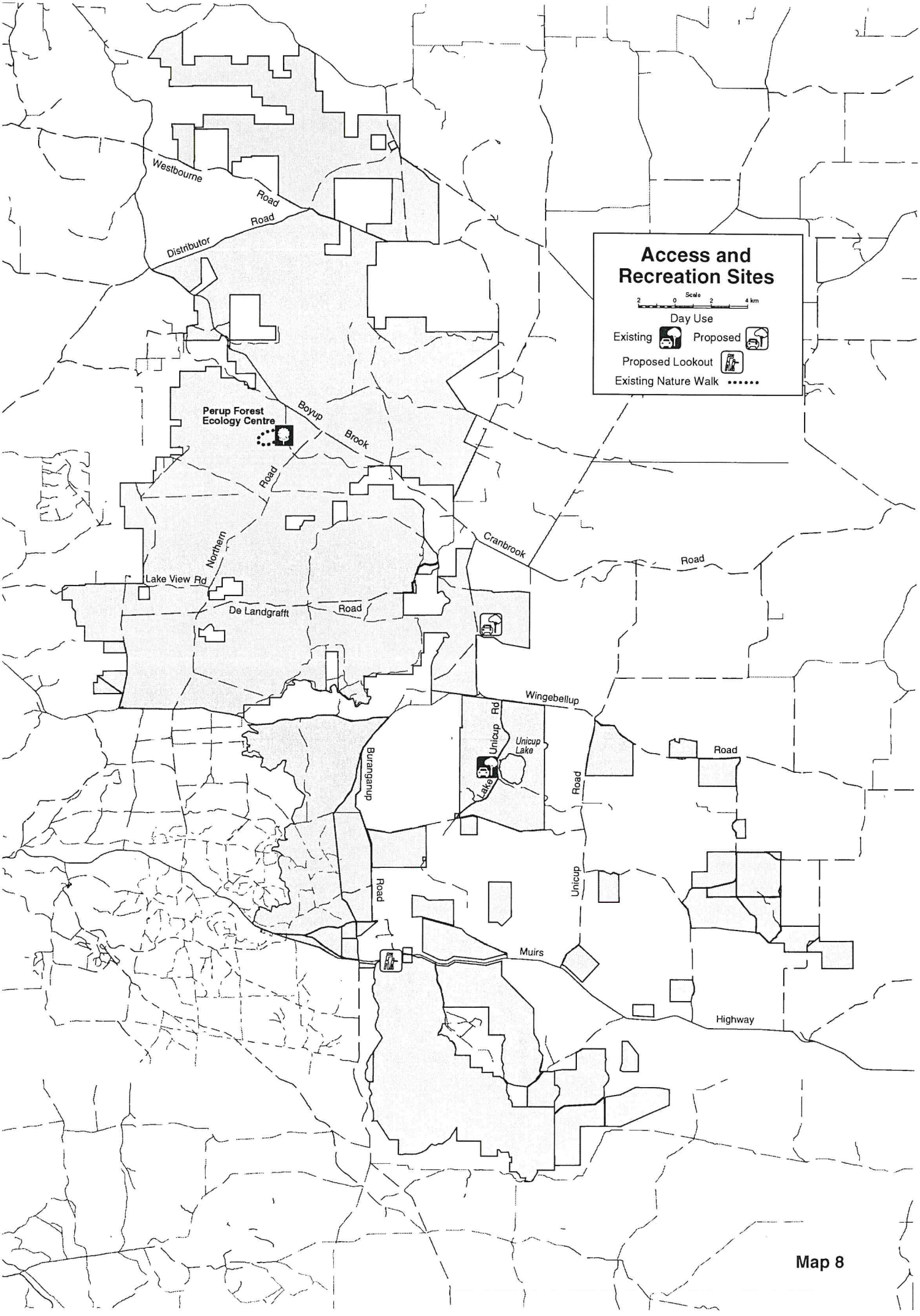
3. **Prohibit, if necessary, visitor access to specific areas for wildlife conservation, safety or other reasons.**

4. **Close and rehabilitate tracks that are not required for public access or management. Involve the community in rehabilitation projects (see Section 13.0 Rehabilitation).**

5. **Remove forest produce, where appropriate, that is associated with essential works with approval under the CALM Act.**

17.0 RECREATION AREAS

The objective is to provide and maintain suitable recreation areas while ensuring the reserves' values are not adversely affected.


Access and Recreation Sites
Scale
2 0 2 4 km
Day Use
Existing
Proposed
Proposed Lookout
Existing Nature Walk
Westbourne Road
Distributor Road
Perup Forest Ecology Centre
Boyup Brook Road
Northern Lake View Rd
De Landgrafft Road
Cranbrook Road
Wingebellup Road
Unicup Rd
Unicup Lake
Lake Unicup Road
Burganup Road
Unicup Road
Muirs Highway
Map 8

Lake Unicup Site
It is proposed to redesign the recreation site at Unicup Lake. Facilities may include toilet, picnic tables, information display, gas barbecues, carpark, signs, boat launching facility and jetty.

Lake Muir Site
It is proposed to develop a lookout at Lake Muir accessed from the Muir Highway. The site may include an elevated boardwalk, toilet and an interpretive display. The site may also be suitable for a short nature study walk if the need is identified.

Wandoo Picnic Site
It is proposed to develop a picnic site in an area of Wandoo in Perup Forest. Facilities may include a parking area, picnic table, information and toilet.

Tammar Hide
It is proposed to develop a site in the proposed Perup Forest for the observation of tammars. The site would include a hide and parking area.

RECOMMENDATIONS

1. **Design, develop and maintain recreation areas and facilities to departmental standards. Site development plans will be required.**

2. **Monitor the levels of change and impacts of visitor use on recreation areas and facilities. Alter recreation and tourism management where appropriate.**

18.0 RECREATION ACTIVITIES

The objective is to provide and facilitate nature-based recreation activities that are compatible with the goals of this plan.

Given that recreational pursuits should be dependent on the values of the area and consistent with maintaining the reserves' natural character, the following criteria have been applied to determine the acceptability of recreation activities:

- Activities will be based on the values of the area. The participation in, or enjoyment of the activity will be in some way dependent on the natural features and resources.
- Activities will be compatible with other recreational uses of the area and will not diminish the enjoyment of other users.
- Activities will depend on the availability of resources.
- Priority will be given to those activities that do not degrade the area or reduce its conservation values.
- The intensity of the activity will be controlled, if necessary, to ensure that it does not degrade the conservation values of the reserves.

18.1 Nature Study/Appreciation

Nature study and appreciation includes such activities as bird watching, spotlighting, photography, landscape painting and drawing and writing. Nature study particularly is a popular activity. The provision of various types of access facilitates these activities and the provision of interpretation enriches visitor experiences.

Through greater awareness and understanding of the natural environment, visitors are likely to gain a greater appreciation of the conservation values of the reserves as well as the social values that the natural environment inspires. Opportunities are available to enhance visitors' appreciation of the environment through interpretive programs (see Section 22.0 Information, Interpretation and Education). These programs could be based on particular themes such as birdlife, threatened fauna, the role of fire in ecosystem management, wetland management and cultural heritage of the area.

Nature study walks are proposed from the Perup Ecology Centre in the Perup Forest. Key access for spotlighting activities will also be identified in Perup. Other sites suitable for nature study walks may be identified and developed in the reserves.

RECOMMENDATIONS

1. **Provide visitors with a variety of opportunities to experience and appreciate the reserves' natural features.**

2. **Liaise with Birds Australia, the West Australian Wildflower Society, the Western Australian Naturalists Club, Friends of Perup and other local naturalist groups to identify other appropriate nature based activities and facilities.**

18.2 Bushwalking

Bushwalking is an activity that is enjoyed by people of all ages, interests and levels of fitness. Commercial tour operators are also becoming increasingly more interested in bushwalking tours.

The impact of walking on the physical environment, while generally low, is variable depending on soil conditions, vegetation type and intensity of use. Where use levels are high, walking can lead to the loss of vegetation as well as localised soil compaction and erosion problems. These problems must be minimised effectively through the sensitive location, design and maintenance of walks and suitable education.

It is proposed to develop a selection of bushwalks in the reserves using the following guidelines:

- walks should provide a variety of opportunities in alignment, length and difficulty;
- beginnings of walks should be relatively accessible to vehicles to facilitate visitor and management use, and provide information about the walk;
- walk alignments or routes should, at places, be located along or near the boundaries of different landforms, soil types or plant communities to provide maximum visual diversity, recognising the special significance of ecotones; and
- walks should be in locations that are capable of sustaining them.

A loop walk track starting from the Perup Ecology Centre has been developed in Perup Forest. Other walks may be developed in the reserves as need arises.

RECOMMENDATIONS

1. **Develop foot access in the reserves according to the guidelines set out above.**

2. **Close foot access temporarily or permanently where the results of monitoring indicates that this is appropriate to protect the environment or, in extreme fire danger, the walker.**

3. **Monitor the environmental impacts of bushwalking and whether bushwalking opportunities are meeting visitor needs.**

4. **Provide interpretive and educational material for walkers with emphasis on the reserves' conservation values.**

5. **Encourage guided walks in association with Birds Australia, the WA Wildflower Society, the WA Naturalists Club, Friends of Perup, and other local naturalist groups.**

18.3 Water-based Activities

Waterskiing occurs on Unicup Lake within Unicup Nature Reserve. Facilities associated with the use of the lake for waterskiing were erected at the site by the Unicup Water Ski Club in 1968. The Club is a small group which maintains the associated recreational facilities.

Unicup Lake is one of many wetlands in the system and is the only wetland permitted to have active recreational use. There is limited local recreation opportunities in the area and the lake is an important community recreational resource. On present knowledge the conservation values of Unicup Lake are less significant that those of other wetlands in the system.

Under the current tenure of Unicup Lake, waterskiing is not consistent with the reserve's vested purpose. The proposed purpose change in Section 3.1 will rectify this.

It is proposed that an area of Unicup Lake be changed to a Conservation Park and its status remain as 'A' class. The remaining area of the reserve will stay as nature reserve. This proposed change of purpose allows for waterskiing and associated recreational use while still protecting conservation values.

Active water-based recreation such as power boating and waterskiing can have a detrimental effect on the environmental condition of wetlands. The impacts of such activities on Unicup Lake will still need to be closely monitored and the activities modified if adverse impacts are observed.

Water-based activities, including canoeing, boating, sailing, and swimming are not permitted on the remaining wetlands in the reserves.

RECOMMENDATIONS

1. **Permit waterskiing in a gazetted area on Unicup Lake.**

2. **Monitor water-based activities on Unicup Lake and modify or prohibit where adverse impacts are observed.**

3. **Continue to prohibit any water-based recreational activities on the reserves' wetlands, except for the gazetted area on Unicup Lake.**

4. **Provide information on the conservation values of the wetlands to explain to visitors why recreational water-based activities are not permitted on these wetlands.**

5. **Liaise with the Department of Transport in relation to providing information to visitors on regulations and safety requirements.**

18.4 Cycling

Cycling is rapidly increasing in popularity, particularly mountain bike riding. Potential exists at Perup Forest for the provision of bike riding along existing access roads in the reserve. Access to the proclaimed Disease Risk Area (DRA) in Perup Forest requires a permit.

RECOMMENDATION

1. **Identify existing access roads and tracks in the reserves suitable for bicycle riding and advertise these to visitors where appropriate.**

18.5 Picnicking and Barbecuing

Currently the only facilities provided for picnicking and barbecuing are adjacent to the Unicup Lake waterskiing site. Other sites suitable for picnicking may be identified in the reserves. Appropriate facilities which may include picnic tables, toilets and gas barbecues will be located at these sites. A picnic site is proposed in an area of Wandoo in Perup Forest. Wood fires are not permitted in the reserves because of the risk of wildfire and the impacts of firewood gathering on native vegetation.

RECOMMENDATIONS

1. **Provide low key facilities for picnicking and barbecuing in the reserves.**

2. **Prohibit wood fires in the reserves.**

18.6 Scenic Driving

Scenic driving is a popular activity. Roads and tracks in the reserves afford views of the diverse range of vegetation and landforms in the reserves. Facilities which could be provided include small carparks, short nature walks and interpretive signs.

RECOMMENDATIONS

1. **Identify roads that may be promoted and managed as scenic drives.**

2. **Provide appropriate facilities for drivers to stop and enjoy the environment.**

18.7 Horseriding

According to CALM policy, horseriding is not permitted in nature reserves. Horseriding can adversely affect the natural environment. Potential impacts within the reserves include; soil erosion, trampling and grazing of native vegetation, introduction and spread of plant diseases and weeds, siltation and fouling of watercourses and the potential for conflict with other visitors.

RECOMMENDATIONS

1. **Prohibit horseriding in the reserves.**

2. **Inform visitors where appropriate why horseriding is not allowed in the reserves.**

19.0 COMMERCIAL VISITOR SERVICES

The objective is to encourage tour operations in a manner consistent with conservation and other goals.

To enhance visitor use and enjoyment of CALM-managed lands, commercial concessions providing appropriate services may be granted. It is recognised that many CALM-managed reserves have the natural resources to provide for many facets of nature-based tourism. Through these activities potential exists to generate income to financially assist in the management of the reserves.

With the growing popularity of nature-based tourism, opportunities exist for partnerships between CALM and private sector tourist operators. CALM has a complementary role with the tourism industry in managing and presenting natural assets (Shea and Sharp, 1992). Management strategies, including conditions attached to commercial licenses, will ensure that visitors are given the opportunity to appreciate the reserves and at the same time protect and preserve their natural and cultural values in perpetuity.

There are currently six commercial operators conducting spotlight tours and guided walks in Perup Forest. The primary attractions are the richness, diversity and accessibility of the wildlife and the wilderness experience. There are currently no commercial operations within the Lake Muir/Unicup Nature Reserves. Potential exists at the Lake Muir Reserves for sensitive terrestrial nature-based tours.

Existing commercial operations will continue to be monitored with special attention to their environmental impacts. License operating conditions will be regularly reviewed and modified to address specific problems, and if necessary licences can be cancelled. New applications for commercial concessions will be assessed as to their suitability by CALM, and all licences must be approved by the NPNCA and the Minister for the Environment.

Expressions of interest or tenders to fill a specific need will be sought for new licences or leases. This process is required where there have been numerous applications and enquiries for only one or limited concessions. If approved, conditions will be established according to the potential environmental and social impacts on the reserves and the surrounding area.

Commercial operators deal with visitors on a regular basis and, therefore, play a significant role in disseminating information. A training and accreditation process should be facilitated to improve commercial operators' understanding of the area's values and management issues, and to enhance visitors' experiences.

Perup Forest Ecology Centre

The Perup Ecology Centre is located on a 100 ha area of State forest and is surrounded by the Perup Forest. Although the Centre is not actually located within the proposed area for the Perup Nature Reserve, its use is important to the management of the proposed Perup Nature Reserve. A redevelopment and business plan has been prepared for the Ecology Centre. This plan recognises the potential for nature-based tourism at the Centre. The location of the Ecology Centre provides a unique opportunity to view some of Australia's rarest animals in their natural habitat, and provides a base for interpretive and wilderness experiences in the forest.

The redevelopment and business plan specifies the size of the redevelopment at the Forest Ecology Centre. Limiting the size of the facilities developed adjacent to the nature reserve will ensure the qualities valued by visitors, being the solitude and opportunity to observe wildlife in their natural surroundings, are preserved.

Major users of the Centre include nature-based tours, community groups such as the Friends of Perup, students, and CALM research staff. The strategy outlined in the redevelopment and business plan will increase visitation by schools, eco-tourist groups and the Friends of Perup organisation. Facilities include low key walk trails and observation hides, and modern buildings and facilities to accommodate a wider section of the community. Revenue raised from the use of the Centre could be used for the management of the Centre such as maintenance, community education and other projects, as well as providing a means for greater management presence.

The Ecology Centre is an important tourism attraction in the region as there are very few nature-based tourism opportunities in the surrounding district. The facilities at Perup enable tour operators to import clients from outside the region and virtually guarantee that they will see wildlife in its natural environment.

The plans for the Forest Ecology Centre are also incorporated in the CALM Southern Forest Region Recreation and Tourism Framework Plan and the Centre is a member of the South West Development Commission's Ecomuseum Association.

RECOMMENDATIONS

1. **Require all commercial operators using the reserves to obtain a CALM Commercial Operators License and to pay necessary fees.**

2. **Monitor and regulate commercial activities through numbers of licences and licence conditions to ensure that they do not compromise the sustainability of the natural resource.**

3. **Ensure that a condition of commercial operators licences is to maintain appropriate safety standards with respect to their clients and reserve users.**

4. **Liaise with tour operators, the WA Tourism Commission, local tourist bureaus and the Friends of Perup organisation so that they are aware of management initiatives, developments and road conditions and to ensure the promotion of the reserves is consistent with the management objectives.**

5. **Facilitate liaison with, and training and accreditation of, commercial operators through appropriate means.**

6. **Ensure commercial operators maintain appropriate standards with respect to information and quality of service provided.**

7. **Consider all commercial proposals that are consistent with the objectives of this management plan and the purpose of the reserves.**

20.0 VISITOR SAFETY

The objective is to take all reasonable and practicable steps to ensure the safety of visitors to the reserves.

People visiting any natural area face inherent risks and dangers. Potential hazards in the reserves area include:

- danger from falling branches;
- snake bites;
- threats of wildfire;
- swimming in untreated water;
- swimming in areas with underwater obstructions or hazards;
- exposure in remote areas in winter and lack of water and sunburn in summer;
- accidents associated with bushwalking on rough tracks, eg. sprained ankles, cuts and bruises;
- driving on bush roads; and
- boating accidents.

Walk tracks and other facilities are expected to be developed and maintained to provide safe visitor experiences.

RECOMMENDATIONS

1. **Provide and support provision of educational material aimed at visitor safety.**

2. **Locate and design recreation facilities to minimise potential risks to visitors.**

3. **Make provision for dealing with safety threats, accidents and search and rescue operations.**

4. **Train staff to assist in emergency situations.**

21.0 DOMESTIC ANIMALS

The objective is to protect the reserves and visitors from the impacts of domestic animals.

According to CALM policy, dogs, cats, horses and other domestic animals are not permitted in nature reserves. Domestic animals can disturb wildlife and visitors, can introduce disease and foul recreation areas. For example, the smell and general activity of domestic animals impedes activity of wildlife. Other problems include the spread of dieback disease and weed species by horses and other hooved animals. The reserves must be protected from potential problems associated with domestic animals.

Guide dogs for the blind and tracker dogs being used in search and rescue operations are permitted in all reserves.

RECOMMENDATIONS

1. **Prohibit domestic animals, including horses and dogs, in the reserves.**

2. **Inform visitors of the reasons why domestic animals are not allowed in the reserves.**

COMMUNITY RELATIONS

22.0 INFORMATION, INTERPRETATION AND EDUCATION

The objective is to increase awareness, appreciation and understanding of the values of the reserves, and support the strategies used to manage and conserve them.

An effective information, interpretation and education program is essential to achieve the goals and objectives for the management of the reserves. It informs the public of attractions, facilities and opportunities available and provides an avenue for an appreciation and a greater understanding of the natural environment. At the same time, it fosters appropriate behaviour so that adverse impacts on the environment are avoided.

The program has three parts:

- Information - providing details of facilities, activities and regulations;
- Interpretation - reveals meanings and relationships between cultural and natural values; and
- Education - providing detailed materials and programs designed to facilitate learning, focussing on target groups (eg. school groups, community groups).

An integrated information, interpretation and education program will be developed for the reserves. Mechanisms for facilitating the program include signs, displays, publications and activities.

Information will be designed to enable visitors to become orientated, be aware of access routes and opportunities available and to advise of the restrictions in the reserves and the reasons for these restrictions.

Interpretive stories should encourage exploration toward enhancing visitors' experiences and understanding the areas' values. A number of sites should be identified in the reserves for provision of a range of messages. Messages could include the role of fire in ecosystem management and the remnant fauna of the area, the importance of the complex of wetlands in the reserves, the control of foxes and the use of 1080, the reserves' birdlife and communities, and cultural heritage of the area.

It is important that the information conveyed is integrated throughout the reserves, the District, and the Region (sites should provide a different thematic story and also reinforce recurring messages regarding minimising visitor impact).

RECOMMENDATIONS

1. **Develop and implement a visitor information, interpretation and education program for the reserves that highlights the reserves' natural features (including flora and fauna), cultural heritage, and management issues.**

2. **Develop information, interpretation and education opportunities as appropriate in the reserves.**

3. **Provide interpretive activity programs, including guided and self-guided tours for schools, community groups and other visitors, using volunteers where appropriate.**

4. **Monitor all programs regularly and revise as required.**

23.0 COMMUNITY LIAISON AND INVOLVEMENT

The objective is to develop, encourage and facilitate effective involvement of the community and other relevant authorities in management.

Liaison helps create effective communication and is an essential component of management, providing a forum for the community to contribute to the management of the area and be informed about values and management issues. Communication with neighbours and other land managers also provides for integrated land management which is of particular importance when management issues go beyond the boundaries of the reserves such as surface and ground water management, fire, weeds and visual landscape management.

Community Involvement

Community involvement is an integral part of CALM's operations. The community is encouraged to be involved in planning and management at all levels of the organisation, including through volunteer programs. The principal benefits from community involvement are better informed decisions which will have greater public acceptance, a better relationship between CALM and the public through the development of an appreciation for the Department's

role, responsibilities and actions, and the availability of additional resources, including information, labour, and financial support.

The reserves have a high ratio of boundary to area. With many adjacent neighbours there is greater potential for impacts from altered water flows, salinisation, weeds, uncontrolled fire, and feral animals. However, there are also benefits such as the increased role of the community in the detection and suppression of fires. The reserves are within the boundaries of the Manjimup, Boyup Brook, Mobrup, and Frankland Below Gordon Land Conservation District Committees. The Unicup Landcare Group, within the reserves' catchment boundaries, is part of the Manjimup Land Conservation District. Interaction with these groups is very important to provide for integrated land management.

A community based non profit organisation has been formed for Perup Forest. The Friends of Perup has as its basis the premise that as more people realise the values of the Forest, then the deeper their understanding of complex land management issues becomes. Thus it is dedicated to broadening the access to and use of the facilities, and contributing to the management of the Forest in a sustainable manner which benefits the local community, protects the natural assets, and involves community participation.

The local community has become actively involved in the management of the Perup Forest Ecology Centre. CALM has run spotlighting and lecture nights in conjunction with the Boyup Brook Land Conservation District Committee. These and other activities raise community awareness and interest in the unique natural assets of the Perup Forest.

Government Agency Liaison

Liaison with the Shires of Boyup Brook, Cranbrook and Manjimup is essential for:

- integrated fire and disease management;
- integrated management of the Shire reserves within the area; and
- provision and maintenance of the public road network.

Liaison with Agriculture WA is essential for:

- integrated feral animal (particularly pig) control; and
- integrated weed eradication and control

Liaison with the Water and Rivers Commission and Agriculture Western Australia is essential for:

- integrated catchment management and rehabilitation.

Ongoing liaison with the Bush Fires Board, local Bush Fire Control Officers and volunteer brigades regarding fire protection is essential. It is very important that CALM ensures that other Government agencies whose role overlaps with the reserves recognise the values of the area and the main issues of concern, and the part that they play in the protection of the environment of these areas.

It is of particular importance to maintain liaison with other agencies such as Western Power, Main Roads Western Australia, Department of Minerals and Energy, Telstra, South West Development Commission, Western Australian Tourism Commission, Department of Transport, and the Ministry for Planning.

RECOMMENDATIONS

1. **Maintain liaison with adjoining landowners, Land Conservation District Committees, landcare/catchment groups, local authorities and Government departments to ensure that, as far as possible, land management is integrated.**

2. **Encourage shires and the local community to take responsibility for weed control, feral animal control and visual resource management on adjoining lands.**

3. **Continue involvement and develop partnerships with local individuals and organisations, such as school communities, with an interest in conservation and land management in the reserves.**

4. **Encourage and recognise public participation in implementing this plan.**

5. **Promote and provide advisory services to local communities on issues impacting on the reserves.**

OTHER USES

24.0 MINING, MINERAL AND PETROLEUM EXPLORATION

The objective is to minimise the impact of mining, mineral and petroleum exploration on the reserves.

An exploration tenement occurs over Perup Forest and mining tenements occur over Red and Cowerup Lakes in VCL adjacent to Lake Muir Nature Reserve. Government policy and legislation on mineral and petroleum exploration and mining in nature reserves require that no tenements will be approved until the Minister for the Environment clears these activities with the Minister for Mines. Normally the National Parks and Nature Conservation Authority provides advice to the Minister for the Environment. Proposals for explorations and mining may be referred to the Department of Environmental Protection (DEP) and the Environmental Protection Authority (EPA) for assessment. All exploration activities are subject to stringent environmental controls.

Mining will not be permitted in 'A' class nature reserves and conservation parks unless approved by both Houses of Parliament.

Any exploration and mining activity is likely to have a significant impact on the reserves' values and, given their high conservation values, should be opposed. If approved, exploration and mining should be subject to, and meet with, conditions that will ensure the impacts on conservation values are minimised.

RECOMMENDATIONS

1. **Oppose exploration, mining and petroleum resource development that would have a deleterious impact on the reserves' values.**

2. **Liaise with the Department of Environmental Protection, the Department of Minerals and Energy and the mining and petroleum industries over any proposals for mineral or petroleum resource development adjacent to the reserves or within their catchments to ensure that the reserves' values are protected.**

24.1 Basic Raw Materials

The objective is to minimise the impact of the extraction of basic raw materials on ecosystem values.

Basic raw materials, including gravel, limestone, marl sand and rock aggregate, are needed for road construction and maintenance, and recreation site developments within the reserves. It is preferred that these materials are obtained from outside the reserves, or from areas that are already disturbed or which are of lower conservation value.

Gravel and other industrial materials may only be extracted from the reserves in accordance with the NPNCA Policy Statement on Basic Raw Materials. Extraction is regulated under the Local Government, CALM and Mining Acts.

Leases for the extraction of sand in the Perup Forest expired at the end of 1995 and will not be extended.

RECOMMENDATIONS

1. **Follow the NPNCA's Policy Statement on Basic Raw Materials when considering proposed and existing extraction of raw materials from the reserves.**

2. **Enforce dieback hygiene measures when extracting raw materials and maintain dieback-free pits in a dieback-free condition.**

3. **Rehabilitate all or parts of pits as material extraction is completed. Remove top-soil separately and store it for later rehabilitation work. Use seed collected within the area for rehabilitation work wherever possible.**

25.0 APICULTURE

The objective is to mimise the impact of apiculture on the reserves' nature conservation values.

Commercial beekeeping involves the short term placement of managed populations of the introduced honeybee (*Apis mellifera*) into areas of land to take advantage of the availability of nectar or pollen.

There has been considerable debate over the possible environmental effects of honeybees on the Australian biota, especially in relation to managed apiary operations in national parks and nature reserves. Environmental concerns have focused on:

- the effects of competition for nectar and pollen between honey bees and native pollinators;
- the efficiency of pollination by honeybees; and
- the displacement of native birds and mammals from nesting hollows by feral colonies.

The environmental implications associated with the presence of honeybees from commercial hives are not yet fully understood. Further research is required to fully understand the impact of the interaction of honeybees on native flora and fauna.

Under current policy (Policy Statement No. 41, 1992), CALM will continue to assist the apiculture industry in so far as it is consistent with the Department's responsibilities in conservation and land management. The policy provides for apiary sites to be relocated at acceptable intervals, taking account of constraints such as the need to avoid transferring disease, including dieback and diseases of honeybees, and the occurrence of declared rare flora. Until CALM's policy for apiculture is reviewed no new sites will be permitted in the Perup Forest and Lake Muir/Unicup Nature Reserves.

There is currently only one apiary site remaining in the Lake Muir/Unicup Nature Reserves. However, this apiary site is scheduled for relocation outside the reserve within the year. The two apiary sites previously located within the Perup Forest and managed by one registered beekeeper, have been relocated out of the reserve.

RECOMMENDATIONS

1. **Review hive locations and access to these sites subject to current CALM policy.**

2. **Manage access to sites in accordance with dieback hygiene principles. Cancel and relocate sites (if possible) if access poses an unacceptable disease risk.**

3. **No additional sites will be permitted in Perup Forest and Lake Muir/Unicup Nature Reserves until CALM's policy for Apiculture is reviewed.**

26.0 UTILITIES AND SERVICES

The objective is to minimise the impact of utilities and services on the values of the reserves.

Western Power and Telstra service lines and transport links traverse the reserves. Muir Highway and Boyup Brook-Cranbrook Road are the major roads that cross the reserves.

Future proposals for utilities and services should be based on physical, biological, social and visual considerations, and their relationship with other land uses. All proposals that may have a significant adverse impact on the environment will be referred to the Department of Environmental Protection (DEP) and the Environmental Protection Authority, and will be subject to environmental impact assessment in accordance with the *Environmental Protection Act 1986*.

RECOMMENDATIONS

1. **When the opportunity arises, negotiate to place new utility and service corridors outside the reserves or in association with existing utilities.**

2. **If a utility or service corridor must go through the reserves, ensure that its placement and maintenance have minimal impact on the environment and strict dieback hygiene measures are implemented.**

3. **Control and monitor the effects of utility corridors and their maintenance upon conservation, landscape and recreation values.**

INTERACTION WITH NEARBY LANDS AND WATERS

27.0 PRIVATE PROPERTY

The objective is to encourage management of nearby private property to minimise impacts on the reserves' values.

Private property owners within the area shall be encouraged to manage their properties to minimise adverse impacts on the reserves. The major threats to the wetland ecosystems are rising watertables and increased run-off and salt loads resulting from clearing in the catchments. Other threats to the reserves include the possible eutrophication of the lakes from increased nutrient input into the wetlands from private property and deterioration of fringing vegetation (see Section 5.0 Water Catchments and Hydrology).

The reserves have many shared boundaries with landholders. Controlling disease, weeds and feral animals requires continued liaison between CALM, private landowners and Agriculture WA (see Section 16.0 Community Liaison and Involvement). Fuel reduction burning programs and fire suppression activities require continued liaison with the Bush Fires Board, local Bush Fire Control Officers and volunteer brigades.

RECOMMENDATIONS

1. **Encourage private property owners to manage their properties to minimise adverse impacts, such as altered water flows, salinisation and eutrophication, on the reserves.**

2. **Inform reserve neighbours about management practices for the reserves and encourage them to manage their lands in sympathy with the reserves' objectives.**

3. **Liaise with private property owners regarding control of feral animals and weeds.**

28.0 LOCAL GOVERNMENT

The objectives are to:

- *Negotiate with local government to encourage land management practices that complement management of the reserves.*
- *Negotiate for local government planning to be consistent with the reserves' management objectives.*

The reserves are within three local government authority boundaries: Shire of Manimup, Shire of Boyup Brook and Shire of Cranbrook. There are a number of areas near the reserves that are vested in the local government authorities (see Map 2).

The planning process at the local government level can act to inform present and prospective landowners of allowable land uses and environmental constraints in Town Planning Schemes. Rural Studies and District Planning Strategies are important inputs into Town Planning Schemes. Local rural strategies can be used to properly plan rural areas on the basis of land capability and land suitability. Town planning schemes are land use documents and can also consider issues of land capability and nutrient management.

The Authority responsible for implementing the Town Planning Scheme is the Local Government Council. Any proposal to develop or change land that is likely to have an effect on the reserves' values, should be referred to CALM for advice and recommendations.

Local councils should consider groundwater flows, proximity to wetlands, objectives of management plans in the area, the Perup Forest and Lake Muir/Unicup Nature Reserves Management Plan and particularly the potential impact of any proposal, on water quality within the area. Proposals that do not appear to be consistent with achieving the plan's objectives should be referred to CALM for advice.

RECOMMENDATIONS

1. **Negotiate with local government authorities to encourage land near the reserves to be managed in a way that is consistent with management objectives.**

2. **Liaise with local government planning staff and councillors to ensure that proposed land use changes on private land are referred to CALM and are assessed for potential impacts on the reserves' values.**

3. **Encourage local government authorities to plan for operations and management that are consistent with CALM's**

planning and policy documents for the area.

4. **Assist local Shires to conserve natural areas, particularly areas adjacent to the reserves.**

29.0 STATE GOVERNMENT

The objectives are to:

- *Negotiate complementary management of nearby State Government land with management of the reserves.*
- *Negotiate State Government planning to be consistent with the reserves' management objectives.*

Land held by or vested with State Government agencies near the reserves includes the vacant Crown land held by the Department of Land Administration and a number of reserves vested in the Water and Rivers Commission (see Map 2).

Agriculture WA is currently coordinating the preparation and development of a Catchment Management Plan for the Lake Muir/Unicup catchment area. This involves providing information, advice and assistance to landholders on catchment planning and sustainable land management practices. The Department can also provide land capability assessment information for land management purposes and for assessment of the impact of changes in land use. Agriculture WA also administers the Soil and Land Conservation Act to ensure that land clearing and land drainage activities do not result in increased salt and nutrient losses from the land.

Other State Government agencies that provide advice to landholders on land use practices in the vicinity of the reserves' catchment include the Water and Rivers Commission and the Department of Minerals and Energy.

The Water and Rivers Commission is carrying out geomorphic wetland mapping and wetland evaluation in the area of the reserves as part of the Busselton-Walpole Regional Water Allocation study. This study may provide useful information relevant to management of the wetlands. As a salinity control measure, clearing restrictions which cover areas of the Unicup Lake, Tone, Perup, Tweed, Gnowergorup and Yerraminup catchments (see Map 3) have been imposed by the Water and Rivers Commission. This restriction covers some of the reserves and areas in the vicinity of the reserves.

The Warren-Blackwood Regional Planning Study, prepared by the Ministry for Planning, will also address issues affecting the reserves. The Plan will formulate land use strategies on the basis of natural resource zones (ie. principally catchment based) and will identify preferred land uses for various locations and recommendations for land use activities. These will form guidelines for detailed planning at the local authority level.

Agriculture WA, CALM, the Department of Enviromental Protection and the Water and Rivers Commission have developed a WA Salinity Action Plan (1996) for the Government of WA. The aims of the Action Plan are to: reduce further deterioration and where possible recover salt-affected land; protect and restore key water resources and high value wetlands; maintain natural biodiversity; and protect designated infrastructure affected by salinity. The Lake Muir/Unicup system of wetlands has been identified in the Action Plan as a priority area for a recovery plan. A recovery plan will be developed through catchment or sub-catchement approaches and, where necessary, short-term emergency actions will be identified.

RECOMMENDATIONS

1. **Encourage Agriculture Western Australia to advise and inform the Manjimup, Boyup Brook, Mobrup, and Frankland Below Gordon Land Conservation District Committees to manage their properties to minimise adverse impacts on the reserves.**

2. **Encourage other State Government Departments to plan for operations and management consistent with CALM's planning and policy documents in the area.**

3. **Liaise with relevant State Government Departments to ensure that land-use on adjoining land does not adversely affect the reserves' values.**

RESEARCH AND MONITORING

30.0 RESEARCH AND MONITORING

The objective is to obtain knowledge necessary to maintain or enhance the values of the reserves.

Background

Research and monitoring of the natural environment and visitor use is an essential component to evaluate management and to provide sound information on which to base management.

Ongoing monitoring is important to evaluate the effectiveness of management practices. The gathering of new knowledge associated with research, both in the reserves and elsewhere, also provides a scientific basis for improving management practices.

Monitoring should evaluate:

- the effectiveness of management practices;
- the social and environmental effects of management practices; and
- the operation of management methodologies.

Environmental research and monitoring projects should give priority to those values identified as being most at risk (sensitive to disturbance) and to activities or processes that are most likely to have adverse ecological impacts.

Social research and monitoring projects should determine whether recreation, environmental education and interpretation activities and facilities are meeting visitor needs and CALM's expectations.

Research projects and monitoring programs can benefit from involving volunteers, educational institutions and individual researchers as this can potentially reduce research and monitoring costs, and can help provide information to the broader community. CALM currently undertakes and encourages research within Perup Forest and Lake Muir/Unicup Nature Reserves.

Research projects have the potential to adversely impact on the reserves' values. Proposals for research should be assessed as to their suitability and appropriate conditions applied if considered acceptable.

Perup Forest

The Perup Forest has been a centre of research on Jarrah forest mammals for over 20 years. It was the Perup Forest which originated the concept of Fauna Priority areas within State forests (Christensen 1974). These areas including the Perup Forest were later to become national parks and nature reserves.

It is also where the initial work on fox predation on native fauna started (Christensen 1980a and 1980b).

Benchmark studies on the effect of fire on the woylie and tammar wallaby have been carried out in the reserve (Christensen 1980a and Christensen & Maisey 1987). Similar studies have also been carried out on other species such as the western ringtail possum, common brushtail possum (Inions et al 1989), numbat (Christensen *et al* 1984) and brush-tailed phascogale.

Research on the effects of fire frequency and intensity as well as on flora and invertebrates is currently being carried out in Perup Forest. This research which is based on a series of fairly large field trials is ongoing and should be given high priority for continuing.

Perup is a particularly important reserve for Critical Weight Range fauna. Many of the mammals present in the Perup Forest have now been studied. One of the species which is known to be declining in the south west and which requires study is the brush wallaby (*Macropus irma*). The Perup Forest Ecology Centre is an excellent centre from which to base a study on the biology of this species in relation to predation and fire.

Perup Forest is also a useful site to which to have monitoring programs for a number of species such as the woylie, tammar wallaby, western ringtail possum and others. Good baseline data exist on several species in the area.

The opportunity also exists for visitors to the Perup Forest Ecology Centre to carry out monitoring of several species with spotlight surveys and other techniques. This potential resource for carrying out important monitoring in the area should be utilised.

Lake Muir/Unicup Nature Reserves

In the mid 1960's core samples were taken from the bed of Lake Muir for palaeontological (fossil pollen) studies (Churchill, 1968).

A basic survey of the flora and vegetation of Byenup, Poorginup and Tordit-Gurrup was conducted by consultants at the time that mining of the peat of these three wetlands was first proposed. A detailed vegetation survey of Unicup, Kulunilup and Yarnup Nature Reserves has also been conducted by Griffin (1984). Twenty four vegetation units were defined and mapped for these reserves.

During the 1970's coarse estimates of waterfowl (duck and swan) numbers and species composition on Lake Muir were made during aerial surveys of south west wetlands conducted in spring each year by T.L. Riggert (to 1976) and J.Lane (1976-78).

Water depth and quality (salinity, pH, total phosphorus) of Byenup, Muir, Poorginup, Red, Tordit-Gurrup, Unicup and Yarnup lakes have been monitored by CALM for varying periods since 1977. The monitoring of Poorginup, Tordit-Gurrup and Byenup was initially undertaken to provide a baseline against which possible impacts of peat mining of those wetlands could be assessed. Monitoring of the other wetlands was initiated either to provide an objective measure (twice yearly) of wetland conditions as a basis for determining recreational duck shooting seasons (Lane & Munro 1983), or to provide a measure (at two monthly intervals) of wetland conditions during the 1981-85 Royal Australasian Ornthologists Union (RAOU) and Department of Fisheries and Wildlife survey of waterbird usage of wetland nature reserves (Jaensch et al 1988). Monitoring continues in September and November each year to follow long term trends in these key parameters of ecological health.

Waterbird usage of the reserves was assessed during the period 1981-85 as part of a larger study of waterbird usage of all wetland nature reserves in the South West and Eucla Land Divisions (Jaensch et al 1988). This study was conducted by a project officer and almost 200 members of the RAOU, with guidance and support from the Department of Fisheries and Wildlife.

DeHaan (1987) collected aquatic invertebrate and water samples from Poorginup, Tordit-Gurrup and Byenup in December 1985 and April 1986 and speculated on possible adverse impacts of proposed peat mining on invertebrate communities. This work was undertaken as an Honours project (Bachelor of Science) with Murdoch University.

Other small collections of aquatic invertebrates have been made by the WA Museum (Harvey 1987, 1996) and students of Curtin University.

Systematic surveys of waterbirds using the eastern Muir wetlands (Byenup and Tordit-Gurrup Lagoons) were conducted monthly in 1986-87 by RAOU project officers with CALM support. Particular emphasis was focussed on use of the wetlands by Australasian Bitterns *Botaurus poiciloptilus* (Jaensch & Vervest 1988a).

Counts of ducks, swans and coots were conducted on several Muir/Unicup wetlands in March each year from 1986-88 (Jaensch & Vervest 1988a, 1988b) and November and March each year from 1988-92 (Halse et al 1992, 1994, 1995). This work was undertaken as part of two larger projects in which waterfowl were counted by RAOU staff and volunteers and CALM staff on a large sample of south-west wetlands, including many unreserved sites.

Halse et al (1993) prepared coarse descriptions of the vegetation and lists of the dominant flora of Muir, Poorginup, Tordit-Gurrup, Unicup and Yarnup.

The Water and Rivers Commission is currently assessing water resources in the Busselton-Walpole region with the intention of allocating these water resources to particular uses. As part of this work the Commission has engaged the V & C Semeniuk Reseach Group to investigate the Muir/Unicup wetlands and their regional setting. This work involves both detailed mapping of the wetlands and advice on the hydrology of the area to assist development of a catchment hydrology management strategy.

Mr Darren Ryder of Edith Cowan University (Joondalup Campus) is currently studying the origin and fate of organic matter in the Bokerup, Kodjinup and Noobijup wetlands as a PhD project. This project will describe how carbon is cycled in each wetland, identifying sources and availability of organic matter important for aquatic faunal nutrition and ecosystem functioning relative to management history and various environmental characteristics. The results of this project may have implications for fire and salinity management in particular.

In the context of the major threats now posed by regional water table rise and salinisation, the most significant gap in scientific knowledge of the wetlands is the lack of a complete inventory of their biota. Virtually nothing is known of the aquatic flora of the wetlands and their fish and frog faunas, and knowledge of the aquatic invertebrate fauna is limited. There are still significant gaps in knowledge of the avian fauna.

Major surveys of the fringing, emergent and aquatic flora, the aquatic invertebrate and fish fauna, and the physico-chemistry of the Muir/Unicup wetlands have recently been initiated by CALM, with funding from the Commonwealth Government's National Wetland Program (J. Lane, pers. comm.).

RECOMMENDATIONS

General

1. **Encourage volunteers, educational institutions and other organisations to undertake and participate in research projects that promote the objectives of the plan.**

2. **Implement the survey, research and monitoring recommendations in the relevant sections of this plan.**

3. **Ensure that research activities do not adversely impact on the reserves' values.**

Perup Forest

4. **Continue ongoing monitoring of Critical Weight Range fauna and other vertebrate fauna.**

Lake Muir/Unicup Nature Reserves

5. **Instigate detailed biological surveys in the reserves.**

6. **Collate existing water quality data for the Lake Muir/Unicup wetlands and analyse trends.**

IMPLEMENTATION

31.0 MANAGEMENT STRUCTURE AND STAFF RESOURCES

The objective is to provide sufficient staff and funds to implement this plan.

The reserves are managed by CALM officers from Manjimup. Implementing the recommendations contained in the Perup Forest and Lake Muir/Unicup Nature Reserves Management Plan over the next ten years will place considerable demands on existing staff. Volunteer assistance in implementing the plan would alleviate some of these demands.

CALM provides funds to manage the reserves. External funding has also been provided for special research projects. Implementing this plan will require additional funding resources, particularly in planning, design, supervision and interpretation. Alternative means of funding will be investigated.

Commencing in 1997/98, additional resources have been provided through increased State Government funding to CALM for implementation of the WA Salinity Action Plan.

RECOMMENDATIONS

1. **Provide sufficient trained staff to implement the recommendations contained in this plan.**

2. **Seek sufficient financial resources from both Government and private sources to implement this plan.**

3. **Investigate and implement revenue raising mechanisms to increase resources available for management.**

4. **Develop volunteer programs to assist in implementation of the plan.**

32.0 PRIORITIES AND REVIEW

The objective is to regularly review implementation of the plan according to priorities.

Many recommendations are made in this plan. While many are guidelines for management, others prescribe specific actions and developments. These prescriptions require funding and will be implemented on a priority basis by CALM's Manjimup District, subject to the availability of staff and funds. Table 4 presents management priorities for all recommendations in this plan.

Priorities will be reviewed on an annual basis or as circumstances change. Section 61 of the CALM Act provides for the plan to be amended as required. If major changes to the plan are proposed, the revised plan will be released for public comment.

The NPNCA is responsible for the mid-term and end of term monitoring of the implementation of this management plan. To facilitate review of the plan and its implementation CALM will report as required to the NPNCA.

The term of this plan is ten years.

RECOMMENDATIONS

1. **Prepare a ten-year implementation plan taking into account the priorities outlined in Table 4.**

2. **Monitor the implementation of the plan according to NPNCA policy and also prior to preparing an annual works program, or as circumstances change. This should identify which recommendations have been achieved and to what degree, and any new information that may affect management.**

Table 4
RECOMMENDATIONS BY LEVEL OF PRIORITY

KEY RECOMMENDATIONS

3.1 Boundaries and Land Tenure

1. Implement the changes to tenure and nomenclature proposed in Table 1.

3.2 Surrounding Land

1. Implement the proposed actions detailed in Table 2.

4.0 Geology, Geomorphology and Hydrology

2. Encorage and facilitate further hydrogeological and landform studies in the catchments to map and describe features affecting ground and surface hydrology.

5.0 Wetlands, Catchments and Drainage

1. Integrate all hydrological data and vegetation survey information as a consolidated base for further catchment investigations and operational monitoring.
3. Liaise with adjoining landholders, LCDC's, Landcare Groups, local authorities and Government departments to facilitate the development of integrated management strategies to protect the reserves' catchments from further degradation.
4. Encourage and where possible facilitate practices such as the preservation and management of remnant vegetation, use of deep rooted perennial and high water use crops, strategically located high water use trees and protection and revegetation of drainage lines.
5. Encourage and assist landholders, in conjunction with Agriculture Western Australia, to develop and implement a strategic revegetation plan for the whole Unicup/Muir catchment area as part of the development of the Catchment Management Plan for the area.
9. Liaise with adjoining landholders, LCDC's, Landcare Groups, Agriculture Western Australia, the Water and Rivers Commission and the Department of Environmental Protection to identify the actions that need to be taken in the short and long term to prevent further groundwater rise and salinisation of the wetlands catchments.

11.0 Fire Protection

1. Implement the Fire Management Plan for Perup Forest and the Lake Muir/Unicup Nature Reserves (Map 7) which classifies the reserves into 'No Planned Burn', 'Vegetation Management' and 'Prescribed Burning' zones.
2. Identify all peat wetlands in the reserves and where appropriate ensure that they are protected by early spring burns to prevent them being burnt by summer wildfires, which may significantly damage the peat.

12.0 Introduced Plants and Animals

4. Continue and expand active trapping, shooting and baiting of feral pigs in the reserves.

31.0 Management Structure and Staff Resources

2. Seek sufficient financial resources from both Government and private sources to implement this plan.

ONGOING PRIORITY

5.0 Wetlands, Catchments and Drainage

2. Follow the NPNCA's Policy Statement on Drainage in regard to drainage proposals affecting the reserves.

6.0 Vegetation and Flora

3. Design facilities and management practices that minimise adverse impacts on flora and vegetation values.

9.0 Landscape Management

1. Implement CALM Policy No. 34 (Landscape Management) in all aspects of land management of the reserves.
2. Apply the landscape management guidelines set out in Table 3.

ONGOING PRIORITY cont.

10.0 Plant Disease

3. Inform users of the reserves about plant diseases and their management, and why it is important to prevent their introduction and spread.
5. Include disease management specifications in contract documents (including scientific flora collecting licences) and job prescriptions, where appropriate.

12.0 Introduced Plants and Animals

2. In conjunction with Agriculture WA and adjacent landholders, further develop and implement programs to prevent introduction, and control existing populations of exotic plants and animals, as resources allow.

13.0 Rehabilitation

2. Rehabilitate degraded areas in accordance with CALM Policy Statement No. 10 (Rehabilitation of Disturbed Land) and guidelines.

15.0 Recreation Opportunities

1. Prepare a comprehensive Recreation Plan for the reserves.
2. Ensure that Site Development Plans are produced and approved before development works are undertaken.
5. Provide nature-based recreation opportunities and facilities with minimal environmental impact which will appeal to a wide range of community interests.
7. Preserve the unique opportunities and features that attract visitors to the area.

16.0 Access

1. Rationalise the access system in the reserves.
2. Design and maintain vehicle access to minimise the risk of spreading dieback disease and causing erosion.
3. Prohibit, if necessary, visitor access to specific areas for wildlife conservation, safety or other reasons.

18.1 Nature Study/Appreciation

1. Provide visitors' with a variety of opportunities to experience and appreciate the reserves' natural features.

18.2 Bushwalking

5. Encourage guided walks in association with Birds Australia, the WA Wildflower Society, the WA Naturalists Club, Friends of Perup and other local naturalist groups.

20.0 Visitor Safety

4. Train staff to assist in emergency situations.

24.1 Basic Raw Material Extraction

1. Follow the NPNCA's Policy Statement on Basic Raw Materials when considering proposed and existing extraction of raw materials from the reserves.
2. Enforce dieback hygiene measures when extracting raw materials and maintain dieback-free pits in a dieback-free condition.
3. Rehabilitate all or parts of pits as material extraction is completed. Remove top-soil separately and store it for later rehabilitation work. Use seed collected within the area for rehabilitation work wherever possible.

26.0 Utilities and Services

1. When the opportunity arises, negotiate to place new utility and service corridors outside the reserves or in association with existing utilities.

29.0 State Government

2. Encourage other State Government Departments to plan for operations and management consistent with CALM's planning and policy documents in the area.
3. Liaise with relevant State Government Departments to ensure that land-use on adjoining land does not adversely affect the reserves' values.

ONGOING PRIORITY cont.

32.0 Priorities and Review

2. Monitor the implementation of the plan according to NPNCA policy and also prior to preparing an annual works program, or as circumstances change. This should identify which recommendations have been achieved and to what degree, and any new information that may affect management.

HIGH PRIORITY

3.2 Surrounding Land

2. Incorporate where appropriate other adjoining land, such as Water and Rivers Commission land, if identified as having high conservation significance.
3. Continue liaison with reserve neighbours to establish cooperative management, particularly in regard to catchment, fire and dieback management, control of introduced animals and landscape management.

5.0 Wetlands, Catchments and Drainage

6. Request the Water and Rivers Commission and Agriculture Western Australia to collate existing monitoring data for the catchments and analyse for trends.
7. Encourage and assist relevant agencies and landholders to develop and implement a program to further investigate and monitor flow rates, salinity and nutrients in surface and ground waters in the Lake Muir/Unicup catchments to quantify the extent of threats to the wetlands.
8. Assess the level of threat posed by current inflows to Byenup Lagoon. Consider the environmental acceptability of diversion and other options where necessary.
11. Where private property encroaches on the wetlands encourage fencing to prevent stock access.
12. Consider potential adverse impacts on surface and groundwater during all management activities within the reserves.

7.0 Fauna

1. Protect fauna habitats from wildfires, pollution and human disturbance.
3. Manage fire to promote a mozaic of fire ages suitable for a wide range of flora and fauna.
4. Continue special fire regimes to promote and maintain tammar wallaby habitat.
5. Protect fauna from exotic predators through appropriate baiting regimes.

8.0 Cultural Heritage

2. Ensure that visitor and management activities do not adversely impact upon significant historical and cultural sites.

11.0 Fire Protection

3. Monitor the Fire Management Plan annually to take into account major wildfires and completed burning programs. Major modifications to the burn plans must be approved by the Director of Nature Conservation.
4. Modify, relocate or defer burns where planned burns are considered to have a deleterious effect on Declared Rare Flora and Fauna.
9. Contain wildfires to the minimum size possible consistent with the regime for each reserve.
10. Minimise use of heavy machinery for fire suppression in small reserves.

12.0 Introduced Plants and Animals

3. Continue and expand the current fox baiting program in Perup Forest under the Western Shield to include appropriate areas of the nature reserves.

15.0 Recreation Opportunities

3. Continue to provide education and recreation opportunities in Perup Forest to complement opportunities available elsewhere on CALM-managed and other public land in the region.
6. Work with State and local authorities in promoting minimum impact visitor use which is appropriate in the reserves.

18.2 Bushwalking

2. Close foot access temporarily or permanently where the results of monitoring indicates that this is appropriate to protect the environment or, in extreme fire danger, the walker.

HIGH PRIORITY cont.

18.3 Water-based Activities

2. Monitor water-based activities on Unicup Lake and modify or prohibit where adverse impacts are observed.
3. Continue to prohibit any water-based recreational activities on the reserves' wetlands, except for the gazetted area on Unicup Lake.

18.7 Horseriding

1. Prohibit horseriding in the reserves.

19.0 Commercial Visitor Services

1. Require all commercial operators using the reserves to obtain a CALM Commercial Operators License and to pay necessary fees.
2. Monitor and regulate commercial activities through numbers of licences and licence conditions to ensure that they do not compromise the sustainability of the natural resource.

20.0 Visitor Safety

2. Locate and design recreation facilities to minimise potential risks to visitors.
3. Make provision for dealing with safety threats, accidents and search and rescue operations.

21.0 Domestic Animals

1. Prohibit domestic animals, including horses and dogs, in the reserves.

22.0 Information, Interpretation and Education

1. Develop and implement a visitor information, interpretation and education program for the reserves that highlights the reserves' natural features (including flora and fauna), cultural heritage, and management issues.
2. Develop information, interpretation and education opportunities as appropriate in the reserves.
3. Provide interpretive activity programs, including guided and self-guided tours for schools, community groups and other visitors, using volunteers where appropriate.

24.0 Mining, Mineral and Petroleum Exploration

1. Oppose exploration, mining and petroleum resource development that would have a deleterious impact on the reserves' values.

27.0 Private Property

1. Encourage private property owners to manage their properties to minimise adverse impacts, such as altered water flows, salinisation and eutrophication, on the reserves.
2. Inform reserve neighbours about management practices for the reserves and encourage them to manage their lands in sympathy with the reserves' objectives.

29.0 State Government

1. Encourage Agriculture Western Australia to advise and inform the Manjimup, Boyup Brook, Mobrup and Frankland Below Gordon Land Conservation District Committees to manage their properties to minimise adverse impacts on the reserves.

30.0 Research and Monitoring

2. Implement the survey, research and monitoring recommendations in the relevant sections of this plan.

31.0 Management Structure and Staff Resources

1. Provide sufficient trained staff to implement the recommendations contained in this plan.
3. Investigate and implement revenue raising mechanisms to increase resources available for management.
4. Develop volunteer programs to assist in implementation of the plan.

32.0 Priorities and Review

1. Prepare a ten-year implementation plan taking into account the priorities outlined in Table 4.

MEDIUM PRIORITY

4.0 Geology, Geomorphology and Hydrology

1. Consider the vulnerability of geological and hydrogeological features, landforms, soils and surface water movement in all management operations, such as new access, firebreaks and site developments.

5.0 Wetlands, Catchments and Drainage

10. Encourage and assist research into water use of intact native vegetation compared with tree plantations.
13. Provide visitors with information on the hydrology of the wetlands and their catchments.

6.0 Vegetation and Flora

1. Prepare detailed vegetation maps for all the reserves (with the exception of Unicup, Kulunilup and Yarnup Nature Reserves which have already been mapped).
2. Identify and protect vegetation and flora that is rare, unique or in some way warranting special consideration.
4. Protect populations of species that are vulnerable to particular fire regimes by implementing appropriate fire management strategies.
5. Provide visitors with information on the area's vegetation, its features and the need to protect it.
6. Research the response of plant community types to management regimes, especially fire. Modify practices as necessary.

7.0 Fauna

2. Instigate further fauna surveys, particularly on:
   - frog, fish and invertebrate faunas of the Muir/Unicup wetlands;
   - shorebird use of Lake Muir;
   - fauna of the Perup wetlands;
   - terrestrial fauna of the Muir/Unicup Reserves; and
   - terrestrial invertebrates of Perup Forest.

9.0 Landscape Management

3. Encourage neighbours to recognise the importance of landscape management by the sensitive siting of facilities and signs, selection of site-compatible materials and colours, and careful planning and siting of utilities and roads to minimise impacts on the reserves' landscape values.

10.0 Plant Diseases

1. Identify priority areas for protection from pathogen introduction and spread based on conservation values, risk of introduction and dieback hazard.
4. Train staff associated with the area to recognise *Phytophthora* dieback and *Armillaria* and in sampling and management techniques.

11.0 Fire Protection

5. Undertake Wildfire Threat Analysis to determine prescribed burning priorities if the values in and around the reserves change significantly during the life of the Plan.
6. Maintain a network of roads and fire management access tracks, and firebreaks using methods which reduce the risk of introducing, spreading or intensifying dieback, and minimise the risk of soil erosion
7. Construct and maintain a network of water supply points at strategic locations within or near the reserves.
8. Permit the use of gas fires only at designated recreation sites in the reserves.
11. Continue to work closely with local authorities and brigades, adjacent landholders and the Bush Fires Board to ensure an effective fire management force is in place.
12. Work with the Bush Fires Board and local authorities to provide an information and education program on fire safety and survival, the reserves' values and fire risks to neighbours and visitors, to improve their appreciation and support for fire management programs.
13. Continue to monitor the application of Vegetation Management regimes to ensure that these are achieving the prescribed outcomes.
14. Continue research on fire ecology by CALM's Science and Information Division staff and by promoting further research by tertiary institutions.

12.0 Introduced Plants and Animals

5. Liaise with Agriculture WA, neighbours, local Government and other relevant authorities to encourage an integrated approach to introduced animal and plant management.

MEDIUM PRIORITY cont.

12.0 Introduced Plants and Animals contd.

6. Remove exotic trees where considered necessary. If the trees are to be taken under licence and sold, follow the approval procedures of the CALM Act.
7. Monitor the efficiency of control programs on target species and any effects on non-target species and make changes to procedures if required.
8. Encourage volunteers, educational institutions and other organisations to participate in research projects related to introduced plant and animal issues in the reserves.
9. Inform users of the reserves about the impacts of introduced plants and animals and their management, particularly via the Perup Forest Ecology Centre.

15.0 Recreation Opportunities

4. Ensure a regional perspective is taken by developing education and recreation opportunities in the Lake Muir/Unicup Nature Reserves to complement opportunities available elsewhere on CALM-managed and other public land in the region.

17.0 Recreation Areas

1. Design, develop and maintain recreation areas and facilities to departmental standards. Site development plans will be required.

18.3 Water-based Activities

4. Provide information on the conservation values of the wetlands to explain to visitors why water-based activities are not permitted on these wetlands.

18.5 Picnicking and Barbecuing

2. Prohibit wood fires in the reserves.

18.7 Horseriding

2. Inform visitors where appropriate why horseriding is not allowed in the reserves.

19.0 Commercial Visitor Services

3. Ensure that a condition of commercial operators licences is to maintain appropriate safety standards with respect to their clients and reserve users.
4. Liaise with tour operators, the WA Tourism Commission, local tourist bureaus and the Friends of Perup organisation so that they are aware of management initiatives, developments and road conditions and to ensure the promotion of the reserves is consistent with the management objectives.
5. Facilitate liaison with, and training and accreditation of, commercial operators through appropriate means.
6. Ensure commercial operators maintain appropriate standards with respect to information and quality of service provided.
7. Consider all commercial proposals that are consistent with this management plan and the purpose of the reserves.

20.0 Visitor Safety

1. Provide and support provision of educational material aimed at visitor safety.

21.0 Domestic Animals

2. Inform visitors of the reasons why domestic animals are not allowed in the reserves.

23.0 Community Liaison and Involvement

3. Continue involvement and develop partnerships with local individuals and organisations, such as school communities, with an interest in conservation and land management in the reserves.
4. Encourage and recognise public participation in implementing this plan.

24.0 Mining, Mineral and Petroleum Exploration

2. Liaise with the Department of Environmental Protection, the Department of Minerals and Energy and the mining and petroleum industries over any proposals for mineral or petroleum resource development adjacent to the reserves or within their catchments to ensure that the reserves' values are protected.

MEDIUM PRIORITY cont.

27.0 Private Property

3. Liaise with private property owners regarding control of feral animals and weeds.

28.0 Local Government

1. Negotiate with local government authorities to encourage land near the reserves to be managed in a way that is consistent with management objectives.
2. Liaise with local government planning staff and councillors to ensure that proposed land use changes on private land are referred to CALM and are assessed for potential impacts on the reserves' values.

30.0 Research and Monitoring

1. Encourage volunteers, educational institutions and other organisations to undertake and participate in research projects that promote the objectives of the plan.
3. Ensure that research activities do not adversely impact on the reserves' values.
4. Continue ongoing monitoring of Critical Weight Range fauna and other vertebrate fauna.
5. Instigate detailed biological surveys in the reserves.
6. Collate existing water quality data for the Lake Muir/Unicup wetlands and analyse trends.

LOW PRIORITY

8.0 Cultural Heritage

1. Liaise with the local Aboriginal community and the Department of Aboriginal Sites concerning the protection of significant Aboriginal sites in the reserves.
3. Where appropriate, incorporate material on historical and cultural sites in interpretive displays and community education programs.
4. Continue to compile information on historical sites located in the reserves and maintain an up-to-date database of sites.

10.0 Plant Diseases

2. Develop a broad scale dieback map of the Perup and Lake Muir area and a dieback hazard map based on vegetation and landform types.
6. Review the existing road and firebreak network to ensure that the positioning of these does not pose unacceptable risk to special communities or landforms.
7. Ensure that additions to the Perup Forest, such as Keninup and Talling blocks, are considered for gazettal as DRA.

12.0 Introduced Plants and Animals

1. Develop an inventory of introduced plants and animals and monitor these populations.

13.0 Rehabilitation

1. Prepare a rehabilitation program.
3. Review the rehabilitation on an annual basis.
4. Provide opportunities for interested individuals and groups to be involved in rehabilitation projects.

16.0 Access

4. Close and rehabilitate tracks that are not required for public access or management. Involve the community in rehabilitation projects (see Section 13.0 Rehabilitation).
5. Remove forest produce, where appropriate, that is associated with essential works with approval under the CALM Act.

17.0 Recreation Areas

2. Monitor the levels of change and impacts of visitor use on recreation areas and facilities. Alter recreation and tourism management where appropriate.

LOW PRIORITY cont.

18.1 Nature Study/Appreciation

2. Liaise with Birds Australia, the West Australian Wildflower Society, the Western Australian Naturalists Club, Friends of Perup and other local naturalist groups to identify other appropriate nature based activities and facilities

18.2 Bushwalking

1. Develop foot access in the reserves according to the guidelines set out above.
3. Monitor the environmental impacts of bushwalking and whether bushwalking opportunities are meeting visitor needs.
4. Provide interpretive and educational material for walkers with emphasis on the reserves' conservation values.

18.3 Water-based Activities

1. Permit waterskiing in a gazetted area on Unicup Lake.
5. Liaise with the Department of Transport in relation to providing information to visitors on regulations and safety requirements.

18.4 Cycling

1. Identify existing access roads and tracks in the reserves suitable for bicycle riding and advertise these to visitors where appropriate.

18.5 Picnicking and Barbecuing

1. Provide low key facilities for picnicking and barbecuing in the reserves.

18.6 Scenic Driving

1. Identify roads that may be promoted and managed as scenic drives.
2. Provide appropriate facilities for drivers to stop and enjoy the environment.

22.0 Information, Interpretation and Education

4. Monitor all programs regularly and revise as required.

23.0 Community Liaison and Involvement

1. Maintain liaison with adjoining landowners, Land Conservation District Committees, landcare/catchment groups, local authorities and Government departments to ensure that, as far as possible, land management is integrated.
2. Encourage shires and the local community to take responsibility for weed control, feral animal control and visual resource management on adjoining lands.
5. Promote and provide advisory services to local communities on issues impacting on the reserves.

25.0 Apiculture

1. Review hive locations and access to these sites subject to current CALM policy.
2. Manage access to sites in accordance with dieback hygiene principles. Cancel and relocate sites (if possible) if access poses an unacceptable disease risk.
3. No additional sites will be permitted in Perup Forest and Lake Muir/Unicup Nature Reserves until CALM's policy for Apiculture is reviewed.

26.0 Utilities and Services

2. If a utility or service corridor must go through the reserves, ensure that its placement and maintenance have minimal impact on the environment and strict dieback hygiene measures are implemented.
3. Control and monitor the effects of utility corridors and their maintenance upon conservation, landscape and recreation values.

28.0 Local Government

3. Encourage local government authorities to plan for operations and management that are consistent with CALM's planning and policy documents for the area.
4. Assist local Shires to conserve natural areas, particularly areas adjacent to the reserves.

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APPENDIX 1 Landscape Character Types

Scenic Quality	Scenic Quality Classification
DARLING UPLANDS Landscape Character Sub-type	
HIGH	
Landform	Isolated peaks or hills with distinctive form and visual dominance that become focal points. Granite domes, outcrops or groups of boulders. Undulating and steeply sloping terrain of distinctive shape and abrupt appearance. Well defines V-shaped or U-shaped valleys, heavily dissected steep slopes and/or number and configuration of lateral irregular tributaries.
Vegetation	Distinctive stands of vegetation creating unusual forms or striking displays of seasonal colour. Strongly defined patterns in areas of native vegetation, with openings of a natural appearance, associated with wetlands and rock forms, and unbroken stream vegetation. Areas of remnant native vegetation of a natural appearance exhibiting an attractive diversity of colour, height and species. Gradual and naturally appearing transitions between agriculture and other land uses, with forested land.
Waterform	Permanent watercourses with continually changing flow characteristics and features such as rapids or waterfalls. Reservoirs, lakes or wetlands with dominant natural characteristics (eg. retained fringing vegetation, design utilised existing natural features). Permanent river pools.
MODERATE	
Landform	Broad or shallow valleys and tributaries. Rounded hills surrounded by more landform of a similar nature. Minor rock outcroppings. Broad slopes or extended valleys that are not distinctively defined by adjacent landforms.
Vegetation	Open forest and woodland combined with natural openings and species mix in patterns that offer some visual diversity. Vegetation pattern evident but of regular pattern relative to the surrounding landscape character. Remnant areas of naturally appearing streamline and roadside vegetation exhibiting some structural diversity and colour.
Waterform	Seasonal wetlands, intermittent streams and creeklines. Reservoirs with some natural characteristics.
LOW	
Landform	Large expanses of indistinctly dissected landform with limited topographic features of specific visual interest.
Vegetation	Extensive areas of similar vegetation with limited variation in diversity, texture and colour.
Waterform	Waterforms absent.

Scenic Quality	Scenic Quality Classification
PEMBERTON SLOPES Landscape Character Sub-type	
HIGH	
Landform	Distinctly dissected slopes and deeply defined valleys. Isolated hills, granite domes, outcrops or groups of boulders which provide obvious contrast to the landform pattern in the surrounding landscape.
Vegetation	Single plants, trees or patches or forest which become focal points due to contrasting or conspicuous shapes, colour, isolation or position in the surrounding landscape. Strongly defined patterns of vegetation associated with granite outcrops, unforested swampy lowlands and forested higher ground. Vegetation showing distinctive displays of seasonal colour.

Waterform	Watercourses with continually changing flow characteristics and features such as rapids or waterfalls. Reservoirs, river pools and swamps with dominant natural characteristics.
MODERATE	
Landform	Broad slopes and low, rounded hills which do not appear to be prominent or distinctive in the surrounding landscape. Broad, shallow valleys.
Vegetation	Some structural, textural and seasonal colour patterns evident in vegetation, but lacking in uniqueness or distinction relative to the surrounding vegetation or landform.
Waterform	Watercourses with long stretches of unchanging flow characteristics. Watercourses, reservoirs or swamps with some natural characteristics remaining.
LOW	
Landform	Extensive areas of gently inclined topography, poorly dissected with few distinctive visual features.
Vegetation	Extensive stretches of vegetation with little or no structural, colour of textural diversity.
Waterform	Waterform with few evident natural characteristics.