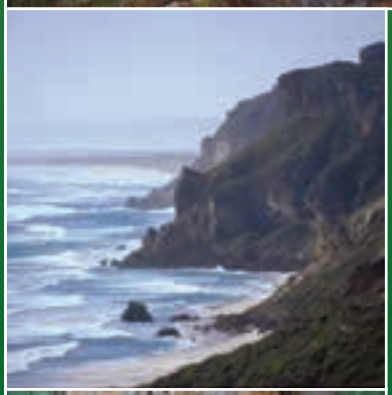
Shannon and D'Entrecasteaux National Parks

Management Plan No. 71 2012



Department of Environment and Conservation

Conservation Commission WESTERN AUSTRALIA

SHANNON AND D'ENTRECASTEAUX NATIONAL PARKS

Management Plan

2012

Department of Environment and Conservation

Conservation Commission of Western Australia

VISION

By the year 2022, the natural and cultural values of the parks are in the same or better condition than in the year 2012 and there will be a greater understanding of the threats and impacts on these values. The parks will continue to support a wide range of nature-based recreational activities that are compatible with the conservation values whilst preserving the remote nature and wilderness values of the parks. The local community as well as the wider community will highly value the parks and will want to be involved in their protection and conservation. The Indigenous cultural heritage of the parks will be kept alive and promoted by active and ongoing involvement of the traditional owners who will have been able to reconnect with and care for their country.

PREFACE

All national parks, conservation parks and nature reserves in Western Australia are vested in the Conservation Commission of Western Australia. The Department of Environment and Conservation, in accordance with the *Conservation and Land Management Act 1984,* carries out the management of these reserves and prepares management plans on behalf of the Conservation Commission. The Conservation Commission issues draft management plans for public comment and provides final management plans for approval by the Minister for Environment.

The Conservation and Land Management Act specifies that management plans must contain:

- a statement of the policies or guidelines proposed to be followed; and
- a summary of operations proposed to be undertaken.

This final management plan is for the Shannon and D'Entrecasteaux national parks, the proposed additions to the parks and the section 5(1)(g) reserve adjacent to Lake Jasper as well as two small section 5(1)(g) and 5(1)(h) reserves enclaved within D'Entrecasteaux National Park. The plan replaces the *Shannon Park and D'Entrecasteaux National Park Management Plan 1987-1997* (CALM 1987).

In accordance with section 55 of the Conservation and Land Management Act, the term of the final management plan will be 10 years, or until the plan is superseded by a new management plan.

Changes since the Previous Management Plan

The parks have been managed according to the *Shannon Park and D'Entrecasteaux National Park Management Plan 1987-1997*. Since 1987, many of the tenure proposals in the previous plan have been implemented, including the gazettal of Shannon National Park in 1988. Due to further tenure proposals and changes since the previous management plan, the Shannon and D'Entrecasteaux national parks required a new management plan. Changes since the previous management plan include changes in legislation and policy, new research and knowledge, increased demand for and use of the parks and a shift in societal values, which are summarised below and reflected throughout this management plan.

Changes in Government Legislation and Policy

- The Conservation Commission was formed in 2000 to replace the National Parks and Nature Conservation Authority as the controlling body for the terrestrial conservation reserve system in Western Australia.
- Changes to the Conservation and Land Management Act have given the Conservation Commission responsibility for submitting management plans to the Minister and developing guidelines for monitoring and assessing the implementation of the management plans. Consequently management plans are now outcome-based in terms of performance assessment, and include Key Performance Indicators that will be assessed by the Conservation Commission.
- A bioregional approach to conserving Australia's biodiversity has been developed. In the south-west 'forest ecosystems' have been defined to further the establishment of a comprehensive, adequate and representative reserve system for the State.
- The Department has developed the *Identification And Management Of Wilderness And Surrounding Areas* policy. There is an opportunity to gazette wilderness within the parks and this management plan identifies proposed wilderness areas to be gazetted and managed according to the policy.
- New legislation such as the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such changes provide stronger protection for species and communities within the State.
- The development of an *Environmental Weed Strategy for Western Australia*, which rates weeds according to specific criteria to aid in determining priority for control.
- The development of the updated Policy Statement No. 19 *Fire Management* which includes 12 scientific principles which places a greater emphasis on burning for biodiversity and fire ecology.
- The development of the *Conservation and Land Management Regulations 2002* and a revised Policy Statement No. 18 *Recreation, Tourism and Visitor Services* and associated guidelines which reflect the new regulations, incorporates a wider range of recreational activities and clarifies issues with pre-existing uses that may not be necessarily permitted in national parks but have arisen from the creation of new national parks from state forests where these activities were formerly permitted.
- The policy on commercial beekeeping in national parks is being reviewed and this management plan takes the reviewed policy into consideration.

New Research and Knowledge

- Recognition of the potential impacts of climate change (and decreasing rainfall).
- Impacts associated with management of the broader catchment have been recognised, in particular adjacent land use impacts on hydrology and water quality within the parks.
- The wetland areas of the parks have been identified as potential acid sulphate soil areas.
- Further surveying and research has been carried out with regards to flora, fauna and communities within the parks. In particular threatened ecological communities have been identified which require specific management to address threats such as feral pigs.
- A series of wetland surveys along the south coast have assessed the values of the wetlands within the parks and many have been identified as being of national importance.
- More knowledge has been gained with regard to diseases and their effects on species within the parks.
- Fire management has undergone a major change recently. There is now a strong emphasis given to using fire to manage for biodiversity at a landscape scale.
- Further surveying has aided in assessing the threat status of the State's plants and animals.
- Landscapes in the State have been identified and described as Landscape Character Types. The parks have been further assessed in terms of scenic quality.
- Archaeological surveys in the parks, in particular in the Lake Jasper area, have dramatically improved knowledge of cultural values.
- Research into the impacts of horse-riding in the parks has been carried out.

Increased Demand for and Use of the Parks

- Pressure on the parks has increased in terms of recreational use and demand as well as mining, commercial use and infrastructure to service Windy Harbour and private property enclaves.
- There is a marked increase in four-wheel drive use of the parks. Many of the tracks within the parks require consolidating or seasonal closure and the previous management plan needs updating and/or clarification in this regard.
- Many of the visitors to the parks are also seeking new adventure activities that were not planned for in the previous management plan.
- There is increased pressure on the parks to remain remote as visitation to the south-west increases.
- Management arrangements with regards to power-craft on Lake Jasper are no longer workable and impacts warrant changing the previous plan.
- There is a need to identify further opportunities for walktrails and built accommodation to meet the demand for a range of recreational opportunities within the parks. There is also a need to upgrade/rehabilitate many of the existing camping areas.

NOMENCLATURE

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

The word '*Nyoongar*' can be spelt in numerous ways. The spelling of Nyoongar in this form should be seen to encompass Noongar, Nyungar, Noongah and Nyungah spellings.

The '*parks*' refer to Shannon National Park, D'Entrecasteaux National Park and an adjacent section 5(1)(g) reserve north of Lake Jasper, formerly comprising some private property and part of D'Entrecasteaux National Park. Two further small reserves are part of the parks; a section 5(1)(g) reserve on the top of Mt Chudalup and a section 5(1)(h) reserve that incorporates the lighthouse at Pt D'Entrecasteaux. The '*planning area*' refers to the parks (as defined above) and proposed additions to the parks.

Whilst this management plan is specifically for the 'parks', it is the objective of the Department that the proposed additions to the parks are managed in a similar way, especially where the Department is the managing body. During the life of this management plan, the additions are proposed to be added to either Shannon National Park or D'Entrecasteaux National Park. Therefore, where management refers to the 'parks', this will include any additions to the parks subsequent to gazettal of this management plan.

When '*South West*' is used in this management plan, it refers to the South West Planning Region used by the South West Development Commission and Western Australian Planning Commission. The South West Planning Region follows the boundaries of the shires of Harvey, Collie, Boyup Brook and Manjimup. The South West Planning Region does not correspond with the regional boundaries of the South West Region of the Department of Environment and Conservation. When '*south-west*' is used, it refers to the general south-west corner of Western Australia.

In this management plan, records used for '*endemic fauna*' refer to fauna with their natural range being restricted to the south-west and '*endemic flora*' refers to flora being endemic to the Warren bioregion. '*Locally endemic*' refers to flora and fauna with a range of less than 150 kilometres.

ACKNOWLEDGMENTS

This management plan was prepared by the Shannon and D'Entrecasteaux National Parks Planning Team: Aberline Attwood (Planner and management plan co-ordinator), Rod Annear (former Ranger in Charge, Donnelly District), John Gillard (Donnelly District Manager), Jeff Kimpton (Senior Ranger, Donnelly District), Greg Mair (Blackwood District Manager and former Walpole District Manager), Mark Virgo (Senior Ranger, Frankland District) and Cliff Winfield (former Parks and Visitor Services Regional Leader, Warren Region).

The Planning Team would like to thank the many other Departmental staff who contributed to and commented on sections of this plan over the years (including those who have since changed roles or left the Department).

The assistance of the Shannon and D'Entrecasteaux National Parks Advisory Committee is also especially acknowledged: Peter Keppel (Chairman), Koodah Cornwall, Barbara Dunnet, Andrea Endacott, Dave Evans, Thomas Gerner, Carol McKennay, Don Milligan, Tom Muir, Helen Nixon, Paul Owens, Andy Russell and Joanna Young.

Front cover images:
Mount Chudalup, D'Entrecasteaux National Park – Main photo by Aberline Attwood
Point D'Entrecasteaux, D'Entrecasteaux National Park – Photo by Aberline Attwood
Karri tree, Shannon National Park – Photo by Aberline Attwood

CONTENTS

MAPS

TABLES

FIGURES

PART A. INTRODUCTION

1. BRIEF OVERVIEW

The Shannon and D'Entrecasteaux national parks and the adjacent section 5(1)(g) reserve near Lake Jasper and two small section 5(1)(g) and 5(1)(h) reserves[1] enclaved within D'Entrecasteaux National Park (the parks) are located south of Manjimup on the south coast of Western Australia and cover a total area of 171,778 hectares (Map 1 Management Planning Area).

The parks were a result of the recommendations by the Conservation Through Reserves Committee for conservation reserves throughout Western Australia to establish a reserve system for the State (Conservation Through Reserves Committee 1974). One of the many recommendations was for a south coast national park to preserve a large area free from human development, which provided wilderness and solitude for visitors, magnificent coastal scenery, varied natural features and diverse vegetation types. Another recommendation was for a national park to preserve a large area of wet sclerophyll forest based on a river catchment, at a time when much of the karri (*Eucalyptus diversicolor*) forest was not formally reserved, and clear-felling methods were being introduced to the region.

These national parks are now known as D'Entrecasteaux National Park and Shannon National Park, and are a result of the amalgamation of various State forest and timber reserves, Crown land, Shire of Manjimup reserves, conservation reserves, pastoral leases and freehold purchases since the 1970s. The section 5(1)(g) reserve near Lake Jasper was excised from D'Entrecasteaux National Park in 1994 to allow mining (only part has been mined at this stage) and it continues to be managed similarly to D'Entrecasteaux National Park as much as possible (see Section 3 Management Plan Area).

The parks are managed by the Department of Environment and Conservation (the Department) from the Warren regional office at Manjimup and the Donnelly and Frankland district offices at Pemberton and Walpole respectively. The Department manages the parks on behalf of the Conservation Commission of Western Australia (the Conservation Commission).

Shannon National Park includes most of the water catchment of the Shannon River and includes extensive old growth and regrowth karri forest. The old Shannon townsite within the park was once a settlement for timber workers and its interpretive and recreational values are significant. D'Entrecasteaux National Park has long been valued for its rugged coastlines, beaches and dune systems as well as extensive and nationally significant wetland systems that provide habitat for a range of endemic flora and fauna.

Both parks provide a valuable recreational resource for the local communities in the Manjimup, Pemberton, Northcliffe and Walpole area as well as a significant drawcard within the region (see Section 2 *Regional Context*).

The conservation values of the parks are a function of their large area and wide diversity of wetland, woodland and forest ecosystems. The parks provide large intact fauna habitats, and protect restricted vegetation communities and rare and priority flora and fauna within the south-west. They also contain the lower reaches of a major group of rivers, including the Donnelly, Warren, Gardner and Shannon. These provide an important conservation and recreational resource as well as water supply potential. Shannon National Park is included in the 'Walpole Wilderness', which includes the existing Mt Frankland National Park, Walpole-Nornalup National Park and four other proposed national parks. The Walpole Wilderness, coupled with the D'Entrecasteaux National Park, represents nearly half-a- million hectares of continuous national parks stretching from near Augusta in the west to in the west to Denmark in the east.

Visitation to the parks is increasing—Shannon National Park as part of the forest experience of the south-west, and D'Entrecasteaux National Park as part of the coastal four-wheel driving, fishing and camping experience. Recreational pressures from increased visitor use include conflicts between user groups, vandalism, domestic dogs being brought into the park, firewood collection, the continued use of closed tracks and the creation of new tracks, camping in sensitive areas, and the spread of *Phytophthora cinnamomi*.

[1] Reserves as per either section 5(1)(g) or 5(1)(h) of the *Conservation and Land Management Act 1984.*

These impacts, along with changing Departmental policy and community expectations, have influenced the review of the previous management plan. This new management plan will provide more effective and relevant guidelines to protect the values of the parks and proposed additions (see Section 4 *Key Values*).

2. REGIONAL CONTEXT

The parks and proposed additions (the planning area) are located within the South West Planning Region of Western Australia (Map 2 *Regional Context*). This region covers an area of about 24,000 square kilometres (SWDC 2009) and is the most popular destination for tourists in Western Australia outside of Perth. The planning area is within the local authorities of Nannup and Manjimup. The region's attractions include the coastal landscapes, beaches, wineries, forests, national parks, caves, festivals and events, and the numerous opportunities for recreation and nature-based tourism.

The South West Planning Region has a population of approximately 162,164 people who mostly live along the western coast in the major towns of Bunbury, Busselton and Margaret River (SWDC 2011). Other towns in the region include Collie, Donnybrook, Nannup, Bridgetown, Manjimup, Pemberton, Northcliffe, Augusta and Walpole. The South West Planning Region has the highest population within regional Western Australia and its five-year growth rate of 3.1 per cent is higher than that of both the state and national average (2.6 and 1.8 per cent respectively).

The region has the most diversified economy of the State's nine planning regions. Extensive mineral wealth has made it a major world producer of alumina and mineral sands. The region's economy is also based on strong agricultural, horticultural and emerging aquaculture industries, timber and forest produce, viticulture and tourism. The gross regional product is estimated at almost $10 billion with the largest contributors to the region's economy being mineral extraction and processing ($2.3 billion), retail ($1,626 million), tourism ($569 million), and agriculture ($550 million) (SWDC 2009).

Lands vested in the Conservation Commission and managed by the Department (including the parks) are promoted as significant drawcards. The way in which these assets are managed will continue to impact on the tourism and recreational potential of the region. Liaison with local authorities will be important in promoting and managing the conservation and nature-based recreation values of the parks.

Based on Departmental 2008-09 visitation figures, the top five parks/sites within the region were:

- Leeuwin-Naturaliste National Park (about 2.33 million visits);
- Walpole-Nornalup National Park – Valley of the Giants (158,176 visits);
- Gloucester National Park, which includes the Gloucester Tree (108,321 visits);
- D'Entrecasteaux National Park (168,497 visits, see Section 25 *Recreational Opportunities* – Visitor Numbers and Trends); and
- Wellington National Park (98,852 visits).

Tenure proposals in the *Forest Management Plan 2004-2013* (Conservation Commission 2004) aimed to add approximately 370,000 hectares to the public conservation estate and create at least 23 new national parks in the South West Planning Region (Map 2 *Regional Context*) (the *Forest Management Plan* replaces previous proposals under the 1999 *Regional Forest Agreement* and the 1994 *Forest Management Plan*). By 2010, implementation of the Forest Management Plan has created about 300,000 hectares of conservation estate and 19 new national parks within the South West Planning Region.

The Walpole Wilderness will be an added attraction for tourists visiting the South West Region, along with the associated interpretive experiences such as the proposed Walpole Wilderness Discovery Centre. Icon attractions such as the Gloucester Tree and the Tree Top Walk, together with the marketing of the Walpole Wilderness, will ensure the continuing value of national parks to the South West Planning Region's economy.

This management plan should be implemented in the context of the management prescriptions of the conservation estate within the wider region. The following management plans for other reserves within the South West Planning Region have been finalised to date:

- the *Walpole Wilderness and Adjacent Parks and Reserves Management Plan 2009*;
- the *Lane Poole Reserve and Proposed Reserves Additions Management Plan 2011*;

- the *Leeuwin-Naturaliste National Park Management Plan 1988-1998* (the draft of a new plan including Gingilup Swamps Nature Reserve, Scott National Park and other proposed new national parks Yelverton, Bramley and Forest Grove along the Leeuwin-Naturaliste Ridge was released for comment in 2010).

3. MANAGEMENT PLAN AREA

The planning area covered by this management plan (Map 1 Management Planning Area):

The Planning Area

The Parks

- Shannon National Park[2] (gazetted as 52,598 hectares);
- D'Entrecasteaux National Park (gazetted as 116,686 hectares, however with recent purchases and cancellation of road reserves, the area is now 118,779 hectares);
- the section 5(1)(g) reserve (400 hectares) in the vicinity of Lake Jasper;
- the section 5(1)(h) reserve (0.8 hectares) at Point D'Entrecasteaux lighthouse; and
- the section 5(1)(g) reserve (0.4 hectares) at Mt Chudalup.

Proposed Additions

- an area of land in the vicinity of Lake Jasper, the size of which is yet to be determined (CALM Executive Body property);
- the proposed Quannup pastoral lease addition to the parks (4500 hectares);
- land to be added to the parks under the *Forest Management Plan 2004-2013* (two parcels totalling 1600 hectares);
- Gardner River estuary;
- undeveloped road reserves within the parks to be cancelled during the life of the plan; and
- private property enclaves within the parks purchased during the life of this management plan and associated road reserves as applicable.

In total, the management plan covers an existing reserve area of approximately 171,778 hectares, and may, by the end of the life of the plan, cover an additional about 6100 hectares. The planning area is mostly within the Department's Warren Region (both Donnelly and Frankland districts), with the proposed 'Lake Jasper land addition and one parcel to be added from the *Forest Management Plan 2004-2013* (CCWA 2004) which currently are within the Department's South West Region.

D'Entrecasteaux National Park

D'Entrecasteaux National Park comprises two class A reserves (Nos. 36996 and 43961) vested in the Conservation Commission and set-aside for the purpose of 'national park and water' (see Map 3 *Tenure*). Reserve 43961 was the former Banksia Flats pastoral lease created as a separate reserve in 1995. This reserve is to be cancelled and added to Reserve 36996 with all further additions being included into Reserve 36996 in the first instance.

At present, D'Entrecasteaux National Park covers an area of approximately 118,779 hectares along a coastline of 130 kilometres, from Black Point in the west to Long Point in the east. Along the open shore of this section, the D'Entrecasteaux National Park extends to the low water mark.

D'Entrecasteaux National Park shares parts of its boundary with Walpole-Nornalup National Park, Mt Frankland South National Park, Shannon National Park, Boorara-Gardner National Park, Warren National Park, Greater Hawke National Park, the section 5(1)(g) reserve near Lake Jasper and Gingilup Nature Reserve.

The park also borders unallocated Crown land, State forest and private property. There are also internal enclaves of private property, a pastoral lease and Crown reserves vested in or under the control of the Shire of Manjimup (Windy Harbour [90 hectares] and Camfield [40.5 hectares] townsite on the north-eastern edge of Broke Inlet). There are also three trigonometrical stations (unmanaged reserves each less than 0.5 hectare in area) enclaved within D'Entrecasteaux National Park that are not part of the park (located on Callcup Hill, around the Pt

[2] The park is part is of the Walpole Wilderness, and is mentioned within the *Walpole Wilderness and Adjacent Parks and Reserves Management Plan 2009*, however the Shannon and D'Entrecasteaux National Parks Management Plan will be the prime document in regards to specific management of Shannon National Park.

D'Entrecasteaux lighthouse reserve and near Banksia Camp) and one enclaved within Shannon National Park (located in the north eastern corner).
D'Entrecasteaux National Park wholly encompasses the small inlets of the Donnelly, Warren and Meerup rivers and Doggerup Creek. However, the estuary of Gardner River is not within D'Entrecasteaux National Park and is considered a proposed addition. D'Entrecasteaux National Park also includes the shoreline of Broke Inlet (to low water mark) and the islands in the inlet (i.e. Shannon, Bald and Clarke islands). Broke Inlet is considered the only large estuary in the south-west with minimal development around its shores and within its catchment.

In 1994, 368 hectares of land in the Lake Jasper area was excised from D'Entrecasteaux National Park and along with 32 hectares of private property a section 5(1)(g) reserve with the purpose of 'conservation and mining' was created to facilitate mining (see Section 32 *Mining*). Part of the northern part of the section 5(1)(g) reserve has already been mined and rehabilitated and is to be returned to D'Entrecasteaux National Park.

Cable Sands indicated in mid-2010 that it will not be proceeding with mining in the remainder of the section 5(1)(g) reserve. Therefore it is to be returned to D'Entrecasteaux National Park, and most of the adjoining CALM Executive Body property will be returned to Cable Sands. The department is negotiating to establish a buffer area located to the north and north-west of Lake Jasper to be incorporated into the park because it contains important wetland habitat and vegetated areas. A new mining tenement has been established over the area.

There are also two further reserves enclaved within D'Entrecasteaux National Park. The lighthouse at Point D'Entrecasteaux is located within a section 5(1)(h) reserve (0.08 hectares) and has a purpose of 'navigation, communication, meteorology, survey and conservation'. The other reserve is a section 5(1)(g) reserve (0.4 hectares) which is located on Mt Chudalup and has a purpose of 'conservation and protection and use of geodetic survey mark'. These two reserves along with the section 5(1)(g) reserve at Lake Jasper are vested in the Conservation Commission and are managed in effect as part of D'Entrecasteaux National Park.

A number of pastoral leases (four of the five existing) and private property (14 of the 26 available) have been added to the park since gazettal of the 1987 management plan. These additions total 12,640 hectares (7921 hectares of pastoral lease and 4719 hectares of private property).

The park still surrounds 12 private properties (totalling 1234 hectares). Coastal and enclave properties, rather than properties on the edge of the park, as well as those mostly undisturbed with high conservation value are considered a higher priority for purchase if they become available (Appendix 1).

There are also many gazetted road reserves traversing both parks, some of which are currently undeveloped or unimproved. Some of the road reserves leading to private enclaves are poorly located in relation to landscape and environmental values, and should be relocated. Other road reserves may no longer be required such as the extension to Woodarburrup Road through the western end of D'Entrecasteaux National Park to link to Scott Road. The Department has successfully worked with the Shire of Manjimup to cancel the road reserves not required within that shire's authority and these reserves have been added to the park. There are four other road reserves within the Shire of Nannup that also should be cancelled and added to the parks following further negotiation with the local authority (Appendix 1).

Proposed additions other than the section 5(1)(g) reserve include the Quannup pastoral lease, a 600 hectare area of State forest to the north of the section 5(1)(g) reserve near Lake Jasper and 1000 hectares of State forest on the east side of Gardner River.

Shannon National Park

Shannon National Park is a class A reserve (No. 40836) vested in the Conservation Commission and set-aside for the purpose of 'national park'. The National Park was established in 1988 in accordance with the recommendations of the 1987 management plan. The park incorporated State forest, vacant Crown land, part of Sir James Mitchell National Park and an old school site to cover an area of 52,598 hectares.

The boundaries of the park generally follow the catchment of the Shannon River and adjoin State forest, Mt Frankland National Park and private property. New national parks to the east and west of the existing park have been created under tenure recommendations from the *Forest Management Plan 2004-2013* and include Mount Frankland South and Boyndaminup national parks to the east and Boorara-Gardner, Jane and Greater Dordagup national parks to the west.

4. KEY VALUES

The following are the key values that this management plan seeks to protect.

Conservation Values

- Extensive, varied, unique and nationally significant wetland systems that provide habitat for a range of endemic flora and fauna.
- A rich mosaic of vegetation complexes representing riparian, wetland, woodland and forest ecosystems protecting restricted vegetation communities and conservation significant flora populations.
- Areas of old growth forests and scenic areas of mature forest.
- Extensive areas of intact fauna habitat and populations of conservation significant fauna.
- Intact and varied natural landscapes with high scenic quality such as coastal cliffs, lakes, wetlands, inlets, rivers, granite outcrops and beaches.
- Sites of outstanding geoheritage, important for research and for understanding the formation of the landscape and environment.
- Statutory protection through reservation of almost an entire water catchment.

Recreational Values

- Remote areas of wilderness.
- A terrestrial environment that provides opportunities for a wide range of nature-based recreational opportunities including recreational driving, bushwalking, picnicking, camping, fishing and wildlife interaction.
- Coastal day use opportunities for local communities of the lower south-west.
- Long distance hiking opportunities on the Bibbulmun Track and proposed cycling opportunities on the extension to the Munda Biddi Mountain Bike Trail.

Cultural Values

- Aboriginal sites and landscapes of mythological, ceremonial, cultural and spiritual significance.
- Sites, landscapes and stories of European exploration, cattle grazing and droving, and timber settlements of cultural and ceremonial significance to non-Indigenous people.

Economic Values

- Nature-based tourism opportunities for commercial tour operators, focusing on the parks' wide range of natural and cultural values.
- Tourism expenditure from visitors attracted by the parks' natural and cultural values.

Educational Values

- An extensive range of community educational and interpretation opportunities to describe the native flora and fauna, Aboriginal and non-Indigenous cultural heritage, fire management and ecology of the south-west and the Department's management of the area.
- A diverse array of natural environments providing numerous research opportunities to increase knowledge associated with ecosystem biological and physical processes, species of flora and fauna and their habitats, and the effects and management of threatening processes.

5. PUBLIC PARTICIPATION

This management plan has been developed in consultation with local communities, park users and other interested parties in the following ways:

- public submissions were invited through State and local newspapers, media releases, letters to stakeholders, the Department's website and *The Planning Diary* during preparation and public consultation period of the draft management plan;
- community consultation meetings were conducted;
- a community advisory committee was formed to have input in the development of the draft management plan;
- other government agencies were consulted, including the Department of Indigenous Affairs, the former Department of Environment, Department of Water and the former Department of Industry and Resources; and
- meetings were held with stakeholder groups and interested individuals.

PART B. MANAGEMENT DIRECTIONS AND PURPOSE

6. VISION

The vision for the Shannon and D'Entrecasteaux national parks is that:

> *By the year 2022, the natural and cultural values of the parks are in the same or better condition than in the year 2012 and there will be a greater understanding of the threats and impacts on these values. The parks will continue to support a wide range of nature-based recreational activities that are compatible with the conservation values whilst preserving the remote nature and wilderness values of the parks. The local community as well as the wider community will highly value the parks and will want to be involved in their protection and conservation. The Indigenous cultural heritage of the parks will be kept alive and promoted by active and ongoing involvement of the traditional owners who will have been able to reconnect with and care for their country.*

This vision of this plan is derived from State legislation and policy, and community input including specifically input from the Shannon and D'Entrecasteaux National Park Advisory Committee. The vision also reflects the key values of the parks and the importance of sustainably managing those values (see Section 4 *Key Values*).

7. LEGISLATIVE FRAMEWORK

Legislation

The *Conservation and Land Management Act 1984* governs the management of protected areas and, in the process, imposes certain obligations relating to management planning of these areas.

National parks and section 5(1)(g) and 5(1)(h) reserves are vested in the Conservation Commission and managed by the Department in accordance with the Conservation and Land Management Act. Management of these reserves includes the preparation of management plans as required by section 54(3)(a)(i) of the Act, which are to contain a statement of policies or guidelines to be followed in the management of the area, and a summary of the operations proposed to be taken over the life of the management plan (section 55 of the Act).

Each management plan is written with a 10-year time frame. Over this time, the management plan is subject to audit by the Conservation Commission (see Section 10 *Performance Assessment*). As a result of the review and auditing process, or for some other reason, it may be necessary to amend the management plan. The procedure to make an amendment to a gazetted management plan is governed by section 61 of the Conservation and Land Management Act and involves a public consultation process. If a management plan is considered still relevant after 10 years, it will not be a Departmental priority to replace it. All plans, whether 10 years old or not, remain in force until a replacement management plan is gazetted.

National parks are a category of protected area under the Conservation and Land Management Act and are terrestrial areas of national or international significance for biological, scenic, or cultural values. Commercial exploitation of flora and fauna is not permitted and only recreational pursuits that do not adversely affect ecosystems and landscapes are permitted.

Land reserved as a section 5(1)(g) or 5(1)(h) reserve is set aside to achieve the purpose for which the land was reserved, or for which the care, control and management of the land were placed with the controlling body. For example, in the case of the section 5(1)(g) reserve in the Lake Jasper area, the purpose is for 'conservation and mining'.

The *Wildlife Conservation Act 1950* also provides for specific protection of native flora and fauna on all lands and waters within the State boundaries (see Section 18 *Species and Communities of Conservation Significance*).

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* also contains provisions relating to the protection of nationally-listed threatened species and ecological communities and listing of key threatening processes (see sections 12 *Climate Change*, 18 *Species and Communities of Conservation Significance*, 20 *Introduced and Other Problem Animals* and 21 *Diseases*).

This management plan is required to conform to the *Bush Fires Act 1954* and satisfy the Fire and Emergency Services Authority that adequate fire protection will be provided for the reserves (see Section 22 *Fire*). Under section 34(1)(1a)(a) of that Act, the management plan requires approval from the Authority.

Under the *Aboriginal Heritage Act 1972*, the Department is required to report Aboriginal heritage sites and ensure that sites are protected (see Section 23 *Indigenous Heritage*). The (Commonwealth) *Native Title Act 1993* requires that native title claimants and representative bodies are notified when a management plan is being prepared or major public works undertaken. The South-West Aboriginal Land and Sea Council is the native title representative body for the parks and has a number of functions prescribed under the Native Title Act.

Recreational fishing in the parks is managed under the *Fish Resources Management Act 1994*. However, under the *Conservation and Land Management Regulations 2002*, fishing on lands managed by the Department may be restricted.

The *Mining Act 1978* and the *Petroleum and Geothermal Energy Resources Act 2007* take precedence over the Conservation and Land Management Act. Activities authorised under either of these acts may override the contents of this management plan although such activities are subject to the concurrence of the Minister for Environment, and any mining leases require the approval of both Houses of Parliament prior to being granted (see Section 32 *Mining*).

Obligations and Agreements

Australia is a participant or signatory to a number of international conservation agreements which affect the management of conservation estate. They include the following:

The Convention on Biological Diversity

Australia signed the Convention on Biological Diversity at the United Nations Conference on Environment and Development (also known as the 'Rio Earth Summit') in 1992. The *National Strategy for the Conservation of Australia's Biological Diversity* was adopted in 1996 as the principal means for co-ordinated implementation of the convention in Australia. Its main goal is to protect biological diversity and maintain ecological processes and systems. To address this goal there has been a number of significant changes to policy and legislation for biodiversity conservation in Australia to strengthen regulatory and institutional mechanisms. This includes the Environment Protection and Biodiversity Conservation Act and the Natural Heritage Trust programs.

Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA) and Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)

Australia's treaties with Japan and China came into force in 1981 and 1988 respectively and Korea recently in 2006, to protect migratory birds in these countries. The treaties provide for cooperation between the governments involved to protect shared migratory species and their habitats. Nearly 80 bird species, many of them associated with wetlands, are listed in these agreements.

Migratory birds listed under these agreements are further protected under the Environment Protection and Biodiversity Conservation Act. This Commonwealth legislation stipulates that all actions likely to impact on such species are subject to environmental assessment and approval. This places Australia in a stronger position to meet its international obligations for the protection and management of migratory birds listed under the JAMBA, CAMBA and ROKAMBA agreements.

There are four bird species covered under the JAMBA, CAMBA and/or ROKAMBA agreements that are recorded in the parks (see Section 18 *Species and Communities of Conservation Significance*).

Bonn Convention

Australia is also a contracting party to the Convention on the Conservation of Migratory Species of Wild Animals (called the Bonn Convention), which came into force in 1992. Under this Convention, countries are expected to agree to protect species that regularly migrate across international boundaries. Australia was successful in listing the 11 species of albatross found in the southern hemisphere on the appendices of the Bonn Convention. Dead, sick or injured albatrosses are occasionally found on Yeagarup and Warren beaches. The

osprey (*Pandion haliaetus*) is also listed under the Bonn Convention and is found in the parks (see Section 18 *Species and Communities of Conservation Significance*).

Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention)

The Convention on Wetlands, signed in Ramsar, Iran in 1971 is an intergovernmental treaty dedicated to the conservation and 'wise use' of wetlands. Australia became a contracting party in 1974. The Convention's mission is:

> *"the conservation and wise use of wetlands by national action and international cooperation as a means to achieving sustainable development throughout the world".*

The Convention encourages contracting parties to designate sites containing representative, rare or unique wetland types, or that are important for conserving biological diversity to the List of Wetlands of International Importance ('Ramsar sites'). These sites need to be managed to ensure their special ecological values are maintained or improved.

There are currently no Ramsar sites in the parks. However it is possible that some of the wetlands in the parks may be nominated for Ramsar listing during the life of this plan as some wetlands have already been identified as being nationally important (see Section 18 *Species and Communities of Conservation Significance*).

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

In 1976, Australia joined CITES, which is an international agreement between governments which covers approximately 5000 fauna species and 28,000 flora species worldwide. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. There are 1093 fauna species and 616 plant species listed that occur within Australia.

The Australian International Council on Monuments and Sites Charter for the Conservation of Places of Cultural Significance (the Burra Charter)

In 1979 the Australia International Council on Monuments and Sites (ICOMOS) adopted a charter for the conservation of places of cultural significance, now known as the *Australia ICOMOS Burra Charter, 1999* (Burra Charter). The charter has been widely been adopted as the standard for heritage conservation practice in Australia and applies to all types of places of cultural significance including natural, Indigenous and historic places with cultural values.

8. MANAGEMENT ARRANGEMENTS WITH ABORIGINAL PEOPLE

The traditional Aboriginal lifestyle was dependent on an intimate knowledge of the land. Nyoongar people used a deep understanding of the land, its attributes and behaviour to make it easier to acquire food, medicines and the requirements for life. Nyoongar people lived and cared for the land with one basic and important understanding—people were a part of the environment, not separate from it.

Aboriginal people sought to influence the environment to provide resources. Fire in particular was used to create successional changes in vegetation thus affecting the ecology of an area (see Section 22 *Fire* – Fire History).

When pastoralists came to the area in the late 1800s, they observed the effect that Aboriginal land management had on potential grazing lands. The cattlemen quickly realised the value of burning to promote grazing country, and when Nyoongar people were removed from the land the pastoralists continued to frequently burn the area as late as the 1970s (Kelly *et al.* 1999).

There has been a renewed interest by the Nyoongar people to be involved in the management of the public conservation estate in the south-west and an interest to re-establish cultural ties to the land. It is obvious that by working together with Aboriginal people to care for the land, there will be great benefits for the preservation of heritage and environment as well as for cross-cultural awareness.

A memorandum of understanding is in place between the Department and the South-West Aboriginal Land and Sea Council. This memorandum sets out both principles and guidelines under which access and co-operative management agreements between the Department and Aboriginal people may be established within the existing provisions of the Conservation and Land Management Act.

Aboriginal people consider the parks to be significant because of previous occupation, and because they have a cultural obligation to understand and care for the area. Aboriginal caring for country is about the whole of the landscape and the interconnected nature of sites, people and environment. It is through these sites that Nyoongar people can rediscover their heritage and develop a reattachment to the land, rediscovering Aboriginal identity and culture. Aboriginal interpretation of their culture is important within the parks and should be promoted (see Section 41 *Information, Education and Interpretation*). Participation of Aboriginal people in promoting cultural heritage to visitors could be encouraged, and facilitated through the provision of commercial concessions (see Section 28 *Commercial Tourism Operations*).

There are currently three registered native title claimant groups that cover part or all of the parks; South West Boojarah (WC98/63), Southern Nyoongar (WC96/109) and Wagyl Kaip (WC98/70) (Figure 1). There are two further unregistered native claimant groups; Wom-Ber (WC96/105) and the Combined Single Nyoongar Claim (WC03/6).

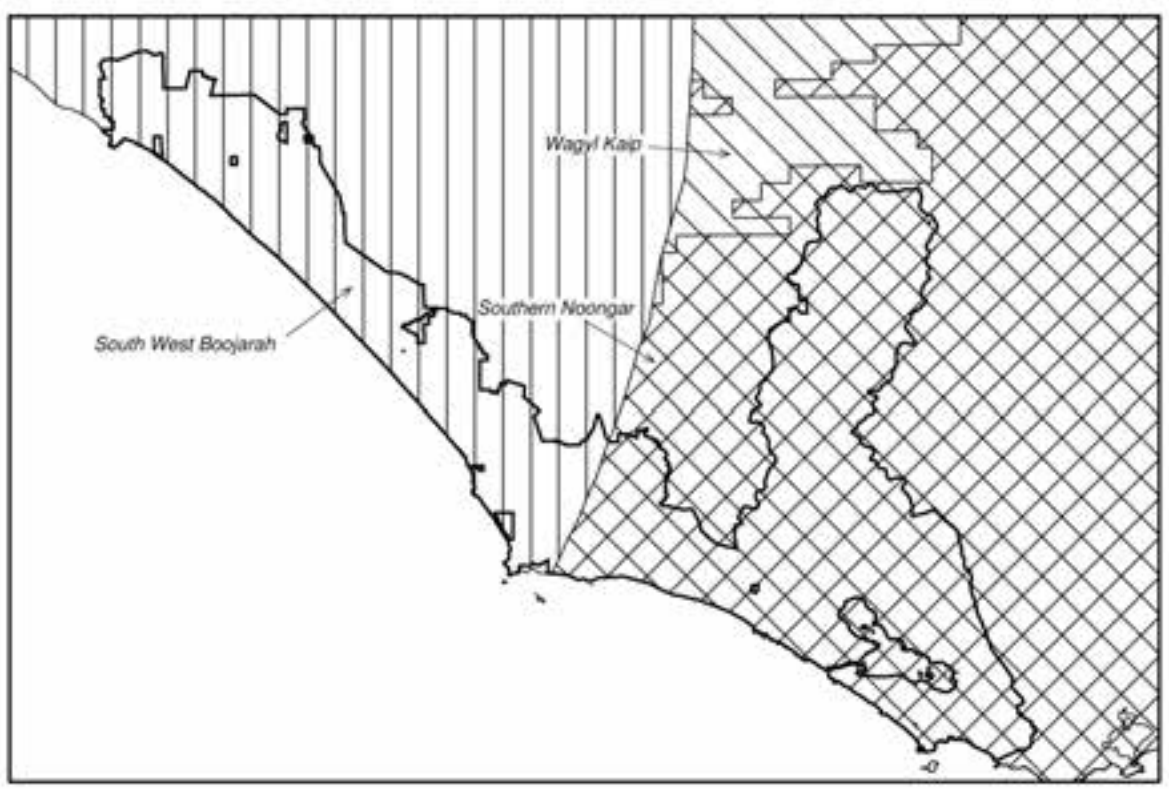
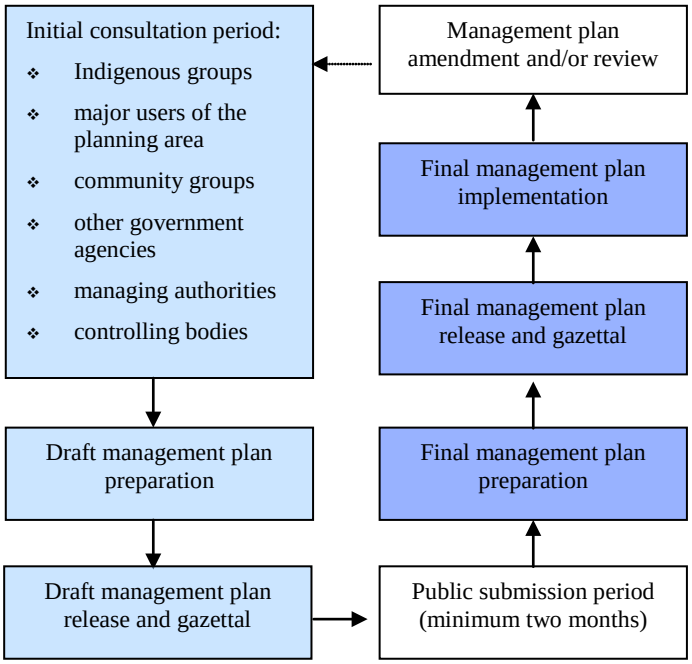


Figure 1: Registered Native Title Claimant Groups of the Planning Area

9. MANAGEMENT PLANNING PROCESS

The Department initiates the preparation of management plans according to State-wide priorities and on behalf of the Conservation Commission. The process of producing a management plan is shown below.

This management plan represents the final management plan prepared subsequent to the draft management plan for the parks produced in 2005 (CALM 2005b) and will replace the *Shannon Park and D'Entrecasteaux National Park Management Plan 1987-1997* (CALM 1987) and will remain in place unless it is either revoked by the Minister for Environment or a new plan is approved (see Section 45 *Term of the Plan*).



10. PERFORMANCE ASSESSMENT

Assessment by the Conservation Commission

The Conservation Commission will measure the success of this plan by using key performance indicators (KPIs), and other mechanisms as appropriate. It is not efficient to measure all aspects of management given resource and technical impediments—consequently, indicators will target key components of the plan. Kanowski *et al.* (2001) defined key performance indicators, when considering the conservation of biodiversity, as:

> "*the minimum set, which if properly monitored, provides rigorous data describing the major trends in, and impacts on, Australian biodiversity.*"

This includes the specification of a measure and target, reporting requirements and a management response to any target shortfall. These components provide a basis for adaptive management, whereby management is altered if necessary to meet a desired outcome.

The Department is responsible for providing information to the Conservation Commission to allow it to assess the success of the Department's management in meeting targets specified in the KPIs. The frequency of these reports will depend upon the requirements of each KPI. Where a report identifies a target shortfall, a response to the Conservation Commission is required. The response may identify factors that have led to the target shortfall, and propose alternative management where appropriate. The Conservation Commission will consider the Department's response on the target shortfall and evaluate the need for action in the context of its assessment and audit function under section 19(1)(g)(iii) of the Conservation and Land Management Act. The Conservation Commission will make the results of audits available to the public.

The application of a KPI within a section is identified throughout the plan and presented with targets and reporting requirements in Appendix 2.

The adequacy of the range of selected KPIs and management will be reviewed following each Conservation Commission assessment.

PART C. MANAGING THE NATURAL ENVIRONMENT

The responsibilities of the Department include conservation of biodiversity at ecosystem, species and genetic levels, and the sustainable management of the resources they provide. The Conservation Commission also has a role in biodiversity conservation through the development of policies "…for the preservation of the natural environment…" (section 19(1)(c) of the Conservation and Land Management Act) and the preparation of management plans. The Department is guided by a number of principles in fulfilling its responsibilities, foremost of which are that the diversity and health of ecological communities and native species throughout Western Australia will be maintained and restored, and the lack of scientific certainty shall not be used as a reason for postponing measures which seek to protect or restore the environment or prevent loss of biodiversity (DEC 2007a).

11. BIOGEOGRAPHY

Creation of a conservation reserve system that is comprehensive, adequate and representative helps meet obligations under the International Convention on Biological Diversity and *Australia's Strategy for the National Reserve System 2009–2030* (National Reserve System Task Group 2009). The Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell 1995) provides a planning framework for selecting a CAR system of protected areas (and for bioregional planning more generally).

Bioregions

The IBRA divides Australia into 85 separate bioregions and 384 subregions, based on lithology, geology, landform, and vegetation. Twenty-six IBRAs are represented in Western Australia. The planning area is predominantly within the Warren bioregion with a small north-eastern section of Shannon National Park within the Jarrah Forest bioregion (Figure 1).

Warren Bioregion

The Warren bioregion is described as dissected undulating country of the Leeuwin Complex and Albany Orogen with loamy soils supporting karri forest, laterites supporting jarrah-marri forest, leached sandy soils in depressions and plains supporting paperbark/sedge swamps and Holocene marine dunes with peppermint (*Agonis flexuosa*) woodlands, in a moderate Mediterranean climate.

The percentage and area of the Warren region within conservation reserves is 46.6% and 378,380 hectares respectively (as of July 2007). This amount includes the majority of additions identified in the *Forest Management Plan 2004-2013*. The parks (including recent additions) will represent approximately 45.3% of the total protected area within the Warren bioregion (see Section 3 *Management Plan Area* and Section 32 *Mining*). An additional 1600 ha is identified in the FMP for addition to D'Entrecasteaux National Park but is yet to occur.

Jarrah Forest Bioregion

The Jarrah Forest bioregion is characterised by jarrah-marri forest on laterite gravels and in the eastern part, by marri-wandoo woodlands on clayey soils (Thackway and Cresswell 1995). The percentage and area of the Jarrah Bioregion within conservation reserves is 25.7% and 618,497 hectares respectively (as of July 2007). This amount includes the majority of additions identified in the *Forest Management Plan 2004-2013*. A small portion (1242 hectares—less than 1%) of the Jarrah Forest Bioregion is within Shannon National Park.

Marine Bioregions

Three major marine biogeographical zones occur on the Western Australian coast: a tropical zone north of North West Cape, a temperate zone east of Cape Leeuwin and a biological overlap zone in between. These three zones are represented by 18 IMCRA bioregions. Parts of both the Leeuwin-Naturaliste and WA South Coast marine bioregions are adjacent to the D'Entrecasteaux National Park converging at Black Head (Figure 1).

Currently there is a regional marine planning process for coastal waters from Augusta to Esperance which is a cross-sectoral framework for integrated marine planning and management on the south coast, consulting with numerous agencies and stakeholders. Whilst it includes economic requirements with conservation objectives, it will also provide a context within which to consider role of and need for marine protected areas on the south coast.

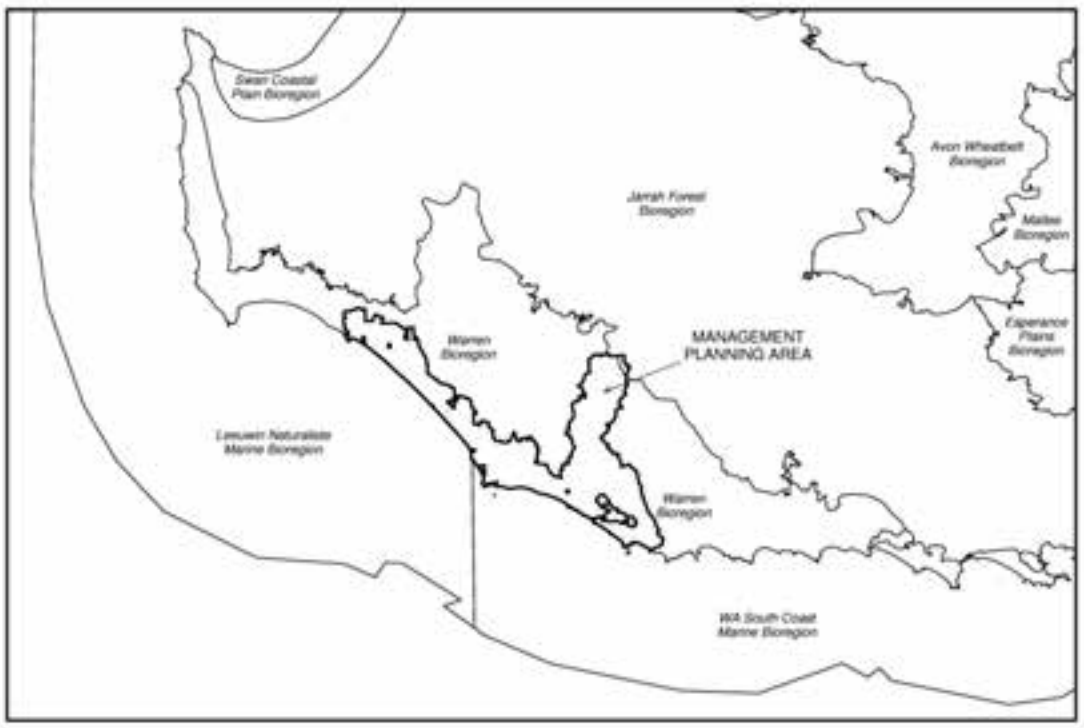


Figure 2: Bioregions in the South-West

Forest Ecosystems

Forest ecosystems were defined in the south-west for use in the Western Australian Regional Forest Agreement by Bradshaw and Mattiske (1997). Twenty six forest ecosystems were identified and used to further the establishment of a comprehensive, adequate and representative conservation reserve system to protect the biodiversity of the south-west forest areas. The forest ecosystems are at a finer scale than the bioregional approach for the rest of the State. They are based on key species of the overstorey, the height of the overstorey, canopy cover and the understorey vegetation communities, and are different to the vegetation complexes and vegetation associations referred to in Section 18 *Species and Communities of Conservation Significance*.

The reservation target for each forest ecosystem in the south-west is 15% of the pre-1750 distribution, except where the forest ecosystem is recognised as rare/endangered and a target of 100% of their remaining extent should be set (ANZECC and MCFFA 1997). To assist in decisions on areas for reservation, information provided at a finer scale is also considered, including vegetation complexes, species richness, the presence of relictual, endemic or disjunct species, old growth forests and wilderness values (see Section 18 *Species and Communities of Conservation Significance* and Section 25 *Recreational Opportunities*).

There are 12 forest ecosystems in the planning area, eight of which meet the agreed target for reservation in a formal conservation system (current reservation ranging from 15% to 98%). The addition of the reserve proposals in the *Forest Management Plan 2004-2013* will increase the representation levels of these forest ecosystems. The informal reserve system within State forests is also managed to increase the protection of less well represented forest ecosystems.

Jarrah Blackwood, Jarrah South and Jarrah Woodland do not currently meet the 15% target for reservation, however with the proposed additions in the *Forest Management Plan 2004-2013* they will reach 23%, 40% and 26% reservation respectively. The target for Bullich and Yate is 100% reservation of extant vegetation, which equates to a target of 87% of pre-1750 distribution. Current reservation of Bullich and Yate is 54%, 98% of

which is within D'Entrecasteaux National Park and the section 5(1)(g) reserve. The proposed addition of Quannup pastoral lease to D'Entrecasteaux National Park will raise the reservation to 77%. Protection of this ecosystem is required on private land to meet the target of 87%.

11. Biogeography – Key Points

- The planning area is predominantly within the Warren bioregion with a small portion within the Jarrah Forest bioregion.
- Approximately 46.6% of the Warren bioregion and 25.7% of the Jarrah Forest bioregion is in a formal conservation reserve.
- The 26 forest ecosystems defined for the Western Australian Regional Forest Agreement are used to assist in the establishment of a comprehensive, adequate and representative national reserve system to protect the biodiversity of the south-west forest area.
- Twelve forest ecosystems occur in the planning area, eight of which meet the agreed target for the national reserve system.

The objective is to ensure protection of a comprehensive, adequate and representative conservation reserve system within the national reserve system and to maintain or increase the parks' contribution to this system.

This will be achieved by:

1. Acquiring, by purchase, exchange or other means when opportunities arise and funds are available, areas within or adjoining the parks that have significant conservation or recreational values, or management benefits that could assist in protecting areas within the parks and contribute to the national reserve system.
2. Incorporating the Quannup pastoral lease into D'Entrecateaux National Park at the cessation of the lease in 2015 or, should it become available, purchasing the lease prior to 2015.
3. Implementing the recommendations in the *Forest Management Plan 2004-2013* to have 1600 hectares of State forest added to D'Entrecasteaux National Park.
4. Purchasing private property within the parks when it becomes available according to conservation value of the areas and as funds allow and adding to the parks.
5. Negotiating with the relevant State agencies and local authorities to add important conservation and recreation reserves under their control to the parks; and
6. Implementing any refinements to the targets for a CAR system over the life of this management plan.

Key Performance Indicators:
There are no Key Performance Indicators for this section

12. CLIMATE CHANGE

Observed and Projected Climate Change

In the south-west of WA, changes in greenhouse gas concentrations, combined with natural variability, have contributed to an observed decline in rainfall (IOCI 2006), especially in early winter (May, June and July). Annual rainfall decreased by up to 10 per cent in the Cape to Cape region for the period 1975-2003 compared to long-term records (DoW 2007b). This resulted in a decline in streamflows for the same period.

Projections for the south-west of WA are for continued warming (increased mean annual temperature) and reduced rainfall (IPCC 2007), with slightly less warming in coastal areas. The Indian Ocean Climate Initiative (IOCI 2006) projects a rise in temperature in all seasons in the south-west by 2030 as well as more declines in winter rainfall. Catchments can expect more reductions in runoff. There are also indications that weather events may be more extreme, with more frequent and prolonged droughts. Changes in ground moisture, temperature and vegetation may also lead to more vigorous fire behaviour in traditionally cooler months and therefore more restricted burning seasons, which is likely to have implications for fire management. Sea levels are also expected to rise, potentially by 9-88 cm by 2100 (IOCI 2006).

Impacts of Climate Change

The potential impacts of climate change on biodiversity are uncertain and poorly understood, although the south-west of WA is considered to be at considerable risk of significant biodiversity loss (IPCC 2007). Potential direct impacts on biodiversity include changes in animal and plant physiology, changes in life-cycle timing, and changes in species distribution and abundance. Indirect impacts may arise from changes in species competition and predation, or through alteration to the nature and intensity of existing biodiversity pressures (e.g. disease, salinisation, density and distribution of weeds, erosion, habitat fragmentation and loss of wetlands). The combination of direct and indirect impacts resulting from climate change could place considerable stress on ecological systems and result in:

- local species extinctions
- changes to ecosystem composition and processes
- changes in fire behaviour
- a contraction or fragmentation in the range of native species
- the dispersal or migration of species from their current locations to locations having more appropriate conditions.

Some plant and vertebrate species in the south-west require specific local climate conditions that may disappear entirely with as little as 0.5-1°C warming. Modelling by the CSIRO shows that with only 0.5°C warming, the habitats for all frog and many mammal species would be significantly reduced and 15 species of endangered or threatened WA mammals would disappear or be restricted to small areas. Species most likely to be affected are those:

- with narrow temperature or cool temperature requirements
- with narrow geographic ranges that are closely associated with local environmental conditions
- dependent on relatively high rainfall
- which are unable to evolve in situ.

In the planning area, some wetlands, lakes and ephemerally moist riparian zones could contract or dry out, reducing this vegetation type and predisposing these areas to fire. This in turn may affect the structure of waterways as well as the aquatic ecology and fringing vegetation. The lowering of watertables and groundwater flow may also affect some habitats and plant communities. There are a number species and communities in the planning area that are endemic, at or near the limits of their range and with restricted wet habitat requirements making it difficult for some species to migrate, and hence may be vulnerable to climate change. Rising sea levels may impact on coastal infrastructure and beach use.

Responses to Climate Change

In Western Australia a climate change and adaptation strategy is being developed. The department has begun work on modelling biodiversity response to investigate the potential vulnerability of WA's plants and animals to climate change, and development of a climate-biodiversity strategy.

At the individual reserve level, implementing strategies that create and expand reserves, control introduced animals and weeds, manage fire, and re-introduce or translocate threatened native plants and animals, will help improve the resilience of species and ecosystems and hence decrease their vulnerability to climate change. A system of monitoring sites should also be established to ensure any changes to ecosystem composition and structure is quickly detected, enabling remedial strategies to be developed and implemented in a timely manner.

12. Climate Change – Key Points

- Predictions for climate change suggest that by 2030, annual average temperatures will be 0.4 to 2.0 °C higher over most of Australia, with slightly less warming in some coastal areas. By 2070, it is predicted that annual average temperatures will increase by 1 to 6 °C (0.8 to 5 °C in the south-west).
- In the south-west, rainfall and river flows have already declined, and this is expected to continue with rainfall predicted to decline by as much as 60% from 1990 levels by 2070.
- The south-west has been identified as a region with medium to high vulnerability to climate change impacts such as loss of biodiversity.
- Reserve creation, introduced predator and weed control, appropriate fire management and reintroduction programs, could help improve the adaptability of species and ecosystems, and decrease their vulnerability to climate change.

The objective is to understand and respond to the effects of climate change on the biodiversity of the parks.

This will be achieved by:

1. Investigating the potential vulnerability of the parks' species and communities to climate change, including where practicable, identifying climatic thresholds for threatened species and communities within the parks.
2. Protecting adequate and appropriate areas as part of the reserve system to provide buffers, corridors and climate refugia.
3. Incorporating the potential for climate change impacts into species recovery plans.
4. Limiting non-climate stresses for species and communities that are vulnerable to climate change.
5. Adapting prescribed burning regimes to take into account long-term climatic changes in ground moisture, temperature and/or vegetation as required.
6. Wherever possible, aiming to reduce greenhouse gas emissions and improve energy efficiency when designing infrastructure and facilities.

Key Performance Indicators:
There are no Key Performance Indicators for this section

13. GEOLOGY, LANDFORM AND SOILS

Geology

The majority of the planning area lies within the Proterozoic Albany–Fraser Orogen, although approximately one-third of the D'Entrecasteaux National Park lies in the Phanerozoic Perth Basin (west of the Darling Fault) (Figure 3).

The main rock types within the Albany-Fraser Orogen are granite and gneiss intruded by dolerite dykes. These rocks formed mostly during the Mesoproterozoic (1345 to 1140 million years ago) when two continental landmasses (the West Australian Craton and the South Australian Craton) collided with each other.

The southern part of the Phanerozoic Perth Basin under parts of the D'Entrecasteaux National Park contains up to 6 kilometres of sedimentary rocks, the oldest being Early Permian in age (approximately 290 million years old). Extensive rifting of the Basin began in the Early Triassic (approximately 250 million years ago), and continued until the breakup of the supercontinent Gondwana (which Australia was a part of) in the Early Cretaceous (approximately 140 million years ago). Tectonism, accompanied by faulting and folding of the Perth Basin sediments occurred during this breakup phase.

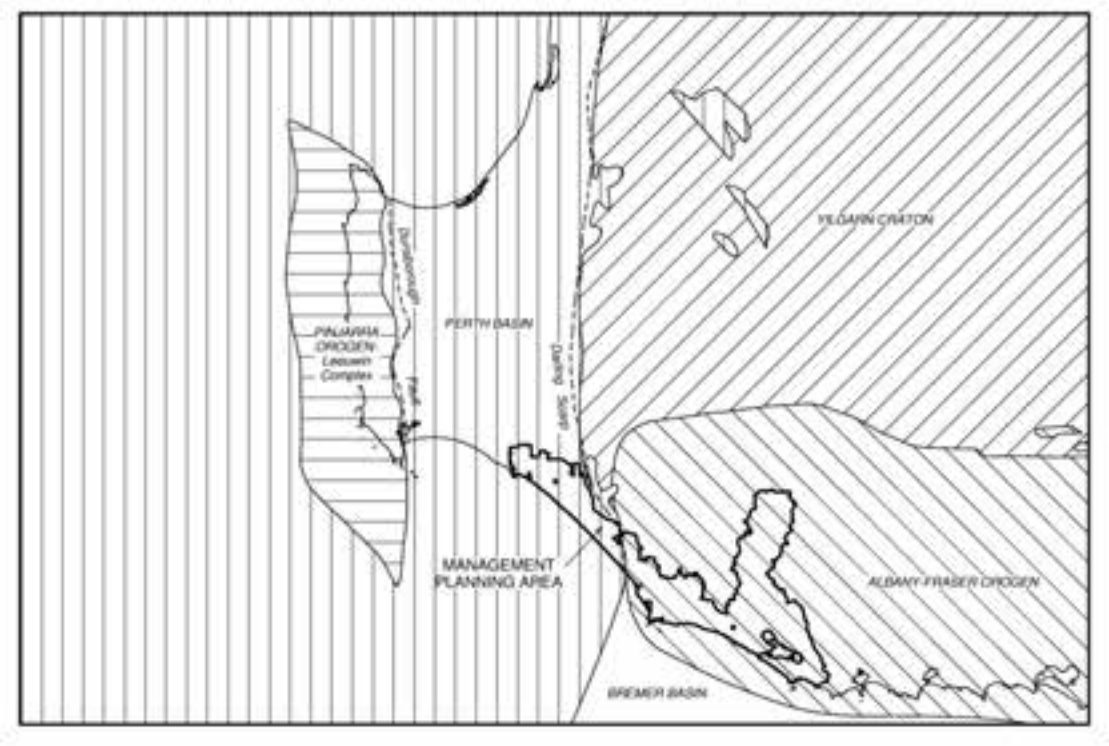


Figure 3: Geology of the South-West

The Bunbury Basalt, that outcrops in columns at Black Point and at the mouth of the Donnelly River, flowed out of volcanoes at 130 and 123 million years ago. The break up of Australia and Antarctica approximately 65 million years ago led to the re-arrangement of the topography of the south coast, formation of the Ravenswood Ramp and Jarrahwood Axis and development of the present river systems. Cainozoic deposits (63 million years ago to present) and weathering profiles overlie most of the older rocks and sediments, and include the extensive laterite profiles. Deposition of sediments in the Bremer Basin in the Eocene (approximately 27 to 54 million years ago) also occurred in this rifting and breakup period and these marine sediments now cover 70% to 80% of the park.

Known Minerals

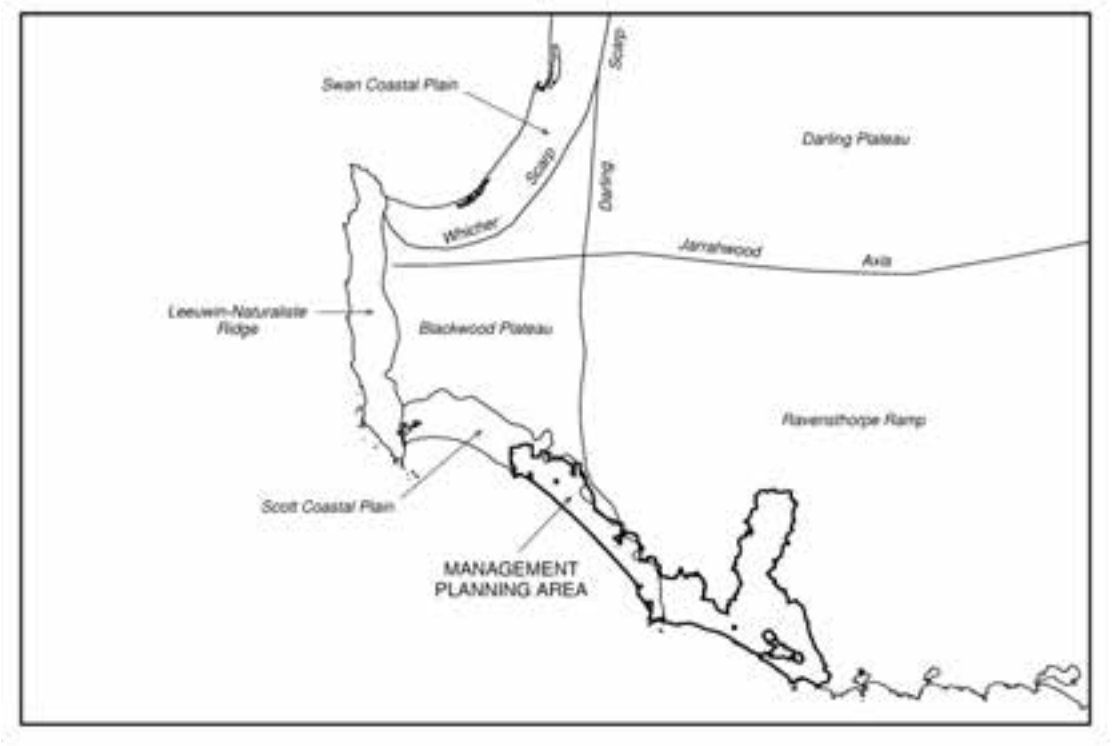
Known minerals in the parks of economic value include bauxite in the northern part of the Shannon basin, coal (only at excessive depths) and lignite deposits within the Scott Coastal Plain from the Warren River westward, heavy mineral sands and limestone. The latter two are the only minerals that have previously been of commercial interest (see Section 32 Mining).

Landform and Soils

The parks cover two major physiographic land units—the Ravensthorpe Ramp and the Scott Coastal Plain (Figure 4). The Scott Coastal Plain is based on deposits of sands of marine and alluvial origin, and is characterised by extensive swampy plains. The Ravensthorpe Ramp is south of the Darling Plateau separated by the Jarrahwood Axis (Cope 1975, Wilde 1981, Wilde and Walker 1984, Hassan 1998). Three broad morphological belts, which lie parallel to the coast; the coastal belt, the marine and alluvial swampy belt, and the dissected laterite belt overlie these physiographic land units.

Coastal Belt

The coastal belt comprises consolidated calcareous and siliceous sands and consolidated dunes, both of which support shallow, sandy soils. These soils are shallow, porous and deficient in most nutrients, although iron can be found in some of the deeper soils. Iron and peaty podsols may also occur on the deep sands of dunes.



(adapted from Hassan 1998 and Cope 1975)

Figure 4: Physiographic Units of the South-West

The coastal belt extends the entire length of D'Entrecasteaux National Park, varying in width from 500 metres near Point D'Entrecasteaux to 9 kilometres in the west and east. The belt consists of aeolian (wind blown) dunes which, in places, form large areas of drifting sand up to 4000 hectares in extent (such as at Yeagarup and Meerup). These coastal dunes have encroached inland over Precambrian bedrock, pre-existing wetlands and estuaries. In general, the dunes are progressively becoming more stable, vegetated and regular in form inland from the coastline (McArthur and Clifton 1975). In other places, the dunes have lithified, creating massive, consolidated ridges, such as those south of Broke Inlet and within the Yeagarup and Callcup areas. Examination of air photography (1951, 1963 and 1975) demonstrate that the northern side of Callcup Dunes migrated inland at a rate of about 1 metre per year during that period (M. Freeman pers. comm. 2004).

Limestone cliffs occur intermittently along the entire length of D'Entrecasteaux National Park, and range in height from 40 metres in the western section near Black Point (where they occur in association with basalt cliffs) to 150 metres in height in the eastern section between West Cliff Point and Cliffy Head. North-west of Doggerup, geologically recent marine deposits have created a new series of dunes in front of the limestone scarp. Beach-building processes appear to be continuing, with the beach at present located about 1 to 2 kilometres from the scarp in the area between Doggerup Creek and the Donnelly River.

Most of the coastal ridges, irregular in form with steep slopes, are covered by younger Holocene (12,000 years ago to present) sand dunes. Older deposits further inland form extensive parabolic dune systems, which are generally stabilised. For example, dunes such as Callcup Hill and Silver Mount are relatively high, reaching 236 metres and 116 metres respectively. The inland margin of the coastal dunes drops sharply into the extensive, seasonally-inundated, swampy plain.

The sandy soil of the coastal plain is readily eroded by wind. They are extremely susceptible where the coastal dunes are sparsely vegetated, near steep slopes or during strong winds. The steep younger dunes closest to the coast are generally more at risk than the older, stabilised dunes further inland. The coastal dunes are moderately susceptible to water erosion (see Section 15 *Catchment Protection*). In the past, water erosion has cut through the primary dune system and allowed the wind to cause the dune blowouts along the coast of the parks. These blowouts can be further exasperated by human activities.

Marine and Alluvial Swampy Belt

The marine and alluvial swampy belt is usually found inland of the coastal dune ridges, where the end of the dune systems brings the land closer to the water table. This belt was created by coastal dunes blocking surface water flow, which has resulted in the formation of a transitional zone of scattered wetlands between the coast and forested laterite plateau.

A prominent example of this is Broke Inlet, which has formed parallel to the coast behind massive consolidated dunes and cliffs. In other areas the wetlands are composed of numerous small lakes, swamps and inundated flats formed in low-lying, interdunal areas or previous lagoons and estuaries (see Section 18 *Species and Communities of Conservation Significance* – Communities – Wetlands). The area is generally flat (subdued relief to approximately 20 metres above sea level) and is dissected by numerous small streams forming swampy, unchannelled watercourses. In the lower dune slopes and interdunal areas, iron podsols and solonetzic soils with a shallow 'A' horizon are common.

Minor exposures of granitic and gneissic remnants occur as outcropping hillocks 20 to 50 metres above the surrounding wetlands. These exposures become more common towards the south-east of the D'Entrecasteaux National Park. Occasionally, the outcropping rocks rise to form prominent hills, such as Mt Chudalup, Mt Pingerup and Woolbales Hills, which dominate the subdued landscape (see Section 18 *Species and Communities of Conservation Significance* – Communities – Granite Outcrops).

Dissected Laterite Belt (or Plateau)

The dissected laterite belt occupies the northern half of the Shannon National Park. The plateau can be divided into three landform units, differentiated by the degree of dissection of the laterite duricrust, the shape of valleys and the nature of the drainage network. In the northern part, deeply weathered rocks, laterisation processes and erosional modification have resulted in a gently undulating plateau, which extends into the central section of the park. The central section of the park is characterised by granite exposures on the upper slopes. The third southern unit features an undulating surface with many distinct hills with rounded crests of remnant laterite. In this area, several valleys have broad drainage floors, which form long, swampy corridors.

The laterite plateau is dominated by yellow duplex soils with varying amounts of laterite gravel. Laterite duricrust occurs in some areas with associated red and yellow earths. Light yellow-brown sandy and gravelly loams, in association with weathered granite, dominate the deeply dissected areas on valley slopes. In areas where metamorphosed rock outcrops occur, the soil has a finer texture, mostly of red or brown clay. Granite and gneissic rock outcrops are common on the hills and ridges as well as where the weathered mantle is extensive. Yellow duplex soils with lenses of gravelly pale grey to brown loamy sand are dominant in these elevated regions. In comparison, deep sands and podsol soils are common on the lower slopes. Yellow or light grey solonetzic sandy soils generally occur within swampy areas on the plateau.

Geoheritage

Geoheritage refers to state-wide and nationally significant features of geology that offer important information or insight into the formation or development of the continent, have high landscape value or that can be used for research, teaching or as a reference site.

Carter (1987) identified three significant geological features in the parks—Black Point, Point D'Entrecasteaux and Mt Chudalup, which have been recognised by the Geological Survey of Western Australia as being State geoheritage sites. Management recommendations include no coastal development at Black Point, and that the Windy Harbour 'granulite exposures' should be protected from development (there are two occurrences of the granulites at Windy Harbour, one within the Shire reserve and one at the base of Pt D'Entrecasteaux within the parks). Semeniuk (1997) has identified other sites of geoheritage in the parks as part of the assessment of values for the *Regional Forest Agreement for the South-West Forest Region of Western Australia* (Commonwealth of Australia and the State of Western Australia 1999). These sites in the parks are summarised in Appendix 3.

Whilst this inventory is a good start, further systematic, thematic regional inventory work is required to identify and map areas and features, and recommend appropriate activities in these areas. Such information could be used with regards to recreation site design and use as well as during the design of management access tracks and fire breaks. Many of the geological and landform features in the parks are highly susceptible to damage if inappropriately utilised.

13. Geology, Landform and Soils – Key Points

- Mining interest within the parks is focused on heavy mineral sands and limestone.
- The parks cover two major physiographic land units—the Ravensthorpe Ramp and the Scott Coastal Plain, separated by the Darling Scarp. These are overlaid by three basic landforms: the Coastal Belt, the Marine and Alluvial Swampy Belt, and the Dissected Laterite Belt.
- Geoheritage in the parks include granite outcrops such as Mt Chudalup and Shannon Rock, Point D'Entrecasteaux, Bunbury Basalt areas at Black Point, caves and karst areas in the parks, and coastal dunes such as Yeagarup and Meerup dunes (Appendix 3).

The objective is to maintain the geodiversity of the parks and protect sites of known geoheritage.

This will be achieved by:

1. Preventing or minimising impacts arising from human activities on geoheritage values in the parks (e.g. restricting foot traffic in sensitive areas such as Mt Chudalup and Black Point [see also Section 18 *Species and Communities of Conservation Significance* – Communities], protecting caves from disturbance, protecting fossil sites from development, and restricting vehicle use of the dune systems, see Appendix 3 for further details).
2. Undertaking assessments of geoheritage values prior to any proposed works in the parks and consulting with the Director of the Geological Survey of WA prior to conducting management works at identified State Geoheritage Sites.
3. Minimising activities in, and public access to, the coastal dune areas that are likely to increase erosion risk and cause significant impacts (e.g. on infrastructure, heritage sites, significant species and communities within the parks).
4. Providing interpretive information, in collaboration with the Geological Survey of Western Australia as appropriate, on geology within the parks, its relationship with landforms, soils and vegetation and their vulnerability to damage (see Section 41 *Information, Education and Interpretation*).
5. Continuing to support the collection and recording of information about sites of geoheritage value in the parks.
6. Liaising with the Geological Survey of Western Australia to encourage any geo-scientific research and collection that they may undertake is consistent with protecting the values of the parks.
7. Only allowing geo-scientific research and collection that is consistent with protecting the values of the parks and liaising with the Geological Survey of Western Australia as necessary.

Key Performance Indicators:
There are no Key Performance Indicators for this section

14. LANDSCAPE QUALITY

Landscape management is based on the premise that the visual quality of any landscape is a resource in its own right and can be assessed and managed in much the same way as other resource values, such as fauna, flora, water and recreation. The role of landscape management is to ensure that all uses and activities are planned and implemented to complement rather than detract from the inherent visual quality of the environments in which they occur.

In the context of this management plan, the term 'landscape' refers to the appearance or visual quality of an area. For many, visual appearance is the most direct way visitors will experience an area and therefore, is often the criterion by which land management practices are judged.

Landscape Character Types

Every landscape has an identifiable visual character determined by its context of geomorphology, hydrology, soils, vegetation, land-use and cultural heritage values. Most people's understanding and response to their environment is largely visual. According to these features, landscapes in Western Australia have been broadly identified and described as landscape character types in order to assess their visual landscape values (CALM 1994b).

Two landscape character types have been identified in the parks: the Scott Coastal Plain (approximately 58% of the parks) and the Darling Plateau (see Map 4 Landscape Management).

Scenic Quality

Within each landscape character type, the scenic quality has been classed as high, moderate or low (see Map 4 Landscape Management). This is typically based on diversity, uniqueness, prominence and naturalism of landform, vegetation and waterform within each type. Areas of high scenic quality are identified in Table 1.

Table 1: Areas of High Scenic Quality in the Parks

Landform	Vegetation	Waterform
Areas of High Scenic Quality		
Deeply defined river valleys of the Donnelly and Warren rivers	Wind-shaped and gnarled vegetation along the coast	Watercourses with changing flow characteristics and features such as the Shannon River
Granite domes which provide obvious contrast to the landform in the surrounding landscape such as Mt Chudalup	Vegetation that shows distinctive displays of seasonal colour	Unusual ocean shorelines and motion characteristics such as at Black Point
Coastal headlands and cliffs such as Black Point, Point D'Entrecasteaux and Cliffy Head	Coastal heaths, peppermint/paperbark woodlands and dune vegetation	All estuaries, lakes, inlets and wetlands such as Broke Inlet and Lake Jasper
Dunes such as the Yeagarup Dunes which have steep and irregular slopes and an abrupt edge transition to low-lying woodland areas	Karri forests as they are unique to the south-west and provide a strong focal point	
Long stretches of undisturbed coastline of D'Entrecasteaux National Park		

(based on CALM 1994b)

In general, most of the parks have high to moderate scenic quality with some areas affected by past land use practices such as mining, road and track placement and past logging activities.

Landscape Management

Landscape management involves maintaining, restoring or enhancing natural and cultural landscape values, as well as planning and designing land use activities and developments to provide diverse views and minimise negative impacts. Human imposed changes to the landscape should be subordinate to the established natural visual character.

Key factors to consider in landscape management include:

- visual changes to the landscape occur continually—natural changes are generally subtle, harmonious and occur very slowly (other than the impacts of fire) whereas human-imposed changes can visually dominate natural elements, appear discordant, alien and can occur abruptly; and
- the ability of the landscape to absorb change without loss of scenic value—depends on factors such as slope, soils, vegetation cover and scope of change.

Guidelines for Management

The Department's Policy Statement No. 34 *Visual Resource Management of Lands and Waters Managed by CALM* provides broad guidelines for landscape management, particularly the planning and implementation of new facilities, buildings, recreation sites, signs and infrastructure.

Areas of high scenic quality (such as Lake Jasper, Yeagarup Dunes, Broke Inlet and Mt Chudalup) are the areas of greatest concern in terms of visual landscape management and are the most sensitive to alterations. Any changes should borrow from the natural established landscape character and not be noticeable to the casual observer.

Changes to areas of moderate scenic quality should borrow significantly from natural elements but may be apparent to the observer.

Areas of low scenic quality are of least visual concern and sensitivity to alterations. Changes should consider natural elements but may be dominant to the observer.

Guidelines for management in high, moderate and low quality scenic landscapes within the parks are included in Appendix 4.

14. Landscape Quality – Key Points

- The Shannon and D'Entrecasteaux national parks are representative of two Landscape Character Types: the Scott Coastal Plain and the Darling Plateau.
- The Department's Policy Statement No. 34 *Visual Resource Management of Lands and Waters Managed by CALM* provides broad guidelines for landscape management.

The objective is to protect and enhance the parks visual landscape qualities.

This will be achieved by:

1. Assessing any proposed management activities and development of park facilities to determine their impact on landscape values.
2. Planning fire management programs so as to minimise negative scenic impacts.
3. Liaising with neighbouring landowners and local authorities to ensure the Department's visual landscape management guidelines are considered in any development they may undertake, and provide advice upon request.
4. Encouraging sensitive management of visual resources along the access corridors to tourist destinations and park features (e.g. from impacts from activities such as timber harvesting, mining, plantations, and vegetation clearance).
5. Following the general landscape management guidelines set out in Policy Statement No. 34 and Appendix 4.

Key Performance Indicator (See also Appendix 2)

Performance Measure	Target	Reporting requirements
14.1 Changes to areas of high scenic quality	14.1 No permanent or long-term loss of high quality scenic areas within the parks	5-yearly

15. CATCHMENT PROTECTION

Hydrology

The hydrology of the parks (Map 5 Hydrology) is vital for the creation and maintenance of the biotic systems, provides significant recreational opportunities, and is of considerable regional significance in providing opportunities for development of the public water supply. D'Entrecasteaux National Park is reserved for 'national park and water' purposes (see Section 40 *Water Resources*).

There are three distinct drainage patterns, which are related to the major physiographic units in the parks:

- on the Coastal Belt where the soil is free draining there is little surface drainage apart from the major river channels which deflect to the south-west before entering the Southern Ocean;
- on the Marine and Alluvial Swampy Belt , seasonally-inundated swampy flats such as the Chudalup, Lower Shannon and Pingerup Plains, the surface drainage has formed dense stream networks; and
- on the Dissected Laterite Plateau the Shannon River, which emanates from broad flat swampy head waters, surface drainage has carved deep V-shaped valleys in the upper and central parts of the catchment.

Rivers

The majority of the rivers and streams in the parks are perennial with marked variations in summer and winter flow with total stream flow for the summer period up to 70 times less than total winter flow. Most streams on the plateau (Shannon National Park) are maintained by groundwater seepage and are often only a series of swampy pools by the end of summer. The character of the rivers, and of river flow to the estuaries, is dictated by their location in the highest rainfall part of the south-west, with predominantly winter run-off from hilly, forested country. Although the major river flow is in winter and spring, some flow generally continues through summer and autumn.

Seven rivers run through the parks—the Donnelly, Warren, Meerup, Gardner, Shannon, Forth and Inlet. The majority of the catchment area of the Shannon River and Broke Inlet, a large proportion of the Meerup River (70%), and Doggerup Creek (90%) lie within the parks. The estuaries and lower reaches of the Donnelly and Warren rivers are also encompassed within the parks (the Gardner River estuary is a proposed addition). The four major rivers; Donnelly, Warren, Gardner and Shannon have the potential to yield (if developed for water supply purposes) approximately 680 million cubic metres of water per annum (Ian Loh 2004). The Warren River is the single, largest potential source of water in the south-west. Any proposal to use the water resources within the parks or its catchments that is likely to impact on the park's values will be referred to the Environmental Protection Authority for assessment (see Section 40 *Water Resources*).

Twenty six wild rivers have been identified in Western Australia (Williams *et al.* 1999). Within the parks, the Forth River in D'Entrecasteaux National Park meets the criteria of 'wild', and five other rivers within the parks have been identified as relatively natural (priority 2) for management purposes (Map 5 Hydrology). A wild river is defined as:

> *"those rivers which are undisturbed by the impacts of modern technological society. They remain undammed and exist in catchments where biological and hydrological processes continue without significant disturbance. They occur in a variety of landscapes, and may be permanent, seasonal or dry watercourses which flow only occasionally."* (Williams *et al.* 1999)

Conservation guidelines for the management of wild rivers have been published by Environment Australia (1996b).

Estuaries

The major estuaries of the parks are closed by sand bars for most of the year but can break at various times throughout the year depending on stream flow and sandbar formation. The bars are therefore usually open in mid-winter, when stream flow is greatest. Broke Inlet (covering approximately 4500 hectares) is seasonally open, and several small inlets in the mouths of the Donnelly, Warren, Meerup and Gardner rivers as well as Doggerup Creek, may be flooded with tidal water for brief periods in early summer.

Lakes and Wetlands

There are many freshwater lakes in the wetland areas of the parks. The largest are Lake Jasper (the largest in the south-west), Lake Maringup and Lake Quitjup, all of which overlie sandy floors. The majority have formed immediately behind the coastal sand dunes that have blocked seaward drainage. Lake Jasper is known as a 'white water lake' due to the lack of tannic acid in the water, which results in good light dispersion and clear water. Most of the smaller reedy lakes, such as lakes Wilson, Smith, Samuel, Florence and Doggerup overlie deep organic sediments.

Dams

A small dam on the Shannon River, north of Shannon townsite was built in 1949 to supply water over the summer months to the former Shannon Mill and residences. The dam is now occasionally used for recreational purposes such as swimming and fishing.

There are also a number of constructed water points for fire control purposes in the parks.

Groundwater

The groundwater on the Shannon plateau responds relatively slowly to seasonal differences in rainfall. High rainfall causes only small variations in the permanent groundwater table. The watertable lies several metres below the surface in this area and reaches maximum level in September to October (two months after the peak rainfall period) and its lowest in April to May. In winter, shallow perched groundwater systems develop above impermeable layers, which contribute to the majority of the stream flow.

In the coastal and wetland areas, the groundwater systems respond more rapidly to rainfall. In the wetland areas, the watertable lies within a metre of the surface. On the sandy coastal areas, large unconfined aquifers contribute to perennial seepage areas and small streams (e.g. springs near Black Point and Malimup).

The Leederville aquifer and the underlying South West Yarragadee aquifer are to the west of the Darling Scarp and lie underneath the western parts of the parks, in the Black Point and Lake Jasper areas. The Leederville aquifer is the most widely used source of groundwater in the Swan Coastal Plain, and water is used for domestic, irrigation, and industrial uses. The deeper South West Yarragadee aquifer is the largest freshwater aquifer in the

south-west, and although partly used for agricultural irrigation, it has been investigated as an additional source of freshwater for the south-west (see Section 40 *Water Resources*). Any future use may impact on groundwater dependent ecological communities such as the Lake Jasper wetlands and would require detailed assessment and approval from the Environmental Protection Authority.

A small amount of groundwater from within the D'Entrecasteaux National Park currently supplies the settlement at Windy Harbour (see Section 40 *Water Resources*). There is the potential for drawdown to affect vegetation in the parks, so the Department and the Shire of Manjimup are working together to ensure that water extraction is sustainable. To this end, water use should be quantified and monitored.

Salinity

In 2006, monitoring of groundwater levels by Department of Agriculture and Food hydrologists indicated that groundwater levels (and hence the risk of salinity) are continuing to climb in most agricultural areas. One exception was in parts of the northern agricultural region which was attributed to a run of dry seasons. According to the most recent estimates from Land Monitor (2004) based on satellite images and ground-truthing, about a million hectares in the south-west agricultural region were severely affected by salinity in the year 2000. A further 2.8 to 4.5 million hectares have been identified as representing a salinity hazard.

The parks are located in high rainfall areas where the risk of salinity is generally low. However, the Warren River catchment and some wetland areas are an exception. The Warren River catchment has been assessed as having a medium risk of developing a shallow water table (Short and McConnell 2000). The upper Warren River catchment (north of the South West Highway) is managed by the Department of Water as a 'Water Resource Recovery Catchment', and has been targeted for additional research and management to combat salinity. The salinisation of land in the upper catchment has flow-on downstream effects on aquatic systems, as shown by the high salinity of the Warren River in the upper catchment. The Gingilup-Jasper and Doggerup Creek wetlands have also been identified as having a high risk of salinity (Short and McConnell 2000).

Water Quality

The *State Water Quality Management Strategy No. 1* (Water and Rivers Commission 2003) gives guidance for the management of water quality within the parks. The Department of Water is the lead agency responsible for sustainable management of Western Australia's water resources. Within the parks, the Department of Water monitor surface water quality in the Donnelly and Warren rivers. They also monitor groundwater levels near Lake Jasper at Black Point Road and Jangardup Road.

Agriculture is an important land use within the South West Planning Region as discussed in Section 2 *Regional Context*, and consequently large parts of the catchments of the Warren, Donnelly and Gardner rivers have been cleared for agricultural purposes. However, the use of fertilisers, herbicides and pesticides in these catchments may change the water quality in the lower reaches that are within the parks. Changes in upstream land use adjacent to the parks have the potential to significantly alter water quality within the parks.

In particular, recent changes from beef cattle to dairy cattle in the Black Point Road area on the Scott Coastal Plain have led to an increase in stock numbers, increased groundwater usage, the draining of wetlands, and the discharge of nutrient-enriched surface water run-off to roadside drains which subsequently drain directly into D'Entrecasteaux National Park. Whereas residential subdivisions by the local authority are regulated and the Department is consulted, other land use changes controlled by other agencies do not necessarily involve the Department and surface water control measures are not put in place. Similarly, there have been instances of mineral sands operations discharging water into the parks.

Off reserve land uses of greatest concern are those that:

- change the natural volume of surface water run-off to the parks;
- change the quality of surface water run-off to the parks;
- alter the hydrological cycle of the wetlands within the parks (seasonal flooding); and
- assist weeds being spread through the parks by surface water run-off.

Siltation of watercourses is a consequence of soil disturbance and may result from:

- timber harvesting activities on adjacent land (buffers around watercourses in State forest reduce the amount of sediment);
- the erosion of tracks, walktrails, day use sites and camp sites; and
- run-off caused by roadworks, vegetation clearing and fire.

The total sediment supply to the Shannon River is 12 817 tonnes per year, Donnelly River 16 014 tonnes per year and Warren River 109 750 tonnes per year (Commonwealth Government 2001).

There have been blooms of cyanobacterium (sometimes referred to as 'blue-green algae') in the Warren River upstream of D'Entrecasteaux National Park (Water and Rivers Commission 2003 unpublished). It is possible that similar blooms will also occur further downstream within the park if elevated nutrient levels continue.

The EPA (1989) considered the four main estuaries to be healthy, and in the most natural condition of any estuaries in the south-west. The main human impact on the estuaries is the occasional artificial opening of the Broke Inlet and Donnelly River bars. Any future management problems that arise are likely to be derived from land-based activities surrounding the estuaries rather than water-based activities on the estuaries themselves. An exception to this would be power-boat usage along Donnelly River (Munroe 2006). Water quality along the Donnelly River has been identified as being of potential concern due to the boat fuels and fumes (predominantly 2 stroke motors). The huts along the Donnelly also have the potential to impact on water quality due to a lack of controlled sewage and sewage systems in the area.

The Jasper Wetland System is an outstanding example of a near-pristine, extensive system of freshwater lakes, marshes and shrub swamps and includes the deepest, large freshwater lake in south-western Australia, Lake Jasper. However, nutrient enrichment within the catchment due to a rapidly developing horticultural industry, developing dairy industries, groundwater extraction, power-boat usage, exotic fish species and mining (mineral sands) pose a threat to the water quality of the Jasper Wetland System (Jaensch 1993, J. Gillard pers. comm. 2003).

There is also the potential for septic systems of Windy Harbour (as well as waste water systems from other recreational sites within the parks and in particular along Donnelly River) to impact on the groundwater quality and if there are any overflows, surface water run-off quality within the parks. This will be monitored and remedial action taken where required.

Erosion

When the soil surface is disturbed or vegetation removed, the process of soil erosion can be accelerated (e.g. construction and use of roads, tracks, walktrails and camp sites).

Soil erosion also has the potential for downstream impacts on creeks, rivers, lakes, and the estuarine and marine environments by increasing the supply of sediments to rivers.

Churchward *et al.* (1988) and Churchward (1992) have studied the soils of the area within the parks. Some of these soils and landforms are more susceptible to erosion, waterlogging and compaction. Some risk areas within the parks are:

- the coastal plain, which is affected by wind and water erosion. The younger dunes near the ocean are particularly sensitive to erosion, and dunes that lack vegetation or have steep slopes are also susceptible to severe degradation;
- the extensive flats and wetlands;
- the loam soils of the dissected plateau areas, which have a moderately high susceptibility to water erosion; and
- the gravelly soils of the lateritic uplands, which are affected by water erosion with some also prone to wind erosion.

The susceptibility of the soil to erosion and degradation has serious implications for management of the parks. Whilst the inherent erodibility of soils, which depends on soil structure, is difficult to decrease, the erosion associated with human activity can be reduced by appropriate management. The rotation of camp sites to allow for rehabilitation, the hardening of recreation sites and the temporary or permanent closure of tracks are some measures that can reduce the impact of erosion. This, combined with education of visitors on the effects of erosion and the use of appropriate codes of practice, guidelines and on-site investigations prior to any changes in land use, can minimise erosive activity.

The operation of heavy machinery in State forest is guided by conditions detailed in the *Forest Management Plan 2004-2013*. These conditions were determined specifically for the protection of soil in native forest harvesting, however the principles may be modified for the operation of heavy machinery for general Departmental operations within the parks.

The *Donnelly River Action Plan* (Munroe 2006) has classed the general condition of the foreshore of Donnelly River. The length of Donnelly River from the park boundary to Boat Landing is described as generally healthy, predominantly native assemblage of fringing and in-stream vegetation with active regeneration occurring however it is classed as C1 to C3 (where C1 is 'erosion-prone', C2 is 'soil exposed' and C3 is 'eroded'). This is due in part to historical stock access and in part to river velocity along this section of the river. The natural, dynamic bank undercutting and subsidence have affected the fringing vegetation and there are significant amounts of large woody debris in-stream. Preferred management practice is to leave as much of the woody debris *in situ* as possible to provide important habitat for aquatic fauna and flora, but repositioning it at an angle of 20 to 40 degrees from the stream bank to diminish the effect on water flows and direction.

The section of river from Boat Landing to the river mouth is classed as 55% A2 to A3 (where A2 is 'near pristine' and A3 is 'slightly disturbed'), 25% B1 (where B1 is 'degraded – weed infested') and 20% (the length of the river where the huts are located) C1 to C2. The majority of foreshore is described having a dense healthy assemblage of fringing and in-stream vegetation with stabilised, points of natural, dynamic erosion with some bank cutting occurring. Some human exacerbated erosion problems were noted at three specific locations; the Boat Landing boat launching area, an isolated recreational fishing entry point and the huts area (see sections 24 Non-Indigenous Heritage and 27 Recreational Use) where erosion is occurring off existing tracks. It was also noted that power-boats travelling the river contribute to erosion in that they produce a wake, creating a wave action that disturbs river banks.

Acid Sulphate Soils

Soils that contain iron sulphides within waterlogged sediments are known as 'potential acid sulphate soils'. When these iron sulphides are exposed to air, the mineral oxidises to produce sulphuric acid and dissolved metals (e.g. iron, aluminium and occasionally manganese and cadmium). The acid affects both soil and water, and can damage the environment with impacts such as wetland degradation, fish kills, localised loss of habitat and biodiversity, deterioration of surface water and groundwater quality and invasion of acid tolerant waterplants. The dissolved metal mixture can make the soil toxic as well as acidic, so few plants can survive. There are also human health concerns if groundwater or surface water resources used for drinking water or recreational activities become contaminated with sulphuric acid or heavy metals.

The National Working Party on Acid Sulfate Soils (1999) predicted that iron sulphides were present in coastal embayments and estuarine back swamps around Australia with elevations of less than 10 metres above sea level. The indicative distribution of potential acid sulphate soils includes the wetland areas of D'Entrecasteaux National Park (see Figure 5). Although there can be some neutralising minerals within soils these are often quickly consumed by the large quantities of sulphuric acid that are released.

In undisturbed states, as the soils presently occur, submergence of the soil materials by water prevents oxygen in the air reacting with the iron sulphides. Acid sulphate soils often go unnoticed, causing no problems until inappropriate drainage, groundwater management or some other disturbance initiates a cycle of acid generation that can be difficult to reverse (B. Degens 2004 pers. comm.). Drainage greatly accelerates iron sulphide oxidation rates, so that large slugs of acid groundwater can be released rapidly into waterways during rainfall events. These slugs cause rapid deoxygenation of waterways and smother aquatic life in addition to the effects imposed by the acid and dissolved metals.

The main risk of environmental degradation in the parks due to acid sulphate soils is considered to be from regional groundwater use, short-term dewatering activities or excavation of large areas within or adjacent to the parks. In some cases, where peat overlying the iron sulphide layer has burnt away, the iron sulphide layer is completely exposed to air (see Section 20 *Fire*). The best strategy for managing acid sulphate soils is to avoid disturbing or draining the iron sulphide layer (National Working Party on Acid Sulfate Soils 1999). Iron sulphides will not impact on the environment while protected by stable watertables.

Guidelines for managing acid sulphate soils where disturbance or dewatering is planned require the proponent to undertake detailed site investigations to determine the depth, extent and acid status of soil (Department of Environment 2003a, 2004, 2006). This information is used by the proponent to develop a management plan that avoids oxidation of potential acid sulphate soils and manages any acidity where disturbance is unavoidable (Department of Environment 2003b).

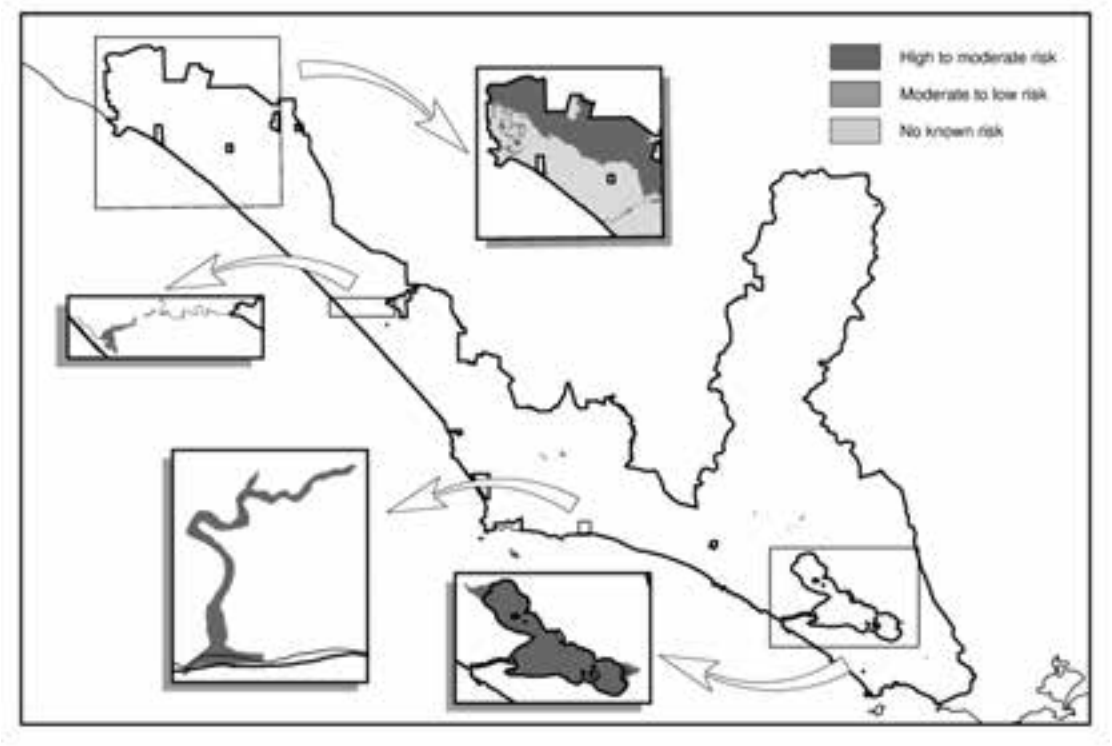


Figure 5: Potential Acid Sulphate Soils in the Planning Area

16. Catchment Protection – Key Points

- The water systems of the parks are necessary to maintain the ecosystems of the parks, provide recreational opportunities and are of regional significance for potential development of public water supply.
- The majority of the rivers and streams in the parks are perennial with relatively low flow in the summer months.
- Water quality and hydrology can be affected by development within the parks and adjacent land uses and activities. For example, salinity is a problem in the upper parts of the Warren River catchment outside the park.
- Cyanobacteria blooms have been recorded in Warren River upstream of D'Entrecasteaux National Park.
- The rivers have high water quality apart from experiencing some sedimentation in the upper reaches, possibly resulting from activities outside the park boundaries (e.g. vegetation clearance, logging or use of unsealed roads).
- There are a number of areas within the parks that are susceptible to soil erosion and a number of human activities that need to be carefully managed to reduce erosion risk.
- Some of the wetland areas contain potential acid sulphate soils and it is important that the iron sulphide is not exposed by draining or disturbance of these areas.

The objective is to protect and conserve the quality and quantity of soil and water within the parks, particularly the wetland systems, the rivers and estuaries and the coastline.

This will be achieved by:

1. Liaising with relevant agencies regarding the management and monitoring of surface water flows, groundwater levels and water quality and providing advice and direction as necessary to ensure values of the planning area are protected.
2. Assessing the potential effects of Departmental operations or developments on catchment values of the parks and identifying and implementing strategies to prevent or mitigate adverse effects.
3. Consulting with adjoining landowners, local authorities, agencies and other stakeholder groups to request and recommend that activities within adjacent areas do not significantly affect the catchment values of the parks and, if necessary, requesting Environmental Protection Authority assessment of activities where there may be significant impact on these values.

4. Protecting water sources, wetlands and hydrological processes within the parks from damage or disturbance that may affect water quality or quantity.
5. Supporting the Department of Water in any monitoring of water quality and quantity in the parks.
6. Encouraging further research to determine water quality within the parks and assess the impact that this is having upon the environment.
7. Notifying the public when recommended levels of cyanobacteria are exceeded.
8. Minimising exposure of soil to mechanisms of erosion as a result of human activity as appropriate, and rehabilitating existing disturbed / eroded areas.
9. Mapping the extent of potential acid sulphate soils within high risk areas of the parks and taking these areas into account when any development and/or fire management is planned (see Section 22 *Fire* and 43 *Research and Monitoring*).
10. Extending the boundaries of the D'Entrecasteaux National Park to include the Gardner River estuary.
11. Promoting compatible management of Broke Inlet with the purposes and management of D'Entrecasteaux National Park.

Key Performance Indicators (see also Appendix 2)

Performance Measure	Target	Reporting requirements
15.1. The area of eroded soil within the parks	15.1 No increase as a result of human activities	5-yearly
15.2. Water quality and quantity in wetlands and rivers within the parks	15.2 No significant adverse change to water quality in the Jasper Wetland System, *Reedia* Swamps threatened ecological community, or Warren or Donnelly rivers	Annually

16. NATIVE PLANTS AND PLANT COMMUNITIES

Native Plants

The vascular flora of the south-west is diverse and has a high level of endemism (Hopper 1992). It has been estimated that there are approximately 8000 species, 25% of which are estimated to be endemic to the south-west (Hopper 1992).

There are 889 native vascular flora taxa (includes sub species) known from the parks (210 in Shannon National Park and 854 in D'Entrecasteaux National Park) as well as over 126 introduced taxa (see Section 19 *Environmental Weeds*). This represents 48% of the total number of vascular taxa in the Warren bioregion.

The major families are Orchidaceae (orchid family – 85), Cyperaceae (sedge family – 66), Myrtaceae (eucalypt and paperbark family – 66), Papilionaceae (pea family – 54), Proteaceae (banksia and grevillea family – 45), Epacridaceae (heath family – 44), Restionaceae (rush family – 40) and Stylidiaceae (trigger plant family – 37). The Warren bioregion has a higher proportion of the monocotyledon families such as Orchidaceae, Cyperaceae and Restionaceae than the rest of the State (Green 1985).

The species list of the vascular flora recorded within the parks was derived from Lyons *et al.* (2000), from survey work conducted by Havel and Mattiske (2000) and Herbarium records. The species list is probably a significant under-estimate for the parks, especially the Shannon National Park, given that the parks contain most of the major habitats of the Warren bioregion such as granite outcrops, karri forest, coastal communities and wetlands (M. Lyons pers. comm. 2002). In addition, the northern part of Shannon National Park is within the Jarrah Forest bioregion, for which a comparable comprehensive study to Lyons *et al.* (2000) has not been compiled.

The collection of wildflowers or other plant parts can reduce the available seed stock and by reducing the numbers of flowers available for cross-pollination, may reduce genetic diversity. Driving into areas to pick wildflowers may lead to the spread of *Phytophthora* and there have been instances of arson when preferred wildflower picking areas have been lit to increase productivity of the wildflowers. In order to protect representative plant communities, the Conservation and Land Management Act prohibits the removal of flora and fauna from national parks and nature reserves. Wildflower picking sometimes occurs illegally in the Shannon National Park.

Non-vascular flora such as mosses and liverworts and other biota such as algae, fungi and lichen have not been well studied within the State, with many unnamed and unknown species existing.

The work that has been carried out on non-vascular flora within the State shows that the greatest diversity and abundance of moss species occur in the regions of high rainfall (over 800 millimetres) such as in the south-west, in settings such as granite outcrops, fern gullies and sclerophyll woodlands (Stoneburner and Wyatt 1996, Hopper 1992). Moss species of the south-west have strong affinity with species of southern Australia but are less diverse. Endemism of Western Australian moss species is 2% (four species, including one known from within the parks see Section 18 *Species and Communities of Conservation Significance*), which compared to vascular plants is very low. However, 25% of the moss species in Western Australia are restricted to Australia, showing a significant level of continental endemism (Stoneburner and Wyatt 1996).

It has been estimated that there may be 250 000 species of fungi in Australia, including about 5 000 mushrooms and similar types (Pascoe 1991). Perhaps only 5 to 10% of Australian fungi have been named and another 10% are known but not named (Bougher and Syme 1998). Most of the fungi that have been named are known from very few locations. This reflects the low knowledge base and attention given to fungi and is not an accurate representation of their distribution. In Western Australia, about 500 species of larger fungi have been recorded, mostly from the south-west (Hilton 1982, 1988), however again this is estimated to be a low proportion of the fungi taxa present in the south-west. There has been little work within the parks to compile any species lists of non-vascular flora or other biota.

Plant Communities

Phytogeography

Plant communities or vegetation types can be described in a number of different ways. Beard (1980) divided the State into botanical provinces, districts and sub-districts on the basis of ecological, climatic, geological and soil characteristics. The parks are in the Warren Sub-district, which occupies the southern portion of the Darling Botanical District, a division of the South West Botanical Province (Figure 6). The Warren Sub-district encompasses the entire karri forest belt and most of the coastal areas between Albany and Busselton. Beard (1980) also identified vegetation associations across the State. There are 24 vegetation associations within the parks.

During the Western Australian Regional Forest Agreement process, vegetation for the forested area within the south-west was considered at forest ecosystem (see Section 11 *Biogeography*), ecological vegetation system and vegetation complex levels (Mattiske and Havel 1998). Vegetation complexes were the 'finest' scale unit of classification. In the area considered in the Regional Forest Agreement, 312 vegetation complexes were identified with 61 of these in the parks. Those of particular conservation significance are discussed in Section 18 *Species and Communities of Conservation Significance*.

In this management plan, the plant communities of the parks are mainly referred to in terms of these vegetation complexes. The vegetation complexes also provide the basis for determining land conservation units and fire management within the parks (see Section 22 *Fire*).

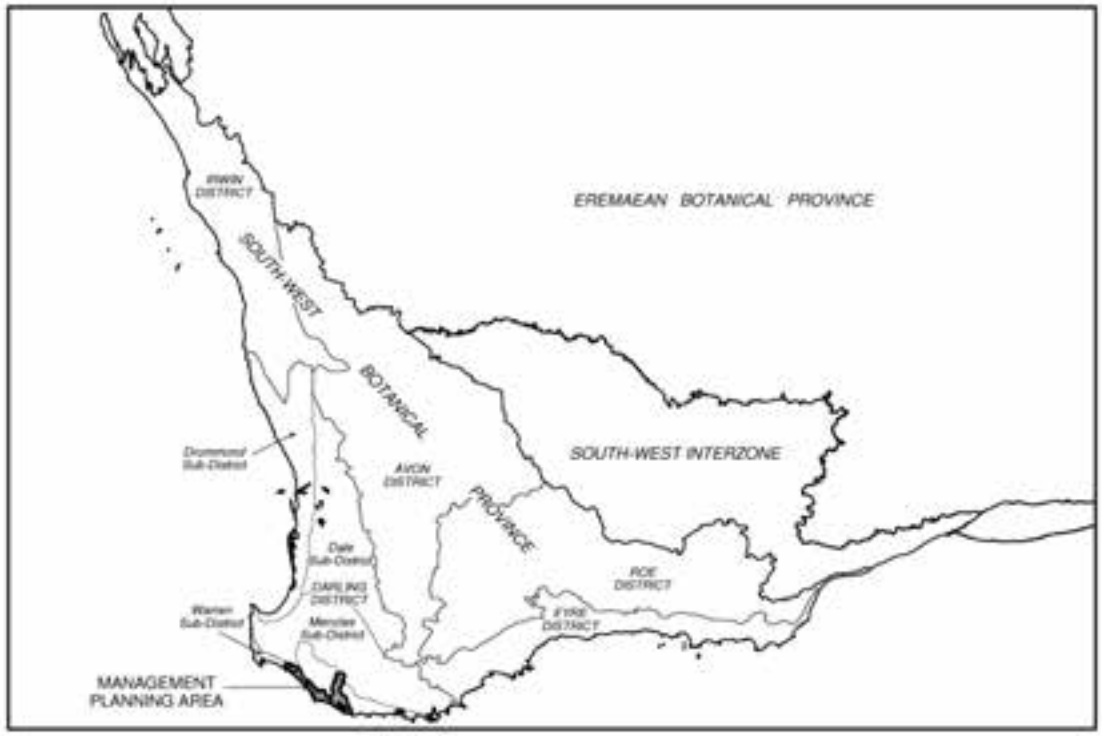
Vegetation

The vegetation of the parks is a mosaic of coastal dune, wetland, woodland and forest vegetation types. The variety and distribution of flora within the parks is generally closely linked to the landform units (see Section 13 *Geology, Landform and Soils*), with changes in vegetation types indicating a corresponding change in soils and landform.

The vegetation of the coastal belt varies from that on largely bare mobile sands to thick low peppermint forest. The wetland areas and low plains are characterised by open low woodlands, thickets and low sedges. The periodic inundation of water in these areas excludes the presence of taller forest type species. There are a large number of species within these areas, including the predominant species *Banksia ilicifolia, B. littoralis,* yate (*Eucalyptus cornuta*), bullich (*E. megacarpa*), peppermint, marri (*E. calophylla*), jarrah (*E.marginata*), *Xanthorrhoea* spp., *Jacksonia* spp., and various rushes and sedges. In some places low sedges (*Loxocarya flexuosa*) form the only understorey, giving a savannah woodland appearance.

The laterite areas support the taller forests and woodlands, mostly old-growth, with species such as karri and jarrah being prominent in these areas. The tall forest dominated by karri, occurs throughout the Shannon National Park and in parts of the D'Entrecasteaux National Park. Its distribution is closely associated with loamy soils derived from granite and gneiss. Pure karri stands occur throughout the Shannon National Park. In the upper reaches of the river basin, karri-marri associations also occur on brown, gravelly, sandy soils and on

laterite soils karri-jarrah associations occur. Isolated patches of pure karri stands occur on low hills throughout the lower Shannon Basin, Pingerup Plains and parts of the Chudalup Plains.



(source: Beard 1980)

Figure 6: South-West Botanical Province

The open structure of the canopy in the tall karri forest allows sufficient light penetration for the development of a substantial understorey of small trees and shrubs. In some parts of the forest, karri wattle (*Acacia pentadenia*) forms an impenetrable thicket more than 2 metres high, particularly four to 14 years after being burnt. In other areas hazel (*Trymalium floribundum*), karri oak (*Allocasuarina decussata*) and water bush (*Bossiaea aquifolia*) are major components of the forest understorey in the more open areas of the forest. *Agonis flexuosa*, *Banksia* species and native willow (*Callistachys lanceolata*) occur along the streams and swampy watercourses.
This wide variety of vegetation provides a wide range of habitats for native animals and contributes significantly to the parks high conservation and scenic values. Being located in the high rainfall south-west, the parks contain a number of species that are geographically restricted to this zone.

16. Native Plants and Plant Communities – Key Points

- There are 889 native vascular flora taxa recorded in the parks.
- The parks represent 48% of the total number of vascular taxa in the Warren bioregion. The Warren bioregion is important as a centre of diversity of herbaceous perennial taxa and for the conservation of high rainfall taxa.
- It is prohibited to remove flora from the parks.
- The collection of wildflowers or other plant parts can reduce the available seed stock, may reduce genetic diversity and may lead to the spread of *Phytophthora* or increased fire risk.
- There are 61 vegetation complexes in the parks, representing 20% of all complexes in the RFA area (Mattiske and Havel 1998).

The objective is to protect and conserve the diversity and distribution of native plants and plant communities of the parks.

This will be achieved by:

1. Identifying native plants and plant communities that may require special protection from threatening processes such as salinity, erosion, environmental weeds, introduced animals, *P. cinnamomi* and inappropriate fire (see sections 15 *Catchment Protection*, 19 *Environmental Weeds*, 20 *Introduced and*

Other Problem Animals, 21 *Diseases* and 22 *Fire*).
2. Rehabilitating native vegetation where disturbance is severe and natural regeneration is less likely to occur (see Section 37 *Rehabilitation*).
3. Continuing to apply fire for biodiversity conservation according to best practice and Departmental policy (see Section 22 *Fire*).
4. Advertising firewood collection areas in the Region and prohibiting firewood collection within the parks (see Section 27 *Recreational Use* – Overnight Stays – Campfires).
5. Liaising with local authorities and private landholders to promote compatible management on adjoining lands.
6. Undertaking as well as encouraging universities and other organisations to undertake further vegetation and flora surveys in the parks.
7. Providing information to park users about the importance of native plants and plant communities of the parks and their vulnerability to human impact.
8. Prohibiting wildflower picking within the parks and promoting alternative locations for commercial wildflower pickers outside the parks.

Key Performance Indicators:
There are no Key Performance Indicators for this section

17. NATIVE ANIMALS AND HABITATS

In general, there has been a decline in native fauna numbers within the south-west since European settlement. Within the parks, it is possible that three species have become extinct since European settlement of the area. Compared to other areas of the south-west, the parks exhibit a relatively intact fauna, probably due to their good condition, size, relative isolation and continuity with adjoining national parks and State forests. The parks are able to provide a wide range of habitats and corridors for dispersal, along with diverse landforms and high rainfall.

Christensen *et al*. (1985, 1992) suggested that fauna of the south-west forests were distributed along a temperature/moisture gradient, particularly in a north/south direction with secondary factors such as vegetation and soils affecting distribution on a local scale. A high percentage are dependent on habitat elements provided by trees in a mature or derelict state, or by fallen logs for nesting or shelter, especially mammals and birds (Wardell-Johnson and Christensen 1992).

Surveys of the vertebrate fauna of the Western Australian southern forests in the period 1970 to 1982 included four survey locations in the parks (Christensen *et al.* 1985). In the period 1992 to 1993, additional surveys along the south coast of WA were carried out (Jaensch 1992a, 1992b, 1992c and 1993) for waterbirds, frogs, fish and invertebrates within wetlands on Crown land, and involved 13 sites within D'Entrecasteaux National Park. On an ongoing basis, the Department conducts regular monitoring of native vertebrate species as part of the Western Shield program (see Section 20 *Introduced and Other Problem Animals*), including a site at Woolbales within the parks. A list of the identified fauna within the parks from these and other sources is presented in Appendix 5. However, fauna information within the parks is still very limited, in particular with regard to invertebrates.

Mammals

There are at least 20 species of native mammals in the parks. This includes one pinniped, four macropods, three possums, four dasyurids, one bandicoot, two rodents and five bats. Although it is thought that only three mammals have become extinct within the parks (the pale field rat *Rattus tunneyi* which is now only found in northern Australia, the heath rat *Pseudomys shortridgei* now only found in Victoria and four locations in Western Australia and probably Gilbert's potoroo *Potorous tridactylus gilbertii* now only found in Two Peoples Bay Nature Reserve—N. McKenzie pers. comm. 2002), populations of many species are thought to have declined and now exist only as small isolated populations (How *et al.* 1987). The causes of decline across their former range include vegetation clearing, logging, mining, hunting and altered fire regimes and predation by foxes (*Vulpes vulpes*) (Burbidge and McKenzie 1989).

Most of the mammal species that have contracted in range are within a 'critical weight range' (mean adult body weight between 35 grams and 5.5 kilograms), which renders them particularly susceptible to predation by foxes. Remaining populations persist in refugial habitats that may not be the most favourable to them, but are less favourable to their agent or means of decline (Caughley 1994). Typically, these habitats include densely vegetated thickets in river, stream and wetland systems, many which also provide corridors for migration. Examples of critical weight range mammals within the parks that have declined include the quokka (*Setonix*

brachyurus), which has suffered a major decline and contraction of its geographic range since the 1930s, particularly in the northern jarrah forest (Kitchener 1995, Hayward *et al.* 2003). The woylie (*Bettongia penicillata ogilbyi*), which has contracted in range from 40% of the Australian mainland to less than 1%, and the chuditch (*Dasyurus geoffroii*) which now occupies less than 2% of its former range (Environment Australia 1996a). Larger species such as the western grey kangaroo (*Macropus fuliginosus*) are much less affected by predation by the fox and are relatively common throughout the south-west (Havel 1989).

Fox control as part of the Western Shield program (see Section 20 *Introduced and Other Problem Animals*), statutory protection and adaptive management is required to maintain and/or increase native mammal populations and in particular threatened species within the parks (see Section 18 *Species and Communities of Conservation Significance*).

Birds

There are at least 120 species of native birds within the parks. The majority of birds listed for forest areas of the south-west (Christensen *et al.* 1985) occur within the parks. Generally, the highest diversity of bird species can be found in woodland areas of banksia, peppermint and bullich, and the highest number of individuals can be found in tall open forest areas such as karri and jarrah forests (Christensen 1992). The former provide diverse food sources, which is reflected by the high number of species in these areas, whereas the latter provide abundant food sources, but only for the few species that inhabit these areas. Overall the density of bird populations in jarrah and karri forests in the south-west is about one half of that in comparable forests in south-east Australia (Abbott 1999).

A comparison of bird distribution in the *Field Atlas* (1977 to 1981) and the *New Atlas* (1998 to 2000) shows that 13 bird species have displayed range reductions across Australia that are substantial and systematic (Environment Australia 2001b). Four of these species occur in the parks: black swan (*Cynus atratus*), great cormorant (*Phalacrocoras carbo*), wedge-tailed eagle (*Aquila audax*) and the Pacific heron (*Ardea pacifica*). The habitats of these bird species are protected within the parks and are contributing to the maintenance of the populations of these species across Australia.

Waterbirds

The optimal habitat for waterbirds includes extensive open water, some bare land and extensive tall sedges or low shrub thickets inundated at the base by water 50 to 100 centimetres deep (Jaensch 1992a). Lake Jasper and Lake Maringup are recognised as two of the five most important wetlands for waterbirds across the south coast; based on rankings of number of species, breeding pairs and number of individuals (Jaensch 1992a). Lake Jasper supported the highest number of species found breeding at any one wetland across the south coast.

During a survey of the Jasper Wetland System (comprising Lake Jasper and nearby wetlands) 27 species of birds were recorded, including seven breeding species such as the priority 4 little bittern (*Ixobrychus minutus*) which nests in sedgy thickets of *Taxandria floribunda* (Jaensch 1992a). Lake Jasper exhibited the highest diversity of birds within the Jasper Wetland System with 25 of the 27 species being recorded, followed by Lake Quitjup with 16 species. Three of the species recorded are listed under international treaties (see sections 7 *Legislative Framework* and 18 *Species and Communities of Conservation Significance*). The most abundant species in the Jasper Wetland System was the little black cormorant (*Phalacrocorax sulcirostris*) (up to 200 on Lake Jasper).

Threats to the waterbirds in the parks include wildfire, proposed mineral sand mining and recreational use of waterbodies disturbing birds during the breeding or moulting seasons.

Reptiles

Reptiles are poorly represented in the area, with only 28 species of native reptiles recorded in the parks (Christensen *et al.* 1985 and Christensen 1992). Geckoes (one species), goannas (two species) and legless lizards (three species) are particularly poorly represented. One species of semi-aquatic tortoise occurs in the parks. The most common species of reptiles in the parks are skinks (15 species) and snakes (five species of elapids, or front fanged venomous snakes, and one blind snake).

Amphibians

There are at least 15 species of frogs within the parks, including two species of tree frog. Substantial areas of sedgeland and shrubland/forest, such as those present at Lake Jasper, support the highest number of the wetland

frog species of the south coast of Western Australia. The Jasper Wetland System supports eight species of frogs; all have been recorded at Lake Jasper with a range of three to five species recorded at other lakes (Jaensch 1993).

Fish

Although Australia is considered to have one of the most diverse marine fish faunas, its freshwater fish fauna is depauperate (less than 200 species), highly endemic and lacks many families that are found elsewhere in the world (Morgan *et al*. 1998). This is related to the relative scarcity of rivers and the seasonal nature of the inland waters.

The freshwater fauna of south-western Australia is even more depauperate than that of south eastern Australia. The south-west contains only ten species of native freshwater fish which includes eight endemic to the region. Of these ten species, eight are known to occur within the parks. With the exception of the freshwater cobbler (*Tandanus bostocki*), none of the endemic species typically exceed 140 millimetres in total length. Freshwater cobbler occur at Lake Jasper, Lake Wilson and Lake Smith and is the only endemic species targeted by recreational anglers. Though widespread in streams, it is not known from other lakes of the south coast and is largely absent from the parks.

There are also five species that have marine affinities but are still abundant in the estuaries and freshwaters of the parks: mangrove mullet (*Mugil cephalus*), pouched lamprey (*Geotria australis*), blue spot goby (*Pseudogobius olorum*), big-headed goby (*Afurcagobius suppositus*) and the western hardyhead (*Atherinosoma wallacei*).

Four exotic freshwater species (see Section 20 *Introduced and Other Problem Animals*) occur in the parks and throughout the south-west, and although there is limited information on the impacts of introduced species in south-western Australia, there have been deleterious effects caused by the same or comparable species in eastern Australia (Morgan *et al.* 1998).

The most common and widespread endemic freshwater species in the south-west are the western minnow (*Galaxias occidentalis*), the night fish (*Bostockia porosa*) and the western pygmy perch (*Edelia vittata*).

Invertebrates

Information on the diversity of invertebrates specifically occurring within the parks is quite poor. The Aquatic Research Laboratory UWA (1992), Jaensch (1993) and Edwards *et al.* (1994) have conducted aquatic invertebrate studies on the wetlands of the south coast. The number of invertebrate taxa recorded in the wetlands varied from 54 at Lake Smith (including 20 Dipterans) to 22 at Lake Jasper. Marron (*Cherax canei*) and gilgies (*Cherax quinquecarinatus* and *C. crassimanus*) are also widespread in small lakes and wetlands within the parks, however populations are decreasing (R. Annear pers. comm. 2004) (see Section 27 *Recreational Use* – Recreational Activities – Fishing and Marroning).

The suite of estuarine benthic animals is represented by only a few species within the Donnelly and Gardner inlets. Only a few obligate estuarine benthic animal species are normally present throughout the year. Invasion of other invertebrates sometimes occurs in spring when the bar is open but few survive the subsequent winter.

There have been some other surveys on invertebrates concentrating in the south-west such as spiders in the karri area (Curry *et al*. 1985), macroinvertebrates of acid peaty flats (Pusey and Edwards 1990), insects in forested areas (Abbott 1992), aquatic invertebrates, fish and amphibians of the Warren bioregion (Trayler *et al.* 1996), aquatic invertebrates in peatlands and shrublands (Horwitz 1997) and crayfish (Austin and Knott 1996, Horwitz and Adams 2000). Abbott (1992) suggested that the total number of insects alone in the south-west forest may be in the order of 15 000 to 20 000 species. No invertebrate species lists have been specifically compiled for the parks.

17. Native Animals and Habitats – Key Points

- The parks are valuable for fauna conservation due to their good condition, size, relative isolation and continuity with adjoining national parks and State forests.
- There are 20 mammal, 120 bird, 28 reptile, 15 amphibian and 13 fish native fauna species recorded within the parks which is representative of the diversity of the southern forests (Christensen 1992).
- Invertebrate information is not readily available for the parks.

The objective is to protect and conserve the diversity and distribution of the native fauna

and habitats within the parks.

This will be achieved by:

1. Protecting fauna habitats from adverse changes to water quality, the spread of weeds, introduced animals, disease, and human disturbance (see sections 15 *Catchment Protection*, 19 *Environmental Weeds*, 20 *Introduced and Other Problem Animals*, 21 *Diseases*).
2. Implementing appropriate fire regimes to maintain or promote biodiversity within the parks (see Section 22 *Fire*).
3. Identifying species that are declining in range and protecting existing habitats for these species that occur within the parks.
4. Continuing existing monitoring of fauna populations and encouraging further research in the parks to determine and monitor distribution and abundance of species, and in particular invertebrates.
5. Protecting Lake Jasper and Lake Maringup as important waterbird habitats from threats such as wildfire, mining and inappropriate recreational use in particular during the breeding and moulting seasons.
6. Reintroducing native fauna to areas where they are known to have formerly occurred once threatening processes have been identified and mitigated.
7. Working with other agencies and private industry to ensure that extractive industries within or adjacent to the parks do not cause adverse environmental impacts (e.g. reduced or increased wetland depth or significant inflow of water contaminants).
8. Controlling introduced species that are damaging or could potentially damage native fauna in ways that do not compromise other conservation objectives (see also Section 20 *Introduced and Other Problem Animals*).
9. Prohibiting domestic animals within the parks (as per actions prescribed in Section 30 *Domestic Animals*).

Key Performance Indicator (see also Appendix 2)

Performance Measure	Target	Reporting requirements
17.1 Changes in the range and population size of critical weight range mammals	17.1 The successful maintenance, or where appropriate increase, of self-sustaining populations subject to natural variations	Annually or as per recovery plans if applicable

18. SPECIES AND COMMUNITIES OF CONSERVATION SIGNIFICANCE

At a State level, the Wildlife Conservation Act provides for species of native flora and fauna to be specially protected because they are under the identifiable threat of extinction. Such specially protected wildlife is considered to be 'threatened'. Departmental Policy Statements No. 9 *Conservation of Threatened Flora in the Wild* and No. 33 *Conservation of Threatened and Specially Protected Fauna in the Wild* provides management direction for specially protected flora and fauna.

The Commonwealth's Environment Protection and Biodiversity Conservation Act provides a listing of nationally threatened species and ecological communities. Western Australian listings under this Act are currently incomplete. However, the principles applied to Commonwealth listings are essentially the same as those used for listing taxa under the Wildlife Conservation Act, although there is no provision under State legislation to recognise and protect threatened ecological communities (they may receive indirect protection under some other State acts, such as the *Environmental Protection Act 1986*).

As well as threatened species, endemic species (i.e. species restricted in their natural range to a particular area) have conservation significance. When a species is referred to as 'endemic', it could either be endemic to the south-west, a particular bioregion, botanical province, or a protected area such as a national park. In this management plan, records used for 'endemic fauna' refer to fauna with their natural range being restricted to the south-west.

The flora of the south-west has a high level of endemism, as many taxa have had to adapt to small population sizes, poor dispersal and persistence in a subdued, unglaciated landscape for millions of years (Hopper 1992). Therefore, due to the scale of endemism of flora in the south-west and the records used, in this management plan 'endemic flora' refers to flora being endemic to the Warren bioregion.

Also used is the term 'locally endemic', which refers to flora and fauna with a range of less than 150 kilometres.

Fauna

Threatened and Other Specially Protected Fauna

The Wildlife Conservation Act provides for the Minister to declare species to be specially protected for the following reasons:

- they are rare or likely to become extinct (commonly referred to as 'threatened');
- they are presumed to be extinct but may be rediscovered;
- they are subject to international agreement, such as JAMBA, CAMBA or ROKAMBA (see Section 7 *Legislative Framework*); or
- they are in need of special protection, other than for the above reasons (e.g. they are uncommon or have commercial value).

There are 11 threatened vertebrate fauna known to occur within the parks: quokka, woylie, chuditch, wambenger (*Phascogale tapoatafa tapoatafa*), Australasian bittern (*Botaurus poiciloptilus*), malleefowl (*Leipoa ocellata*), forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*), Baudin's (long-billed) black cockatoo (*Calyptorhynchus baudinii*), Carnaby's black cockatoo (*Calyptorhynchus latirostris*), western mud minnow (*Galaxiella munda*) and Balston's pygmy perch (*Nannatherina balstoni*) (Appendix 5). The occasional visit from an albatross has also been recorded, such as the shy albatross (*Diomedea cauta*). The specially protected New Zealand fur seal (*Arctocephalus forsteri*) is also known to haul out at Black Point in D'Entrecasteaux National Park. It is also likely that the threatened western ringtail possum (*Pseudocheirus occidentalis*) occurs within the parks, as there have been sightings in forest areas adjacent to the parks.

Quokkas are endemic to the south-west and occur in both parks in wooded areas such as *Taxandria linearifloia* and sedgelands—close to a water source such as a wetland or river. While a large population persists on Rottnest Island, there is evidence that the mainland population has declined since European settlement, especially in the northern jarrah forest (see Section 17 *Native Animals and Habitats*). A recent survey of the southern forests indicated a high number of active quokka populations compared with surveys of the 1970s and 1980s (Burrows and Liddelow 2004). Quokkas are vulnerable to introduced predators, feral pigs and inappropriate fire regimes impacting on their habitat. Quokkas prefer to feed in vegetation that has been burnt in the previous 10 years. However, a patchwork of vegetation age classes allows the quokka to escape fire and predation.

A recovery plan was prepared for the woylie when it was considered threatened (CALM 1995). Due to initial success with conservation actions such as captive breeding, translocations and predator control, the woylie was removed from the Wildlife Conservation Act list of threatened species in 1996. However, woylie populations underwent a rapid decline between 2001 and 2006, reducing the population by approximately 75 % to an estimated 10 000 individuals but the decline has not been consistent across occurrences in the south-west. In 2006 the species qualified for listing as Endangered using IUCN criteria and the species was relisted as threatened in January 2008. Research is now underway to determine possible causes for this decline under the *Woylie Conservation Research Project*, which was initiated in 2006. Possible causes for the decline can be placed into three main categories; limits on food resources, disease/parasites and predation. Results are inconclusive at this stage.

The majority of the remaining chuditch populations are in jarrah forests of the south-west, patchily distributed and at low densities. They den in hollow logs, burrows and tree hollows. Threats include competition and predation by foxes and feral cats, illegal shooting and poisoning, epidemic disease, land clearing, habitat alteration through the removal of suitable den logs, and road traffic (CALM 1994c). Chuditch have only been sighted at Shannon townsite and on South West Highway on the eastern boundary of the parks. A recovery plan has been prepared for this species that concentrates on impacts of prescribed burning regimes and timber harvesting in jarrah forests, in particular the implications on chuditch diet and breeding sites, and maintenance of refuge and den logs as well as fox control and population and habitat monitoring.

The wambenger was listed as threatened in 2006 as there was evidence that the species had contracted to 50% of its former range and local extinctions were highly likely. It occurs in low densities in dry sclerophyll forest and open woodlands that contain hollow-bearing trees but sparse ground cover. Threatening processes include reduced availability of trees with hollows, and predation by introduced predators.

Most populations of the western ringtail possum are now restricted to the near coastal areas of peppermint woodland from Australind to the Albany area. The western ringtail possum is thought to have become locally extinct at all former inland locations, except at Perup and surrounding forest blocks near Manjimup – the only

location where the possum is now found in the absence of peppermint. The occurrence of the peppermint woodland habitat type and sightings adjacent to the parks indicates the possibility that the possum occurs within the parks. Threatening processes include predation by introduced predators and changing fire regimes.

Previously thought to be extinct, the Gilbert's potoroo was rediscovered in 1994 in Two Peoples Bay Nature Reserve. Although it may occur in the dense swamp vegetation within the parks, it is still believed to be locally extinct in the Warren bioregion (see Section 17 *Native Animals and Habitats*).

The preferred habitat of the Australasian bittern includes shallow vegetated wetlands such as the sedgelands around Lake Jasper and Lake Maringup. Large numbers of Australasian bitterns may be found in these wetlands if intensive and comprehensive surveys were conducted. The main threats to the bittern are salinisation or drainage of wetlands as they have narrow habitat preferences and are more sensitive to overall habitat loss than many other wetland species. Inappropriate fire regimes, which destroy fringing vegetation, can also reduce habitat suitability (Marchant and Higgins 1990).

The remaining range of the malleefowl appears to be highly fragmented across southern Australia. Within the parks the malleefowl inhabits jarrah forests and the ecotone between karri forests and coastal heath. Sightings within the parks include Yeagerup Dunes within D'Entrecasteaux National Park and 'Curtin' forest block within Shannon National Park. Highest densities of malleefowl in dry heath areas outside the parks appear to occur on fertile sandy soils with abundant leaf litter (where they can build mounds). For this reason habitat that is long unburnt is preferred for nesting (Garnett and Crowley 2000, Benshemesh 1999). Fire can cause local extinction and it may be 15 years before habitat is suitable and at least 40 years before maximum population densities are attained (Benshemesh 1999). Within the habitats of the parks however, litter accumulation may occur at higher rates, so further research is required to determine the management requirements to maintain suitable malleefowl habitat. Vegetation clearance, increased fire frequency, predation by foxes, inbreeding, infertility, road-kill, and hunting are the main threats for the species.

Baudin's (long-billed) black cockatoo and the forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*) inhabits forest and woodland areas of the south-west, nesting in hollows in mature eucalypts, particularly marri, karri and wandoo (*Eucalyptus wandoo*). Up to a quarter of the species' preferred habitat in the south-west has been cleared for agriculture (Mawson and Johnstone 1997) and in the remaining habitat, density appears to have declined as a result of selective removal of large marri trees from which the species obtains most of its food. Other threats include competition for hollows (see Section 20 *Introduced and Other Problem Animals*), low reproductive rates and continuing illegal culling by orchardists who see Baudin's black cockatoo as a pest. Maintenance of mature stands of forest within the parks and feral honey bee control will help to ensure the long-term survival of the species. A recovery plan has been prepared jointly for these species (Chapman 2007).

Carnaby's black cockatoo occur in eucalypt woodlands, shrubland, and hakea and banksia heathlands. They breed in the wheatbelt and the swan coastal plain areas, however, land clearing has removed significant areas of their breeding habitats. Large flocks of cockatoos move to higher rainfall coastal areas after the breeding season. It is during this time that Carnaby's black cockatoo move into the range of Baudin's black cockatoo and the red-tailed black cockatoo. Preferred feeding habitats include heath, *Banksia* woodlands and/or pine plantations, accessible water and trees surrounding watercourses. The parks would be utilised by the cockatoo in the non-breeding season, most probably the coastal heathlands. A recovery plan has been prepared for Carnaby's black cockatoo (Cale 2003).

The peregrine falcon (*Falco peregrinus*) is a specially protected species that occurs in D'Entrecasteaux National Park. Populations of the peregrine falcon are now generally higher in Australia than elsewhere in the world, however it is considered endangered on a global scale and is also protected under the international CITES treaty, to which Australia is a signatory (see Section 7 *Legislation Framework*). The peregrine falcon is not restricted to a particular habitat and can be found along coastal cliffs as well as in woodlands and open grasslands. Peregrine falcons are easily disturbed so public access to cliffs within D'Entrecasteaux National Park where the birds nest should be restricted during the breeding season.

The western mud minnow (*Galaxiella munda*) is uncommon throughout most of its distribution; it is most abundant in creeks and streams of the Gardner River and Shannon River catchments. It has also been recorded in Lake Jasper, Lake Samuel and Lake Florence (Aquatic Research Laboratory UWA 1992). Threats include habitat alteration from changes in hydrology, increased salinisation, siltation and eutrophication which occur through dam construction, groundwater extraction and agricultural and forestry practices in the upper catchments as well as the presence of exotic species such as redfin perch, trout and mosquito fish (see Section 20 *Introduced and Other Problem Animals*).

Balston's pygmy perch (*Nannatherina balstoni*) is the most uncommon of the endemic freshwater fishes of the south-west. However Balston's pygmy perch is relatively abundant in a number of shallow pools and creeks that dry up in summer, such as those found between Windy Harbour and Walpole (Jaensch 1992c, Morgan *et al.* 1995, Morgan *et al.* 1998). Therefore the small pools that are the habitat for this fish need to be preserved.

A fossil deposit of the threatened invertebrate the Cape Leeuwin freshwater snail (*Austroassiminea letha*) has been found within the parks but it is not known whether it is extant within the parks.

Reintroductions of Threatened Fauna

In late 2007, three western bristlebirds (*Dasornis longirostris*) were released at the junction of Banksia Camp Track and the Bibbulmun Track. The western bristlebird prefers dense low heaths and has a low tolerance to frequent fire. There is evidence that fires at less than five- to 10-year intervals may lead to local extinction (Smith 1987). However, as it seems that broadscale frequent fire is more likely to be the problem, patchy fires at more frequent intervals may still be appropriate. The birds were released into coastal heath approximately 20 years old, surrounded by younger fuels and were all fitted with a temporary tracking device on their tails. The birds were monitored twice a day using the tracking device for the first month, and then once a week until the tracking devices fell off. Ongoing monitoring now includes field surveys for their call once every couple of months.

The D'Entrecasteaux area also has been considered for the reintroduction of the threatened noisy scrub-bird (*Atrichornis clamosus*). Habitat requirements include long-unburnt vegetation (greater than 10 years old) characterised by low forest, scrub/thicket and heath. These formations occur in gullies, drainage lines and the slopes of hills and large granite outcrops, overgrown wetlands and lake margins and in riparian vegetation along rivers and creeks (Danks *et al*. 1996).

Other possible reintroductions of threatened species include the western ground parrot (*Pezoporus wallicus flaviventris*) which currently occurs east of Albany. In these habitats, the western ground parrot forages and nests on the ground in coastal and near coastal heathlands, and also requires long unburnt vegetation (at least 15 years in some areas) (Burbidge *et al.* 1996), however post fire recovery of habitats found within the parks has not been adequately studied and may well differ from that of the birds' known habitat to the east of Albany.

Priority Fauna

The Department also identifies 'priority' fauna[3] that require additional research to determine their true conservation status. There are 11 priority species of vertebrate fauna within the parks, including two priority 1, one priority 2, six priority 4 and two priority 5 species (Appendix 5). Threats to the priority mammal and bird species include fox predation, loss of habitat and fragmentation/alteration, altered fire regimes and competition from introduced herbivores.

In 2002, 40 tammar wallabies (*Macropus eugenii derbianus* – priority 5) were translocated from Perup River to 'Boyndaminup Block' near Mindanup Road, which includes the north-east corner of Shannon National Park which has similar vegetation complexes to the source site. Although the animals were tagged, follow up monitoring has not been successful in relocating these animals. There have been a number of sightings of untagged wallabies within 10 kilometres of the release site, although it cannot be determined whether these wallabies travelled north from the release site or south from the Perup populations. It is expected that in the next few years, if the translocation has been successful then untagged wallabies will be sighted in the translocation area as the wallaby population density would increase to a stage where animals would be more easily sighted.

The water rat (*Hydromys chrysogaster* – priority 4) has declined substantially in the south-west and along inland rivers affected by salinity and degradation (Lee 1995).

The hooded plover (*Thinornis rubricollis* – priority 4) breeds between August and March on coastal beaches of the parks where the eggs and flightless hatchlings are at risk from introduced predators, dogs, and pedestrian and vehicular traffic. Breeding areas within the parks (Birds Australia surveys 1995 to 2007) include:

- Black Point;
- Warren River Mouth;

[3] Priority 1 species: taxa with few, poorly known populations on threatened lands.
Priority 2 species: taxa with few, poorly known populations on conservation lands.
Priority 3 species: taxa with several, poorly known populations, some on conservation lands.
Priority 4 species: taxa in need of monitoring.
Priority 5 species: taxa in need of monitoring (conservation program dependent).

- Salmon Beach;
- Windy Harbour to Cathedral Rocks (Windy Harbour Shire Reserve);
- Windy Harbour to Gardner River;
- Gardner River mouth;
- Coodamurrup Beach, Gardner River to West Cliff Point;
- Broke Inlet;
- West of Cliffy Head Beach; and
- Mandalay Beach.

The increase in four-wheel drive traffic, people, and dogs on beaches, particularly in the Windy Harbour area have reduced the opportunities for the hooded plover to breed within the parks. Where pedestrian or vehicle use may impact on breeding hooded plovers, eggs or hatchlings, restrictions should be imposed, such as seasonal closure or fencing of nesting areas (see sections 26 *Visitor Access* and 27 *Recreational Use*). A management plan for the hooded plover has been prepared by Birds Australia (Raines 2002).

Surveys for the Australasian bittern could incorporate surveys for the little bittern (*Ixobrychus minutus dubius* – priority 4) as similarly there could be greater numbers within the wetlands of the parks. The thicket/sedge wetlands within D'Entrecasteaux National Park and the adjacent Gingilup Swamps Nature Reserve probably constitute one of the most extensive areas of habitat in Western Australia for the little bittern, which remains in good condition (Roger Jaensch pers. comm. 2005).

The black-striped minnow (*Galaxiella nigrostriata* – priority 1) is restricted to the small area of coastal peat flats found from Augusta to Albany, however there are two other disjunct populations in Bunbury and Perth (see Section 18 *Species and Communities of Conservation Significance* – Communities – Wetlands). The centre of distribution is the peat flats surrounding Windy Harbour including Windy Harbour Lake and Doggerup Lake, and is also known to occur in Lake Smith (Aquatic Research Laboratory UWA 1992, Munroe 2006). The species is found in ephemeral pools and often in the same pools as the salamander fish (*Lepidogalaxias salamandroides*) so appropriate management of these pools is important to preserve these species.

The salamander fish occurs in ephemeral pools and creeks. Whilst not considered a priority species by the Department, it is considered a restricted species by the Australian Society for Fish Biology. Whereas it once was found as far west as Margaret River and as far east as Albany it is now mostly restricted to a small area of coastal peat flats between Windy Harbour and Walpole (it is also known to occur in Lake Smith). Therefore the small pools that are the habitat for salamander fish need to be preserved. Morgan *et al.* (1998) warns that when roadside pools are dry in summer, the substrate should not be used for fill or filled in during road maintenance, as these are habitats for the aestivating salamander fish.

There are three priority invertebrate fauna species known within the parks; a copepod (*Calamoecia elongata* – priority 1), a freshwater mussel found in temporary pools on granite (*Fibulacamptus bisetosus* – priority 2), and Doeg's watermite (*Pseudohydraphantes doegi* – priority 2). Doeg's watermite was thought to be extinct after hydrological changes in Pooringinup Swamp in Lake Muir Nature Reserve eliminated the swamp's population but was later discovered in a tributary of Shannon River.

Endemic Fauna

The parks also provide an important habitat for at least 42 endemic fauna including, in addition to four of the threatened and four of the priority species; the honey possum (*Tarsipes rostratus*), Gilbert's dunnart (*Sminthopsis gilberti*), red-capped parrot (*Purpureicephalus spurius*), white breasted robin (*Eopsaltria georgiana*), red-winged fairy wren (*Malurus elegans*), red-eared firetail (*Stagononpleura oculata*), square-nosed snake (*Rhinoplocephalus bicolor*), eight skinks, 14 frogs and five fish species.

Relictual Fauna

The high rainfall zone within the south-west is important for relictual fauna with Gondwanan affinities—fauna thought to have originated in the Jurassic/Cretaceous/Tertiary rainforest environments (Hopper *et al.* 1996). Several habitats have been identified within the southern forests that are likely to contain relictual fauna. These habitats are those that are the most similar to the ancient rainforests of the region such as coastal areas with high precipitation, areas receiving run-off from granite areas, winter wet swamps and areas with a southern or south-western aspect such as valley slopes and floors. Relictual fauna within the parks include: the majority of the frogs recorded (13 of the 15 frogs within the parks), the galaxiid fish (four species), the pouched lamphrey (*Geotria australis*), freshwater crayfish, dragonflies, stoneflies, land snails, earthworms and arachnids (e.g. *Chudalupia meridionalis* and *Chasmocephalon neglectum*). According to Hopper *et al.* (1996), habitats that

contain these relictual fauna should be protected from frequent fire as the fauna are likely to be more vulnerable to such stresses (see Section 22 *Fire*).

International Conventions

There are nine bird species recorded within the parks that are covered under international conventions (see Section 7 *Legislation*). The curlew sandpiper (*Caladris ferruginea*) is covered under JAMBA, CAMBA and ROKAMBA. The great egret (*Ardea alba*) is covered under both JAMBA and CAMBA. The white bellied sea eagle (*Haliaeetus leucogaster*) is covered under CAMBA, the crested tern (*Sterna bergii*) is covered under the JAMBA convention and the osprey is covered under the Bonn Convention. Occasionally albatrosses, which are listed under the Bonn Convention, are sighted in D'Entrecasteaux National Park. Not all these species have been listed as specially protected under the Wildlife Conservation Act yet. There are also 24 species of native fauna listed under the CITES convention.

Flora

Rare and Priority Flora

All native flora in Western Australia is protected under the Wildlife Conservation Act. Taxa that are presumed to be extinct in the wild, or likely to become extinct or rare are afforded special protection by being declared to be 'rare flora' under the Wildlife Conservation Act. These specially protected flora are sometimes referred to as 'threatened' flora or 'Declared Rare Flora'. A permit from the Minister for Environment is required before such flora can be 'taken'.

In addition to rare flora, the Department also refers to 'priority' species. These are species that may be rare but there is insufficient survey data available to accurately determine their true status, or which are rare but not currently threatened and hence are being monitored. Although priority species do not have the same level of legislative protection as rare flora, the priority flora list is maintained as a mechanism to highlight flora of special conservation interest and encourage appropriate management activities in areas such as disease control (see Section 21 *Diseases*), prescribed burning (see Section 22 *Fire* – Fire Ecology), road construction and site development.

Seven rare and 47 priority flora, occurring in 228 populations, have been recorded in 26 vegetation complexes in the parks (Appendix 6). The rare species are the granite banksia (*Banksia verticillata*), Northcliffe kennedia (*Kennedia glabrata*), globular mignonette orchid (*Microtis globula*), shore spleenwort (*Asplenium obtusatum subsp. northlandicum*), three-lobed meziella (*Meziella trifida*), a sedge (*Reedia spathacea*), and a moss (*Rhacocarpus rehmannianus var. webbianus*).

A number of rare and priority flora have been reported to occur in the parks but require confirmation. These include the rare tall donkey orchid (*Diuris drummondii*), *Thomasia laxiflora* (priority 3), *Deyeuxia inaequalis* (priority 1), *Caladenia abbreviata* (priority 2), *Aotus carinata* (priority 4) and *Corybas limpidus* (priority 4) (R. Hearn pers. comm. 2004).

The granite banksia is found in coastal areas growing in granite fissures and deeper soil around granite outcrops. This species is usually killed by fire and regenerates from seed (Robinson and Coates 1995). Its long juvenile period before flowering means populations require a fire-free environment of more than 20 years to build adequate seed banks (see Section 22 *Fire*), but the granite outcrop habitat offers some protection from fires (Kelly and Coates 1995). Most follicles will open without fire after several years (George 1999). Although the banksia is highly susceptible to *P. cinnamomi* (see Section 21 Diseases), the two populations of the banksia within D'Entrecasteaux National Park have not been affected by the pathogen. The Department will continue to monitor these populations and will develop a phosphite treatment program for the banksias if necessary.

The Northcliffe kennedia grows in scattered locations along the south coast from Northcliffe to east of Esperance on shallow pockets of soil on granite outcrops, in association with mosses and herbs. Fire kills this species and stimulates germination of the seeds in the seedbank. The populations within the parks require further study and regular monitoring to ensure that several seasons of seed production occur between fires.

The globular mignonette orchid grows in peaty soils in seasonally wet swamps with other more common species of mignonette orchid (*Microtis* species) in a few locations near Albany and Walpole. These orchids only flower after hot summer fires and can be often mistaken for other mignonette orchids. The two known populations within the parks are near Crystal Springs in the eastern end of D'Entrecasteaux National Park in the vicinity of Walpole-Nornalup National Park. Further surveys following summer fires in this area and similar habitats nearby could reveal other populations.

The shore spleenwort is a small glossy fern that occurs in very exposed locations on maritime cliff faces, in shallow pockets of soil over granite gneiss. It is widespread in other parts of Australia but there are less than 200 plants within Western Australia. One population has been recorded on a granite outcrop at Banksia Camp in D'Entrecasteaux National Park. Other nearby populations are known from Breaksea Island and Chatham Island off the south coast, and on cliffs of Torndirrup and Waychinicup national parks.

The three-lobed meziella is a herbaceous plant that was presumed to be extinct until rediscovered in 1992, 200 kilometres west of Albany. It is found in open grey sandy grey clay depressions in winter-wet flats in association with heaths and rushes between Albany and Scott River.

Reedia spathacea is a sedge that occurs on narrow floodplains that are shallowly inundated in winter and remain waterlogged throughout summer and autumn, and peat paluslopes that have consistently high levels of moisture. *R. spathacea* was upgraded from priority 4 to rare in 2006 due to a decline in the number of plants and populations, and due to threatening processes likely to result in further decline. Threats include disturbance by feral pigs (see Section 20 *Introduced and Other Problem Animals*) and inappropriate fire regimes (see Section 22 *Fire*).

Few non-vascular plants and other biota such as fungi are included in Western Australian threatened and priority listings. These species are poorly known in a taxonomic and conservation sense (it is estimated that only 1% of Western Australia's non-vascular flora is formally named), and their low representation on threatened and priority lists does not reflect their true conservation status (Brown *et al*. 1998). There is one priority 2 species of fungi that has been recorded within the parks *Pertusaria trachyspora*, at Mt Chudalup and one rare and two priority species of moss known to occur within the parks and they have been included in Appendix 6. The rare *Rhacocarpus rehmannianus var. webbianus* is only known from two locations, Mt Chudalup in D'Entrecasteaux National Park and Two Peoples Bay Nature Reserve.

Species Richness

In addition to the threatened flora of the parks, the Warren bioregion is important as a centre of diversity for herbaceous perennial species and for the conservation of high rainfall flora (Lyons *et al.* 2000). The known species within the parks represent about half the native flora of the Warren bioregion (see sections 11 *Biogeography* and 16 *Native Plants and Plant Communities*). Based on predictive modelling, the area of the parks east of the Shannon River and Broke Inlet, is an area of high flora species richness within the south-west (Hearn *et al.* 2003). Another area of predicted high species richness can be found in the Black Point/Lake Jasper area in the west of the parks (Map 6 Species Richness). These areas should be specially protected through appropriate park management.

Endemic, Disjunct and Relictual Flora

There are 24 species that occur within the parks that have narrow ranges of less than 150 kilometres (Appendix 6). These narrow or 'locally' endemic taxa are the most vulnerable to change (climate, hydrological or disease induced) or catastrophic events such as wildfire. There are also 11 species within the parks that are strictly endemic to the Warren bioregion (including five locally endemic), which represents 34% of the total species endemic to the Warren bioregion. Within the parks, the Lake Jasper area to Donnelly River is considered an area important for flora endemism (Map 6 Species Richness).

Species with disjunct distribution have been very significant in the development of the south-west flora. There are nine species within the parks with disjunct distributions (Appendix 6), with centres important for these species in the Lake Jasper area and in the northern Pingerup Plains (Map 6 Species Richness).

Relictual species include taxa with 'primitive' reproductive systems (gymnosperms, ferns and fern allies), monotypic genera (with a single species in it—often considered to be end of the line taxa of almost extinct genera) and taxa considered to be primitive within their families/genera/subgenera (Hearn *et al.* 2003). Although many of these species are common, the relatively low number of taxa in these groups and their genetic distance from the dominant modern flora makes them important for biodiversity and conservation.

There are 39 relictual species (including 22 monotypic taxa) within the parks (Appendix 6), with the centres important for relictual species in the Lake Jasper area, Mt Chudalup, the Windy Harbour area between Doggerup Creek and Gardner River and the northern Pingerup Plains (Map 6 Species Richness). There seems to be an association with sites of high moisture such as wetland areas, rivers and the bases of granite outcrops (Hearn *et al.* 2003).

These areas that are centres for endemic, disjunct and relictual species within the parks should be specially protected through appropriate park management and the impacts of fire should be monitored.

Communities

Threatened Ecological Communities

There are currently 69 threatened ecological communities across Western Australia that are endorsed by the Minister for Environment. One of these is recorded within D'Entrecasteaux National Park at Black Point, and is known as 'rimstone pools and cave structures formed by microbial activity on marine shorelines'. This community is considered within Western Australia to be 'endangered' but is yet to be listed under the Commonwealth Environment Protection and Biodiversity Conservation Act.

The 'rimstone pools and cave structures formed by microbial activity on marine shorelines' community is considered within Western Australia to be 'endangered' but is yet to be listed under the Commonwealth Environment Protection and Biodiversity Conservation Act. The microbial communities are stromatolitic and ill-defined structures, which are formed by inorganic precipitation of a mineral phase with microbial control over morphology. Three types of structure may occur in these communities: rimstone pools (terraces), nodular incrustations; and drapes and carbonates in caves. All contain a very similar selection of microbes and may be formed by similar processes. Although little is known about the communities at Black Point, it is known that they are dependant on springs flowing from Black Point and any change in drainage or flow may affect them. They are also very prone to disturbance by human usage and require special protection, in particular from foot traffic (see Section 27 *Recreational Use*).

There is also a priority ecological community within the planning area at several locations. The '*Reedia spacthacea – Empodisma gracillimum – Schoenus multiglumis* dominated peat paluslopes and sandy mud floodplains of the Warren biogeographical region' community which occurs within both parks, has been identified by the Department as threatened but will be referred to as a priority ecological community until it is endorsed by the Minister.

There are 23 isolated occurrences of the '*Reedia spacthacea – Empodisma gracillimum – Schoenus multiglumis* dominated peat paluslopes and sandy mud floodplains' community in the Warren bioregion with eight within the parks (two in the Shannon National Park and six in the D'Entrecasteaux National Park) (Figure 7). The perennially high water tables of these freshwater wetlands are primarily maintained by the humid climate, collection of rainwater from large natural catchment areas by subsurface flow into confined aquifers, and the water storage capacity of peat. A number of rare and priority species are concentrated in these wetlands including *Reedia spathacea* (rare), *Drosera binata* (priority 2), *Amperea protensa* (priority 3) and *Gonocarpus simplex* (priority 3). The *Reedia* swamp communities are particularly vulnerable to disturbance from feral pigs (see Section 20 *Introduced and Other Problem Animals*), severe and/or frequent fire (see Section 22 *Fire*), disruption of hydrological maintenance of wetlands (see Section 15 *Catchment Protection*), nutrient enrichment, and weed invasion (see Section 19 *Environmental Weeds*). Partial fencing has been implemented both to preserve the reedia from pigs and to study the effects pigs were having on the population. Complete fencing would be difficult due to cost, the practicality of fencing within swampy areas and also protection of the fence from fire, however this strategy will still be considered if deemed necessary.

Vegetation Complexes and Associations

Analysis of the Mattiske and Havel (1998) classification of vegetation complexes in the parks for 'importance'/'significance', in terms of current knowledge, revealed that:

- 25 of the 61 vegetation complexes in the parks contained rare or priority flora; and
- one complex has less that 5% pre-European extent of the complex formally reserved in either existing or proposed conservation reserves and seven complexes reserved at 10 to 15%.

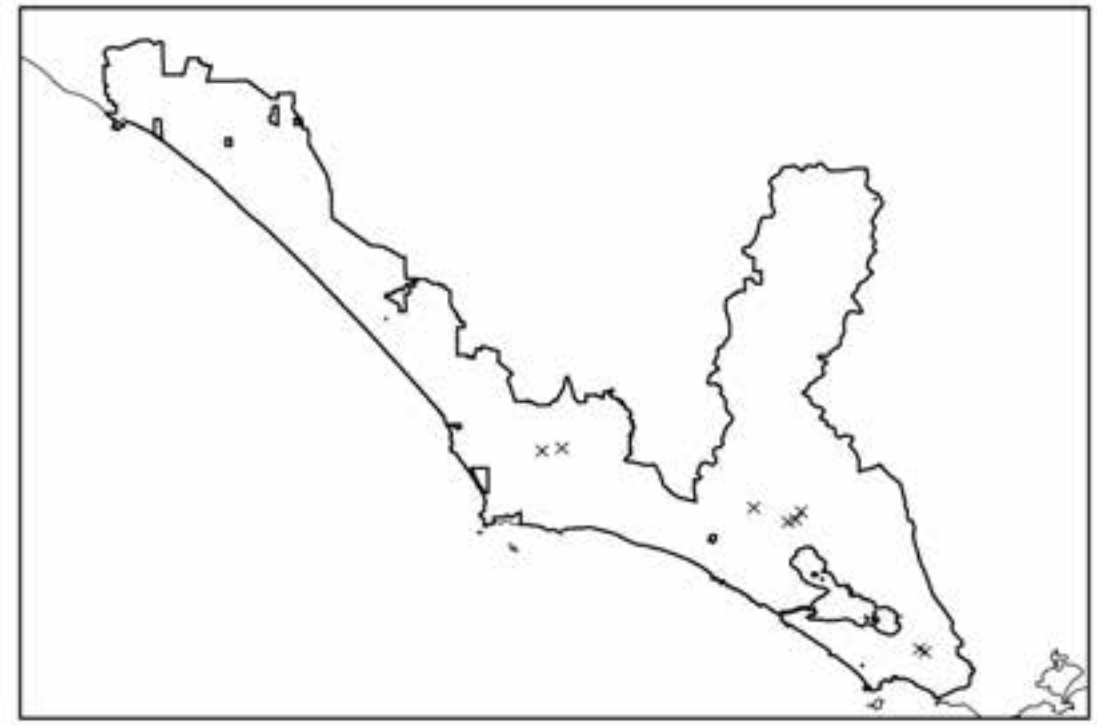


Figure 7: Threatened and Priority Ecological Communities within the Planning Area

Further work is required to determine whether any additional vegetation complexes within the parks require special regard either because they:

- now only exist as small fragmented areas compared to previous distributions;
- are naturally restricted in size or distribution;
- are threatened in some way;
- represent a significant percentage of the total of that vegetation complex on conservation lands;
- have high species richness; or
- contain high levels of endemic, relictual or disjunct flora.

Using the Beard (1980) classification of vegetation associations, there are eight vegetation types in the parks, which meet or exceed the criteria for significance such as reservation level, and extent of association used by Hopkins *et al.* (2000).

Appendix 7 presents information on the significant vegetation complexes and associations currently identified.

Wetlands

States and Territories may list wetlands as 'nationally important' in the *Directory of Important Wetlands in Australia*. The third edition of this directory (Environment Australia 2001a) lists 851 sites as being nationally important. There are four of these wetlands either partly or wholly in the parks: Gingilup-Jasper Wetland System; Doggerup Creek System; Lake Maringup; and the Broke Inlet System (Figure 8).

D'Entrecasteaux National Park covers the majority of the Gingilup-Jasper Wetland System[4], which encompasses all wetlands on the coastal plain between the Donnelly and Scott rivers, notably Lake Jasper and associated swamps, lakes Wilson, Smith and Quitjup and Gingilup Swamps. The Jasper Wetland System is significant as it is an outstanding example of a near-pristine, extensive system of freshwater lakes, marshes and shrub swamps including Lake Jasper—the deepest, large freshwater lake in the south-west. Lake Quitjup is closed to all boating and fishing and is managed as a biological reference area[5].

[4] Part of the Gingilup-Jasper Wetland System is also within Gingilup Swamps Nature Reserve, which is to be covered by the management plan currently in preparation for the parks of the Leeuwin Naturaliste Ridge and Scott National Park.
[5] Recreational use is restricted and biological study is encouraged.

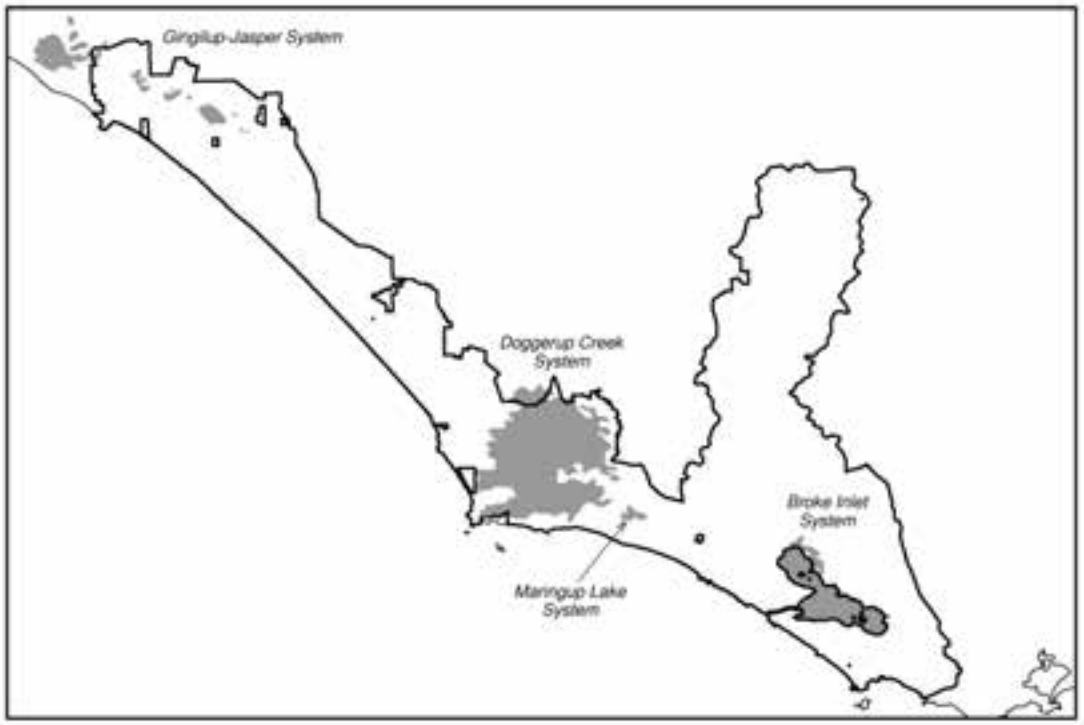


Figure 8: Nationally Important Wetlands in the Planning Area

The system is a 'biological reservoir' for native freshwater fishes, with a representative of all of the native principle freshwater fish species of the south coast (Australian Nature Conservation Agency 1996, Jaensch 1992c). The wetlands are largely isolated from influences that commonly degrade water quality and from major river systems that are known to contain, or are likely to contain, exotic species. Lake Jasper is a major nursery for native freshwater fish species, in particular the western minnow. The threatened western mud minnow has also been recorded at Lake Jasper (Aquatic Research Laboratory 1992).

Threats identified associated with this system include: frequent fire, nutrient enrichment due to developing horticultural activity adjacent to Gingilup Swamps, groundwater extraction, exotic fish, and mining of mineral sands (Australian Nature Conservation Agency 1996). Other threats include inappropriate recreational activity such as power boating (see Section 27 *Recreational Use* – Recreational Activities – Boating).

The Doggerup Creek System is also mostly in D'Entrecasteaux National Park and is a largely undisturbed example of 'acid peat flat', small permanent lakes (Doggerup Lake and lakes Samuel and Florence) and a river (Doggerup Creek). The system contains high levels of endemic fauna, particularly invertebrates such as crustaceans and arachnids and has a high proportion of relictual species. The peat flats are a major habitat for two aestivating inland fish, the black-striped minnow (priority 1) and the salamander fish. The latter is Australia's oldest living teleost fish. Threats to this system include vegetation clearance in the uppermost catchment and frequent fire that may result in erosion of heathland and siltation of the creek system (Australian Nature Conservation Agency 1996).

Lake Maringup is wholly within D'Entrecasteaux National Park and is an outstanding example of a pristine, permanent freshwater lake with peaty marsh. It is a major dry season refuge for native freshwater fish and macroinvertebrates. Potential threats include future extraction of groundwater, frequent fire and the possible spread of exotic wetland plants into the parks such as *Typha orientalis* (Australian Nature Conservation Agency 1996). Lake Maringup is also closed to all boating and fishing and is managed as a biological reference area.

The Broke Inlet System includes Broke Inlet, numerous small lakes and wetlands on the plains around the Inlet and the entire Shannon River. So whilst the inlet itself is not in D'Entrecasteaux National Park, the system does include an area of the park (Figure 8). It is an outstanding example of an unspoilt entire catchment (freshwater river and estuary/inlet system with associated floodplain) in the south-west. The system provides all the life cycle requirements of populations of the endemic black-striped minnow (priority 1), salamander fish and the threatened Balston's pygmy perch. The inlet is a significant drought refuge area for the musk duck (*Biziura*

lobata). Threats to the system include exotic fish (specifically trout *Salmo spp.* which have been released in the Shannon River), possible future water supply demands and mineral sand exploration and mining (Australian Nature Conservation Agency 1996).

Knowledge of the flora and fauna occurring in wetland areas of the parks is not complete especially with regard to the hard-to-access and hostile thicket/sedge swamps and their importance to migratory shorebirds (Roger Jaensch pers. comm. 2005). Further surveys of the wetlands are recommended.

Peatlands

There are extensive areas of wetlands within the parks (mainly D'Entrecasteaux National Park), which also contain areas of organic-rich soils (peatlands). These peatlands are generally restricted to the coastal plains in the south-west and open heath plains of the south coast. Peatlands in particular are important as:

- they act as carbon sinks, storing more carbon per unit area than any other ecosystem (Lafluer *et al*. 2003);
- they contribute important habitats for waterbirds and wetland flora species;
- they are areas of moist microhabitats of high endemism which may contain relictual Gondwanan species, rare flora such as *Reedia spathacea* and small restricted freshwater fish such as the salamander fish and black striped minnow;
- they are important for scientific research into reconstructing landscape and climate change;
- undisturbed peatlands are rare as many have been converted to agricultural land use or mined for peat;
- they slow surface water flow through the catchment;
- they protect the roots of trees such as *Taxandria juniperina* and Melaleuca spp. from desiccation; and
- they form an anaerobic barrier which protects underlying iron rich soils containing ferrous sulphide/iron pyrites/acid sulphate soils from water and oxygen which results in the production of sulphuric acid.

Peatlands are susceptible to fire because of their restricted extent, shallow and sometimes ephemeral nature and the presence of flammable vegetation and organic substrates (Horwitz *et al.* 2003) (see Section 22 *Fire*).

Granite Outcrops

While granite outcrops are scattered throughout the south-west forest region, there are two substantial zones of relatively intense outcropping, landscapes where granite outcrops are conspicuous features and comprise up to 10% of the land surface. One of these is the northern portion of the Darling Scarp, the other is along the south coast hinterland, between Northcliffe and Mt Barker which includes areas of the parks (Figure 9).

The granite outcrops and monadnocks of the parks, such as Mt Chudalup and the Woolbales are significant for the abundance and diversity of flora and fauna habitats they provide. The combination of high solar radiation, rapid rainfall run-off and shallow soils on a rocky substrate provide numerous microhabitats. Conditions may vary over a few metres from cool permanently moist shaded caves with water seepage to dry shallow soils and rock surfaces fully exposed to all the elements.

The diversity of microhabitats on granite outcrops has provided a refuge for many species over evolutionary time whilst the surrounding environment was subjected to dramatic climatic changes. The conditions on the outcrops may have facilitated genetic divergence and speciation (Hopper *et al.* 1997). There is a large number of flora that are endemic to the granite outcrops in the south-west and many species occur as disjunct populations or are restricted to the granite outcrops. Three of the rare flora within the parks occur in association with the granite outcrops of the parks; granite banksia, Northcliffe kennedia and the moss *Rhacocarpus rehmannianus var. webbianus*. The granite outcrop habitats are suitable for the reintroduction of the threatened noisy scrub-bird (Danks *et al.* 1996).

The deeper soils surrounding granite outcrops favour larger woody perennials (this includes eucalypts, wattles and she-oaks). A high number of these species are obligate seeders (i.e. a fire-sensitive species whose population recovery after a fire that caused 100% leaf scorch will depend on recruitment from seed) (see Section 22 *Fire*).

Introduced weed species, mainly annuals, are a threat to granite outcrop communities. Other threats to these communities include feral animals (see Section 20 *Introduced and Other Problem Animals*), inappropriate fire regimes (see Section 22 *Fire*) and *P. cinnamomi* (see Section 21 *Diseases*) (Hopper *et al.* 1997). Recreation can also result in vegetation loss, soil compaction and loss of water infiltration. This increases water run-off and hence the potential for erosion.

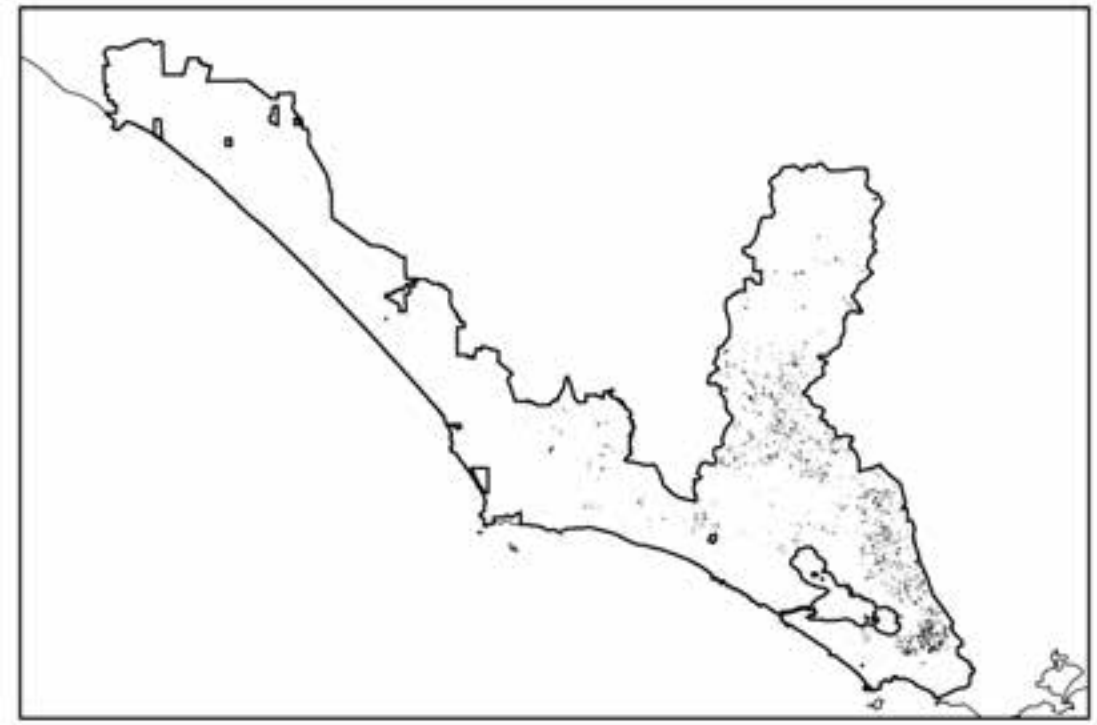


Figure 9: Granite Outcrops in the Planning Area

Old Growth Forest

'Old growth' or 'ecologically mature' jarrah and karri forest, comprising 51% of Shannon National Park, 19% of D'Entrecasteaux National Park and 6% of the section 5(1)(g) reserve near Lake Jasper, has high biological and conservation value (Figure 10).

Mature and senescent trees, karri in particular, provide for the requirements of a range of species which otherwise would be unable to live in regrowth forest for many years (Christensen *et al*. 1992). This includes hollow nesters such as the brush-tailed possum (*Trichosurus vulpecula vulpecula*) and the threatened Baudin's (long-billed) and forest red-tailed black cockatoos, all of which breed in older trees. Introduced species such as honey bees (*Apis mellifera*) and the laughing kookaburra (*Dacelo novaeguinea*) often compete for hollows (see Section 20 *Introduced and Other Problem Animals*). Old growth components of the planning area are shown in Table 2.

Table 2: Forest Structure in the Planning Area

Planning Area	Total Forest	Total Old Growth (% of Forest)	Old Growth by Species		Karri by Development Stage*	
			Jarrah (% of Old Growth)	Karri (% of Old Growth)	Mature (% of Old Growth)	Senescent (% of Old Growth)
The Parks						
Shannon National Park	39 658 ha	26 968 ha (68%)	14 121 ha (52%)	12 847 ha (48%)	12 285 ha (96%)	561 ha (4%)
D'Entrecasteaux National Park	25 462 ha	21 893 ha (86%)	16 450 ha (75%)	5443 ha (25%)	5098 ha (94%)	345 ha (6%)
Section 5(1)(g) Reserve	24 ha	24 ha (100%)	24 ha (100%)	-	-	-
Sub Total	65 144 ha	48 884 ha (75%)	30 595 ha (63%)	18 290 ha (37%)	17 384 ha (95%)	906 ha (5%)
Proposed Additions						

Quannup Pastoral Lease	155 ha	155 ha (100%)	107 ha (69%)	47 ha (31%)	47 ha (100%)	-
FMP 2004 Additions	856 ha	562 ha (66%)	299 ha (53%)	263 ha (47%)	263 ha (100%)	-
Sub Total	1011 ha	717 ha (71 %)	407 ha (57%)	310 ha (43%)	310 ha (100%)	-
TOTAL	**66 155 ha**	**49 601 ha (75%)**	**31 001 ha (63%)**	**18 600 ha (37%)**	**17 694 ha (95%)**	**906 ha (5%)**

* Mature old growth is classed 120 years to 250 years old and senescent old growth is greater than 250 years old

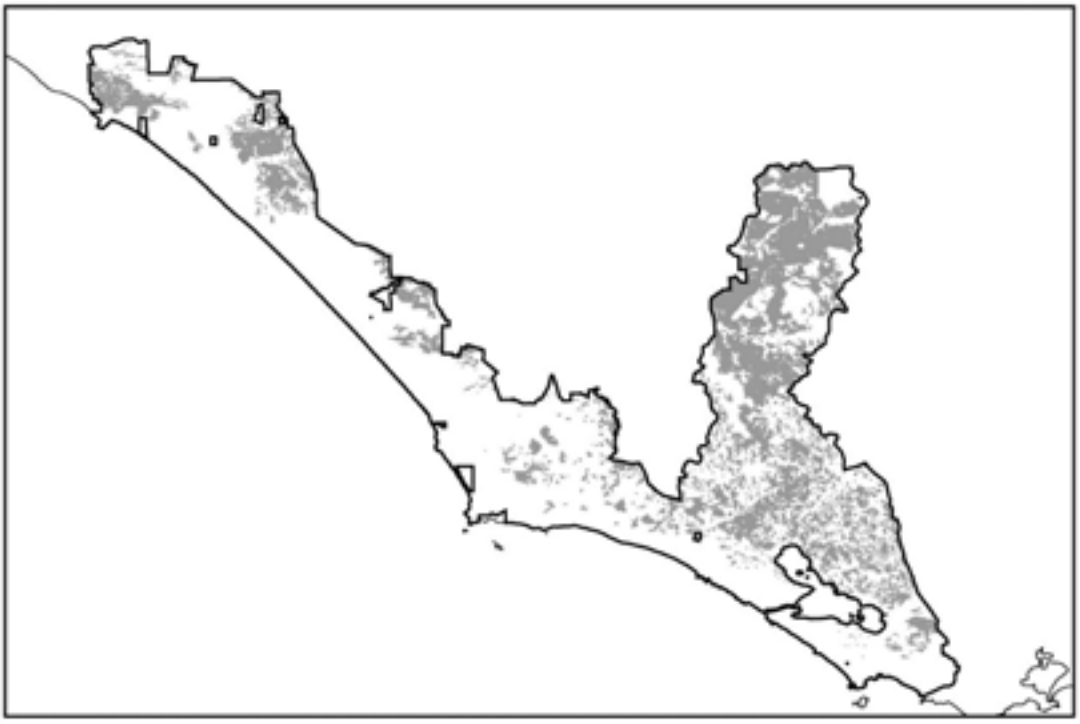


Figure 10: Old Growth Forest in the Planning Area

The approach of the Conservation Commission and the Department to management of old growth forests is guided by the desire to maintain a mix of vegetation age classes to maximise structural and floristic diversity (see Section 22 *Fire*).

The intent of this management plan is to protect the area of old growth forest within the parks by managing:

- disturbance and threats to the old growth forest, such as clearing and development;
- fire regimes, as senescent jarrah will regenerate naturally, however karri usually requires larger scale disturbances such as fire to regenerate; and
- wildfire suppression/prevention to avoid intense wildfires that would replace the whole stand with even-aged regrowth.

As well as managing old growth forests, the Department will need to manage forests that are approaching maturity to ensure adequate replenishment of old growth forest within the parks.

The maintenance of old growth forests is a long-term issue that requires planning for several decades and concerns a scale much wider than the parks. The approach of the Department and Conservation Commission to management of this issue will need to be further developed over the life of this management plan.

18. Species and Communities of Conservation Significance – Key Points

- There are at least 11 threatened, one specially protected and 11 priority species of vertebrate fauna in the parks.

- The western bristlebird was recently translocated into D'Entrecasteaux National Park and there are possibilities of reintroducing a number of other threatened fauna into the parks.
- There are at least seven rare and 47 priority species of flora in the parks.
- Over the life of the plan, the number of rare and priority flora and fauna within the parks is highly likely to change as more is known about the distribution of the species, taxonomic work is undertaken and/or threats are appropriately managed.
- The parks provide habitats for a number of geographically restricted or endemic fauna and flora.
- The microbial community at Black Point is the only threatened ecological community endorsed by the Minister, although *Reedia* swamps within the parks have also been identified by the Department as warranting listing. More threatened ecological communities within the parks are likely to be listed over the lifetime of the plan.
- Eight vegetation complexes are under represented (<15% in formal reserves) in the conservation estate reserve system.
- There are four nationally important wetlands either partly or wholly in the parks: Gingilup-Jasper Wetland System; Doggerup Creek System; Lake Maringup; and the Broke Inlet System.
- The granite outcrops and monadnocks within the parks are significant as they provide habitats for an abundance and diversity of flora and fauna.
- Old growth forests within the parks have high biological, aesthetic and social values.

The objective is to protect species and communities of conservation significance.

This will be achieved by:

1. Providing statutory protection for threatened species and ecological communities in the parks by listing them under the Wildlife Conservation Act (or equivalent legislation) and/or the Environment Protection and Biodiversity Conservation Act.
2. Investigating or supporting studies of the habitat requirements and ecology of threatened and priority fauna and flora, and other conservation significant species susceptible to threatening processes.
3. Conserving the habitat that supports threatened and other conservation significant species within the parks and considering them during management activities (see also Section 15 *Catchment Protection*, 22 *Fire*, 27 *Recreational Use* – Overnight Stays – Campfires, and 32 *Mining*).
4. Preparing and implementing Departmental recovery plans and interim recovery plans for fauna species that are identified within the parks such as the chuditch, Baudin's black cockatoo and Carnaby's black cockatoo, and having due regard for other agency species and community recovery and management plans, such as for malleefowl and the hooded plover.
5. Restricting access to beaches such as seasonal closure or fencing of nesting areas where pedestrian or vehicle use may impact on breeding birds, eggs or hatchlings such as the hooded plover.
6. Implementing the translocation program for the western bristlebird within D'Entrecasteaux National Park.
7. Investigate the possibility of introducing other threatened species into the parks such as the noisy scrub-bird and western ground parrot.
8. Identifying native plants and plant communities that may be threatened and/or require special protection and management prior to ground and/or vegetation disturbing management operations such as site development or fire management operations.
9. Providing information on the location of rare and priority flora and threatened ecological communities within the parks to the State herbarium, and ensuring this information is available to operational staff.
10. Preparing and implementing Departmental recovery plans and interim recovery plans for flora species that are identified in the parks.
11. Encouraging research into the susceptibility to disease, response to fire, reproduction biology, taxonomy and age to maturity of all threatened and priority flora.
12. Collecting and storing seeds/germplasm for future restoration and recovery programs for threatened flora.
13. Maintaining appropriate fire regimes for fire sensitive species, especially if there are any reintroductions of species that require long unburnt vegetation as habitat (see Section 22 *Fire*).
14. Monitoring the *Reedia* threatened ecological community populations and implementing protection measures such as fencing as required.
15. Developing and implementing appropriate fire management regimes for wetland vegetation types with highest priority given to significant wetlands that have not recently been impacted by fire (e.g. Lake Maringup) (see Section 22 *Fire*).
16. Protecting the current level of old growth forests within the parks as well as managing forests that are approaching maturity.
17. Continuing to prohibit fishing, marroning, boating or other recreational use that may have detrimental impact on the wetlands of the parks and in particular, values of Lake Maringup and Lake Quitjup.
18. Undertaking wetland fauna surveys to further determine populations of shorebirds and wetland birds.

19. Carrying out further work on vegetation complexes within the parks to refine significance. **Key Performance Indicator (see also Appendix 2)**		
Performance Measure	**Target**	**Reporting requirements**
18.1 Population numbers of threatened or restricted flora, and the number of individuals within populations	18.1 Remains stable or increases from 2012 levels subject to natural variations	3-yearly or as per recovery plans if applicable
18.2 The range and population numbers of threatened and specially protected fauna	18.2 Maintained or increased subject to natural variations	3-yearly or as per recovery plans if applicable
18.3 Species composition and structure within granite outcrops	18.3 Maintained subject to natural variations	3-yearly
18.4 The number and condition of all occurrences of threatened ecological communities within the parks	18.4 Status of threatened ecological communities remain stable or improve	3-yearly or as per recovery plan as applicable
18.5 Translocated populations	18.5 Successfully established and evidence of second generation progeny	3-yearly

19. ENVIRONMENTAL WEEDS

An 'environmental weed' is an unwanted species growing in natural ecosystems. Environmental weeds displace native plants, particularly on 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 increasing the fire hazard.

Environmental Weed Management

An integrated approach to environmental weed management was developed in the *Environmental Weed Strategy for Western Australia* (CALM 1999a). As part of this Strategy, environmental weeds are rated in terms of their environmental impact on biodiversity. The criteria used to determine the rating for each weed are:

- *Invasiveness* – ability to invade bushland in good to excellent condition or ability to invade waterways.
- *Distribution* – wide current or potential distribution including consideration of known history of wide spread elsewhere in the world.
- *Environmental Impacts* – ability to change the structure, composition and function of ecosystems and in particular an ability to form a monoculture in a vegetation community.

The Department's Policy Statement (Draft) *Environmental Weed Management* is used in conjunction with the *Environmental Weed Strategy* to guide the approach and priority setting for the control of environmental weeds on Departmental managed lands and waters. Priorities for action are to first control any weed that impacts on threatened or priority flora, fauna or ecological communities, or that occurs in areas of high conservation value, and then address high, moderate, mild and low rated environmental weeds in decreasing priority as resources allow.

Options for environmental weed management include prevention, eradication, control, containment, or do nothing. It is the preferred option to prevent the introduction of environmental weeds through appropriate management, as eradication is rarely feasible. Methods of control include managing disturbance, the use of herbicides, biological control, manual control and control through the application of fire. Effective control programs encourage the growth of native species and the suppression of weeds with the overall aim of boosting the area's resilience to further weed invasion.

Various methods and strategies are used to encourage the public to become involved in conservation management programs including use of volunteers. Volunteers involved in programs such as weed control within the parks are entitled to free parks passes and other benefits once they accumulate enough volunteer hours. The Department is also an active member of the Manjimup Weed Action Group.

The Department's *Good Neighbour Policy* (DEC 2007b) provides advice about common cross-boundary management issues including the control of weeds in partnership with farmers, pastoralists and community members.

Environmental Weeds within the Parks

Within the parks, weeds and non-native plants have been introduced as a result of European occupation and use of the parks. Many of these species have a very localised distribution, only occurring at the site where they were introduced, but some of the more effective colonisers have become widespread. To maintain or enhance the natural environment of the parks, it is essential that these introduced plants are managed appropriately.

There are more than 126 species of environmental weeds within the parks (Appendix 8). A wide variety of exotic plants were introduced to domestic gardens around isolated dwellings and townsites in the parks. The introductions have predominantly been small-scale and have remained localised. However in some areas non-native tree species are spreading beyond the original point of introduction (e.g. some wattle species from the old Shannon townsite).

The old Shannon townsite had numerous exotic shrubs and trees, some of which remain and now contribute to the setting and history of the site and may have heritage value. Kammann (1993) found that there are 35 introduced trees, shrubs and vines at the Shannon townsite, of which only three have increased their distribution into the surrounding areas of the National Park. Thirteen other species are colonising within the cleared areas of the townsite. Although most species are not extending their range, Tasmanian blackwood (*Acacia melanoxylon*), blackberry (*Rubus fructicosus*) and maritime pine (*Pinus pinaster*) have extended their range into native vegetation and these species, in addition to those that have the potential to spread, may pose a threat if left unmanaged. The District is currently in the process of developing a more detailed weed management plan for the old Shannon townsite, which will be finalised and implemented over the life of this plan.

Under the *Environmental Weed Strategy* the highest rating environmental weeds in the parks are great brome (*Bromus diandrus*), freesia (*Freesia* hybrid *Freesia alba* x *F. leichtlinii*), hare's tail grass (*Lagurus ovatus*), Victorian tea tree (*Leptospermum laevigatum*), rose pelargonium (*Pelargonium capitatum*) and the arum lily (*Zantedeschia aethiopica*).

Great brome is a tufted annual native to the Mediterranean, it is a widespread weed of offshore islands, wetlands, road verges, granite rocks, pastures and crops in the south-west. Freesia is a hybrid of two South African species that has become a serious weed of urban bushland, coastal heath, woodland and granite rocks from Gingin to Israelite Bay. Hare's tail grass is a hairy annual native to the Mediterranean widespread on sandy soils from Kalbarri to Israelite Bay, especially near the coast (Hussey *et al.* 1997).

Victorian tea tree is a large shrub introduced from south-eastern Australia as a garden plant and is now a major bushland weed. It is spreading along road verges between Jurien Bay and Albany and invading coastal heath and woodlands on sandy and lateritic soils (Hussey *et al.* 1997). Victorian tea tree is present in the parks at Windy Harbour, near Fish Creek and at the Shannon townsite. This species carries a large seed load and spreads rapidly into disturbed areas or following fire. Although control work has been carried out on most populations within the parks this will need to be continued. At Windy Harbour, Victorian tea tree has been used by lease owners as a windbreak. The Department is currently liaising with the Shire of Manjimup to encourage the removal of this species and replanting with native species.

Rose pelargonium is a straggling shrubby perennial, with compact heads of pink flowers native to South Africa. It is a common weed of beach dunes, banksia and tuart woodlands from Cervantes to Esperance (Hussey *et al.* 1997). Rose pelargonium populations within the parks are monitored by the District. Hand weeding and spraying has occurred in an effort to eliminate small populations, or to minimise its spread in the case of larger infested areas. The only effective control method for the larger populations would be chemical or a biological control method. The Department is currently working on these solutions taking into account the ecological values of the wider areas. For example, recent chemical trials for control indicate that 2,4 D Amine has been determined to have minimal effect on native species if used in low concentrations, but is still effective at killing pelargonium. However, the long-term effectiveness still needs to be determined, as infestations can still recruit from the seedbank. There have been reports that capeweed (*Arctotheca calendula*) is following the intruding trail of rose pelargonium into the native vegetation in the Banksia Camp area. Where it is found to occur with rose pelargonium within the parks, it will be treated in the same management program.

Arum lily, native to South Africa, is a widespread and conspicuous weed from the Dandaragan area southwards (Hussey *et al.* 1997). It is primarily found in wet, swampy habitats, where it can be a problem by impeding water flow. It was introduced into Australia for horticulture and its large flowers, up to 15 centimetres across, are still used in the cut flower trade. Arum lilies have established significant populations on the lower Donnelly River with some smaller populations in the area between Scott Road and the Donnelly River. Although there has been significant effort put into controlling these populations (particularly those on the lower Donnelly) the populations have persisted and have proved very difficult to eradicate. Ongoing effort is required to stop these populations expanding their current range.

The arum lily is not only rated high under the *Environmental Weed Strategy* it is also 'declared' under the *Biosecurity and Agriculture Management Act 2007* (BAM Act). Landholders, including the Department, are legally responsible for eradicating plants declared under the BAM Act, although the Act does preserve the Department's right to decide priorities and the level of control according to resources. There are three other declared weeds within the parks: apple of Sodom (*Solanum sodomaeum*), golden dodder (*Cuscuta campestris*) and blackberry. The blackberry whilst rated low in the *Environmental Weed Strategy* is a 'Weed of National Significance' and a Strategic Plan has been prepared for its management (ARMCANZ and ANZECC 2000).

Overall, there are few significant infestations in the forested areas of the parks. However, on parts of the coast, which have had a history of grazing and disturbance, there are broadscale infestations of annual herbs and grasses. Marram grass (*Ammophila arenaria*) is an introduced species, which was used in the 1930s to stabilise foredunes along the coast of D'Entrecasteaux National Park. It has now established itself along most of the coastal foredunes and in other destabilised coastal dune areas. Marram open grassland (less than 10% canopy cover) has also established on plains behind recently formed foredunes between the Donnelly and Warren rivers. Many native species, such as coastal pigface (*Carpobrutus virescens*) and hairy spinifex (*Spinifex hirsutus*), are also vigorous foredune colonisers and are common along the majority of the D'Entrecasteaux National Park coastline. These two species are included in a list of preferred species to be used for foredune rehabilitation by the Western Australian Planning Commission (2003).

The non-native yellow stringy bark (*Eucalyptus muelleriana*) was planted in Shannon National Park when the area was State forest. Several of these stands still persist and could be sold for a range of timber industry products (see Section 39 *Forest Produce*). If these stands are harvested then the areas should be rehabilitated with native forest species.

Within 2 kilometres of the parks there are 34 additional species of environmental weeds that have not yet been recorded within the planning area (although they may have already spread to the parks). These species should be monitored to ensure that they do not establish within the parks. In particular, the three species rated as 'high' under the *Environmental Weed Strategy* should be closely monitored; Geraldton carnation weed (*Euphorbia terracina*), tree mallow (*Malva dendromorpha*) and the harlequin flower (*Sparaxis bulbifera*). The environmental weeds found within 2 kilometres of the parks are also listed in Appendix 8.

19. Environmental Weeds – Key Points

- Weeds can displace native plants, particularly on disturbed sites.
- There are over 126 environmental weed species in the parks. Six have been rated as high priority weeds—great brome, freesia, hare's tail grass, Victorian tea tree, rose pelargonium and arum lily.
- There are four declared weeds under the BAM Act in the parks.
- Many ornamental and garden species were introduced into the parks at Shannon townsite and around other settlements and dwellings
- Many of the weed species in the parks are localised.
- There are 34 other environmental weeds species adjacent to the parks that are potential new weed species for the parks.

The objective is to minimise the impact of environmental weeds on park values.

This will be achieved by:

1. Using the guidelines in the *Environmental Weed Strategy* and Departmental policy, control environmental weeds based on the present status, size of infestation, rehabilitation requirements, likely introduction and level of threat of the species, in particular to specially protected fauna and declared rare flora (Appendix 8).
2. Liaising with the Department of Agriculture and Food, landholders and local authorities regarding weed control within the parks and in surrounding areas.

3. Maintaining a register of georeferenced occurrences and extent of environmental weeds and regularly forwarding this information into the Department's FloraBase.
4. Developing and implementing a weed management plan for the old Shannon townsite including the removal of exotic species.
5. Monitoring populations of environmental weeds adjacent to the parks.
6. Developing a rapid response strategy for new incursions of highly invasive species.
7. Minimising disturbance to soil while carrying out management activities, particularly in areas adjacent to sources of weeds.
8. Using local native species for rehabilitation where possible.
9. Working with the local community, local weed action groups and other volunteers.

Key Performance Indicator (see also Appendix 2)

Performance Measure	Target	Reporting requirements
19.1 The number and cover of environmental weed species	19.1 Decreasing the number and the area covered by environmental weed species rated as 'high' priority over the life of the plan	5-yearly
19.2 The populations of species and communities of conservation significance	19.2 No decrease as a result of weed invasion	5-yearly

20. INTRODUCED AND OTHER PROBLEM ANIMALS

Problem animals have potential for serious impact on natural systems through direct effects such as predation, habitat destruction, competition for food and territory, introduction of disease, and through environmental degradation by selective grazing, accelerating erosion and polluting streams. Problem animals can be either native species that are impacting on natural or agricultural values or feral animals (introduced species that have become established as wild or naturalised populations). An objective of the Department is to achieve sustained strategic management of problem animals in the parks as per Policy Statement (Draft) *Management of Pest Animals on CALM-Managed Lands*. The Department also has responsibilities for control of declared animals on the lands it manages under the BAM Act. Feral species in the parks are listed in Table 3.

Table 3: Feral Animals Recorded in the Parks

Common Name	Species
Mammals	
Black rat	*Rattus rattus*
Fallow deer	*Dama dama*
Dingo*$^{\nabla}$	*Canis familiaris dingo*
Feral cat	*Felis catus*
Feral dog*	*Canis familiaris familiaris*
Feral pig*	*Sus scrofa*
Red fox*	*Vulpes vulpes*
Horse	*Equus caballus*
House mouse	*Mus musculus*
Rabbit*	*Oryctolagus cuniculus*
Birds	
Laughing kookaburra$^{\nabla}$	*Dacelo novaeguineae*
Fish	
Brown trout	*Salmo trutta*
Mosquito fish	*Gambusia holbrooki*
Rainbow trout	*Oncorhynchus mykiss*
Redfin perch	*Perca fluviatilis*
Invertebrates	
(European) honey bees	*Apis mellifera*
Various molluscs	Includes *Oxychilus* sp.
Yabby	*Cherax destructor*

* Declared species under the Agriculture and Related Resources Protection Act (as of April 2001)

∇ Considered 'acclimatised' and protected under the Wildlife Conservation Act

The Department's *Good Neighbour Policy* (DEC 2007b) provides advice about common cross-boundary management issues including the control of introduced and other problem animals in partnership with farmers, pastoralists and community members.

Red Foxes and Feral Cats

The red fox is a major threat to small to medium-sized ground dwelling mammals, arboreal mammals which spend some time on the ground particularly in areas of disturbance, and ground-nesting birds (Environment Australia 1999c, Burbidge and McKenzie 1989). The feral cat is also thought to have been responsible for the extinction of small to medium sized ground dwelling mammals and ground-nesting birds on islands and in the arid areas of the State (Burbidge and McKenzie 1989). Failure of reintroductions of species in the arid areas may also be attributable to the feral cat (Christensen and Burrows 1994). Even though anecdotal evidence may suggest otherwise (D. Algar pers. comm. 2004), strong documented evidence that the feral cat has a significant effect on native wildlife in the south-west is scarce (Environment Australia 1999b, Dickman 1996). Therefore, it is assumed that there is minimal feral cat impact within the parks. This will continue to be monitored along with Departmental research to determine whether the displacement of foxes has led to an increase in feral cat numbers and/or impact.

Predation by both the red fox and the feral cat are listed as key threatening processes under the Environment Protection and Biodiversity Conservation Act. Five-year threat abatement plans have been prepared for both processes to provide national co-ordination, with the main emphasis on local control programs to ensure recovery of endangered species.

The Department implemented the Western Shield program in 1996 in order to control predators such as the red fox and feral cat. The program involves aerial baiting of (mostly) land managed by the Department using 1080 poison (sodium fluoroacetate) baits to enable native wildlife populations to recover, and to allow the reintroduction of native animals to former habitats once foxes and cats have been controlled. Sodium fluoroacetate occurs naturally in Western Australia in native *Gastrolobium* plants, which has enabled native animals to develop a natural resistance to the poison.

Aerial baiting currently occurs throughout the parks four times a year. The Department maintains a bait-free buffer against private property and around recreation sites within the parks. Additional hand baiting is used to supplement the aerial program in areas to protect specific habitats, known populations of rare animals, new fauna release sites, and areas containing significant fauna species that have been recently burnt and are within 3 kilometres of private property where there is a high fox/feral cat reinvasion potential. The current 1080 bait is not particularly effective against the feral cat and research is continuing to develop a bait more attractive to feral cats.

Rabbits

The rabbit is one of the most widely spread and numerous of the introduced mammals in Australia. Competition and land degradation by feral rabbits is a listed key threatening process under the Environment Protection and Biodiversity Conservation Act and a 5-year threat abatement plan has been prepared (Environment Australia 1999a).

Rabbits are widespread throughout the parks but only appear to reach significant numbers in forest areas that have been cleared and native vegetation replaced with annual grasses (e.g. at Shannon townsite). On the coast, rabbits are common and can reach destructive numbers at times when native vegetation is damaged by grazing (R. Annear pers. comm. 2002). Rabbit numbers in the parks appear to correspond to the impact of myxomatosis and more lately calicivirus.

Pigs

Significant populations have established in the Shannon National Park and are also known from several locations, such as the Pingerup Plains, in D'Entrecasteaux National Park. Pigs have the potential to be very destructive to vegetation and can reach high population densities, particularly in wetland areas. Their habit of wallowing and rooting around the margins of watercourses and swamps can destroy vegetation, cause erosion and remove food and nesting sites of native animals. They pose a threat to ground-nesting birds and can spread environmental weeds. Predation, habitat degradation, competition and disease transmission by feral pigs are key

threatening processes (Department of Environment and Heritage 2003) under the Environment Protection and Biodiversity Conservation Act. Guidance for management is provided by the draft *Feral Pig Management Strategy* (CALM 2005a), which outlines the approach and priority setting for control of feral pigs according to the protection of specific values.

Several communities of the *Reedia* swamps (identified as a priority ecological community) within the parks have been partially fenced to protect them from further damage from pigs (see Section 18 *Species and Communities of Conservation Significance*). Further monitoring of the communities may indicate that more fencing is required.

There is an annual trapping, baiting and shooting program conducted within the parks. Illegal pig hunting can compromise key values in the parks if hunting dogs are used, and the use of rifles pose a visitor safety hazard. Unsanctioned pig hunters also often access areas that are closed to the public and may potentially spread *Phytophthora* by accessing disease risk areas.

The Department is also an active participant in community based feral pig control groups based in Northcliffe, Nannup and the Rocky Gully areas.

Deer

Fallow deer are known from the park in the Lake Jasper area. Several head of deer were seen in the area north east of Lake Jasper during a wildfire in Summer 1996/1997. It is thought that they may have escaped from a farming property into the park. There have been few sightings in this area to date.

Horses

There are frequent horse sightings and signs of horses in the upper Shannon National Park on Creekbend Road, Strachan Road, Lockyer Road, North Road, Mindanup Road and Arthur Road. These horses are probably the western extremity of those known from the Lake Muir, Rocky, and Murtin area.

Horses, and to a lesser extent deer, can cause some problems in wet areas by trampling and barking trees. They can also spread weeds and *Phytophthora*.

Feral Dogs/Dingoes

It is the subject of debate whether the dingo is introduced or native, especially as fossil records date back thousands of years. Either way, the dingo is considered native fauna, protected on conservation estate under the Wildlife Conservation Act. It is now thought the dingo may be a subspecies of the Asian wolf (*Canis lupis dingo* as opposed to *Canis familiaris dingo*) (Long 2003).

Dingoes have been known from the park in the past, however it is unlikely that they persist as a pure strain. Dingoes readily hybridise with wild dogs and there have been sightings of hybrid wild dogs/dingoes by rangers in the past few years. Park campers have also reported hearing dogs/dingoes calling at night. Dingoes/wild dogs are susceptible to 1080 poison, and sightings have dramatically reduced since the introduction of baiting to control foxes in the parks.

Kookaburras

The Director of the Zoological Gardens introduced the kookaburra from Victoria in 1897 (Long 1981, 1988). Hundreds were imported into many agricultural areas of the State as a means of controlling snakes, rodents and insects. In order to stop the introduced bird from being shot, it was declared to be ‘native’ under the Wildlife Conservation Act and so remains protected under the Act. The kookaburra does eat native species and compete for food with other carnivorous native birds (e.g. butcherbirds). Although the impacts of the kookaburra are not well studied, Long (1981) considers the kookaburra to cause little damage to other birds and probably only a negligible contribution on any decreases in small bird populations.

Brown and Rainbow Trout

Brown trout were first introduced into Western Australia from stocks in eastern Australia as early as the 1870s and rainbow trout in the early 1900s, as there is a lack of large native freshwater species suitable for recreational fishing. However, it was not until introductions in the 1930s that trout were successfully introduced in the south-west (Department of Fisheries 2002, Morgan *et al.* 2004). Whilst there is evidence that some of these

populations are self-sustaining, trout stocks are largely maintained by restocking as there is an absence of suitable spawning sites (Morgan *et al.* 2004, Arthington and McKenzie 1997).
Trout are not released directly into rivers within the parks, although the Department of Fisheries[6] releases, or authorises the release of, trout into the upper reaches of the rivers that flow through the parks. There were between 50 000 and 100 000 trout released into both the Warren and Donnelly rivers in 2000 (Department of Fisheries 2002). Authorised trout stocking occurs without any impact assessment on threatened or other native species, or an assessment to the cost-benefits of stocking for the recreational fishery.

Although many other human pressures impact on aquatic ecosystems (e.g. vegetation clearing, pollution and physical modification of natural habitats), trout still impact on native species directly through predation and also indirectly by competing for food and space (Arthington and McKenzie 1997, Jackson *et al*. 2004). However, given the long history of trout stocking in the south-west, clear evidence of changes to aquatic ecosystems is hard to demonstrate. For example, native species vulnerable to trout predation and competition might already be excluded from waterways where trout have been introduced.

Trout are thought to be responsible for impacting the populations of native fish, frogs, aquatic snails, aquatic insects and crustaceans such as marron, koonacs (*Cherax plebejus*) and gilgies (Wager and Jackson 1993, Cadwallader 1996, Department of Fisheries 2002, Jackson *et al.* 2004). The presence of rainbow trout coincides with low native fish species diversity in Western Australia (Arthington and McKenzie 1997) and brown trout have been implicated in the decline in a number of threatened fish species Australia wide, in particular galaxiids and minnows (Arthington and McKenzie 1997, Cadwallader 1996). There are two threatened native fish species in the parks; the western mud minnow and Balston's pygmy perch as well as two priority fish species (see Section 18 *Species and Communities of Conservation Significance*). The impact of trout on native fauna via the spread of pathogens (e.g. from hatchery-produced fish) is unknown.

Jackson *et al.* (2004) criticised trout management in Australia as being too focussed on providing improved recreational angling opportunities at the expense of management of trout impacts. In addition, management of these impacts, such as declining native species, only occurs after the native species is threatened. They suggest that the benefit to the fishery should be compared to the cost to implementing a threatened species recovery program should it be required, and that fisheries management should include an examination of the impacts, costs and benefits of stockings, and designation of waters where native species management is the priority. Further, an overview of the impacts of introduced salmonids by Cadwallader (1996) recommended that research should be carried out by the agencies responsible for salmonid fisheries on the impacts on threatened galaxiids, pygmy perches and species other than fish, in order to take a more proactive approach to protecting native fauna.

Based on the impacts and recommendations discussed above, the release of trout into the waters of the parks will continue to be prohibited. However, the restocking of trout upstream of the parks remains a concern to the Conservation Commission and this Department as it still results in trout within the parks. Morgan *et al.* (2004) recommend that no further stocking of trout should occur in areas of high conservation value until work is undertaken to determine the level of predation by trout on the endemic fauna of the south-west.

Redfin Perch

Redfin perch were originally introduced to Australia from Europe in the 1860s. They were introduced into Western Australia at Albany in the 1890s as a recreational fishing species and spread rapidly throughout some water-bodies and river systems of the south-west. Whilst no longer introduced, they are now very abundant in dams and river systems, and continue to be a targeted recreational species. Although rapid growers and very fecund, redfin populations tend to 'stunt' within a few years, reducing their value as a recreational fish.
Redfin perch can rapidly invade and dominate a river or dam to the detriment of local species. This is due to their fast growth rate, high fecundity and feeding habits. Redfin are predators and will voraciously consume other smaller animals including marron, gilgies, frogs, and insects. Their diet also includes many of the fish species native to the south-west.

Redfin perch are present in the parks throughout the Warren and Donnelly rivers and their tributaries. There are no realistic control options for redfin perch in the parks.

[6] The Department, under the Wildlife Conservation Act, is responsible for the protection of native fauna, including fish. The Department of Fisheries is also responsible for the protection and management of native and recreational fish species under the *Fish Resources Management Act 1994*.

Mosquito Fish

Introduced from Central America to Western Australia in 1934 to control mosquitos and ornamental fish, it was soon realised that mosquito fish will only eat mosquito larvae when all other food sources are depleted. They prey on a wide range of food sources, in particular fish larvae as well as 'grazing' invertebrates (such as *Daphnia*) that control the growth of algae and may indirectly result in toxic algae blooms that affect the populations of native fish (Morgan *et al.* 1998 and Jaensch 1992b). Mosquito fish directly affect native fish species by fin-nipping and other antagonistic behaviours, resulting in fin damage, loss of fitness and reduced reproductive success. Mosquito fish have also been shown to prey on young tadpoles leading to a reduction in the number of some frog species in areas where the mosquito fish populations are high. Mosquito fish are widespread in the waterways and wetlands of D'Entrecasteaux National Park. Control programs have been implemented elsewhere in the State in small, contained waterbodies using anaesthetic. This method would be impractical for the parks.

Honey Bees

Honey bees were introduced to Western Australia in 1846 from England to pollinate plants grown by early settlers for food. Swarm dispersal from managed hives has resulted in feral honey bees being established across many parts of the State, including the parks. Honey bees are commercially agisted in managed hives throughout the parks (see Section 38 Beekeeping).

Impacts on Recreational Values

Large numbers of honey bees increase the risk of visitors to the parks being stung. Feral honey bees seek water during hot weather and alternate food sources when nectar, pollen and water become scarce. Feral honey bees can pollute water supplies when large numbers drown in tanks. Water availability for feral honey bees at recreational sites can be reduced by placing gauze on the end of taps and gravel on the ground underneath.

Impacts on Conservation Values

Honey bees may impact on the conservation values of the parks in the following ways:

- via competition for tree hollows (Matthews 1984, Oldroyd *et al*. 1994, Paton 1996, Pyke 1999, NSW National Parks and Wildlife Service 2002). Many birds and tree-dwelling mammals use tree hollows for breeding sites and shelter and are already a limited resource without the impact of feral honey bees—once occupied, feral honey bees can remain for 20 to 50 years;
- via competition for floral resources, such as pollen and nectar (Scheltema 1981, Matthews 1984, Paton 1993, 1996, 1997, 2000, Sugden *et al*. 1996, Schwarz and Hurst 1997, Gross and Mackay 1998, NSW National Parks and Wildlife Service 2002). Feral and managed hive honey bees can remove 80% or more of the floral resources produced, due in part to the longer foraging hours of the honey bee. Native species can be displaced which can thereby affect all other dependant or related flora and fauna. Also native bees may be forced to forage for greater periods of time, thereby exposing nest brood to more predators in their absence. Native birds that depend on nectar resources may also be forced to occupy larger territories, thereby excluding smaller birds from these resources;
- via affecting pollination and seed set of native species due in part to inefficient transfer of pollen or physically damaging flowers (Scheltema 1981, Matthews 1984, Gross and Mackay 1998, Schwarz and Hogendoorn 1999); and
- via increasing seed-set in some weeds as the honey bee and introduced plants may be interacting as invasive mutualists (Barthell *et al*. 1994 and 2001).

Although the honey bee has existed in the south-west for the last 150 years, impacts such as those listed above, may be still impacting significantly on the natural ecosystems. The honey bee has been identified as a key threatening process for the three species of black cockatoo inhabiting the south-west (Cale 2003, Chapman 2007). The problem may be exacerbated by the recent establishment of canola crops in farmlands as chemicals in the pollen of canola contribute to earlier and more frequent swarming of feral bees, which increases the likelihood of new colonies establishing in the wild (P. Mawson pers. comm. 2004). However, no studies have been carried out specifically to quantify the impact of the honey bee within the parks.

The feasibility of completely removing feral honey bees from the parks is currently low as localised eradication would probably be followed by recolonisation from new swarms invading the area (Gross 2001). However, a control program should be developed to protect species most at risk from competition within the parks. Any control program should not affect the production or quality of commercially produced honey and needs to be

safe for native insect populations. The location and appropriateness of the managed hive sites in the parks also need to be regularly assessed (see Section 38 *Beekeeping*).

Yabbies

Yabbies are an introduced species to Western Australia. They are native to New South Wales, Victoria and South Australia, and were stocked into farm dams in Western Australia as far back as 1932. Yabbies can now be found in rivers and irrigation dams throughout the south-west. Yabbies are a threat to the native marron fishery, as they breed faster and may carry diseases, which affect other freshwater crayfish.

It is believed that yabbies have been introduced into some waterholes (usually fire water points) in the parks.

Introduced Molluscs

At least two species of native snails (*Helicarion castanea* and *Occirhenea georgiana)* that may well have occurred in the parks are now listed as presumed extinct. The introduction from Europe of the carnivorous snail *Oxychilus* sp. and other molluscs to the area is thought to have been the key factor in these extinctions (John Blyth pers. comm. 2003). Introduced molluscs remain a threat to native species.

20. Introduced and Other Problem Animals – Key Points

- There are a number of introduced animals in the parks that can out-compete, prey on, or alter the habitat for native animals. Of single greatest concern is the fox, which is the subject of an ongoing control program.

The objective is to minimise the impact of introduced and other problem animals, as well as associated control programs, on the key values of the parks.

This will be achieved by:

1. Complying with threat abatement plans prepared under the Environment Protection and Biodiversity Conservation Act.
2. Controlling introduced and other problem animals in the parks based on the following criteria:
   - existing and potential impact of the species on the key values of the park;
   - the efficiency and effectiveness of control measures;
   - locations and availability of resources; and
   - the level of participation of other stakeholders including the community.
1. Complying with the Department's operational guidelines and policies for introduced and other problem animal control (e.g. the Department's Training Manual for *Safe and Effective Use of 1080 for Vertebrate Pest Control*).
2. Ensuring that any control program does not adversely impact on the key values of the parks, including recreational values.
3. Liaising with landholders, local authorities, the Pastoral Lands Board, the Department of Agriculture and Food, and Department of Fisheries regarding control of introduced and other problem animals surrounding the parks.
4. Not allowing pets in the parks except guide dogs, dogs associated with search and rescue operations or within any future designated areas (see Section 30 *Domestic Animals*).
5. Preventing further introductions of non-native animals in the parks, unless as part of a biological control program and under stringent guidelines.
6. Continuing to prohibit stocking of non-native species in all water bodies in the parks and continuing to work with the Department of Fisheries to obtain adequate conservation outcomes for all waterways in conservation reserves and therefore seeking to prevent restocking of non-native species in rivers that are upstream of D'Entrecasteaux National Park (see Section 27 *Recreational Use* – Recreational Activities – Marroning and Fishing).
7. Managing commercial beekeeping within the parks according to environmental and management criteria (see Section 38 *Beekeeping*).
8. Removing feral bee colonies from areas where there is a high impact on recreational and conservation values in consultation with beekeepers as necessary, and minimising the opportunities for feral bees to utilise water provided for recreation purposes (e.g. water tanks).
9. Producing educational material on the impacts of introduced animals such as pigs and recreational fish/yabbies on the natural environment of the parks.
10. Supporting research programs into the control of and impacts of feral animals (also Section 44 *Research*

and Monitoring).

Key Performance Indicator (see also Appendix 2)

Performance Measure	Target	Reporting requirements
20.1 Threat to native species and communities by problem animal species over the life of the plan	20.1 No increase in the level of impact on the *Reedia* swamps threatened ecological community from feral pigs No loss of populations of critical weight range mammals attributable to foxes	5-yearly

21. DISEASES

Plant Diseases

The south-western ecosystems are being impacted by a high number of active plant diseases (Shearer 1994, Wills and Keighery 1994). However, plant disease knowledge is still very rudimentary with much more work required on disease occurrence, the disease organism and impacts, the host and its susceptibility, and environmental processes that may facilitate spread.

Hopper (1994) suggests that there are four factors that in particular may have contributed to the susceptibility of the south-west flora to disease epidemics:

- a flat landscape with predominantly acidic, highly leached and nutrient deficient soils with slow drainage. Diseases such as *P. cinnamomi* thrive in acidic moist soils;
- a rich vascular flora that has been geographically isolated for a long time, with many adaptations for nutrient deficient soils, many involving symbiotic partnerships with micro-organisms such as fungi—consequently, a diverse range of vulnerable hosts for diseases;
- a climatic regime where drought is common; and
- the rapid and ongoing human development of the landscape following European settlement including direct destruction or alteration of habitat by fragmentation, altered landscape processes, and introduction of numerous weeds and pests.

The most frequently reported disease groups of the south-western native plant taxa include:

- pythiacious root rots (mostly *P. cinnamomi*, *P. megasperma* and *P. citricola*);
- rusts (mostly *Puccinia* spp. and *Uroycladium tepperianum* gall rusts of *Acacia* species);
- *Armillaria* root rots (*Armillaria luteobubalina*);
- stem cankers (*Botryospaeria* spp., *Zythiostroma* spp. and *Cryptodiaporthe* spp.); and
- leaf spots and blights (Shearer 1994).

Families most affected by disease are Proteaceae, Myrtaceae, Mimosaceae, Papilionaceae, Haemodoraceae, Goodeniaceae, Epacridaceae, Poceae and Chenopodiaceae. These families are represented by 287 species within the parks, equating to almost a third of the recorded vascular plant species of the parks.

Plant pathogens not only have major impacts on vegetation communities but also indirectly impact animal communities. Table 4 shows some effects that a pathogen can have on fauna.

Table 4: Possible Effects on Fauna by the Presence of a Plant Pathogen in a Vegetation Community

Effects on Vegetation	Effects on Fauna
Loss of susceptible plants in the understorey and midstorey	❖ Direct loss of food sources such as seeds, nectar, pollen ❖ Indirect loss of food sources such as invertebrates
Decline in plant species richness and diversity	❖ Loss of food for species that prefer

Effects on Vegetation	Effects on Fauna
	floristically rich vegetation ❖ Loss of seasonal food
Decrease in plant cover, increase in bare ground, erosion	❖ Loss of habitat for species dependant on thick ground cover ❖ Increased predation risk ❖ Changes to microclimate
Decrease in canopy cover	❖ Loss of food for arboreal species ❖ Loss of habitat for arboreal species
Decrease in litter fall	❖ Decline in litter invertebrates ❖ Decline in invertebrate food sources for insectivores
Post infection increase in frequency of resistant species	❖ Change of food resources

Source: based on Wilson *et al*. (1994)

Disease caused by *Phytophthora*

The most significant disease threat to plants within the parks continues to be the disease known as 'dieback' caused by the microscopic pathogen, the fungal-like water mould; *P. cinnamomi.* It is thought that this pathogen was introduced during European settlement of Western Australia through the soil around roots of plants brought over for cultivation. There are now known to be eight species of *Phytophthora* occurring within the native plant communities of Western Australia. It is recognised that of these species, *P. cinnamomi* is the most damaging. Once infested, susceptible plants are killed and in many cases are eliminated from the site leading to dramatic and permanent changes to native plant communities and their dependent fauna.

Dispersal

The plant pathogen *P. cinnamomi* is able to move autonomously by producing small motile spores that are distributed over long distances through surface and sub-surface water or travel microscopic distances to infect new roots, or by the growth between roots of mycelial threads. The pathogen can be spread in soil and plant material, which can then be transported by vectors such as humans, vehicles and animals. In response to unfavourable conditions such as extended periods of hot dry weather, the pathogen can produce a spore, which is resistant to desiccation that can itself produce further spores or mycelium once conditions are suitable. Through these dispersal methods, *P. cinnamomi* is continuing to spread through the south-west. The pattern of *P. cinnamomi* distribution is strongly related to the native vegetation community and other site factors such as the presence of watercourses, tracks and roads, with infestation being most common where human activities have taken place in the absence of a hygiene regime.

Effects

The effect of *P. cinnamomi* upon the health of plant communities, and upon the species in them, varies greatly. In many places, lethal root-disease destroys the structure of many native communities, reduces their floristic diversity, decimates their primary productivity and destroys habitat for much dependant native fauna (see Table 4). In some places the pathogen causes little damage at all. Unfortunately in the south-west it is more common to find susceptible communities in vulnerable environments than not.

No simple or single relationship exists between the presence of *P. cinnamomi* and the development of the disease. This is because of the considerable variability, which exists within and between native plant species in their responses to the presence of *P. cinnamomi*, and the complex influence of temporal and spatial variation in environmental forces.

It is evident that among the variety of plant communities occurring within the high rainfall areas of the south-west (>800 millimetres mean annual rainfall), there are four types of distinctive response to the pathogen as follows:

- *no apparent disease at all* – this includes those areas of karri and wandoo forest which contain no floristic elements of the dry sclerophyll (jarrah) forest type and to plant communities on the calcareous soils of the Spearwood and Quindalup Dune Systems and of the Swan Coastal Plain and pedogenically related landscapes;

- *an extremely destructive epidemic of root rot* – this applies within the highly susceptible understorey elements of the dry sclerophyll forest, in banksia woodland and in heathland on podsols, podsolic and lateritic landform;
- *a variable epidemic* – this applies to the dominant jarrah tree component of the forest with all variants in the response of jarrah are coincident with, or preceded by, mass deaths in susceptible elements of the understorey; and
- *an 'endemic' pathogen* – where *P. cinnamomi* has been long established (some 50 years or more) in sites formerly dominated by jarrah/banksia forest and has been very heavily impacted *P. cinnamomi* behaves in a manner characteristic of an endemic pathogen. The forest is often replaced by an open woodland of marri/parrot bush. Periodic outbreaks of mortality in parrot bush (*Banksia sessilis*) follow, with subsequent regeneration by seed.

Each of these circumstances presents a different problem that requires a separate management response.

A broadscale survey of the D'Entrecasteaux National Park in 1984 revealed that the jarrah forest and woodlands, flats and swamps had a high probability of being infested with *P. cinnamomi* and contained numerous plant species that are highly susceptible to the pathogen or in many cases many susceptible species had already been eliminated. In comparison, the karri forest, yate and bullich woodlands, stabilised dunes and coastal dunes are thought not to be vulnerable and did not express the symptoms of disease caused by *P. cinnamomi*. Figure 11 shows the known occurrence of *P. cinnamomi* in the planning area based on Departmental surveys.

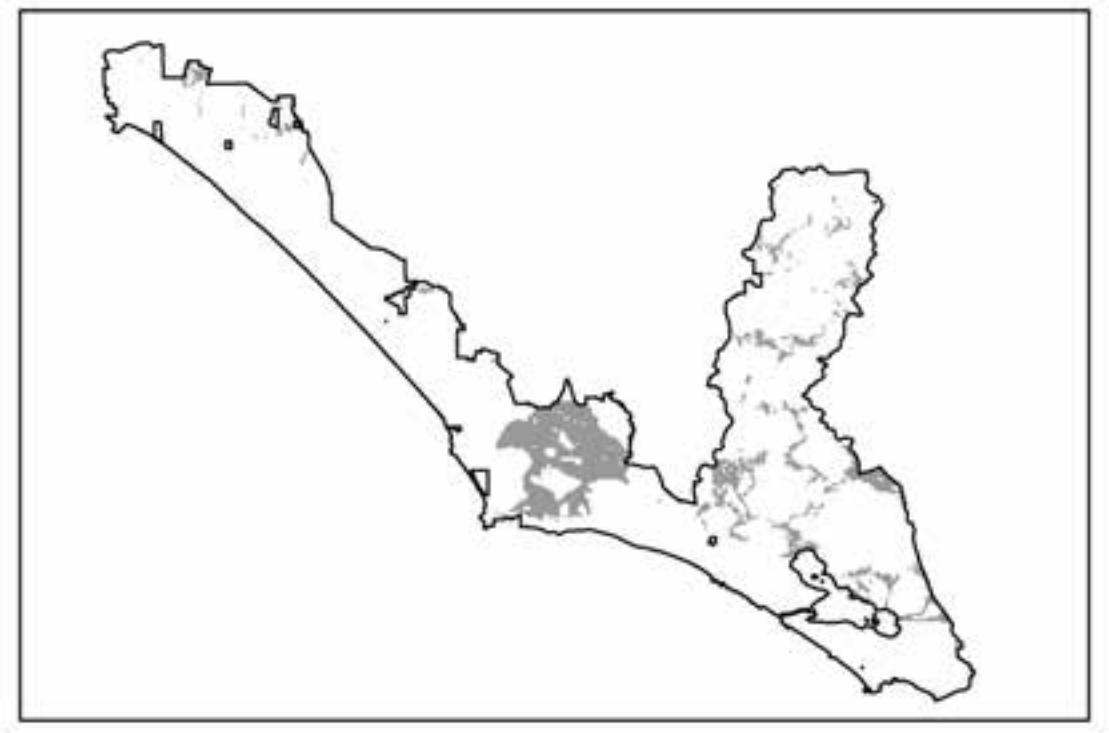


Figure 11: Known *P. cinnamomi* Occurrence in the Planning Area

The heathlands of the D'Entrecasteaux National Park have many members of the families Proteaceae and Epacridaceae. These families which include *Banksia* and *Leucopogon* are highly susceptible to *P. cinnamomi*. *P. cinnamomi*-induced death of these plants, which often dominate the heathlands, is continuing to significantly alter the structure and composition of the plant communities within D'Entrecasteaux National Park (K. Vear pers. comm. 2002).

P. cinnamomi can also have a major impact on faunal habitats (see Table 4). Species such as the honey possum are dependent on plant communities such as the banksia woodlands, which are highly susceptible to diseases caused by *P. cinnamomi*. Such dependent species will be reduced in number or disappear as the autonomous spread of *P. cinnamomi* continues. Impacts may be accelerated if the vectoring of the pathogen by humans into uninfested areas is not minimised.

Management

Effective management of plant diseases requires accurate identification of both the pathogens and their hosts, as well as the nature and extent of genetic variation, which affects the capacity of the pathogen to cause damage, its environmental tolerance and the capacity of the host to resist infection (Podger *et al*. 1996).

Standard management guidelines for *P. cinnamomi* are described in the Department's Manual: *Phytophthora cinnamomi and disease caused by it* (CALM 2000), the revised Policy Statement No. 3 *Management of Phytophthora and Disease Caused by it in Native Vegetation* and the accompanying *Best Practice Guidelines for the Management of Phytophthora cinnamomi*. Dieback caused by *P. cinnamomi* is a key threatening process under the Environment Protection and Biodiversity Conservation Act and a threat abatement plan has been prepared (Environment Australia 2001c).

Management of *P. cinnamomi* within the parks will focus on significant uninfested areas—areas likely to remain uninfested by the autonomous spread of the pathogen in the medium term and referred to as 'protectable areas'—and areas that are already infested but with significant residual values, such as rare flora or threatened ecological communities. Management strategies will be based on the following three elements:

1. containment or retardation of further autonomous spread at the boundaries of existing infestation;
2. reduction of the rate of vectored spread and establishment of new centres of infestation within protectable areas by:
   - preparing *P. cinnamomi* management plans for new developments such as recreational facilities and planned upgrades, or realignments of management access roads and tracks;
   - controlling feral animals, for example pigs, in these areas;
   - applying phosphite (see below); and/or
   - minimising or prohibiting access into these areas (see Section 26 Visitor Access); and
3. implementation of practices which ameliorate the damaging effects of *P. cinnamomi* where it has already established.

In protectable areas, emphasis of management will be on reduction of vectored spread and establishment of new centres of infestation. To accurately determine the extent of *P. cinnamomi* within the parks and to identify protectable areas, on-ground surveys would be required. However, due to resource limitations the first priority will be to interpret aerial photographs of the parks and combine with knowledge of the disease occurrence to produce a map of probable disease spread and protectable areas within the planning area. On-ground surveys should then be prioritised according to risk to conservation values and/or proposed development.

In 'unprotectable' uninfested areas, infested areas and areas where disease spread remains unknown, standard disease management guidelines will apply. However, in some cases, strict adherence to disease hygiene plans may be difficult. For example, construction of emergency firebreaks in wildfire situations may be required to protect human life.

The chemical 'phosphite' has been shown to prevent *P. cinnamomi* killing susceptible native plants in the wild, provided the treatment is continual. As susceptible threatened species, threatened ecological communities and the habitats of threatened native fauna in the park are identified, a program of repeated applications of phosphite will be developed to help protect them subject to resource considerations. In addition, germplasm from threatened native plants may be collected for cryogenic storage.

Other Plant Diseases

Rusts are the second most frequent pathogen on native plant taxa in the south-west (Shearer 1994). In contrast to *Phytophthora*, rust pathogens on native plants are most likely to be endemic and require living hosts for normal development. There is insufficient information on impacts of rusts on native plant communities.

Another disease that occurs widely in the south-west, is the *Armillaria* root disease caused by the soil-borne pathogen *Armillaria luteobubalina.* This endemic fungus is widespread in forests, woodlands and the coastal heath of the south-west, including areas in the parks. Despite a prolific production of spores, the main mode of spread is by root to root contact between healthy and infected plants. The range of species susceptible to the fungus is very large and poorly defined (at least 50 families and over 200 species), with very little information

on the presence of resistant or tolerant species. The highest impact of the disease is in regrowth karri, marri and jarrah forests as a result of the harvesting and thinning operations which provide stumps that *A. luteobubalina* can readily colonise and then infect regrowth saplings and residual trees. Many species that resist infection by *P. cinnamomi* are susceptible to *A. luteobubalina* (Pearce *et al*. 1986, Shearer and Tippett 1988, Shearer *et al*. 1997a, 1997b, 1998).

Mundella yellows is a recently described disease thought to be an introduced virus or virus-like organism of unknown origin possibly spread by insects. It is a slow dieback disease of eucalypts (23 species in Western Australia are known to be affected) and may also affect sheoaks, banksias and wattles. The disease causes progressive decline, yellowing and then death of the trees. The disease has been observed to occur across a scattered distribution in Australia, mostly in coastal areas and mostly in areas of high disturbance such as farmland, roadsides and urban parks (CSIRO 2000, Handol *et al*. 2002). It has not been observed in the parks or in many native undisturbed forests to date, but it is still regarded as a potential threat to native tree species as little is known about the cause or spread of the disease. General plant disease hygiene practices should be implemented to minimise the risk of spreading any new diseases into the parks through human activity.

Animal Diseases

The frog fungus (*Batrachochytrium dendrobatidis*) that lives as a parasite in the skin of frogs and other amphibians, known internationally since 1996 was confirmed to occur in Western Australia in 1998 (although testing of historical material has shown the earliest occurrence of the fungus in the Albany region in 1985). The fungus can cause sporadic death in some populations to 100% death in others (Environment Australia 2002). Studies have shown that there is a broad zone of infection from just north of Geraldton south to Augusta and east to Esperance however this does not imply that all frog populations are infected within this zone (Aplin and Kirkpatrick 2001). Four species of frogs have been shown to be infected more frequently than most other species. Two of these species are found within the parks; the slender tree frog (*Litoria adelaidensis*) and the western banjo frog (*Limnodynastes dorsalis*). Populations of these frogs should be monitored to detect any significant decline in numbers. The infection of amphibians with this fungus is a key threatening process under the Environment Protection and Biodiversity Conservation Act and a threat abatement plan will be prepared.

21. Diseases – Key Points

- *P. cinnamomi* is the most significant pathogen threatening plants within the parks and may kill susceptible plants, irreversibly changing the plant and fauna communities of the area. Other pathogens in the parks include *A. luteobubalina*, rusts and stem canker.
- *P. cinnamomi* spreads by producing small spores that are distributed through surface, sub-surface and stream flows, can transfer between plants by mycelium growth and can be spread by humans, vehicles and animals moving infested plant material and soil.
- Jarrah forest and woodlands, flats and swamps in the D'Entrecasteaux National Park are vulnerable to being infected by *P. cinnamomi* and are continuing to change as a result of the actions of the pathogen.
- Frogs in the parks may be at risk of infection with the frog fungus *Batrachochytrium dendrobatidis*.

The objective is to prevent introducing plant and animal diseases into disease-free areas and minimise the spread or impact where they are already present.

This will be achieved by:

1. Mapping disease occurrence/spread and identifying probable protectable areas within the parks using aerial photographs or similar, and available knowledge of disease spread.
2. Developing protocols for prioritisation and management, including on-ground surveys, of protectable areas and high conservation areas.
3. Preparing a *P. cinnamomi* Hygiene Management Plan for any new development in a protectable area.
4. Implementing seasonal road closures to minimise disease spread as necessary.
5. Providing the public with information about plant disease, emphasising the need to stay on approved roads and tracks and other ways to minimise the impacts of disease.
6. Following the guidelines in the Department's manual on *P. cinnamomi* (CALM 2000) and Policy Statement No. 3.
7. Planning the construction of any new roads, firebreaks and tracks or any operation that requires soil or plant material movement so that the risk of spreading *P. cinnamomi* is minimised.
8. Identifying and treating threatened plants, threatened ecological communities and habitats of threatened native animals with phosphite where feasible.
9. Continuing to implement the training and accreditation program to ensure that all Departmental staff

entering protectable areas are aware of what is required of them for *P. cinnamomi* management compliance.
10. Liaising with neighbours and local authorities to minimise cross-boundary disease spread.
11. Encouraging research into the effects that *P. cinnamomi* and other pathogens are having on the plant and animal associations within the parks, taxonomy, biogeography and ecology of the disease agents, hosts and associates.
12. Restricting the movement of *A. luteobubalina* by establishing quarantine areas depending on the scale of infestation.
13. Liaising with the Western Australian Museum and other researchers to increase knowledge of frog fungus, and other animal diseases within the south-west.
14. Documenting any outbreaks of new diseases within the parks (plant or animal).

Key Performance Indicator (See also Appendix 2)

Performance Measure	Target	Reporting requirements
21.1 Protectable areas within the parks	No new human-assisted infestations of disease caused by *P. cinnamomi* in protectable areas	5-yearly

22. FIRE

The appropriate management of fire is integral to the Department's activities and core management responsibilities, both within conservation estate and on other lands the Department manages. The challenge for the Department is to devise practical and cost efficient fire regimes[7] that conserve biodiversity at agreed spatial and temporal scales, and minimise the adverse impact of wildfires on social, economic and conservation values.

This management plan provides the strategic framework that the Department will use to accommodate the requirements of ecological fire regimes and strategic protection from wildfire for the parks. Over the life of this plan, increasing scientific knowledge about the fire ecology of key fire sensitive flora and fauna as well as habitats will enable the Department to continue to develop appropriate fire regimes that ensure the protection of natural values as well as human life and community assets.

Fire History

Pre-European Settlement

Evidence of frequent fires has been documented dating to 2.5 million years in the south-west of Western Australia, indicating that fire has been a major evolutionary influence since at least that time (Dodson and Lu 2000, Dodson and Ramrath 2001, Hassell and Dodson 2003), and maybe as early as the mid Miocene, approximately 15 million years ago. The former date coincides with a major climatic change from subtropical to Mediterranean (i.e. warm/hot summers, summer droughts and cool winters), which is thought to have led to an associated increase in fire, as evidenced by charcoal in sedimentary deposits. Rainforest species characteristic of the subtropical climate of the Tertiary period (approximately 65 to 1.5 million years ago) were replaced by species characterised by scleromorphy, lignotubers, and large persistent woody fruits that were pre-adapted to nutrient deficient soils (Main 1996). These pre-adaptations were ideally suited to the drought and fire conditions that were to become more prevalent.

Fire, climate and vegetation have a long association on the Australian continent, one that pre-dates the arrival of humans by millions of years (Churchill 1968, Singh *et al*. 1981, Kershaw *et al*. 2002). The relatively recent arrival of Aboriginal people (probably within the last 60 000 years) would undoubtedly have led to changes in fire patterns and fire environment, regardless of the extent of 'firestick farming' by Aboriginal people (Hallam 1975, Kershaw 1986, Pyne 1991, Hassell and Dodson 2003). Fire intervals appeared to be much shorter in areas continually occupied by Aboriginal people in contrast to areas of the south-west that were historically unoccupied, such as the offshore islands and parts of the southern forests (Hassell and Dodson 2003). Fire regimes in areas frequented by Aboriginal people had a controlling effect on vegetation composition and structure, presumably evolving with the economic and ecological needs of the people (Hassell and Dodson 2003). Aboriginal people are likely to have utilised fire to their advantage, opening up dense vegetation for ease

[7] A 'fire regime' is a description of fire in terms of (i) fire frequency (how often it occurs on a site), (ii) fire intensity (how much heat energy is released), (iii) season (what time of year it occurs), (iv) scale (how big it is), and (v) spatial diversity (how patchy it is at both a landscape and local scale).

of access, encouraging prolific growth of forage to aid in the harvesting of game and for the protection of camping spots and areas of high resource value (Hallam 2002).

The co-existence of fire, people and of natural ecosystems that exhibit a variety of responses to different fire regimes has resulted in diverse patterns of response at the species, community and ecosystem level during the last 60 000 years.

Post Aboriginal arrival, the vegetation was burnt to varying degrees by a combination of natural and human-induced sources. Debate continues as to the extent of 'fire-stick' farming, and to what extent fire regimes where manipulated. For example, a review of Aboriginal usage of fire for the period 1696 to 1890 by Abbott (2003) proposes that in some coastal and forested areas of south-west Western Australia, Aboriginal people lit fires, principally in summer, that could be large and burn up to hundreds of hectares at three- to 5-year intervals. This would have varied depending on the flammability of sites (e.g. salt-laden coastal vegetation, steep south-facing slopes or riparian vegetation in higher rainfall areas). Fire history research utilising grass tree stem analysis has indicated that parts of the south-west jarrah forests may have been exposed to fire over a short rotation prior to European settlement (Ward *et al*. 2001). Further research (Burrows and Wardell-Johnson 2003, Enright *et al*. 2005, Hopper 2003, Miller *et al*. 2007, Wells *et al.* 2004) has questioned the validity of the grass tree stem analysis (and its widespread application) and highlighted the need for validation using alternative methods such as remote sensing and examination of fire occurrence records. Therefore, caution is still required before inferring from fire scars on individual trees, or colonial diaries, that Aboriginal firestick farming resulted in landscape-scale burning.

Post-European Settlement

Significant areas of the D'Entrecasteaux National Park have a long history of grazing by domestic stock and frequent burning by graziers, commencing in the late 1800s and continuing until areas became National Park. Bill Ipsen, who used to run cattle in the Yeagarup and Bolghinup areas, wrote that the cattlemen mimicked what they believed to have been the traditional burning methods of the Aboriginal people (Ipsen 2000):

> "*They lit fires at selected points on a four year rotation in order to provide good feed for their cattle and to prevent catastrophic fires from causing serious long-term damage to the forest. Essentially, in order to provide an abundance of new shoots for cattle feed, they used the same technique as the Aborigines who burnt patches of country in a circle in order to see and trap game.*"

Frequently burnt areas supported an open woodland structure with a grassy understorey, which has gradually changed under the more infrequent fire regimes introduced in the mid 1930s. Lew Scott, who had leases in the Lake Jasper area, said that the grasses had disappeared:

> "*…Because its not burnt, you have to burn to get the native grass. You burnt wherever you could … it was only a little fire, it never used to get up in the trees and burn the possums… Controlled burning first came in 1934-35, something like that. They weren't very severe with it but as time went on it got worse and worse, so it was impossible to burn … That's what killed the coast country."*

Irrespective of the burning patterns of Aboriginal people and the graziers of the past, environmental conditions have been altered to such a degree over the past 100 years that the application of historic fire regimes may no longer meet biodiversity conservation objectives (Hopper 2003). Factors such as private property, towns and cities, cleared land, weeds and contemporary conservation values contribute to these changing conditions. The south-west has been subjected to massive social and landscape changes over this period, and it would be inappropriate to try to restore traditional fire regimes in most instances. Rather, this knowledge should be used where appropriate to contribute to the development of ecologically-based fire regimes at a landscape scale.

Recent History

Limited prescribed burning by the Forests Department under controlled conditions to reduce forest fuels was adopted more widely after the severe wildfires that burnt throughout much of the south-west in 1961 (Armstrong 2004). The regular use of low intensity prescribed fire to reduce fuel loads, and consequently reduce wildfire severity (size and intensity), has continued to the current time. Broad scale prescribed burning became more widespread with the use of aircraft for aerial ignition in 1965 (van Didden 1983) and the first large-scale aerial burn occurred later that year on the Pingerup Plains within D'Entrecasteaux National Park. Within a few years the aerial burning program was operational in Western Australia, with more than 180 000 hectares of forest prescribed burnt in the spring of 1967.

The fire history (including both wildfire and prescribed burning) of the parks is detailed on Map 7 Fire History. This provides a useful starting point when planning for fire regimes within fire management units (see Section 22 *Fire* – Fire Management). Over the last decade, there have been a number of escapes from prescribed burns, but these have generally been contained by quick suppression action and represent only a small proportion of the area of the parks burnt by wildfire (Table 5 Wildfire Causes in the Parks 1989 to 2007).

Table 5: Wildfire Causes in the Parks 1989 to 2007

Fire Season	Causes					Total
	Lightning (no./area)	Human-induced			Unknown	
		Accidental (no./area)	Deliberate (no./area)	Escape from prescribed burns (no./area)		
2006-2007	1 (0.5 ha)	(1 (3.45 ha))*			1 (1 ha)	**2**
2005-2006				1 (3328 ha)		**1**
2004-2005	5 (5.4 ha)		2 (412.1 ha)			**7**
2003-2004			1 (2 ha)			**1**
2002-2003	5 (24 476 ha)	1 (16 ha)	1 (500 ha)			**7**
2001-2002	3 (7470 ha)		3 (29 ha)		1 (650 ha)	**7**
2000-2001						**0**
1999-2000		1 (2 ha)	3 (76 ha)	1(400 ha)		**5**
1998-1999		1 (160 ha)	1 (17 ha)			**2**
1997-1998				3 (4650 ha)		**3**
1996-1997						**0**
1995-1996		1 (1950 ha)		1 (140 ha)		**2**
1994-1995	1 (3 ha)					**1**
1993-1994	2 (19 520 ha)	1 (12 ha)	3 (729 ha)	1 (2040 ha)	1 (<1 ha)	**8**
1992-1993			3 (271 ha)		1 (<1 ha)	**4**
1991-1992	1 (<1 ha)		2 (<1 ha)	1 (3500 ha)		**4**
1990-1991	1 (400 ha)	1 (2 ha)	4 (4676 ha)	1 (80 ha)		**7**
1989-1990		2 (15 ha)	1 (31 ha)			**3**
Total	**19 (29.7%) 51 875.9 ha (68.6%)**	**8 (12.5%) 2157 ha (2.9%)**	**24 (37.5%) 6744.1 ha (8.9%)**	**9 (14.1%) 14 168 ha (18.7%)**	**4 (6.2%) 653 ha (<1%)**	**64 75598 ha**

* Data in brackets indicates a fire with an ignition point <500 metres outside of the parks. Fire boundary area may therefore include some areas within the parks. However, this fire has not been included in the totals for this table.

In the period 1989 to 2007, 64 wildfires were reported in the parks. Of these, 41 were human-induced (criminal or accidental arson, or escapes from Departmental prescribed burns), which burnt a total of 23 039 hectares. Nineteen wildfires attributed to natural causes (lightning strikes) burnt a total of 51 876 hectares. Table 5 details the wildfires according to either natural or human-induced causes.

There were three wildfires that left the parks and burnt adjacent private properties in the period 2000 to 2004. The two largest were 210 hectares caused by lightning in 2001/2002 and 153 hectares caused by arson in 2002/2003. The third was an 8 hectare wildfire in 2002/2003 caused by an escape from a non-Departmental burn.

The high number of deliberately lit fires (arson) is of particular concern and if not contained quickly and effectively they have the potential to cause large wildfires affecting the values of the parks and adjacent areas. Education is an important part of dealing with arson, and the Department will seek to co-operate with agencies such as the Fire and Emergency Services and Police with education and enforcement to combat arson affecting the conservation estate.

Fire Ecology

Fire is a natural environmental factor that can have both destructive and beneficial effects. Fire ecology is the study of the interaction between fire, habitats, flora and fauna. Knowledge of the impacts of these interactions is

integral in not only protecting biodiversity, but also human life and community assets. Studies within the field of fire ecology can examine changing species assemblages, species diversity, vegetation composition and structure and habitat characteristics in response to factors such as time since last fire, fire season, fire interval and/or fire intensity. In addition, ways in which fire can influence ecosystem processes can also be studied. However, knowledge of local fire ecology within the parks is incomplete, so fire management within the parks (see Section 22 *Fire* – Fire Management) will continue to adapt as new scientific knowledge and management experience is obtained.

Flora and Fauna Response to Fire

Flammable vegetation and a Mediterranean-type climate with hot dry summers and cool wet winters, ensures that fire will continue to shape the environment within the parks. The flora of the parks, in particular, possesses a variety of traits that enable persistence in this fire-prone environment (Gill *et al.* 1981, Burrows and Wardell-Johnson 2003), including:

- soil protection of buried buds;
- bark protection of aerial buds;
- bud survival and sprouting;
- fire stimulated flowering;
- fire triggered opening of fruits; and
- on-plant seed storage.

For many species, reproduction and regeneration are cued or enhanced by fire and for some plant communities, is necessary for the maintenance of floristic and structural diversity (Burrows and Wardell-Johnson 2003). However, no single fire regime is optimal for all species and some species are sensitive to fire, or particular fire regimes (Table 6).

Table 6: Species Most Vulnerable to Fire or Extreme Fire Regimes

Fauna	Flora
Require specialised habitats	Killed by fire
Have low fecundity	Have short life spans
Exist as discrete dispersed populations	Long juvenile periods
Have low dispersal capacity	Canopy-stored seed
Require mature late successional state vegetation	Regenerate only from seed (‘obligate’ seeders)
Prone to predation	

source: Burrows and Friend (1998) and Burrows and Wardell-Johnson (2003)

Typically, these species are confined to more mesic or less flammable environments such as riparian zones, wetlands and granite outcrops where fire is less frequent (see Section 18 *Species and Communities of Conservation Significance*). However, even fire sensitive species may require fire at some stage for their regeneration, except perhaps peat wetlands (Burrows and Wardell-Johnson 2003). Generally plant communities in the drier, upland areas of the forest are burnt more frequently and display a greater resilience to fire. Extreme regimes, such as sustained, high frequency burning or infrequent but large, intense fire regimes, are more likely to be the most damaging to biodiversity values than more moderate, intermediate regimes (Burrows and Friend 1998, Burrows and Wardell-Johnson 2003).

Fire sensitive species in the parks include fauna such as the threatened quokka and reintroduced western bristlebird and flora such as the rare Northcliffe kennedia and granite banksia, as well as communities such as the *Reedia* swamps which are a proposed threatened ecological community (see Section 18 *Species and Communities of Conservation Significance*).

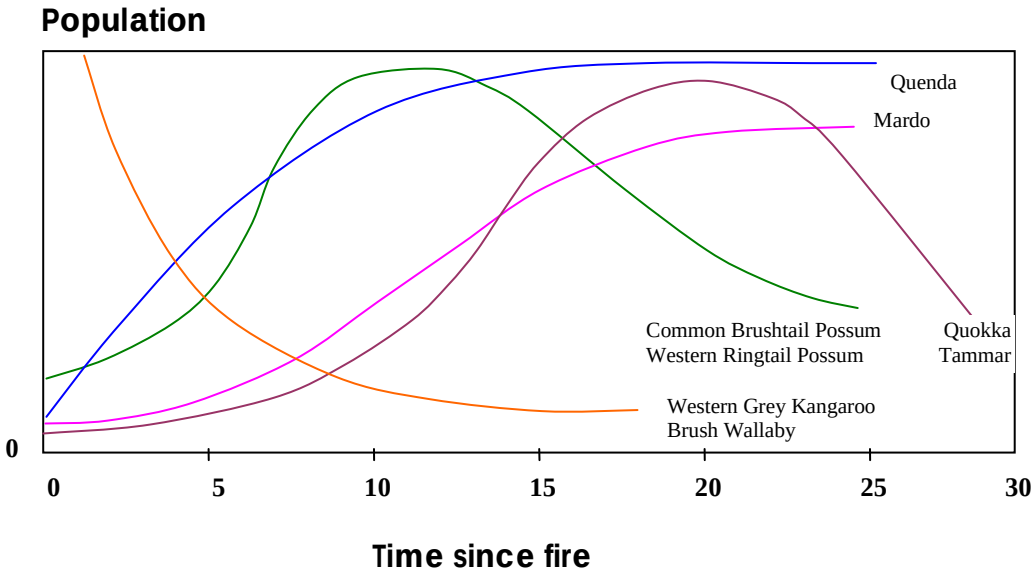
The rate at which plant species are able to regenerate and produce adequate seed for regeneration after fire needs to be considered in determining the minimum prescribed frequency of burning. For example, Burrows and Friend (1998) showed that the majority of understorey plants on upland high rainfall jarrah forest sites flower within 3 years of fire. Of the 17 species known to have juvenile periods longer than 3 years within the south-west, 10 of these occur within the parks (Burrows *et al*. 2008). On low lying sites such as gullies and broad valley floors, some species may take six to 7 years to flower after fire. This has implications for prescribed burning—on the basis of current knowledge, doubling the juvenile period (which is defined as the time when at least 50% of the population has reached flowering age), of the slowest maturing fire sensitive species to allow for the replenishment of seed banks, provides a minimum interval between fires that are lethal to adults of that

species (see Section 22 Fire – Fire Management). Populations will survive more frequent fires provided that the intensity of the fires is insufficient to kill the adult plants (Burrows and Wardell-Johnson 2003).

Wet sclerophyll forests, such as karri, usually produce important habitats for relictual taxa as moist conditions restrict the period where the vegetation is susceptible to fire for only two to three months annually (see Section 18 *Species and Communities of Conservation Significance*). In contrast, jarrah/marri forest and shrublands are susceptible to fire for at least twice that period.

Research indicates that the immediate impact of fire on fauna is directly proportional to the scale of the fire, the intensity of the fire, the patchiness of the fire and the interval between fires (Abbott and Burrows 2003, Friend 1995, Burrows and Friend 1998, Friend 1999). This impact will be modified by the presence of predators where displaced species have to travel across open ground to find suitable habitat (Friend 1999).

For mammals at least, the response post-fire is reasonably predictable and consistent (Figure 12) and could be considered in terms of their life history categories based on shelter, food and breeding requirements, and the scale, intensity and patchiness of the fire (Burrows *et al*. 1999, Friend 1999). Responses are largely dependent on vegetation structure and floristic composition, which simplifies the prediction of fire impacts (Friend 1999). Friend also noted that the post-fire response patterns of reptiles was less predictable, and that the response of amphibians was extremely variable.



(source: N. Burrows pers. comm. 2003)

Figure 12: Idealised Relationship between the Abundance of Mammal Species and Time Since Fire

The Department is developing a 'Fauna Distribution Information System' that is a tool designed to predict the likely presence of fauna in particular habitats and to aid the fire manager in developing fire regimes and burn prescriptions that incorporate the needs of fauna. However, this is an ongoing project that will require ongoing refinement.

The fire response patterns of flora in the south-west are currently being collated into the Department's 'Fireresponse' database. Information on post-fire regeneration strategies, time to first flowering, time to peak flowering, time to flowering decline, and disease sensitivity of approximately 1500 species have been collated into this database (Burrows *et al.* in press). Knowledge of the distribution and habitat preferences of fire sensitive flora species within the parks will be also used to develop and implement fire regimes.

Also sensitive vegetation complexes and habitats such as wetlands, coastal woodlands, granite outcrops and old growth forests need to be identified so that appropriate fire regimes can be put in place. Fire ecology information must be combined with other considerations such as public risk (including the safety of visitors and fire fighters), and protection of community assets (including recreation sites and plantations), and will be used as a basis in determining the frequency, season and spatial arrangement of prescribed burning (see Section 22 *Fire* – Fire Management).

Coastal Woodlands

There has been no detailed fire research on the plant communities in the coastal woodlands to determine the effect of various fire regimes. Observations following summer wildfires suggest that high-intensity fires in woodlands of yate and peppermint usually kill large mature trees and lead to the development of dense understorey thickets of peppermint and wattle. Large areas of woodland between the Donnelly River and Black Point were converted to dense thickets following severe summer fires in 1988 (Bradshaw 2000). Further research and adaptive management experimentation is required to determine the most appropriate fire regime for these coastal woodlands. Based on best available knowledge, a Fire Management Guideline has been produced by the Department for the South West Coastal Plain (DEC 2007f), which includes objectives and strategies for the heaths and woodlands of the coastal landscapes between Augusta and Denmark.

Savannah Grasslands

Extensive grasslands in D'Entrecasteaux National Park were most likely a product of the traditional Aboriginal burning practices prior to European settlement and then maintained by the pastoralists and the grazing of cattle along the coast (see Section 22 *Fire* – Fire History). In 1852, the surveyor AC Gregory reported 80,000 acres (320 square kilometres) of grassland principally near the mouths of the Donnelly and the Gordon (Gardner) rivers (in his letter to the Colonial Secretary 9th July 1852). This was before the area was subjected to cattle grazing. Chief Superintending Surveyor Frederick Slade Brockman reported 60,000 acres (240 square kilometres) of "first class" grassland over much of the same area in 1904 (in his report to the Surveyor General). Brockman and Gregory give different distribution of grasses for the area between the Gardner River and the Broke Inlet.

In order for these grasslands to be maintained, or even recreated in many instances, a specific fire regime would need to be implemented. A Fire Management Guideline has been produced by the Department for the South West Coastal Plain, which includes objectives and strategies for the grasslands of the coastal landscapes between Augusta and Denmark.

Wetlands

Inappropriate fire regimes, coupled with the impacts of climate change, can have detrimental impacts on some wetlands (see Section 18 *Species and Communities of Conservation Significance*). Over the past 30 years, winter rainfall in the south-west has declined by 10 to 20% (Indian Ocean Climate Initiative 2002). This has had the effect of drying out the organic substrates of some wetlands and predisposing them to destruction by fire. Indicators of fire impacts in organic rich wetlands include burnt edges, exposed roots, remnant pedestals and cracked soil. Fire in a wetland can both spatially and temporally change the aquatic habitat—many of these changes are likely to be short term, while others could be long term. These impacts include removing shade and organic matter provided by the fringing vegetation, reducing ground litter and consequently the organic input into the system, increasing exposure to light and raising the temperature of the water body (Horwitz *et al.* 2003). However there is a lack of knowledge on the long-term impacts of fire in these areas.

The community has raised the potential issue of fire and the subsequent formation of acid sulphate soils across the waterlogged areas of the parks (see section 15 *Catchment Protection* and 18 *Species and Communities of Conservation Significance*). Fire, by removing the covering organic soil layer, can potentially accelerate the oxidation of iron sulphides in wetlands (particularly where associated with shallow peat materials) and generate large quantities of sulphuric acid (B. Degens pers. comm. 2004). There have not been any documented instances to date of this occurring in the wetlands of the south coast, however with the drying climate this may be an emerging risk.

Reed and rush habitats within the wetlands also provide important habitats for a large diversity of species and are a significant breeding habitat for a number of fauna species including waterbirds, crustaceans and frogs.

Identification and mapping of the organic soil complexes within the parks and ongoing research of fire impacts will be important in developing appropriate fire regimes for these systems (see Section 15 *Catchment Protection* and Section 44 *Research and Monitoring*). Fire Management Guidelines have been produced by the Department for organic-rich soils (peatlands) (DEC 2007c) and for habitat protection (birds) within reeds and rushes (DEC 2007d), both of which includes objectives and strategies applicable to the wetlands within the parks.

Granite Outcrops

The fire frequency of granite outcrops is lower than the surrounding landscape because the vegetation is often low in stature and biomass, and fragmented by areas of sheet rock or boulders that provide a discontinuous distribution of flammable material that limits fire spread under mild/moderate conditions (Hopper 2000). Granite outcrops, such as Mt Chudalup and Mt Pingerup in D'Entrecasteaux National Park, therefore act as refuges for fire-sensitive species. These areas have several populations of rare and priority flora as well as endemic, relictual and disjunct species that may be vulnerable to frequent fire (see Section 18 *Species and Communities of Conservation Significance*). There are also species and communities that are intolerant to fire and they include non-vascular flora such as rock lichens, moss swards and *Boyra* meadows. These are readily killed by fire and do not appear to require fire for their persistence. However, some species on granite outcrops may require infrequent fire under certain conditions to regenerate. Hopper (2000) found a high number of fire-sensitive obligate seeders (77%) regenerating post-fire on a granite outcrop in the wheatbelt, and suggested:

> *"…intervals between fires measured in decades are likely to be required to ensure an adequate seed bank is available and local extinction is averted".*

This may be the case with flora species associated with granite outcrops within the parks also, and requires further investigation. Occasional (every 15 to 45 years), patchy and low to moderate intensity fires may be necessary for the maintenance of floristic and structural diversity of heathlands, shrublands and woodlands on the granite outcrops. A Fire Management Guideline has been produced by the Department for the granite outcrops within the Warren and Jarrah Forest bioregions of the south-west (DEC 2007e), which includes objectives and strategies applicable for the granite outcrops of the parks.

Old Growth Forests

Seventy five percent of the jarrah and karri forest within the parks can be considered old growth (see Section 18 *Species and Communities of Conservation Significance*). Old growth forest provide important habitat and potential habitat for hollow nesters such as the brush-tailed possum and the threatened Baudin's (long-billed) and forest red-tailed black cockatoos, all of which breed in older trees. Whereas old growth forest is classified as such after 120 years, the average age of nesting trees for the cockatoos is 233 years (Water Corporation and WA Museum 2003).

The intent of this management plan is to protect this area of old growth forest and to allow it to continue to mature which includes appropriate fire management with regard to fire regime and wildfire suppression/prevention. It is important that intense wildfire is avoided, however some variability in fire intensity is desirable because fire also has a role to play in the formation of hollows.

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 May each year. Dry periods during the cooler months may also provide opportunities for fire spread, particularly in drought years.

Fire behaviour is affected by wind speed, topography, fuel dryness, the amount and type of fuel, air temperature and relative humidity (Sneeuwjagt and Peet 1985). Different vegetation types accumulate fuel at different rates and have different fire behaviour characteristics. Within each major fuel type there is a threshold weight of dry fuel above which fire behaviour in summer conditions may be severe and too dangerous to be suppressed by direct fire suppression methods, even on days of moderate fire danger.

The vegetation types in the parks are karri forest (pure and mixed), even-aged jarrah and karri regrowth, jarrah/marri forest, peppermint woodland and coastal and seasonally inundated heathland/wetland communities. These differing vegetation types have different fire behaviours associated with them and unique considerations for fire suppression activities. For example, the wetlands are generally very difficult areas in which to suppress fires because of their high flammability and poor accessibility. This often results in very high rates of fire spread and very low rates of fireline production (the time taken to produce a mineral earth firebreak).

Fire Management

The influence of fire in shaping biodiversity has been clearly demonstrated. However, in addition to using fire to manage biodiversity, the Department must also consider the risk to human life and damage to other values (e.g. property and forest products). It does this in a hierarchical manner—the Department first considers the requirements to achieve biodiversity conservation objectives, and then undertakes a systematic wildfire threat

analysis to determine the level of threat posed by wildfire to assets within and adjacent to the parks, such as life, property, community assets and other values. Fire management can then be modified, if necessary, so that the risk or threat of wildfire can be adequately dealt with in addition to achieving biodiversity objectives. Although by default, regimes for biodiversity conservation may achieve wholly or in part, strategic asset protection objectives as well. However, where life and community asset protection coincides with high biodiversity values, and it is not possible to achieve both objectives, the priority will be given to the protection of life and community assets of high value (such as Windy Harbour settlement, private enclave infrastructure and/or community lifelines such as water and main power transmission lines).

Fire planning is guided by 12 scientific principles, which are included as Appendix 9 (Burrows and Friend 1998, Fire Ecology Working Group 1999, Burrows and Abbott 2003). Departmental policy on fire management has been updated in the Policy Statement No. 19 *Fire Management,* which was made available for public comment in February 2004.

Fire management in the parks will utilise the existing track network but also seasonal weather conditions, natural fire barriers and landscape variation in fuel moisture levels. For example, fuel moisture differentials will be used to attempt to prevent fire from burning into wetland areas. Roads and tracks will be maintained according to Department standards to ensure safe access for fire fighting vehicles and permit effective fire containment. In many of these areas, internal tracks are used for management purposes only and should be closed to the public at all times with physical barriers in years between burns.

Fire management will require soil-disturbing activities such as fire break construction and maintenance. Baring the earth and moving soil can result in the introduction or spread of *P. cinnamomi* (see Section 21 *Diseases*). Earthworks can also accelerate erosion and alter the hydrology of an area by impeding drainage, resulting in the intensification of disease expression in some vegetation and landform types. Consequently, fire management activities must be planned and undertaken with strict erosion control and *P. cinnamomi* management measures in place. Inappropriate earthworks may cause more damage in the long term compared to a large fire. It may be appropriate to identify areas where management of fire will not include heavy machinery. Where temporary roads, firebreaks or firelines are constructed during fire suppression activities, these areas should be rehabilitated as soon as practicable (see Section 37 *Rehabilitation*).

In order to complement fire management within the parks, the Department will seek the co-operation of adjoining land managers to ensure complementary fire management on adjacent lands. In addition, ongoing liaison in regard to fire protection and prevention will occur with agencies controlling land adjoining the parks, such as Main Roads Western Australia, Department of Regional Development and Lands, Department of Water, the shires of Nannup and Manjimup and organisations with fire suppression responsibilities, such as the Fire and Emergency Services Authority of Western Australia.

The Department through the Master Burn Plan planning process, prepares a 3-year indicative fire program that incorporates both conservation and protection objectives, and is reviewed on an annual basis. This also includes the preparation of prescribed burning plans and the completion of a pre-burn checklist that considers all potential environmental impacts, especially the need to control diseases, and minimise impacts on landscape and visual resources. All burns carried out in the parks by external agencies, such as local brigades, are carried out according to the prepared strategies of the Department.

Although the specific details of the Department's fire management activities for the parks are not included in this management plan, the Master Burn Plan is made available for public comment annually. The consultation process usually involves the District and Regional Fire Co-ordinators meeting with interested community groups and local authorities to discuss the proposed Master Burn Plan. The Conservation Commission, through their assessment function, will periodically examine the Department's performance against Master Burn Plans. A copy of the fire program is also available at each Department District office and on the department's website.

Scales of Fire Planning

Managing fire for biodiversity conservation objectives requires consideration at four scales:

- *bioregional scale* – these are the bioregions defined in Section 11 *Biogeography*;
- *landscape scale* (30 000 to 100 000 hectares) – these consist of landscape scale units which are a mosaic of local ecosystems and landforms repeated in a similar form across a kilometres-wide area. In the south-west these are based on amalgamations of vegetation complexes (see Section 18 *Species and Communities of Conservation Significance* and Appendix 7) and referred to as Landscape Conservation Units;

- *fire management scale* (500 to 5000 hectares) – a fire management unit is an element within the landscape, and may comprise a sub-catchment or some other logical mapped management boundary and referred to as Logical Burn Units; and
- *vegetation complex scale* – these consist of areas within a fire management unit that may be subjected to different burn frequencies or intensities (e.g. uplands versus wetland complexes).

It is the last three levels that are of most interest in this management plan. Havel and Mattiske (2000) identified 26 Landscape Conservation Units in the south-west, based on amalgamations according to their burning characteristics of the 315 vegetation complexes (see Section 16 *Native Plants and Plant Communities*). Within these Landscape Conservation Units, the concept is to provide a mosaic of different burn histories. The parks incorporate parts of nine Landscape Conservation Units (however, the parks only include very minor portions of four of these) (Map 8 Fire Landscape Conservation Units).

The concept for fire management on Department-managed lands is to provide a spatial and temporal diversity of burnt and unburnt areas by varying the season of burn, frequency and intensity of fire based on vital attributes and life histories of fire sensitive taxa and vegetation communities (See Section 22 *Fire* – Fire Ecology). The Department is developing this concept with pilot studies across the south-west. The pilot studies involve the collection and organisation of data on fire history, the fire regime requirements of the biota, and the strategic asset protection requirements. This information is then manipulated utilising computer modelling tools to assist in analysing the implications of different fire regimes at the Landscape Conservation Unit scale and at the local or fire management scale (Logical Burn Unit).

Managing Fire Based on Species and Communities of Conservation Significance

Threatened flora and fauna and threatened ecological communities are protected by State and Commonwealth legislation, which imposes requirements in relation to how fire management activities are conducted, for example, burning is considered to be 'taking' under the Wildlife Conservation Act and Ministerial approval must first be obtained before known areas containing rare flora can be burnt.

It is appropriate to devise and implement fire regimes specific to particular species and/or communities of conservation significance (see sections 18 *Species and Communities of Conservation Significance* and 22 *Fire* – Fire Ecology) based on their known vital attributes[8] to ensure their persistence. For example, the Department has developed a fire management guideline[9] for the threatened quokka (DEC 2007g) that describes how fire is applied to a Logical Burn Unit that contain this species (or its riparian habitats that are in the intermediate to late seral post-fire stages) to protect extant species and/or suitable habitat, or to regenerate suitable habitat that begins to senesce 25 to 35 years after fire.

The wetlands have a specific fire regime to maintain habitat and biodiversity. The Department's Fire Management Guideline for organic rich soils (peatlands) (DEC 2007c) states that the fire management objectives for organic soils is to specifically protect organic soil habitats from wildfire and avoid ignition of organic solids as a result of prescribed fire operations. Specific fire management strategies for peatlands include:

- no fires should be lit or allowed to burn, within or adjacent to peatlands, under conditions that are sufficiently dry to allow the ignition and burning of large volumes of peat. Prescribed burns conducted in areas in the vicinity of peatlands should be undertaken in moist spring conditions when the peat is not flammable due to its high moisture content. Where practical, it is prudent to ensure that the peat is moist and unlikely to burn;
- collection and collation of information on the location, extent and composition of peatland sediments, and their associated hydrology is required. Similarly, information is required on the stages of flammability of peatlands throughout the year to allow identification of wetlands at high risk of combustion. The identification of substrates constituting an acid sulphate hazard is also required;
- fire vulnerable peatlands should be protected by perimeter buffer zones of higher frequency burning that provide protection from unplanned high intensity fire; and
- fire retardant chemicals and fire suppressant foam can be toxic to aquatic organisms including algae, aquatic invertebrates and fish (Horwitz *et al*. 2003). It is recommended that this fire suppression tactic should only be applied to peatlands after careful consideration of the benefits and dis-benefits to peatlands habitats and their species.

[8] Vital attributes are critical physical and longevity characteristics of species, which determine their ability to survive different fire intervals. These attributes consist of: method of persistence, conditions for establishment and timing of life stages.
[9] The Department has prepared several fire management guidelines for a number of species and communities with the proviso that compromises may be necessary to optimise the achievement of overlapping objectives where logical burn units involve a variety of species and communities with fire management guidelines.

Information on the relationship of fire and peatlands in Western Australia is limited. Monitoring of the peatland species may be necessary for their protection and the determination of recovery rates. Any new knowledge relating to fire management in the peatlands that comes from credible scientific research or the monitoring of burn operations, fire suppression of post-fire recovery should be integrated into future management (i.e. adaptive management).
In addition, the Fire Management Guideline for habitat protection (birds) within reeds and rushes (DEC 2007d) contains guidelines for protecting reed/rush habitats within wetlands. Four species of waterbirds have been identified by the Department as requiring consideration when planning prescribed burning operations amongst reeds and rush habitats, including the rufous night heron (*Nycticorax caledonicus*) which occurs in D'Entrecasteaux National Park, a widespread but uncommon bird in the south-west.

The Department's Fire Management Guideline for granite outcrops states that the fire management objectives are to specifically:

- minimise the risk of damaging (high intensity) wildfire impacting on granite outcrops;
- protect fire intolerant species and communities (e.g. rock lichen, moss swards, *Boyra* meadows) from damage by fire (including flaming combustion, radiated and convected heat);
- protect fire regime specific vegetation communities (e.g. heaths, shrublands and woodlands) from fire intervals of less than 15 years; and
- maintain structural and floristic diversity of fire maintained communities by introducing low to moderate intensity fire at intervals of greater than 15 years without damaging or degrading fire intolerant communities and species.

Managing fire and the flammability of the vegetation in the surrounding landscape is crucial for protecting the ecological integrity and function of granite outcrops. The regular introduction of low intensity fire in the surrounding more flammable and fire tolerant vegetation types in the landscape when outcrop vegetation is unlikely to burn, is a key strategy for protecting outcrop communities from damaging wildfires and to allow them to act as fire refuges.

Specific fire management strategies for granite outcrops and surrounding areas (also see sections following on Managing Fire Based on Key Fire Response Species and Habitats as granite outcrops are also considered key response habitats) include:

- recurrent introduction of low intensity, spring/late autumn, patchy fire into the landscape surrounding granite outcrops at burn intervals twice the time to first flowering of the slowest maturing fire sensitive species in forested ecosystems (usually 5 to 8 years);
- less frequent (15 to 25 years) introduction of low to moderate intensity fire late summer/early autumn into the landscape under conditions such that fire maintained outcrop communities are likely to burn without damaging fire intolerant communities;
- not deliberately lighting granite outcrops during prescribed burning or fire suppression operations; and
- not permitting physical disturbance of vegetation and soils, including firebreak construction and roading, or the use of chemical retardants and surfactants because of the risk of damaging plant communities, introducing disease, and/or activating soil erosion.

Monitoring of the outcomes of the fire management strategies for granite outcrops and surrounding landscapes will be important to assess whether the fire management objectives are being achieved as well as to allow adaptive management.

It is important that intense wildfire is avoided for old growth forests to protect the mature trees and the hollows. Some areas may also be used for fauna translocation and may be on longer burn rotations. However, prescribed fire is necessary for both protection (fuel reduction) and biodiversity outcomes as fire has an important role in regeneration of the understorey. Specific fire management strategies in the Department's Fire Management Guideline for black cockatoos (DEC 2007h) (which use the old growth forest in the parks) include frequent low-intensity patchy burns resulting in a mosaic of fuel ages, including recently burnt and long unburnt and occasional moderate intensity burns.

Where fire ecology interactions of species or communities of conservation significance are not well understood, they will be protected from fire regimes that are known to or are likely to cause a decline, and no discrete/isolated or sole population should be impacted upon by a single fire event. Inappropriate fire regimes may include long periods of fire exclusion, large and intense wildfires, and sustained frequent burning. Where no fire ecology

information exists for a threatened species, carefully monitored experimental burning might be considered. Often, prescriptions for threatened species in particular, are developed as part of a recovery plan.

Adopting an approach based on a conservation significant species is especially legitimate when the species is also an umbrella species, which means managing for this species is most likely to accommodate the needs of other species in the ecosystem. In this context, an umbrella species is generally a fire regime sensitive species, for example an obligate seeder with a relatively long juvenile period such as mohan (*Melaleuca viminea*), river banksia (*Banksia seminuda*) or the feather-leaved banksia (*B. brownii*). So in any plant community, the idea is to identify the obligate seeder that has the longest juvenile period and then it can be used as an "umbrella" species. For fauna, it is also the species that require a specific fire regime or require long unburnt or late seral stage vegetation. Examples include tammar wallaby (infrequent fire), quokka (mix of recent and long unburnt), honey possum (prefers relatively long unburnt) and the western ringtail possum (very low intensity fire). However, developing fire management based on single species ecology needs to be closely evaluated and monitored for possible adverse impacts on other species and communities.

Managing Fire Based on Key Fire Response Species and Habitats

Within each Landscape Conservation Unit (or Logical Burn Unit), an ecological fire regime is devised that accommodates the most fire prone (least sensitive) vegetation complex and protects the most fire sensitive areas. This will typically require consideration of two habitat types, although this may vary depending on the fire response of flora and fauna species in the area:

- the drier, more flammable fire regime tolerant (fire prone) habitats such as upland areas, which generally contain flora species that are mostly resprouters and have relatively short juvenile periods and fauna that do not require mature or medium to late successional state vegetation; and
- fire regime specific (fire sensitive) habitats such as wetlands, granite outcrops and valley floors which generally contain flora with relatively long juvenile periods and fauna that prefer mature, medium to late successional stages of vegetation.

A typical fire regime for a Logical Burn Unit incorporating these two habitat types is shown in Figure 13. This regime will provide greater protection from wildfire for the less frequently burnt fire regime specific habitat by the more frequently burnt fire regime tolerant habitat.

Knowledge of the juvenile period, longevity and regeneration and establishment requirements of key fire response plant species are used to establish minimum and maximum fire intervals and the season and intensity of fire. Knowledge of the habitat requirements (seral stage) and dispersal capacity of key fire response fauna species also assists with determining fire interval and spatial scale or patchiness. Having devised fire regimes based on habitat types and plant attributes, these regimes can then be cross-checked for their efficacy against co-occurring key fire response fauna species and amendments can be made if necessary. There are gaps in the knowledge of vital attributes of many species. However, consistent with an adaptive management approach, knowledge will be gained and fire management improved by on-going research (see Section 22 *Fire* – Fire Research) and as already mentioned, by monitoring of operational programs.

Where there is the need to protect human life and property or high value assets this regime may be modified. Also if there is a wildfire event, then the regime would take this into account and recommence at Burn 1.

Managing Fire for Particular Vegetation Outcomes

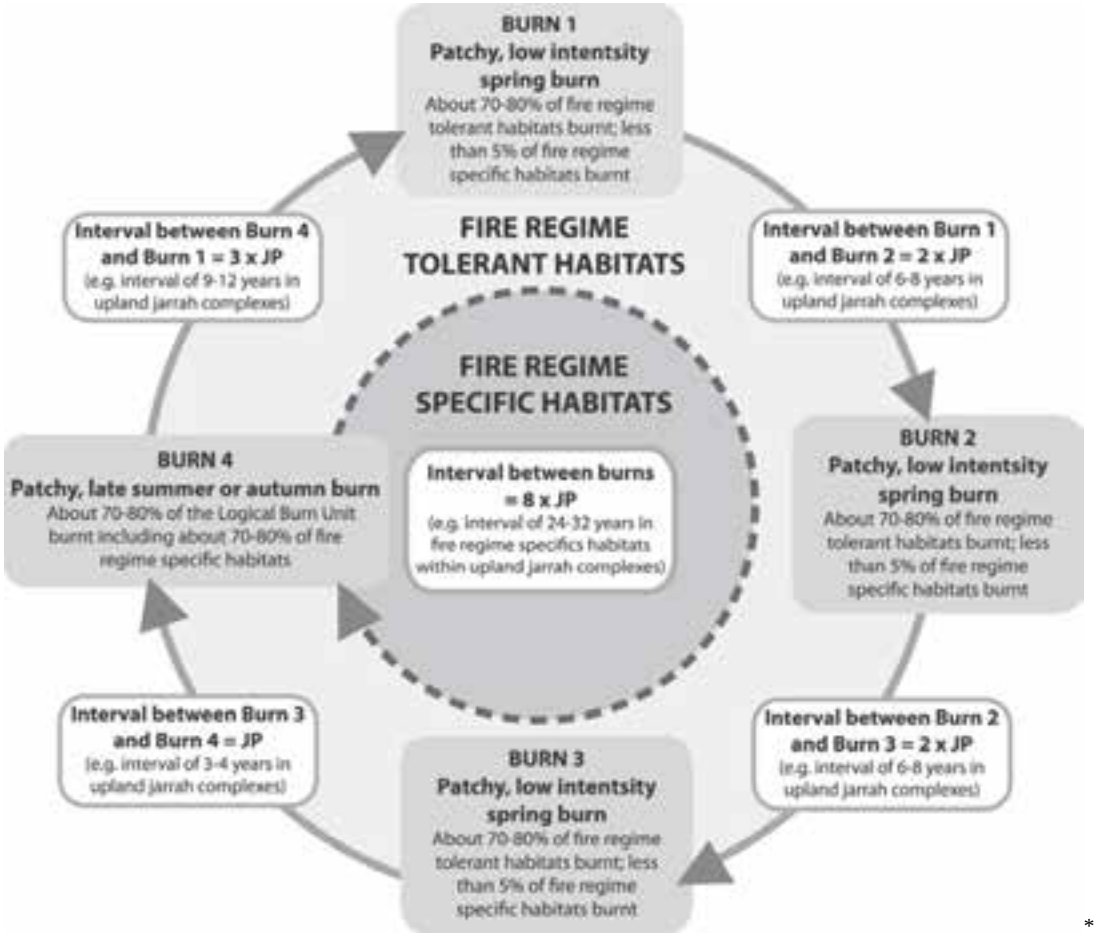
The coastal woodlands and savannah grasslands have not been identified as conservation significant in themselves. However they have been identified as requiring particular fire regimes to promote and maintain these structural components within the parks and also as areas for further research and adaptive management experimentation.

The Fire Management Guideline for the South West Coastal Plain (DEC 2007f) which includes the coastal woodlands and grasslands of the parks recommends that fire is introduced relatively frequently under mild conditions and at times of the year when fuel moisture differentials do not dispose fire intolerant species and communities to combustion. The introduction of fire will be aimed at establishing and maintaining a fire-induced mosaic of fuel ages across the flammable landscape.

An operational trial in D'Entrecasteaux National Park east of Windy Harbour has commenced which involves frequent application of fire to create a coarse grain mosaic or patchwork of burnt and unburnt areas with a particular focus on sustaining key vegetation complexes such as the Warren River cedar, mature peppermint woodlands and the open grasslands.

Managing Fire for Diverse Post-fire (Seral) Stages

Maintaining a diversity of post-fire fuel ages, seral stages or habitats through space and time, is fundamentally important for ecosystem health and enhances biodiversity by providing diverse habitats. The process of post-fire vegetation change is continuous, and the rate of change will depend on the severity of disturbance events, such as fire, and local soil and climatic conditions.



* JP is the juvenile period of the slowest maturing fire sensitive understorey species.

Figure 13: Example of an Ecological Fire Regime for Managing Ecosystems based on Vital Attributes

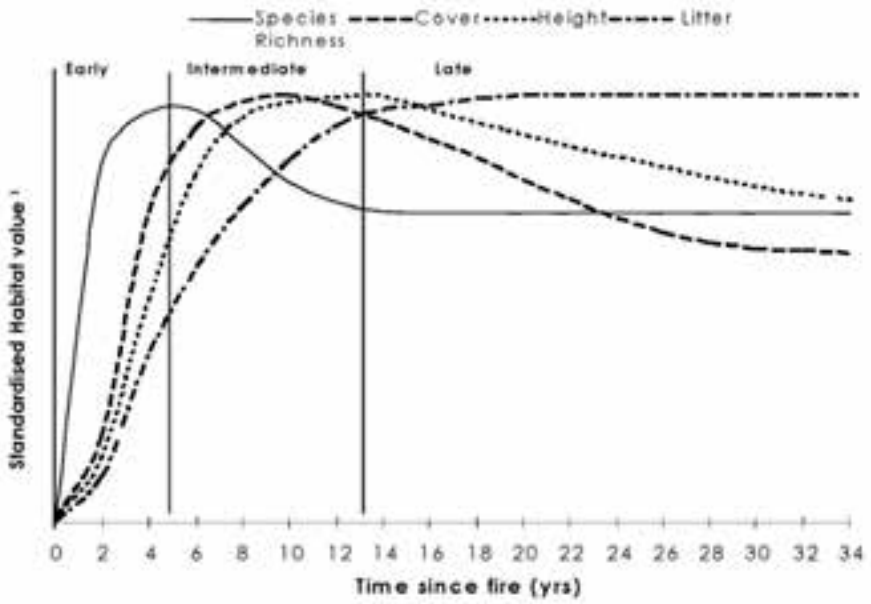
(adapted from Burrows and Friend 1998, and Burrows 2008)

There are at least three broad post-fire seral stages that can be recognised – early, intermediate and late, based on the rate of change of the understorey vegetation structure and floristics. Post-fire seral stages are based on the understorey as forest overstorey species of the south-west are very resilient to fire and so 'stand replacement' fires, or fires that kill the overstorey, are relatively rare and therefore most changes in the seral stage occurs in the understorey vegetation. Each seral stage is characterised by a combination of species richness and vegetation cover, height and amount of litter (Figure 14).

The transition from one seral stage to the next is somewhat arbitrary, but is based on the vital attributes of a species and can be estimated using the juvenile period[10] (JP) of the slowest maturing fire sensitive plant species within the major vegetation type (Burrows 2008). In a low rainfall upland jarrah forest for example, the juvenile period of the key fire response species is about 4 years, which is similar to the period recognised as the 'early'

[10] In the south-west ecosystems, there is a strong relationship between rainfall, site productivity and juvenile period (Hopkins 1985, Burrows 2008), so juvenile period is a useful indicator of the post-fire rate of change of floristic composition and structure for a given ecological unit.

seral stage for that ecological unit. The 'intermediate' seral stage for the same ecosystem is from about 4 to 12 years post-fire, or from JP to 3JP and the 'late' seral stage is from about 12 years to about 30+ years, or from 3JP to about 8JP.



[1] = Standardised habitat value – the graphs are standardised from a zero value (minimum) to a peak value (maximum) for each characteristic. (source: Burrows 2008)

Figure 14: Relationship between Changes in Vegetation Properties and Time Since Fire

In any one landscape, all of these functional habitat characteristics and seral stages are desired. The question of the relative proportion of each seral stage within the landscape may best be determined by examining recent approaches to ecosystem and fire management (Weir *et al*. 2000, Tolhurst and Friend 2001). These approaches aim to produce disturbance-induced mosaic patterns across the flammable parts of the general landscape, which are thought to resemble those produced by natural disturbance events. These patterns are based on achieving a spread of recently burnt through to long unburnt fuel (understorey) ages at all times across a Landscape Conservation Unit, as indicated by a negative exponential distribution as shown in Figure 15.

The proportion of each seral stage in the landscape is influenced by the fire frequency, with older seral stages less abundant than young because they must remain unburnt for much longer periods of time. The transition between seral stages is determined from the relationship of seral stages in Figure 14 and vegetation age in Figure 15. This relationship will determine what proportion of the landscape the Department aims to have at the various seral stages, and will guide decisions on where, how much and when to apply the various fire regimes.

On a finer scale, significant habitats within the landscape (such as granite outcrops, savannah grasslands, coastal woodlands, wetlands including peat swamps and old growth forests as mentioned previously) may have a different fuel age distribution to Figure 15. Noting that in the case of old growth forest, and forest in general, the theoretical distribution of the fuel ages refers to the understorey.

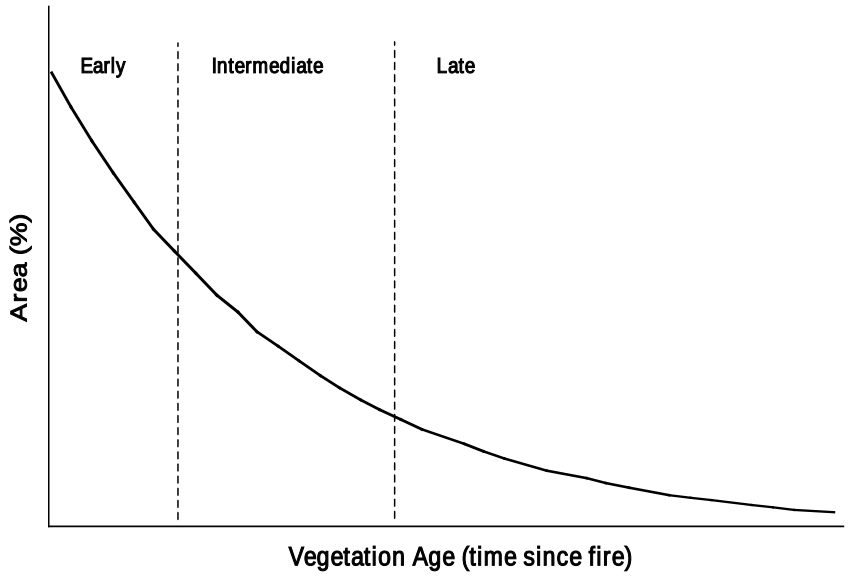
While there is not sufficient information at present to describe what distributions might best represent post-fire ages for all different specific fire sensitive ecosystems, the further development of guidelines for these ecosystems will improve knowledge about these post-fire age distributions.

Protecting Biodiversity by Managing Fire Based on Fuel Accumulation Rates

Intense summer wildfires damage, degrade or threaten natural values, including species and communities that are threatened or are fire sensitive (Burrows 2008). Less intense, smaller and less frequent wildfires can produce

some longer term benefits to ecosystems, such as reducing flammable fuel levels, promoting habitat regeneration (Catling *et al*. 2001), increasing the quantity of dead wood (logs and dead standing trees) and promoting hollow formation (Inions *et al.* 1989).

The Department will seek to reduce the threat of wildfire to significant biological values by employing a mosaic of fuel age classes or post-fire seral stages across the landscape, and specific fuel-reduced buffers to reduce fuels around biological values.



(source: Burrows 2008)

Figure 15: Distribution of a Stable Time-Since-Fire Spatial Mosaic of a Landscape Conservation Unit

Managing Fire in Wilderness Areas

There are two proposed wilderness areas within the parks (see Section 25 *Recreation Opportunities – Wilderness*). Fire in wilderness areas is acceptable to achieve biodiversity outcomes and strategic protection of natural values in and outside of wilderness areas. Consistent with Policy Statement No. 62 *Identification and Management of Wilderness and Surrounding Areas* the Department will apply prescribed fire to wilderness areas. A range of fire management strategies (as discussed above) and tactics will be considered during the life of the plan for the conservation of biodiversity values within and adjacent to wilderness areas including consideration of longer inter-fire intervals within wilderness areas and, hence, shorter inter-fire intervals in surrounding areas. The introduction of fire into wilderness areas will be planned and managed within the Master Burn Plan process. The Master Burn Plan process will focus on achieving ongoing fire management that protects the natural values and ecological processes of the area and surrounding areas.

As wilderness areas are to have minimal internal disturbance in terms of fire access and fire breaks, they must be considered as a much larger single Logical Burn Unit. Where possible, fuels within surrounding areas will be managed so that the risk of a fire entering a wilderness area or escaping from a wilderness area is minimised and the values of wilderness areas are protected.

In the event of a wildfire occurring within a wilderness area, the Regional Manager will determine on a case-by-case basis whether to allow a wildfire to burn out to existing roads and tracks or to carry out ground disturbing activities to contain the wildfire. In many cases, the former may be the more acceptable option. However, if the latter is judged to be the best option, then approval for mechanised access for wildfire suppression will be sought from the Department's Director General.

Managing Fire to Protect Life and Community Assets

The existence of towns and settlements, private property, farmland and other developments in close proximity to the parks, as well as the increasing use of natural areas for recreation, requires that the protection of life and community assets be considered in fire management for the planning area.

Fuel reduction burning, the practice of purposefully applying low intensity fires under defined conditions of fuel, weather and topography to consume a proportion of available fuels, aims to reduce the severity (scale and intensity) of wildfires by reducing their potential intensity, thus reducing damage and increasing opportunities for safe suppression (Underwood *et al*. 1985, Cheney 1994). Fuel reduction by prescribed burning aims to maintain fine surface fuel quantity below about eight to 9 tonnes per hectare and 19 to 20 tonnes per hectare for jarrah and karri forests respectively over about 60 to 80% of the burn area. The time taken for fuels to reach these levels, hence the interval between prescribed fires, depends on the rate of fuel accumulation. This varies from about five to 10 years, depending on site productivity and rainfall (Sneeuwjagt and Peet 1985, Burrows 1994). For example, in most jarrah forests, fine surface litter fuel quantity reaches quasi-equilibrium in 15 to 17 years (Figure 14). Fuel reduction by burning rarely prevents wildfires, but where a significant proportion of the landscape is managed this way, wildfire severity and scale, and consequently the impact on life and community assets, can be significantly reduced.

Identifying fire vulnerable community assets within the planning area, and determining the risk, likelihood and consequences posed by wildfire to those assets will assist in managing the threat posed by high intensity wildfires. The Department, where possible, seeks to apply fire in a way that does not compromise biodiversity values. Often prescribed burning can have multiple benefits and, in many cases, applying prescribed burns for biodiversity conservation can achieve community asset protection and also *vica versa*, for example by using smaller burn cells to achieve biodiversity outcomes. However, where life and community asset protection coincides with high biodiversity values, and it is not possible to achieve both objectives, the priority will be given to the protection of life and community assets and variations in the standard ecological fire regime (Figure 13) may need to occur.

The Department's *Wildfire Threat Analysis*[11] provides a strategic framework for managing fire to protect life and community assets and provides the basis for a more detailed analysis and evaluation of susceptible areas and specific fire pre-suppression tactics. This process will also assist in developing strategies to mitigate the threat to biodiversity values.

Fire Research

Burning may also be planned to deliver specific research outcomes to guide future management. Particular regimes may be implemented under controlled research protocols or under an adaptive management approach. To assist in this approach, 'Fire Exclusion Reference Areas' of up to 500 hectares have been established in most Landscape Conservation Units. These areas will be reserved from prescribed fire and where possible protected from wildfire, and will provide long unburnt reference points for variables used to measure the impacts of a particular fire regime. There are four such areas located within the planning area (Map 8); Murtin, O'Sullivan, Yeagarup and Black Point. These have been selected to coincide with biodiversity values and meet the 10 criteria for establishing Fire Exclusion Reference Areas which includes:

- representation of the major ecosystems/habitats that typify the Landscape Conservation Unit;
- are of a sufficient size to allow for monitoring and/or research on most plants, fungi, invertebrates, small terrestrial vertebrates and sedentary bird species;
- located such that they do not present an unacceptable wildfire risk to communities, properties and other values;
- are 'protectable' and allow a rapid effective fire suppression response; and
- the surrounding landscape is available for fuel reduction burning in order to provide protection to the reference area from wildfire.

There are also some other parts of the planning area that will not be burnt over the life of the plan and may provide future opportunities for Fire Exclusion Reference Areas.

In the future, fire management carried out by the Department may benefit from advances in technology or from new knowledge gained through research, pre- and post-burn monitoring and experience. During the life of the management plan, fire regimes may be reviewed to incorporate any of these new findings.

22. Fire – Key Points

[11] The wildfire risk analysis is consistent with the accepted framework under which risk assessments are implemented in Australia – the Australian/New Zealand Standard AS/NZS 4360:2004 – Risk Management. Variables in the analysis procedure, such as fuel age, may change over time and hence the analysis only provides an assessment of risk at the time of analysis. Consequently, the analysis process is used as a guide and Department expertise and experience is necessary to formulate long-term risk mitigation strategies.

- Fire sensitive species and vegetation complexes are most typically associated with the moister parts of the landscape (eg wetlands and riverine communities) and areas with discontinuous vegetation (eg granite outcrops).
- Most wildfires (in terms of number) in the parks are due to human activities and education of the public will be invaluable in protecting the parks.
- Fire management for the parks will aim to maintain a diversity of seral stages across the landscape based on vital attributes of key fire response species. Biodiversity will be maintained by varying interval, season, intensity and placement of fire throughout the landscape, and accounting for wildfires. Patchiness of burning is an important factor in providing environmental heterogeneity at a local level.
- Fire will also be used in a planned way to reduce the potential severity of wildfire events and, in turn, provide safety to fire fighters, neighbours and visitors as well as protection of community assets.
- The Master Burn Plan process will achieve strategic biodiversity conservation and community protection fire management objectives in the planning area through the production of indicative rolling three-year and one-year burn programs, which are modified each year on the basis of what was burnt previously, improving conservation knowledge and community input.
- Fire management of wilderness areas aims to protect and maintain natural values and processes, and fire in wilderness areas is acceptable to achieve these outcomes.
- Research will improve the knowledge and understanding of fire regimes and the vital attributes of key fire response species and habitats.

The objective is to protect and maintain conservation values while protecting people, property, heritage and recreation assets in and near the parks.

This will be achieved by:

1. Implementing fire management for the parks according to Departmental policy, principles, guidelines and the Master Burn Plan which will integrate fire management in the parks with that of the surrounding lands based on knowledge of the fire response of flora, fauna and habitats to particular fire regimes.
2. Providing opportunity for the public to have input into the Master Burn Plan process annually, or as appropriate.
3. Continuing to focus on the protection of life and property, fire sensitive communities, fire sensitive species, heritage sites and recreation assets.
4. Ensuring that any new construction of roads, firebreaks or firelines are carried out under strict hygiene and avoid significant environmental impact.
5. Continuing to liaise with local authorities, the local Bush Fire Brigades and the Fire and Emergency Services Authority of Western Australia to ensure community protection from fire is at an appropriate level.
6. Restricting visitor entry to the parks when appropriate on days of 'Extreme' fire danger or where fire activity (predicted, existing or recent) may threaten park users in particular areas.
7. Actively promoting public education and awareness on:
   - the contribution of fire to the maintenance of biodiversity;
   - the damaging effects of inappropriate fire regimes on park values;
   - fire risk; and
   - safety and survival of people and protection of property.
8. Facilitating and participating in research on fire ecology, biological indicators and habitat requirements of fauna, flora and vegetation communities.
9. Ensuring, where practicable that at least one Fire Exclusion Reference Area is established in each Landscape Conservation Unit occurring across the parks.
10. Developing and implementing, with the advice of the Conservation Commission, specific fire management guidelines for protecting and conserving significant habitats of the parks, such as grasslands, coastal woodlands, wetlands (including peat swamps), granite outcrops and old growth forests.
11. Incorporating new technology and/or knowledge, in particular knowledge associated with biodiversity values and fire regimes within the parks.
12. Managing fire in gazetted or proposed wilderness areas through the Master Burn Plan process and in accordance with Departmental policies by implementing a range of strategies and tactics, taking into consideration maintenance of wilderness values.
13. Ensuring that an analysis of wildfire potential is incorporated into all risk analyses for work proposed in the parks, and that appropriate risk mitigation work is undertaken during developments.
14. Liaising with the Department of Agriculture and Food in the mapping of organic rich as well as potential acid sulphate soils within the parks.

Key Performance Indicator (see also Appendix 2)		
Performance Measure	**Target**	**Reporting requirements**
22.1 The fuel age distribution within the Landscape Conservation Units	22.1 Match the defined frequency distribution model for each unit	Annually
22.2 The impact on human life or significant community assets	22.2 No loss of human life or significant community assets, or serious injury attributable to the Department's fire management	Annually
22.3 The area of adjacent land that is affected by wildfire emanating from the parks	22.3 A reduction in the number of fires originating from the parks that affect private property during the life of the plan as compared to the previous 5-year period	5-yearly
22.4 The condition of nominated fire sensitive habitats and communities (e.g. granite outcrops, wetlands, *Reedia* Swamp communities)	22.4 Fire sensitive habitats and communities maintained	5-yearly
22.5 The persistence of fire sensitive species within the parks (e.g. *Banksia verticillata, B. seminuda* or *Melaleuca viminea*)	22.5 Nominated populations of species maintained	5-yearly

PART D. MANAGING OUR CULTURAL HERITAGE

In Western Australia, the Aboriginal Heritage Act protects places and objects customarily used by, or traditional to, the original inhabitants of Australia. A register of such places and objects is maintained under the Aboriginal Heritage Act; however, the Act also provides protection for sites whether they have been entered on the register or not. Under the Act it is an offence for anyone to in any way alter an Aboriginal site or object without the relevant Minister's permission.

National heritage is one of seven matters of national environmental significance specifically protected by the Environment Protection and Biodiversity Conservation Act. Under the *Environment and Heritage Legislation Amendment Act (No. 1) 2003*, a National Heritage List will record the natural, Indigenous and historic places with outstanding national heritage. Actions that are likely to have an impact on the National Heritage values of a National Heritage place require approval from the Commonwealth Minister of the Environment and Heritage.

The Register of the National Estate (RNE) is a record of natural, cultural and Indigenous heritage places of national value, but offers no statutory protection. The amendments to the EPBC Act in February 2007 will see the phasing out of the RNE as a statutory register within five years, after which it will be retained as an archival record only. No new places will be assessed or added to the RNE in this time.

The *Heritage of Western Australia Act 1990* provides for the registering and protection of places of historic interest as 'heritage places'. These sites are registered on the Western Australian 'Register of Heritage Places' database. Places listed under the Act are afforded statutory protection and must not be damaged or altered unless a permit to do so has been granted by the Heritage Council of Western Australia. The Act also requires local government authorities to maintain an inventory of places of heritage significance in their area, referred to as the Municipal Inventory.

23. INDIGENOUS HERITAGE

There are 21 registered sites on the permanent register under the Aboriginal Heritage Act and 11 on the interim register (March 2004) within the parks. These sites include numerous artefact sites, two fish trap sites, two quarry sites, one burial site and one mythological site. The majority of sites occur in the Lake Jasper, Doggerup Creek and Meerup Dunes areas with a few sites also at Black Head/Malimup, Broke Inlet, Windy Harbour, Warren Beach, Long Point, Donnelly River and Fish Creek. A report prepared by Kelly *et al.* (1999) makes recommendations for the management of some of the most important known Aboriginal sites in the parks. Some work has been undertaken to protect these sites, although in places further work is still required. Artefacts continue to be uncovered as a result of erosion, road building and vegetation disturbance.

As the register is not a comprehensive listing of all sites, assessments will be necessary prior to any operations where there is potential to inadvertently damage sites. Appropriate approvals under the Aboriginal Heritage Act are required to proceed with any works that may affect Indigenous heritage values.

Currently, there are no sites on the National Heritage List, however Lake Jasper is registered on the Register of the National Estate for Indigenous culture within the parks.

Aboriginal Use and Occupation

There is evidence that Aboriginal people have occupied the southern coastal areas of Western Australia for at least 6000 years. There are thought to be at least 13 different Aboriginal groups in the south-west, collectively known as Nyoongars. The word Nyoongar, or its linguistic equivalent, is identifiable as the word for an Aboriginal person from this region although they may have different vocabularies. The traditional groups closest to the parks are from the Murram (murrum) group (Crawford and Crawford 2003).

The south-west of Western Australia was the first region of the state affected by European settlement. Within about 50 years of the founding of the Swan River Colony in 1829, the local traditional lifestyle had all but disappeared as the region was cleared and transformed into an agricultural-based economy especially along the coast and in the Wheatbelt.

What is known about the Aboriginal use and occupation of the parks has been pieced together from historical records, the discovery of many Aboriginal sites, and from oral histories. The parks, in particular D'Entrecasteaux National Park, were an ideal place to live as they were fertile, ecologically diverse and with little limitation of food or fresh water (Kelly *et al.* 1999).

Lake Jasper is of particular archaeological and cultural significance to Aboriginal people. Numerous Aboriginal stone artefacts occur on the lakebed amongst numerous tree and grasstree stumps up to 10 metres below current surface levels. This indicates the presence of a number of major camp sites, quarry/factory sites and 'chipping floor' sites within a prehistoric (approximately 4000 to 3400 years before present) forest landscape (Dortch 1990, 1995 and 1996, Dortch and Godfrey 1990, WA Planning Commission 1997). Several of these sites occur at the edge of Lake Jasper, which are vulnerable to disturbance and change in water levels. Appropriate management of recreational use of the lake is required to protect these sites (see Section 27 *Recreational Use* – Recreational Activities – Boating).

23. Indigenous Heritage – Key Points

- Archaeological and ethnographic sites have been recorded at many places throughout the parks.
- Some sites are threatened by current visitor use, especially at the edge of Lake Jasper.

The objective is to protect and conserve the Aboriginal heritage and cultural resources within the parks.

This will be achieved by:

1. Complying with provisions of the Aboriginal Heritage Act prior to commencing any potentially damaging operations, and ensuring that actions are implemented as necessary to prevent damage to culturally significant places and objects within the parks.
2. On an ongoing basis, consulting with Aboriginal people, the State Aboriginal Site Register and the Register of the National Estate for sites of Aboriginal Heritage significance, and ensuring that actions are implemented as necessary to prevent damage to culturally significant places and objects within the parks.
3. Conducting and supporting ethnographic and/or archaeological surveys across the parks (e.g. Yeagarup Dunes area), where appropriate, to increase and contribute to the knowledge and understanding of Aboriginal heritage of the area.
4. Collating existing information on cultural sites located in the parks.
5. Developing a communication plan to increase Aboriginal heritage awareness for park visitors.
6. Developing an Aboriginal heritage site management plan to protect and maintain known sites.
7. Identifying where possible, areas for Aboriginal cultural and ceremonial purposes based on traditional occupation and use

Key Performance Indicator (see also Appendix 2)

Performance Measure	Target	Reporting requirements
23.1 Protection of registered heritage sites	23.1 No disturbance without formal approval	3-yearly
23.2 Involvement of Aboriginal people in management	23.2 Increased level of Aboriginal involvement in management of the parks	3-yearly

24. OTHER AUSTRALIAN HERITAGE

The Dutch were exploring the south coast of Western Australia as early as 1627. In 1791 Captain George Vancouver, in command of the sloop *HM Discovery* and armed tender *Chatham*, left Falmouth, England to survey the southern coast of New Holland on his way to America. It was the first hydrographic survey of the southern coast of Australia. Vancouver's survey began at Chatham Island (Map 1 Management Planning Area) on 27 September 1791 and during the following 19 days charted over 400 kilometres of coastline, which included the discovery of King George Sound. Vancouver and his expedition took possession for Britain of the land seen "*North West of Cape Chatham or far as we might explore its coasts*" (Royal West Australian Historical Society 1995).

In 1792, just a year after Vancouver, Admiral Bruny D'Entrecasteaux led the largest scientific expedition in the 18th Century sent to explore Australia. D'Entrecasteaux's party consisted of two research ships; *La Recherche* and *L'Esperance*, and 16 scientists from the French Society of Natural History. They began their survey of the

southern coast between Silver Mount and the Donnelly River on 5 December 1792. Point D'Entrecasteaux was named after the admiral as they passed, however D'Entrecasteaux and his party were largely unimpressed with the land they sighted from their ships (Royal West Australian Historical Society 1995).

Little interest was shown in the area over the next 40 years other than by the sealers and whalers that were operating along the coast just prior to and after settlement in Albany in 1826. Many were ex-convicts who had served their time in Van Dieman's Land (Fernie and Fernie 1989).

In 1831 Lieutenant William Preston made a trip in a whaleboat from near Peaceful Bay, around Point D'Entrecasteaux finally ditching in heavy seas "*six miles north west of Point D'Entrecasteaux*" (probably either on Doggerup or Malimup Beach). Preston and his men all survived a hike from this point to Augusta and then on to 'Murray River' describing the coastline of what is now D'Entrecasteaux National Park (Cross 1833).

Later, in 1841, the adventurous William Nairne Clark (Fernie and Fernie 1989) also explored the area. On his first trip Nairne Clarke sailed as far west as Chatham Island and walked to Broke Inlet principally to report on the suitability of the land for grazing and farming. On his second visit to the area, also in 1841, Nairne Clark travelled as far as Point D'Entrecasteaux and spent nearly 2 weeks camped on Sandy Island. From here, in the company of two of his men, Nairne Clark set out on foot to explore the country between Point D'Entrecasteaux and Nornalup. He describes the beginning of his journey:

> *"We walked about 7 miles straight into the interior from the beach to the hills about Point D'Entrecasteaux and far inland abound in rich sheep pasture, and as we traversed the plains, we everywhere found them of great extent, abounding in fine cattle feed, plentifully watered".*

In the 1850s farmers began settling in the Pemberton, Manjimup and surrounding areas. Edward Reverly Brockman settled on the Warren River and built Warren House. He bred horses, which he shipped to India and also raised sheep. Settlers in the area found that the land on the coast provided much needed summer grazing for their stock and many families began droving their cattle to the coast each summer.

The Muirs, Scotts, Gibletts, Youngs, Wheatleys, Moirs, Blechendens, Dousts, Mottrams and others took out leases and purchased land along the coast from the 1880s in what is now D'Entrecasteaux National Park with grazing continuing in some areas up until the 1980s. The cattle could not be kept on the coast for too long or they began to suffer 'coasty', a trace element deficiency. They usually spent about four or five months on the coast beginning between Christmas and New Year and returning inland in late May or early June before calving (Heritage and Conservation Professionals 2000). Their droving routes took them through the parks, with some stock routes later becoming formalised into vehicle tracks (e.g. Deeside Coast Road).

As the cattlemen sometimes spent long periods on the coast, they built huts to provide shelter. Some of these early huts, such as Bolghinup Hut and Coodamurrup Hut, remain. Stockyards and later loading ramps were also constructed. As many of the historical structures are made from perishable materials, active measures are needed to preserve them. One grazing lease still remains in the area (Quannup) although this is not currently stocked. Other grazing leases have progressively been bought and incorporated into the parks (see Section 3 *Management Plan Area*).

Between 1901 and 1903 there were reports of oil prospectivity along the coast between the Donnelly and Warren rivers (see Section 32 *Mining*). Although there was disagreement about the likelihood of finding oil, several test bores were sunk—the first oil wells in the State, near the mouth of the Warren River and on the Fly Brook. One bore reached a depth of 500 metres. An interested spectator in these drilling operations was Colonel 'Biltong' Vialles who stayed on to raise cattle after the failed oil exploration. His property on the lower Warren River is still known today as 'The Colonels'.

On 29 May 1911, the 900 ton iron barque *Mandalay* sailing from Delagoa Bay, Mozambique to Albany was driven on shore by prolonged south-west gales. The wreck can sometimes be seen from Mandalay Beach when tides and sand shift to uncover the steel structure. A second ship, the *Michael J Goulandris*, was wrecked 22 kilometres south-west of Windy Harbour on 21 December 1944. Two thousand tonnes of rations bound for Perth floated into shore between Salmon Beach and Fish Creek. Many of the locals took advantage of the situation by hauling loads of the cargo by hand, by cart or using horses. Then, in order to hide their bounty from the authorities, they buried what they had salvaged in their gardens.

Timber milling came to the area in 1912 and in the 1920s land settlement schemes opened up more land for farming. The Shannon area was one of the last areas in the south-west to be opened up for logging, due to its

inaccessibility. The Shannon area was largely untouched until the 1940s, when an acute shortage of timber after World War Two prompted the State government to establish a timber mill there. Timber cutting began in the Shannon basin in the mid-1940s and the town and timber mill were established in the late 1940s. About 15% of the Shannon National Park has been logged over the past century with most of the timber going to the Shannon Mill, which operated between 1950 and 1970 (see Section 37 *Rehabilitation*).

The information shelter at Shannon townsite is near the site of the old mill. The town was built across the highway where the camping ground is now situated. The settlement was designed for 90 mill houses in a double horseshoe surrounding the area, which eventually included a hall, church, store, post office and nurse station. A dam was built upstream from the mill site in 1949 to ensure summer supplies.

During the life of the mill, the residents of the Shannon townsite used the parks extensively for recreation. Hunting, marroning and fishing were popular pastimes and near the townsite a golf course and cricket oval were constructed.

After Shannon mill closed, the houses from the old townsite were sold and taken away (long before the National Park was created). Only traces of the mill town and former forestry settlement can now be seen, such as the fruit trees still growing in cleared areas of the Shannon camping ground and the grassed areas of the former golf course and oval. There are also the remains of old buildings and railway lines along the Shannon Dam walktrail. The old logging tramways and roads are now used for walktrails and scenic drives.

A small amount of the D'Entrecasteaux National Park has also been logged mostly for Warren River cedar (*Taxandria juniperina*), which was used in boat building.

From the days of the early cattlemen, the park was used for recreation, particularly fishing on the coast and in the inlets. More huts were constructed throughout the park, mostly as weekenders and fishing shacks (see Section 27 *Recreational Use* – Recreational Sites – Huts). Huts continued to be built in the parks until the late 1970s and early 1980s. Forty-three were constructed at the mouth of the Donnelly River, the first being built in the 1920s. As the area is not accessible by road, all materials used in the construction of the huts were brought in by boat.

A heritage study of the huts other than those at the mouth of the Donnelly River concluded that seven huts had high heritage value: Coodamurrup (Moore's) Hut, Bolghinup Hut, Voutier Hut, East's Hut, Mottrams' Hut, Hester Hut and Muirs' Hut (Heritage and Conservation Professionals 2000). These huts will be retained and managed by the Department for cultural heritage and interpretative purposes. There are conservation plans already prepared for Coodamurrup and Bolghinup huts (Muir undated, Molyneux 2002).

Many of these structures are vulnerable to fire and so the huts and the surrounding areas will be managed to provide appropriate protection from wildfire, with due consideration of the natural values of the areas. Fire suppression activity could also include the use of water bombers and water tankers to reduce the turnaround time, as many suitable water sources are distant from the huts.

A heritage survey of the Donnelly Huts may be required during the life of this plan to ensure appropriate management of the huts. A summary of proposed management of the remaining huts (for heritage and recreation purposes) is outlined in Section 27 *Recreational Use* – Recreational Sites).

While there are a number of non-Indigenous cultural heritage places on the local authorities' municipal inventories within the parks, there are no sites registered on the National Heritage List or the Western Australian Register of Heritage Places. The Point D'Entrecasteaux Lighthouse within the section 5(1)(h) reserve is registered on the Register of the National Estate as a historic place. The lighthouse was originally built in 1960 and was the last acetylene light in the State. The lantern house and lens was removed in 1989 and the light was converted to solar power electric. The lighthouse complex is mainly of interest for its association with the history of maritime navigation in Western Australia.

24. Non-Indigenous Heritage – Key Points

- European involvement within the parks mostly started in the late 1800s with droving of cattle to the coast for grazing.
- Stockmen huts, bridges and stockyards are significant European structures in the parks.
- The wreck of the *Mandalay* is sometimes visible from the coast within D'Entrecasteaux National Park.

The objective is to protect and conserve the non-Indigenous cultural heritage of the parks.

This will be achieved by:

1. Protecting and maintaining non-Indigenous cultural features of educational or historical significance including regular inspections and remedial work to minimise the risk of wildfire damage (see also Section 27 *Recreational Use* – Recreational Sites – Huts).
2. Protecting non-Indigenous cultural heritage during any new developments or management programs.
3. Restoring where applicable non-Indigenous cultural sites in the parks through liaison with community groups, the WA Museum, the WA National Trust and the WA Heritage Council.
4. Collating existing information on historic sites located in the parks and maintaining a current register of sites.
5. Providing information and interpretation to the public in regard to important sites and past non-Indigenous use within the parks.

PART E. MANAGING VISITOR USE

It is recognised that the public conservation estate managed by the Department has the capacity to provide a significant portion of the public's growing demand for outdoor recreation and tourism, in particular 'nature-based' tourism, and in doing so contribute significantly to the social, psychological, physical and economic wellbeing of the community (see Section 2 *Regional Context*). An assessment of the economic value of recreation and tourism in the area between Manjimup and Walpole (incorporating the parks) determined to be approximately $62 million dollars annually, could be attributed to nature-based activities, the natural environment and the attraction of tall forests (Carlsen and Wood 2004). Consequently, the proposals in this plan and the Department's subsequent management activities are important to the regional economy.

The number of visitors to the State's reserve system has increased markedly over the past decade, from 8.3 million visits in the 1998 to 1999 year to over 14.2 million in 2009 to 2010. The reason for such significant visitor interest is that the estate managed by the Department covers an area of more than 27.4 million hectares of lands and waters protecting unique landscapes, geological formations, plants and animals, and cultural sites. However, conserving these lands and waters for future generations, and managing them for recreational use by the present one, is a complex process.

Firstly, public expectations for recreation and tourism within the conservation estate are as diverse as the environments the Department manages. Secondly, whilst the public conservation estate bring many benefits to the community as well as the community to the environment (see Section 42 *Working with the Community*), the desire to interact with these unique environments can lead to significant impacts on the natural environment. This part of the management plan addresses these issues, at the same time ensuring that visitors are able to gain an appreciation and understanding of the parks' values by providing appropriate nature-based recreation opportunities, which should, in turn, foster an appreciation and understanding of the conservation of these areas.

The Department's Policy Statement No. 18 *Recreation, Tourism and Visitor Services* outlines the principles, operational guidelines, procedures and administrative controls in relation to facilitating recreation and tourism on the public conservation estate. This management plan is guided by Policy Statement No. 18 where applicable.

25. RECREATIONAL OPPORTUNITIES

Regional Recreational Context

The parks are within the most visited area of the State outside of the metropolitan area (see Section 2 *Regional Context*). Recreation opportunities within the South West Planning Region are varied and numerous, although many are nature-based and include four-wheel driving, scenic driving, biking, boating, walking, caving, climbing, sight seeing, camping, fishing, swimming, surfing and picnicking. These opportunities are provided in national parks, State forests, local authority managed lands, Crown lands and privately owned lands.

The location and size of the parks make them an important resource for recreation and tourism in the South West Planning Region but in particular for the local community. Visitors to the parks include people from the towns of Pemberton, Northcliffe, Manjimup, Nannup and Walpole as well as those who travel from further afield to enjoy the opportunities that the parks offer as part of the experience of the whole region (Map 2 Regional Context).

Whilst some of the opportunities of the parks are also present in other natural areas of the South West Planning Region, what sets the parks apart is their remoteness and undeveloped nature (see Section 4 *Key Values*). The D'Entrecasteaux National Park contains over 130 kilometres of coastline. This coast is relatively isolated and is an important area for coastal four-wheel driving and remote camping, and consequently provides a different coastal experience than the west coast (e.g. such as that provided by Leeuwin-Naturaliste National Park).

Most recreation opportunities in the parks are nature-based, consistent with the purposes of national parks. However as a large area of the South West Planning Region is conservation or proposed public conservation estate, especially in the area of the parks, opportunities for other activities, not necessarily nature-based such as horse-riding, dog exercising, sandboarding, climbing, or caving are generally limited. This places added pressure on the conservation estate to meet the needs of those interested in pursuing these activities.

Recreation activities and access in D'Entrecasteaux National Park are concentrated on coastal areas and the park's rivers—areas of high scenic value and where a combination of recreation opportunities are available—including Black Point, Donnelly River, Yeagarup Dunes, Warren Beach, Malimup Beach, Salmon Beach, Windy Harbour, Gardner River, Coodamurrup Beach, Fish Creek, Broke Inlet, Banksia Camp and Mandalay Beach. Other recreation areas are focussed on waterbodies and scenic viewpoints such as Lake Jasper, Mt Chudalup, Mt Pingerup and the Woolbales.

In the Shannon National Park most recreation and tourism activities are centred on the old Shannon townsite, Shannon River and the Great Forest Trees Drive. There are few other areas promoted or developed for recreation and tourism in Shannon National Park. In terms of recreation in the karri forests of the region, the Valley of the Giants and Walpole-Nornalup National Park as well as the parks around Pemberton such as Gloucester, Warren and Beedelup national parks have a far higher visitation than Shannon National Park.

The Bibbulmun Track runs through the whole region and includes five overnight shelters across both parks.

The promotion of the Walpole Wilderness (which includes Shannon National Park) may increase visitation to the parks as the southern part of the region gains a higher profile.

Visitor Numbers and Trends

Until recently, visitation data in the parks has been difficult to collect because of the numerous entry points to D'Entrecasteaux National Park. Traffic counters are now in place at seven points through the parks and estimates are taken at 11 other recreation sites.

In the 12 months to June 2010, the total annual visits to D'Entrecasteaux National Park was about 137,000. The more popular sites were Salmon Beach Road (44,250 visits), Mandalay Beach (24, 231 visits), Donnelly Boat Landing (19,598 visits), Lake Yeagarup (16,039 visits) and Mt Chudalup (10,780 visits)[12]. Visitation to four-wheel drive accessible sites is popular and includes Black Point Road (9,000 visits), Jasper Beach (4,000), Warren Beach (3,000 visits), Malimup Beach (3,000 visits) and Coodamurrup Hut (2,000 visits).

In the 12 months to June 2010, the number of visitors to Shannon Campground within Shannon National Park is recorded as about 16 500 visits per year and with a further estimation of 4000 visits to the Great Forest Trees Drive, this is a total of approximately 20 500 visits to Shannon National Park.

This is a combined total of about 158 000 visits to the parks in the 2009 to 2010 year. In addition to these figures, estimates of visitors to the Bibbulmun Track within the parks are 4,000 visits for the 2009 to 2010 year. It is difficult to estimate current motorbike or mountain bike visitor numbers within the parks.

For much of the year, the majority of park visitors come on weekends from nearby towns and farms, recreating—especially fishing and four-wheel driving—on the coast. During long weekends and the summer and autumn holidays, there is also a substantial influx of tourists sightseeing, recreational driving, camping and fishing. There are also 120 tour operators (as of 30 June 2010) licensed to use the parks for a wide range of nature-based activities (see Section 28 *Commercial Tourism Operations*), however not all licensed operators actually use the parks. A number of school and not-for-profit organisations also use the parks for education and adventure activities (see Section 27 *Recreational Use* – Recreational Activities – Non-Commercial, Education and Not-for-Profit Activities).

In 1999, over 200 visitors were surveyed. The main points of interest from the survey were that:

- 75% were repeat visitors, with more than half having visited the parks five times or more;
- over 80% of park visitors used four-wheel drive vehicles to enter the parks;
- around 55% of visitors to the parks came from country areas of the State (18% from Manjimup, Pemberton, Northcliffe and Walpole) and 37% from the Perth metropolitan area;
- visitors highly valued aspects of the parks such as unspoiled surroundings, sense of remoteness, nature/wilderness, scenic views and four-wheel driving and camping opportunities;
- the main activities undertaken were fishing, camping, four-wheel drive driving, bushwalking, sightseeing and relaxing;

[12] A visit is the number of people per day visiting a specific location. The visit figure comprises both recorded numbers of visits from traffic counter devices, surveys and other data sources as well as estimated numbers of visits based on field observation.

- visitors to the parks rated the enjoyment, satisfaction and pleasure of their visit very highly, indicating a liking for the current level of services and development in the parks; and
- even though most visitors wanted the parks to stay as they were, there were some suggestions for extra services or facilities that they would like provided such as toilets, rubbish bins, drinking water and a general improvement of park facilities.

The challenge for managers is preserving these experiences, the 'unspoiled surroundings' and sense of remoteness whilst providing for the possibility of increased visitation.

Visitor Management Settings

Typically as the use of natural areas such as national parks increases, resource conditions change until the character of the setting has been modified to a point where it no longer has the attributes that originally attracted people to the area. Thus the initial users are displaced by people who are more tolerant of the changed resource conditions, with the process continuing until a uniform developed level of services and facilities are provided within the natural area. This is the idea of 'recreational succession'—the very conditions of an area that attract recreational use are inevitably changed by that use (Prosser 1986).

The provision of visitor services, facilities and experiences in the parks should also consider the range of opportunities available in neighbouring parks, coastlines and forests across the south-west. The Department aims to provide visitors with a wide range of nature-based experiences on the public conservation estate, rather than a homogenous developed facility and access experience, whilst ensuring that impacts on the environment are managed within acceptable limits.

The Recreation Opportunity Spectrum developed by Clark and Stankey (1979) has been commonly applied as a standard planning tool in natural areas to address this issue. The Department is using 'visitor management settings', derived from the Recreation Opportunity Spectrum principles, to manage for recreational succession in natural areas such as national parks. The criteria for the settings are included in Appendix 10.

Visitor management settings are purely to guide the Department in determining what sort of recreation development may be appropriate within the settings. This system will assist in preventing the natural areas within the parks being subjected to incremental development and maintain the remote qualities of the parks, which are a significant value of the parks. Any recreation site or track development pursued through the life of this plan will need to be consistent with the visitor management settings.

Visitor management settings for the parks are shown on Map 9. The visitor management settings are also shown in the relevant tables throughout this management plan (tables 7, 8, 9, 10 and 11). The allocation of an area to a particular setting does not necessarily mean the full extent of the setting has to be met. The use of a site classification system as described in Appendix 10 provides scope for a range of camping areas and/or day use areas to be provided within a range of the settings.

Wilderness

There is a growing awareness from within the community and the scientific world that wilderness areas support values that should be protected from the impacts of modern technological society. These values include:

- maintenance of the integrity of ecological processes, with wilderness areas including the most natural land remaining;
- protection of biodiversity;
- maintaining opportunities for solitude, inspiration and self-reliant recreation;
- providing an insight into the past and a baseline for management in the future; and
- representing a vast store of knowledge, ideas and genetic resources yet to be discovered from which human society will continue to benefit. The protection of the biodiversity of wilderness areas helps maintain the widest range of options for the future.

Identification

The International Union for Conservation of Nature and Natural Resources, now known as the World Conservation Union, defines wilderness as a:

> *"…large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition".*

The Australian Heritage Commission has compiled and maintains the National Wilderness Inventory (NWI), which is designed to identify wilderness quality across Australia. The NWI uses a quality index rating of 0 to 20, with 20 being the highest quality.

The NWI data for the parks (Map 10 Wilderness Quality) has been based on the following criteria:

- remoteness from settlement – how remote a site is from permanent human occupation;
- remoteness from access – how remote a site is from established access routes;
- apparent naturalness – the degree to which a site is free from permanent structures associated with modern technological society; and
- biophysical naturalness – the degree to which a site is free from biophysical disturbances caused by the influence of modern technological society.

The Department's Policy Statement No. 62 *Identification and Management of Wilderness and Surrounding Areas* provides for areas that have a NWI wilderness quality index of at least 12, and a minimum size of 8 000 hectares to be identified as candidate areas for wilderness during the management planning process.

This management planning process determined which areas, if any, were appropriate to be designated as a 'wilderness area' within the parks and gazetted under section 62(1)(a) of the Conservation and Land Management Act. The Conservation Commission and the Department sought public input into the possible creation of wilderness areas within the parks through the management planning process.

Four 'candidate wilderness' areas in the parks were identified (Map 10 Wilderness Quality) within the following forest blocks:

- Chesapeake and Pingerup blocks (north of Broke Inlet);
- Chudalup block (east of Windy Harbour Road);
- Malimup and Callcup blocks (centred on Meerup River); and
- Yeagarup block (part of the Yeagarup Dune system).

Subsequent to public submissions to the draft management plan and further assessment, it has been determined that two of the four candidate wilderness areas could be gazetted subject to an assessment of final boundaries. The main concern expressed in the public submissions was that vehicular access to the beaches would be affected, however none of the candidate wilderness areas include the beaches—so access to the beaches adjacent to the now 'proposed wilderness' areas would not be affected. In addition there are no existing recreation sites or public vehicular access currently permitted within these areas, so the creation of the proposed wilderness areas would not affect current recreation use other than perhaps walk-in commercial tour groups. The fine scale boundaries of the proposed wilderness areas are yet to be determined and will take into account:

- wilderness quality and minimal size requirements;
- fire and other management implications;
- logical boundaries;
- whether buffers need to be increased from settlements, public access and recreation sites; and
- rehabilitation opportunities.

Whilst the size of each proposed wilderness area would need to be over the 8000 hectare minimum size threshold, some work is required to obtain NWI wilderness quality 12 or greater within these proposed wilderness areas. The NWI data that is available for the planning area dates from the wilderness quality assessment carried out for the State's south-west forests as part of the 1998 Comprehensive Regional Assessment. This data now requires revision to take into account changes in access, for example the Vehicle Access Strategy in this management plan (Appendix 11) and beach four-wheel drive access. In addition, there are gaps in the data for two of the proposed wilderness areas which when assessed may also increase the wilderness quality. Regeneration and rehabilitation of the proposed wilderness areas will also aim to contribute to the attainment of a minimum of 8000 hectares of wilderness quality 12 or greater within the next 10 years. A brief summary of each area follows.

Malimup and Callcup Proposed Wilderness Area

This proposed wilderness area occurs between the Warren Beach Track and Summertime Track within D'Entrecasteaux National Park. It includes the portion of Meerup River that is within D'Entrecasteaux National Park and the Meerup Dunes. The area is significant as a proposed wilderness area because it:

- includes a significant section of the Meerup River with limited historical access;
- includes the Meerup Dune system;
- includes areas of cultural significance and potential archaeological sites such as artefact scatters; and
- provides opportunities for self-reliant (unmarked) day walks and wild camp experiences.

The area is approximately 12,317 hectares and 56%, or approximately 7000 hectares, is already wilderness quality 12 or greater. Approximately 1075 hectares of this proposed wilderness area has no data recorded, which if assessed, could increase the area of wilderness quality greater or equal to 12. Therefore, the minimum 8000 hectares required is achievable although the final boundaries will require further assessment.

Yeagarup Proposed Wilderness Area

This proposed wilderness area within D'Entrecasteaux National Park is east of Donnelly River and west of Yeagarup Track which is the official track through the Yeagarup Dunes to the beach. The area consists of the extensive Yeagarup Dune system and Bolghinup Hut, which is a hut of heritage value (see sections 24 Non-Indigenous Heritage and 27 Recreational Use – Recreational Sites – Huts) that has no public vehicular access to it, but could be accessed on a walk-in basis. The area is significant as a proposed wilderness area because it:

- includes the extensive Yeagarup Dune system;
- includes areas of cultural significance and potential archaeological sites including artefact scatters;
- contains the largest area of wilderness quality 12 and above in the parks; and
- provides opportunities for self-reliant (unmarked) day walks and wild camp experiences.

The area is approximately 11,100 hectares and 69%, or approximately 7700 hectares, is already wilderness quality 12 or greater. According to the NWI assessment, this proposed wilderness area has the largest area of wilderness quality greater than 12 of the four areas within the parks. Approximately 1720 hectares of this proposed wilderness area has no data recorded, which if assessed, could increase the area of wilderness quality greater or equal to 12. Also, an extension of the proposed wilderness area northwards into Greater Hawke National Park may be possible. Therefore, the minimum 8000 hectares required is achievable although the final boundaries will require further assessment.

Chudalup Proposed Wilderness Area

This proposed wilderness is within D'Entrecasteaux National Park and is contained by Windy Harbour Road in the west, Chesapeake Road to the north, the Bibbulmun Track to the east and Tragedy Track to the south (all buffered by at least 500 metres). During consideration of the boundaries of the proposed wilderness area, it was determined that an area east of Gardner River could be included into the wilderness area, providing a larger wilderness area.

The area consists of low lying wetland areas with several scattered pockets of karri which form part of the nationally important Doggerup Creek System (see Section 18 *Species and Communities of Conservation Significance* – Communities – Wetlands). This area is significant as a proposed wilderness area because it:

- covers a nationally important wetland;
- can be viewed from the top of Mt Chudalup, providing a unique opportunity to provide interpretation of the importance of wilderness and to appreciate the scenic and remote qualities of the wilderness, without actually entering it; and
- contains approximately 870 hectares of old growth forest.

The area is approximately 9485 hectares and 37% of this, or approximately 3513 hectares, is wilderness quality 12 or greater. Since the NWI assessment, some access tracks within the area have been closed to the public and are now management access only tracks. There are also several road reserves that have been cancelled and returned to the parks that are within this proposed wilderness area. These changes since the original NWI assessment should increase the wilderness quality of the area.

However, achieving a minimum size of 8000 hectares of wilderness quality of 12 or greater would be difficult in the life of this plan and therefore establishing this area as a gazetted wilderness area will be deferred. The area

will be given a 'natural' setting (see Section 25 Recreational Opportunities – Visitor Management Settings) and management of the area will be such that current wilderness values will be maintained.

Chesapeake and Pingerup Proposed Wilderness Area

This proposed wilderness area occurs across both parks and encompasses a portion of Shannon River as well as the 'wild river' Forth River (see Section 15 *Catchment Protection* – Hydrology – Rivers). The area is mostly karri to the west and pockets of karri amongst the Pingerup Plains to the east.

The area is contained within Deeside Coast Road to the west, the Bibbulmun Track to the north and east, and Chesapeake Road to the south. The gazetted wilderness would be at least 500 metres from any of these boundaries. This area is significant as a proposed wilderness area because it:

- includes one of the few wild rivers remaining in Western Australia;
- includes part of Shannon River which has its catchment almost entirely within a conservation reserve;
- contains approximately 1400 hectares of old growth forest; and
- provides opportunities for walkers to leave the Bibbulmun Track for self-reliant (unmarked) day walks and wild camp experiences.

The highest level of wilderness quality is currently within the eastern portion with the lowest rating of wilderness being Pingerup Road, which has been closed to the public and is currently used as a management access track. The area is approximately 12,659 hectares and 40% of this, or approximately 5063 hectares, is of wilderness quality 12 or greater. A reassessment of the wilderness quality of the area, taking into account the closure of Pingerup Road to the public, may result in an increase in the area of wilderness quality.

However, achieving a minimum size of 8000 hectares of wilderness quality of 12 or greater would be difficult in the life of this plan and therefore establishing this area as a gazetted wilderness area will be deferred. The area will be given a 'natural' setting (see Section 25 Recreational Opportunities – Visitor Management Settings) and management of the area will be such that current wilderness values will be maintained.

Management of Wilderness

Policy Statement No. 62 sets out the general guidelines for management of the gazetted wilderness areas with regards to managing the values and threats to wilderness values of the areas. The gazetted wilderness areas within the parks will correspond with the most remote of the visitor management settings and be consistent with the Department's policy on wilderness. Areas that have a high level of wilderness quality but did not qualify, due mainly to suitable boundaries not being available to provide the minimum size criteria, will be managed according to a 'natural' visitor management setting and wilderness qualities maintained. For example, areas of high wilderness quality around Lake Quitjup and east of Broke Inlet.

It is important to note that the Wilderness Policy does not preclude tracks being maintained for management access and therefore, essential access will be maintained. Fuels in surrounding areas will be managed so that the risk of a fire escaping from the wilderness area into the surrounding area and *vica versa* is minimised and the values of the wilderness are protected (see Section 22 Fire). Also fire management of the wilderness areas will include prescribed burning to maintain biodiversity values as detailed in the Master Burn Plan. In the event of a wildfire occurring within a wilderness area, the Regional Manager will determine on a case-by-case basis whether to allow a wildfire to burn out to the existing roads and tracks or to carry out ground disturbing activities to contain the wildfire. In many cases the former may be the more acceptable option. However, if the latter is judged to be the best option, then approval for mechanised access for wildfire suppression will be sought from the Department's Director General.

The main points from Policy Statement No. 62 that will influence management of the gazetted wilderness areas within the parks are:

- wherever possible, ground disturbing activities for fire management will be conducted outside of wilderness areas—this includes construction and maintenance of access roads, firebreaks, fuel-reduced buffers, and water points;
- prescribed burning within wilderness areas may be carried out for the protection and maintenance of biological values and processes as determined through the preparation of area and regional management plans;
- appropriate fire protection strategies according to established standards will be implemented around wilderness areas where life, property and natural resource values may be threatened;

- management of wilderness areas and its surrounds will be consistent with the principles in the Malimup Communiqué[13];
- structures listed as being significant by either the National Trust of Australia or Government heritage bodies will be protected as far as practicable;
- use of mechanised transport is not permitted within wilderness areas, except for emergency or essential management operations, or reasons of cultural importance;
- the landing of motorised and non-motorised aircraft within wilderness areas will not be permitted, with the exception of non-fixed wing aircraft access for rescue and essential research and management operations;
- constructed walktrails, signs, track markers and toilets will not be provided in wilderness areas;
- any existing vehicle tracks and constructed walktrails within wilderness areas that are not required for emergency and essential management purposes will be closed;
- any existing incompatible recreation and tourism uses and/or structures within wilderness areas will be removed and rehabilitated;
- education and/or recreation expeditions will be permitted within wilderness providing they are consistent with the maintenance of the qualities of the area;
- commercial recreation and tourism is not permitted within wilderness areas; and
- the taking of forest produce will not be permitted within wilderness areas.

The two areas proposed to be gazetted as wilderness will be managed as if they are gazetted wilderness areas until the specific boundaries are determined and the gazettal takes place.

25. Recreational Opportunities – Key Points

- Visitors value the unspoilt surroundings, sense of remoteness, nature/wilderness, views and the four-wheel driving, camping and bushwalking opportunities provided by the parks.
- The paradox for managers of natural areas is in preserving the unspoilt surroundings and sense of remoteness whilst visitation continues to grow.
- Recreational succession can be avoided by assigning areas to different visitor management settings for the life of the plan.
- The provision of recreation experiences, facilities and services in the parks considers the range of opportunities available in neighbouring national parks, state forest, shire reserves and other tenures across the region.
- The Department has identified two proposed wilderness areas to be gazetted to protect the natural, recreational and scientific values of these areas.

The objective is to provide visitors with a range of sustainable nature-based experiences to facilitate their understanding of the natural values of the area.

This will be achieved by:

1. Ensuring future recreational development is guided by the visitor management settings.
2. Formally protecting wilderness values within the parks by gazetting 'wilderness areas' under section 62 of the Conservation and Land Management Act.
3. Rehabilitating areas within the gazetted wilderness areas to achieve larger areas of wilderness quality (e.g. NWI of 12 and above).
4. Monitoring wilderness quality of the parks to ensure wilderness quality of the gazetted wilderness areas is improved or at least maintained.
5. Providing education regarding the values and appropriate activities within the wilderness areas.

Key Performance Indicator (see also Appendix 2)

Performance Measure	Target	Reporting requirements
25.1 The range of visitor management settings over the life of the plan	25.1 No reduction in the area of wilderness, natural or natural-recreation visitor management settings	5-yearly
25.2 Visitor satisfaction levels of nature-based experiences within the parks over the life of the plan	25.2 Maintained or increased	3-yearly

[13] The Malimup Communiqué was developed between Aboriginal communities, government authorities and non-government environmental groups in May 1998 at Malimup Springs in Western Australia. It is concerned with Aboriginal people and the management of areas reserved/zoned as wilderness, primarily within national parks, or other lands reserved for conservation or recreational purposes.

26. VISITOR ACCESS

Lands and waters managed by the Department are generally open to public recreational use. However, there are some areas where public access is restricted for reasons of safety, cultural sensitivity, disease control, protection of conservation values, preservation of a particular recreational experience and/or maintenance of roads and tracks.

The following types of access are available to gain access to and through the parks (Map 11 Public Access – Vehicle and Boat and Map 12 Public Access – Walktrails).

Vehicle Access

Most visitors to the parks arrive by car. The standard of vehicle access within the parks varies from roads accessible by two-wheel drive vehicles to tracks accessible by four-wheel drive vehicles only for part of the year.

Motorbikes and bicycles share the same roads as motor vehicles with motorbikes requiring licensing to gain access to the parks. Mountain bike off-road access is proposed to be provided by the long distance Munda Biddi trail through Shannon National Park (see Section 27 *Recreational Use* – Recreational Activities – Cycling).

Access Demand

Demand for vehicle access by visitors within the parks is either:

- destination-based, for example in order to fish, go marroning or to camp; or
- as an activity in its own right, such as four-wheel driving or scenic driving.

Destination-based access has traditionally predominated in the parks. However the surge in popularity of four-wheel drive ownership has increased the demand for driving as an activity, especially within the D'Entrecasteaux National Park. Experiences that challenge the driver and/or vehicle such as crossing the Yeagarup Dunes, climbing Calcup Hill or crossing one of the many rivers have become popular with visitors. For example, 39 vehicles were recorded on Yeagarup Beach over Easter 1987 whereas in 1999 there were over 200.

In 2007 there were 260,825 new four-wheel drives sold in Australia (not including luxury vehicles), an increase of 45% over the last 5 years (Federal Chamber of Automotive Industry figures). The WA 4WD Association states that there are almost 200,000 four-wheel drives registered in Western Australia alone. Four-wheel drive ownership in Western Australia may continue to increase over the life of this management plan, however recent high fuel prices have been impacting on the sale and use of large cars such as four-wheel drives with the long-term impact of fuel prices yet to be seen.

The demand for four-wheel drive access can potentially lead to conflict between vehicles and the maintenance of environmental values, other vehicles and opportunities for other users (walkers), and may compromise public safety and the Department's duty of care. Illegal use of off-road vehicles occurs throughout the parks, particularly in the Yeagarup Dunes and on beaches in the park. An increased level of access within the parks has also led to demands on park facilities. Day use facilities and informal camping areas that were once adequate are now becoming significantly degraded and unable to sustain current visitation levels.

Fully satisfying the demand for access within the parks could further compromise the qualities of remoteness that are highly valued by visitors and the community (see Section 25 *Recreational Opportunities* – Visitor Management Settings). The type of access provided affects the level and type of use of an area. Therefore, access needs to be carefully managed in consultation with visitors to the parks and according to the proposed visitor management settings. This will ensure that visitors will continue to have access to a wide variety of experiences within the parks without compromising the remoteness of the parks and the natural values.

State and Local Government Roads

Some of the access roads to the parks are State or local government managed roads. This includes the sealed roads South Western Highway and Windy Harbour Road which are Main Roads Western Australia and Shire of Manjimup managed roads respectively, and various unsealed local government roads to private enclaves within the parks, such as Deeside Coast Road, Chesapeake Road and Broke Inlet Road to Camfield. There are also various four-wheel drive tracks that service private enclaves such as part of Fish Creek Track to Location 5273, Summertime Track to Location 153 and Pneumonia Road and Scott Road to Location 13101. These tracks and

accompanying road reserves are not the responsibility of the Department and are not part of the parks (Map 3 Tenure).

Proposed road developments for State and local authority roads in the south-west are detailed in the *Roads 2020 Regional Road Development Strategy* (MRWA 1997). This document is due for review, however there are three relevant proposals—deemed low priority—that are adjacent to the parks. To improve traffic flow and safety conditions, South Western Highway is proposed to be widened to a Type 5 sealed road (7 metre seal width) and provide overtaking lanes. Middleton Road (a local authority road between Northcliffe and the South Western Highway) is proposed to be widened (currently less than 6 metres wide) and upgraded to a Type 5 sealed road to ensure adequate capacity and road safety. Windy Harbour Road (approximately 5.3 metres wide) is proposed to be upgraded to a Type 4 sealed road (6 metre seal width) to facilitate and encourage further tourism in the area, and to ensure adequate capacity and road safety.

When implementing road developments, Main Roads Western Australia and the local authorities are required to undertake the necessary environmental impact assessments according to the Environmental Protection Act, the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* and the Wildlife Conservation Act.

As part of the recent acquisition of some private properties within the parks, in 2006 the Shire of Manjimup agreed to cancel the road reserves to these properties and to the addition of the road reserves into D'Entrecasteaux National Park. Also as stated in the draft management plan there are several road reserves within the parks that have not been developed into roads. These are important areas of vegetation that are not part of the conservation estate. The Shire of Manjimup agreed to cancel the unused road reserves in its shire and these areas have now also been incorporated to the parks. A total of 32 road reserves have been added to D'Entrecasteaux National Park as part of these processes. If any of the remaining private enclaves were to be included into the parks in the future, then the Department would seek for these local government road reserves also to be incorporated into the conservation estate.

Negotiations are continuing with the Shire of Nannup to have the unconstructed road reserves within its shire incorporated into D'Entrecasteaux National Park.

The bridge over the Donnelly River on Scott Road is nearing the end of its serviceable life and will most likely be closed and removed during the life of this plan. The bridge currently has a 4 tonne load limit so the Department has constructed a low level crossing over the Donnelly River to provide emergency access for heavy vehicles such as fire trucks and earth moving equipment. The Department, the Shire of Nannup and Main Roads Western Australia are currently working on a joint project to upgrade Pneumonia Road (also a Shire of Nannup road) to provide alternative long-term access to the recreational facilities, natural attractions and private property enclaves west of the Donnelly River.

Departmental Managed Public Access Roads/Tracks

The remainder of the tracks within the parks are part of the parks and managed by the Department to either provide public access to recreational sites and/or activities or they are management access only tracks.

Roads and tracks proposed to remain open to park visitors are shown in Map 11 Public Access – Vehicle and Boat, Map 12 Public Access – Walktrails, and listed in Appendix 11. The wide variety of access that has been planned for the parks ranges from walking tracks to sealed roads suitable for two-wheel drive vehicle access. In comparing recommendations in the previous 1987 plan with this plan, there are no new road closures to recreation sites other than only providing a one access track to a site where there may have been two.

Two-Wheel Drive Vehicle Access

Most of the Shannon National Park was once State forest and a number of logging and fire management tracks have been constructed throughout the park, especially in its northern half. Although, many of these tracks are now overgrown or closed, Preston and Nelson roads as well as various smaller roads, remain. The usage of Nelson Road has significantly reduced due to the cessation of logging of old growth forests and creation of new parks within the adjacent State forest. However as areas of State forest still exist east of Shannon National Park between Nelson Road and the South Western Highway, Preston Road is still used in conjunction with other smaller roads within and adjacent to the park for access. A review of the various smaller tracks is recommended to alleviate noise, dust and visual impacts on the park values.

Access in Shannon National Park for visitors will be provided along a few well-maintained gravel roads suitable for two-wheel drive vehicles including Deeside Coast Road, Curtin Road, Creekbend Road, Strachan Road, Upper Shannon Road and Lower Shannon Road which, with part of the sealed Middleton Road, form the 'Great

Forest Trees Drive'. Other two-wheel drive roads include Bevan Road, Dog Road, and Jeffery Road (Map 11 Public Access – Vehicle and Boat).

Mandalay Beach Road, D'Entrecasteaux Drive and Salmon Beach Road provide two-wheel drive all-year access to the coast. Other two-wheel drive roads within the parks are Broke Inlet Road, parts of Chesapeake Road, Lewis Road, Donnelly Boat Landing Road, and Jangardup Road (Map 11 Public Access – Vehicle and Boat). Some parts of both parks are accessible from sealed main roads or highways that run through or alongside the parks such as the South Western Highway and Windy Harbour Road. This road network provides two-wheel drive vehicle access to the diversity of natural features within the parks.

Improving access by upgrading from four-wheel drive to two-wheel drive potentially increases visitation. This places additional pressure on end-point facilities and the natural environment, and consequently changes the visitor experience. It could also duplicate the recreational experiences of adjacent parks and those elsewhere in the State. For these reasons, providing additional two-wheel drive access within the parks is not proposed in this management plan.

Four-Wheel Drive Vehicle Access

In the past cattlemen used to access most of the coastal areas throughout the park by horse; today access is gained to the coast usually by four-wheel drive vehicles. The increase in four-wheel drive use of D'Entrecasteaux National Park has placed significant pressure on the conservation values of the park. What once was irregular and mainly seasonal four-wheel drive access by locals has increased to year-round use by many sectors of the community with hundreds of four-wheel drives in the park during peak periods.

Much of the coastline in the D'Entrecasteaux National Park is sensitive to erosion, with several large mobile dune-fields interspersed by areas of consolidated wind-blown sand. Many of the vehicle tracks in the park traverse sensitive landforms that may be seasonally inundated or easily eroded (see Section 15 *Catchment Protection*).

Phytophthora in the park is also extensive with vehicles being a major factor in its spread (see Section 21 *Diseases*). The Department is trialing portable self-contained vehicle clean-down stations and it may be feasible to introduce this to the parks at some point in the future.

Some of the beaches are habitats for breeding birds such as fairy terns (*Sterna nerveis*) and hooded plovers (priority 4 – see Section 18 *Species and Communities of Conservation Significance*) and vehicle use on these beaches can damage nests during the breeding season. Therefore seasonal closure of some sections of these beaches to vehicles may be required (see Section 18 *Species and Communities of Conservation Significance* – Fauna).

Continuing to educate users on the appropriate techniques for four-wheel driving in the parks (e.g. reducing tyre pressure in sensitive landforms such as sand dunes) could aid in reducing the impacts of four-wheel driving. However, in some cases such as for disease or erosion control, habitat protection or to maintain visitor experience, access may need to be managed by either track reinforcement, realignment, closure (permanent or seasonal) or by use of a permit system (Map 11 Public Access – Vehicle and Boat and Appendix 11).

In contrast, Shannon National Park has few four-wheel drive tracks open for public use. Managing four-wheel drive access within the Shannon National Park is much easier as the density of the surrounding forest generally prevents vehicles from leaving public roads and tracks.

Departmental Management Access Only

Management access tracks are closed to public vehicle use although walkers may use them. These roads and tracks are predominantly needed for fire management. However, they may also be used for flora and fauna monitoring, baiting and trapping feral animals, weed control, water monitoring and access for maintenance.

Some management access tracks were at one time open for public use. Whenever public vehicle access to a track is removed, there may be resistance. Vandalism to gates at newly closed tracks is common in D'Entrecasteaux National Park as is the formation of new tracks to get round barriers.

Management access tracks are not shown on Map 11 Public Access – Vehicle and Boat as they are for Departmental use only.

Other Access

Boat Access

Boat access to the parks is provided from the coast and along the waterways. For example the mouth of the Donnelly River and mouth of Broke Inlet can be reached by boat throughout the year, the Warren River provides access by canoe to parts of the park which are otherwise inaccessible and boats can approach if not land at all of the beaches in D'Entrecasteaux National Park.

Walking

Limited walking trails are provided within and to the parks. The Bibbulmun Track, which begins near Perth and travels through parts of both parks, provides access by foot and is the most developed and promoted of the walking trails.

There are also opportunities for self-planned bushwalking routes in the parks via existing tracks, and extensive tracts of open coastal heathland and beaches. Within the proposed wilderness areas, visitor access will be via self-guided walk-in access only (see Section 25 *Recreational Opportunities* – Wilderness).

Horse-riding

Early settlers created their own access to the parks when riding to the coast with their cattle for grazing. Outside the parks these stock routes are generally now two-wheel drive routes. Inside the parks, these tracks have mostly now reverted to natural vegetation or have been used for another purpose such as four-wheel driving or walking. Some horse-riding tracks are used by a commercial operator to gain access to areas around Fish Creek (see Section 28 *Commercial Tourism Operations*). Recreational horse-riding access may be permitted from Windy Harbour beach and within Shannon townsite. Horse-riders continue to be able to use the State and local authority roads, however cannot leave these roads to access the parks (see Section 27 *Recreational Use* – Recreational Activities – Horse-riding).

26. Visitor Access – Key Points

- Visitors to the parks seek 'destination-based' access as well as opportunities for four-wheel driving and scenic driving as specific activities.
- Access needs to be carefully managed so it does not compromise the qualities of remoteness and wilderness valued by visitors.
- Two-wheel drive roads already provide access to most types of significant natural features in the parks including access to the coast.
- The timber industry has developed a network of log-haulage roads through the Shannon National Park with Preston Road and Arthur Road currently still being used for log-haulage.
- Four-wheel drive use in the D'Entrecasteaux National Park has increased and may remain at high levels.
- Some of the current four-wheel drive access tracks traverse sensitive landforms and require repair, realignment or closure.
- Vehicles can contribute to the spread of *Phytophthora* through the parks.
- Track closure sometimes results in vandalism and further environmental damage in D'Entrecasteaux National Park.

The objective is to provide and maintain a range of safe access types that do not adversely impact on conservation or other values of the parks and facilitate the visitor's appreciation of the parks' natural values.

This will be achieved by:

1. Maintaining, upgrading, realigning, rehabilitating or closing roads and tracks as indicated in the Vehicle Access Strategy (Appendix 11).
2. In addition to those identified in the Vehicle Access Strategy, in consultation with the Conservation Commission, realigning or removing and rehabilitating tracks if in the future there is an adverse impact on fragile areas or they are deemed not required.
3. Closing access to sites that have ongoing significant safety and/or environmental issues.
4. Seasonally restricting access along beaches that have safety and/or environmental issues as required such as during the breeding bird season.
5. Continuing to prohibit vehicles driving off established roads and tracks except by authorised persons in exceptional circumstances.
6. Ensuring management access tracks are effectively closed to the public.

7. Providing information to visitors explaining why they cannot access certain areas, alternative routes, and where similar experiences may be provided.
8. Negotiating to cancel unnecessary road reserves within the parks and adding these to the Shannon and/or D'Entrecasteaux national parks.
9. Applying a code of practice for driving on four-wheel drive tracks and beaches within the parks.
10. Investigating the use of vehicle wash down points or portable self-contained clean-down stations for visitors to use to minimise disease spread.
11. Not upgrading or improving access to areas within the parks without first ensuring that the level of access is appropriate for the level of facilities provided at recreation sites.
12. Negotiating with private property owners, Main Roads Western Australia and local authorities to ensure that road reserves to private enclaves are best located to protect conservation and landscape values of the parks and satisfy owners access requirements.
13. Liaising with Main Roads Western Australia and/or local authorities where development is proposed in a road reserve adjacent to the parks to ensure appropriate management with regards to flora surveys, *P. cinnamomi*, weeds, drainage control, visual amenity and rehabilitation.
14. Continuing to work with four-wheel drive associations and other community groups to maintain and/or rehabilitate tracks.
15. Ensuring that at least the following conditions are imposed on log haulage operations within the parks:
    - encouraging trucks to limit their speed to 60 kilometres per hour;
    - road or verge development is managed to minimise disturbance;
    - vegetation is not removed from the road verges unless for public safety (e.g. slashing is allowable if required to improve visibility);
    - appropriate disease control procedures are implemented;
    - the maintenance standard is acceptable to the District Manager; and
    - gravel for log road maintenance is to be obtained from outside the parks and existing pits within the parks are to be rehabilitated.
16. Suggesting alternative routes for log haulage outside the parks.

Key Performance Indicator (See also Appendix 2)

Performance Measure	Target	Reporting requirements
26.1 Condition of four-wheel drive tracks designated for seasonal closure or permit only access and protection of values at the destination	26.1 Track/destination condition is maintained or improved from 2012 levels	Annually

27. RECREATIONAL USE

Recreational activities and sites in the parks are shown in Map 12 Existing Recreation Use.

Recreational Activities

Recreational Driving

Many owners of four-wheel drives and motorbikes seek recreational driving experiences within the parks (see Section 26 *Visitor Access*). Rough four-wheel drive tracks, sand dunes, creek and river crossings and diverse scenery combine to attract an increasing number of four-wheel drive clubs and enthusiasts to the parks.

It is important that any recreational driving within the parks complies with the Conservation and Land Management Regulations to avoid damage to the environment, damage or injury to visitors and their vehicles and conflict with other users. Some four-wheel drive club members regularly volunteer their time to environmental projects in the parks, such as to rehabilitate tracks, clear rubbish and remove weeds. Unfortunately, there are still many recreational drivers within the parks who are not aware of, or ignore, the need to minimise environmental impacts.

Although it may appear that dune systems like the Yeagarup Dunes would not be adversely affected by off-road driving, the dune vegetation is very sensitive to four-wheel driving and visitors who choose to leave the marked tracks can cause dune damage. As the dunes regularly change shape and can form very steep dune faces, visitors who leave marked tracks also place themselves and property at risk. There is one marked track that crosses the Yeagarup Dunes, which is checked regularly to ensure it provides a safe passage to the beach. However, due to natural dune movement access to and across the dunes is likely to be cut off during the life of this plan. The

Department will consider an alternative route if the environmental impacts are acceptable, or put in place management options to keep the current route open.

While the use of dune buggies on the beaches of D'Entrecasteaux National Park has decreased, the use of four-wheel motorbikes for off-road riding and accessing beaches for fishing has increased. Many trail motorbikes also regularly visit the parks (particularly D'Entrecasteaux National Park) and illegally drive off-track through sensitive vegetation and dune systems. Motorbikes are also able to get around gates and barriers placed to close roads and tracks.

All vehicles within the parks must be registered under the *Road Traffic Act 1974*, and all drivers must possess a current driver's licence. The relevant road rules, such as not driving under the influence of alcohol or drugs and not using excessive speed, also apply. Any vehicle registered under the *Control of Vehicles (Off-road Areas) Act 1978* is not permitted to operate in the parks except under exceptional circumstances with permission from the District Manager (such as four-wheel drive bikes that can facilitate disabled person access).

Recreational Driving – Key Points

- Shannon and D'Entrecasteaux national parks provide many opportunities for recreational driving experiences.
- Inappropriate recreational driving can cause damage to the environment.
- Recreational driving needs to be controlled in the Yeagarup Dunes to protect vegetation and visitor safety and enjoyment.
- All vehicles must be registered and drivers have to be licensed and obey normal road rules.

The objective is to provide opportunities for recreational driving within the parks that do not conflict with other users, damage the environment or cause damage or injury to visitors and their vehicles.

This will be achieved by:

1. Ensuring any motorised vehicle used in the parks is appropriately registered and complies with the Department's requirements.
2. Not permitting vehicles to drive off marked tracks or roads within the parks (Map 11 Public Access – Vehicle and Boat).
3. Maintaining a defined track across the Yeagarup Dunes and informing drivers that leaving the marked route is not permitted.
4. Maintaining some areas of the parks as vehicle-free by instituting appropriate visitor management settings and gazetting wilderness.
5. Developing and distributing information on appropriate behaviour in the parks for four-wheel drivers and those looking for recreational driving experiences.
6. Investigating appropriate information signage for the Departmental-managed tracks and beaches.
7. Continuing to work with local, state and national four-wheel drive and off-road vehicle clubs and associations to actively promote responsible use in the parks.

Key Performance Indicator (see also Appendix 2)

Performance Measure	Target	Reporting requirements
27.1 Incidence of inappropriate recreational driving	27.1 Number of incidents decrease from 2012 levels	Annually

Scenic Driving

During a visitor survey conducted in the parks in 1999 (see Section 25 *Recreational Opportunities – Visitor Numbers and Trends*), in addition to four-wheel driving (66%), sightseeing (51%) and pleasure driving (55%) were also popular activities carried out in the parks. Sightseeing and driving for pleasure are important recreational pursuits for many visitors. A large proportion of visitors experience the park and gain their enjoyment and appreciation of the natural environment in this way.

Generally, scenic drives are built to a standard capable of accommodating two-wheel drive vehicles. There are two formal scenic drives in the parks—the Great Forest Trees Drive in the Shannon National Park and the drive to the lookout at Point D'Entrecasteaux (Map 13 Existing Recreation Use). Other two-wheel drive access roads include:

- Boat Landing Road to Donnelly River;

- Lewis Road to Warren Beach Track;
- Windy Harbour Road to the settlement of Windy Harbour;
- Deeside Coast Road through Shannon National Park;
- South West Highway through Shannon National Park linking Manjimup and Walpole;
- Broke Inlet Road to the settlement of Camfield and Broke Inlet;
- Mandalay Beach Road to Mandalay Beach;
- Salmon Beach Road to Salmon Beach; and
- D'Entrecasteaux Drive from Windy Harbour to Pt D'Entrecasteaux.

These roads cross a variety of landscapes and provide additional scenic driving opportunities (Map 11 Public Access – Vehicle and Boat).

Much of the access for vehicles to the coastal areas of the parks is confined to four-wheel drives (see Section 26 *Visitor Access* and Map 11 Public Access – Vehicle and Boat). Therefore there is some pressure to increase access for two-wheel drive vehicles for scenic driving purposes and in particular commercial bus tours. However, two-wheel drive access is already available to the diversity of features in the park and 26% of park visitors surveyed in 1999 indicated that the aspects of D'Entrecasteaux National Park they most valued were the unspoiled surroundings, isolation and peace, with another 8% reporting that the parks natural features were most important. Some park visitors (12%) were concerned that an increase in the quality of access in the parks would diminish the very characteristics that they came for (see Section 25 *Recreational Opportunities – Visitor Management Settings*).

It is important to protect the remoteness of the parks, and it is planned that two-wheel vehicle access will continue to be limited in the parks and particularly along the coast of D'Entrecasteaux National Park (see Section 26 *Visitor Access – Two-Wheel Drive Vehicle Access* and Appendix 11). If further scenic drives are required through the parks over the life of this plan, the existing road network and links to roads external to the parks will be considered. No new or improved public vehicle access will be permitted other than that identified in the Vehicle Access Strategy (Appendix 11).

Scenic Driving – Key Points

- Approximately half of the visits to the parks include scenic driving as an activity.
- There needs to be a balance between providing two-wheel drive and four-wheel drive access so as to not affect the natural settings enjoyed whilst scenic driving.

The objective is to provide a range of scenic driving opportunities that facilitate appreciation of the natural values of the parks without compromising conservation and other recreational values.

This will be achieved by:

1. Maintaining the designated scenic drives and tourist routes.
2. Preparing promotional and interpretive material about the scenic drives and tourist routes throughout the park and disseminating this through appropriate outlets such as tourist centres, Streetsmart maps and RAC guides.
3. Using the existing network of roads for developing scenic opportunities in the parks and linking any new scenic drives in the parks with surrounding natural areas, where appropriate.
4. Implementing the Vehicle Access Strategy (Appendix 11)

Bushwalking

In its various forms, bushwalking can encompass everything from a short, leisurely stroll to a major trek lasting days or even weeks. In comparison with motorised types of access, bushwalking enables visitors to experience the natural environment at close quarters. Six categories of walking trails are recognised by Standards Australia (2001), from trails where there is no modification to the natural environment (Class 6) to broad, hard surfaced tracks suitable for wheelchair use (Class 1). All categories may be provided for in the parks.

This gradation from remote to developed fits in with the visitor management settings approach (see Section 25 *Recreational Opportunities – Visitor Management Settings* and Appendix 10) with the more developed trails provided in the more 'developed' settings although it is recognised that many trailheads are more developed than the overall setting of the walk (such as for the Mt Pingerup Walk). Existing walking trails in the parks are described in Table 7 and those over 1 kilometre are shown in Map 12 Public Access – Walktrails.

Table 7: Existing Walking Trails within the Parks

Walk	Length (One Way)		Class(es) 1-6	Visitor Management Setting
	km	Hours		
❖ Pt D'Entrecasteaux Lighthouse (Pupalong Trail)	0.5	<1	2	Highly Modified - well built walking trails in concentrated area of modified environment
❖ Shannon Dam	3.5	2	2	
❖ Windy Harbour to Pt D'Entrecasteaux (Coastal Survivors Walk)	2.8	1	3	Recreation - well built walking trails in mostly natural areas
❖ Pt D'Entrecasteaux to Tookulup (Cliff Top Walk)	2	1	2 to 3	
❖ Mt Chudalup	1	1	3	
❖ Great Forest Trees Walk	4	3	3	
❖ The Rocks	5.5	3	3	
❖ Mandalay Beach Track Access	0.5	<1	2 to 3	
❖ Bibbulmun Track – *Gardner River to Lake Maringup*	15.9	7	4	Natural-Recreation - formed walking trails in predominantly natural areas
❖ Bibbulmun Track – *Lake Maringup to Dog Rd*	24.5	7	4	
❖ Bibbulmun Track – *Dog Rd to Mt Chance*	19.4	7	4	
❖ Bibbulmun Track – *Mt Chance to Woolbales*	20.4	7	4	
❖ Bibbulmun Track – *Woolbales to Long Point*	17.2	7	4	
❖ Mt Pingerup	3	3.5	4	
❖ Highway Access Track to Bibbulmun Track via Woolbales	4	3.5	4	
❖ Bottleneck Bay	0.5	<1	5	
Total	124.7 km			

The impact of bushwalking on the physical environment, while generally low, can be quite variable depending on soil conditions, topography and intensity of use. Soil compaction and erosion problems are the main issues of concern, although other impacts such as the introduction and/or spread of weeds and plant diseases or the escape of fires from campfires may also occur. Usually these problems can be effectively minimised through the sensitive location and design of paths and careful selection of camp sites.

Where no rubbish collection facilities are provided by the Department, all rubbish should be carried out according to the 'clean, crush and carry' philosophy of rubbish disposal. Where no toilet facilities are provided by the Department, all toilet waste should be buried at least 100 metres from any creek or watercourse at a depth of at least 15 centimetres.

There can be safety problems associated with long distance hikes including the threat of wildfire or becoming lost or injured. Such problems can largely be overcome through the provision of a self-registration system, effective signs and visitor information programs designed to ensure walkers are adequately informed about and equipped to handle the conditions they will encounter.

The Bibbulmun Track has the most developed facilities of any trail in the parks, and is the most promoted and most heavily used. However, an increasing number of park visitors are looking for more remote off-track experiences or walking routes. The diverse landscapes of the parks provide for a greater range of opportunities for walking tracks than currently available. In particular, opportunities for Class 5 and 6 walks are absent and will be considered.

Some potential bushwalking opportunities have been identified and are described in Table 8 below. These walking trails will be considered during the life of this plan. Further walks may be developed as the need arises in consultation with the community and the Conservation Commission as long as they fit within the visitor management setting of the area, provide an increase in the range of natural values that can be appreciated and environmental disturbance is minimised.

Table 8: Potential Walking Trails within the Parks

Walk	Length (one way) km	Hours	Class(es) 1-6	Management Setting
❖ Black Point	5 to 10	5	2 to 4	**Recreation** – well built walking trails in mostly natural areas
❖ Donnelly River	~15	8	3 to 4	
❖ Tookulup to Salmon Beach	<5	2	3	
❖ Salmon Beach to Pt D'Entrecasteaux (loop option)	7	4	3 to 4	
❖ Shannon Townsite Walk	<5	2	2 to 3	
❖ Banksia Camp walk	1	<1	4	
❖ Crystal Springs to Mandalay Beach Track	9	5	4	
❖ Lake Jasper	5 to 10	5	4	**Natural-Recreation** - formed walking trails in predominantly natural areas
❖ Yeagarup Lake to Yeagarup Dunes	5 to 10	5	4	
❖ Northern Shannon Circuit	10 to 25	2 days	3 to 5	
❖ Mandalay Beach to Crystal Springs via Long Point (loop walk)	13	8	4	
❖ Black Point to Mandalay Beach Coastal Walk	70 to 80	4 days	6	**Natural** - walking routes in natural areas
❖ Lake Jasper to Black Point	15 to 20	2 days	4 to 5	
❖ Crystal Springs to Woolbales	5 to 10	5	4 to 5	
❖ Lake Maringup to Mandalay Beach via Broke Inlet Mouth (providing loop walk in conjunction with Bibbulmun Track)	35 to 45	3 days	4 to 6	
❖ Boat Landing Rd to Yeagarup Dunes	15 to 20	2 days	5 to 6	**Wilderness** – unformed walking routes in remote natural areas

Bushwalking – Key Points

- Bushwalking enables visitors to experience the natural environment at close quarters.
- There are approximately 120 kilometres of walking tracks of classes 2 to 4 provided within the parks.
- Although the impact of bushwalking on the environment is generally low, soil compaction, loss of vegetation, the spread of weeds and diseases such as *Phytophthora*, littering and campfire escapes can occur.
- Walkers need to be aware of the safety problems associated with bushwalking in a remote area.

The objective is to provide a range of bushwalking opportunities across a range of landscapes that do not adversely impact on conservation, landscape and other values.

This will be achieved by:

1. Careful appraisal of visitor needs and environmental impacts as well as the availability of resources for construction and ongoing maintenance.
2. Considering options for the provision of new or altered tracks of a variety of classes in consultation with walking and community groups.
3. Ensuring that the standard of new tracks is appropriate to the relevant visitor management setting.
4. Constructing and locating all tracks in accordance with established planning procedures and environmental controls, for example:
   - tracks located so as to minimise environmental impacts, enhance visitor experiences and, where appropriate, provide interpretation opportunities;
   - alignments and grades selected so as to provide a range of standards to suit user requirements and safe access with minimum disturbance to the natural environment and minimum maintenance;
   - signposting tracks to indicate their degree of difficulty;
   - providing tracks of a uniform class where possible;
   - minimising risks to the users and interference to park values;
   - locating walking tracks in the parks that complement or link up with tracks on adjoining lands, where practicable;
   - constructing interpretive walks and shorter loop paths to a standard suitable for use by people with

disabilities, where practicable; and
- providing boot cleaning stations for disease control.

5. Developing and making available to bushwalkers a code of conduct that applies to bushwalking within the parks including:
   - recommended party size;
   - camping and campfire policy; and
   - toilet waste disposal and general waste disposal.
6. Providing adequate information from which visitors can choose the walk best suited to their needs and interests.
7. Encouraging long-distance bushwalkers to register their intentions in logbooks or with the Department.
8. Controlling bushwalking in areas temporarily or permanently closed for reasons such as disease management, protection of threatened species, rehabilitation or impact from fire.
9. Introducing management controls including the issuing of permits, the temporary resting or closure of tracks and backpack camp sites where the intensity of hiking in remote areas threatens resource values or the enjoyment of other users.

Cycling

Cycling brings health benefits, allows for disabled access and encourages closer interaction with the environment. Demand for all-terrain cycling has increased markedly over the past decade, as evidenced by the increase of sales of mountain bikes in Western Australia (in 1999 over 90% of all bikes sold in Western Australia were mountain bikes).

While the Department recognises these benefits, and is actively developing mountain biking trails throughout the State, cycling can also conflict with other users and have negative impacts on the environment. Possible environmental impacts include facilitating the spread of disease, destruction of vegetation and soil erosion. A study within the south-west showed that some mountain bike riders would support a code of conduct to promote protection of the environment and that there is a need to raise rider awareness and understanding of diseases such as *P. cinnamomi* (Goeft and Alder 2000).

The Department is currently developing the Munda Biddi Trail[14], a long-distance mountain bike trail through State forest and national parks from Perth to Albany. Facilities will include camp sites, toilets, picnic sites and water tanks at regular intervals. The trail will be implemented in three stages, with the third stage linking Northcliffe and Albany and passing through Shannon National Park (Map 2 Regional Context and Map 13 Existing Recreational Use). The details of this stage are still being developed in consultation with communities and user groups. The proposed alignment currently includes Shannon townsite but the final alignment may pass through the park on a more direct route between Northcliffe and Fernhook Falls on the Deep River, east of D'Entrecasteaux National Park. Loop trails along the length of the trail is also being investigated.

The Munda Biddi Trail and associated loops should be sufficient to meet the demands for mountain bike use in the parks. As it is a purpose built trail, conflict with other users should be minimised. If the trail is not constructed during the life of this plan, then other opportunities for mountain biking consistent with the visitor management settings will be considered. For example, provision of mountain bike trails or multi-use paths along existing rail alignments may also be assessed as part of the ongoing development of the Shannon townsite.

Cycling – Key Points

- Most bike sales in Western Australia are mountain (all-terrain) bikes.
- Impacts to be managed include conflict with other users and the spread of disease, vegetation damage and soil erosion.
- The Munda Biddi long-distance mountain bike trail is proposed to traverse Shannon National Park.

The objective is to provide opportunities for bike riding that minimise the impact on the environment and on other visitors.

This will be achieved by:

1. Continuing to facilitate cycling on public access roads and tracks in the parks as shown on Map 11 Public Access – Vehicle and Boat, which includes those accessible by four-wheel drive vehicles.
2. Educating cyclists about the impacts on the environment and actions that can be taken to minimise these

[14] The Munda Biddi is a purpose built trail based on the concept of, but separate from, the Bibbulmun Track which is a long-distance walking trail which does not permit mountain biking.

impacts.
3. Completing the third stage of the proposed Munda Biddi Trail and associated loops through the Shannon National Park on an alignment endirsed by the Conservation Commission.
4. Allowing cycling on the proposed Munda Biddi Trail and associated loops, or on similar specifically designated cycle tracks within the parks.

Horse-riding

Horse-riding in natural bush settings and scenic coastal areas is a popular recreational activity in the south-west. According to Departmental policy, horse-riding may be permitted in national parks where:

- the activity is a pre-established use;
- environmental and social impacts are considered manageable; and
- the activity does not conflict with other values.

Biological and physical impacts of horse-riding include conflict with other users, trampling and grazing of plants, spreading weeds and disease, disturbing native fauna, soil compaction and erosion (Newsome *et al*. 2004). The level of impact is dependent on the extent, frequency and intensity of use, topography and soil type. Climatic aspects such as rainfall and wind speed are also compounding factors. Some sites are therefore susceptible to more damage than others, especially areas with steep slopes, sandy or clayey soils, and wetland areas. The landscapes of the D'Entrecasteaux National Park generally have a very low capability to sustain uses that involve disturbance of the soil or vegetation, such as horse-riding. The previous management plan prescribed that the effects of horse use in the parks be monitored and suggested that the plan be amended as appropriate dependant on the information gained from the monitoring.

Phillips (2000) studied the impacts of trampling, compaction, erosion, grazing and the spread of plant diseases and weeds of a commercial tour operator in D'Entrecasteaux National Park. The results indicated that low levels of horse-riding cause a significant degree of vegetation and soil impact, and potential erosion, invasion and spread of weeds and *Phytophthora* (Phillips 2000, Phillips and Newsome 2002). The conclusion of the study was that the environmental impacts of horse-riding, when undertaken on a commercial tour operator basis with strict controls in place, are localised and can be managed.

Newsome and Phillips (2002) identified three management options for D'Entrecasteaux National Park:

1. prohibiting use – "*the most effective means of minimising the impacts of horse-riding"*;
2. unrestricted open access; and
3. managing tour operators.

They concluded that "*…open access of protected areas for recreational horse-riding is inconsistent with conservation objectives and should not be allowed*". However, they acknowledged that managed access on specified trails (as opposed to cross country) using tour operators could directly control the number of users and area of use.

It is therefore recommended that one operator will be allowed to continue horse-riding tours in the Fish Creek of D'Entrecasteaux National Park on routes approved by the District between Gardner River and Broke Inlet (Map 13 Existing Recreation Use) subject to the license conditions listed in Appendix 13. One of these conditions will be that the commercial horse-riding operation uses private property for overnight tethering. The commercial horse-riding operation will be monitored regularly and managed appropriately if adverse impacts occur.

As the impacts of recreational horse-riding in D'Entrecasteaux National Park are difficult to manage, no public bridle trails will be provided in D'Entrecasteaux National Park. However, horse-riding may be permitted on the beach between low and high water mark from Windy Harbour to Gardner River as long as the Shire of Manjimup approves access through the Windy Harbour reserve and impacts along the beach are manageable with regards to other users and breeding birds.

As part of the negotiations to purchase Banksia Flat pastoral lease in 1992, the lessees were offered a lease for continued use of the hut on the property until 2015, and access was granted for them and their family to continue recreational horse-riding on the former lease and to access the coast. From 30 June 2015, however this permission will cease.

In comparison to D'Entrecasteaux National Park, much of the Shannon National Park may be capable of supporting horse use on the network of existing roads and tracks as the soils are more stable, the vegetation is less susceptible to *Phytophthora*, and the conflict with other users is not as great.

Establishing one or two loop bridle trails from Shannon townsite using some of the disused tracks and/or firebreaks will be investigated. Overnight tethering may be permitted at Shannon townsite. Otherwise no horses will be permitted to be kept overnight in the parks.

In the adjacent parks of the Walpole Wilderness, there are several horse-riding opportunities that have been identified for investigation and development. There are also opportunities for public bridle trails in State forest in the region.

Horses are classed as vehicles under the Road Traffic Act and are therefore permitted on gazetted public roads managed by Main Roads Western Australia or local government (see Section 26 *Access*). Horse-riding has been occurring alongside Deeside Coast Road which can continue under the Road Traffic Act as well as along Chesapeake Road, as long as it is contained within the road reserve which is not part of the conservation estate.

Educational material and signage will be provided in suitable locations for horse-riding in the parks such as the Shannon townsite.

Horse-Riding – Key Points

- Horse-riding can lead to conflict with other users, trampling and grazing of plants, spread of weeds and plant disease, disturbance to native fauna, soil compaction and erosion.
- The landforms of the D'Entrecasteaux National Park have a low capacity to sustain horse-riding.
- There is currently one commercial horse-riding company licensed in the D'Entrecasteaux National Park and recent research suggests that the impacts can be managed if adequately confined.
- There are opportunities for public bridle trails in the adjacent parks of the Walpole Wilderness and neighbouring State forest.

The objective is to provide horse-riding opportunities in the parks that minimise the impact on the environment and on other visitors.

This will be achieved by:

1. Allowing one commercial horse-riding operator) as per Departmental policy and licence conditions in Appendix 13 (see Section 28 *Commercial Tourism Operations*).
2. Restricting the commercial horse-riding operation to identified routes subject to the approval of the Department.
3. Negotiating with the commercial horse-riding operator to minimise environmental impacts of activities such as soil erosion, vegetation trampling and disease spread by applying suitable environmental criteria to licence conditions as necessary.
4. Investigating options for one or two loop bridle trails from Shannon townsite using some of the disused tracks and/or firebreaks.
5. Investigating options for overnight tethering at Shannon townsite but not elsewhere in the parks.
6. In conjunction with the Shire of Manjimup, trial horse-riding along the beach from Windy Harbour to Gardner River as long as there are no impacts with other users or on natural values, in particular breeding birds currently or previously known to use the area.
7. Otherwise prohibiting horse-riding within the parks.
8. Monitoring all horse-riding within the parks to ensure all impacts are managed appropriately and discontinuing use if impacts cannot be managed.
9. Encouraging recreational horse-riding in areas outside the parks which are able to sustain this activity.

Key Performance Indicator (see also Appendix 2)

Performance Measure	Target	Reporting requirements
27.2 Condition of landscapes used for commercial horse-riding	27.2 Landscape condition is maintained	5-yearly

Boating

The main water bodies in and near the parks used for boating are Broke Inlet, the Warren, Gardner and Donnelly rivers and Lake Jasper. Different types of boats and water-craft previously used in the parks include power-craft

(power-boats and jet-skis), sail-craft and kayaks/canoes/rafts. Uses include fishing, water-skiing, jet-skiing and gaining access to destinations such as the mouth of the Donnelly River or Broke Inlet. However, jet-skiing has always been prohibited and this plan proposes to also prohibit water-skiing and all powercraft on Lake Jasper.

The environmental impacts of canoeing and sailing are relatively small whereas power-craft use can have negative effects upon other water users, flora and fauna, water quality and may cause bank erosion or disturbance to sensitive lakes or riverbeds. Some activities also require additional facilities such as launching ramps, small jetties and parking bays for trailers.

The Department has prepared a draft *Paddling Management Strategy for the Warren Region* (CALM 2004) that aims to minimise risk associated with paddling activities by the provision of appropriate information and to a lesser extent, facilities.

Canoeing and other forms of non-motorised boating are allowed within the parks on Shannon Dam, Lake Jasper and all of the rivers within the parks (Map 11 Public Access – Vehicle and Boat and Map 13 Existing Recreational Use). Power-boat use is allowed along the Donnelly River from the mouth of the river to Boat Landing Road and in the lower reaches of Gardner River although this is a low level of use due to the nature of the river and small area of navigable water. A commercial licence to operate power-boat tours on the Donnelly River (see Section 28 *Commercial Tourism Operations*) will be permitted as long as monitoring shows that there are no adverse environmental impacts.

The previous management plan for the parks (CALM 1987) allowed for power-craft use on Lake Jasper in an area gazetted by the Department of Transport for such use. However, since the publication of the previous management plan archaeologists and divers from the Western Australian Museum identified a number of submerged Aboriginal sites on the bed of Lake Jasper in 1989 (see Section 23 *Indigenous Heritage*). Local Aboriginal people believe that the continued use of power-craft on the lake is disrespectful to the importance of the area to the Aboriginal culture due to the presence of these sites and the uniqueness and significance of the area to Aboriginal people. This was confirmed, subsequent to the release of the Draft Management Plan (CALM 2005b) when the Department met with the Walgenup Aboriginal Corporation on the 29 September 2005 and the native title claimants on the 24 November 2005. At both meetings, the groups confirmed that their views were that power-craft on Lake Jasper is disrespectful, and supported the prohibition of power-craft on the lake. The Conservation Commission is also committed to upholding the views of the Aboriginal community in this regard.

Also since the publication of the previous management plan, the environmental values of the lake have been further highlighted. A systematic overview of the environmental values of the wetlands, rivers and estuaries in the region conducted by the former Water and Rivers Commission (Pen 1997), lists Lake Jasper as an important wetland. This report also recognises water-skiing on Lake Jasper as a potentially major degrading activity (see below). In addition, Lake Jasper and the surrounding wetlands are listed in the Directory of Important Wetlands in Australia (Environment Australia 2001a) (see Section 18 *Species and Communities of Conservation Significance*).

Regular inspection of Lake Jasper by the Department of Transport and the Department has also shown that previous management arrangements were not workable or enforceable and the effort needed to ensure compliance by power-craft users is not an effective use of financial and staff resources. For example:

- most of the buoys used to demarcate the ski area are either removed by users or the wind;
- information signs at the boat launching ramp to reinforce the power-craft zone were regularly vandalised;
- power-craft routinely operate outside the 'power-craft zone' and use most parts of the lake;
- the designated swimming area is one of the most popular areas used by power-craft;
- an increasing number of jet-skis are using the lake even though this is prohibited;
- power-craft towing skiers come close to the lake edge at high speed to 'drop-off' skiers as well as when pulling skiers away from the lake edge, creating backwash which can lead to shoreline erosion;
- complaints are often received from day visitors and campers about the noise pollution caused by power-craft on the lake, and visual 'pollution' caused by the buoys.

There has been no targeted research specifically on the impact of power-craft use on Lake Jasper, however since power-craft has been allowed on Lake Jasper several comments have been made on the impacts as part of other environmental and archaeological studies of the lake as per below:

- Pen (1997) singles out waterskiing on Lake Jasper (and Lake Unicup) as an example of an activity that threatens to degrade natural areas in the long-term, through infrastructure developments, effluent disposal, noise, odours, dust, trampling, littering, and erosion;

- Charlie Dortch, formerly of the WA Museum, the supervisor for the archaeological surveys found the lake environment and setting to be deteriorating steadily through intensifying human impact and he cites the ultimate cause of this, as the 1987 decision to allow water-skiing (Dortch 1996);
- Robinson (1992) in a report on the flora of wetlands on the south coast of Western Australia, ranks Lake Jasper highly but states its conservation value was lessened by its high degree of accessibility and recreational use; and
- Dortch (1996) suggests that the lake's marron population has been overfished, and the birdlife has been disturbed by the "*racket and commotion of powerboats, motor vehicles, generators and stereos*".

In addition, power-craft represents an unacceptable risk to the fauna values of the nationally significant wetland.

Importantly, the Department seeks to manage risk to the significant natural values of Lake Jasper, therefore it is not necessarily about what impacts have been shown to date, but the potential impacts of power-craft use (and other recreational use). For example an oil spill would have an unacceptable outcome on the flora, fauna and water quality of the lake.

In summary, the Aboriginal significance of the site, it's listing as an important wetland, the impacts on conservation and other recreational values, and the potential impacts of power-craft use justify the closing of Lake Jasper to power-craft.

The nearest alternatives for locals are Lake Towerining at Moodiarrup, and Molloy Island on the Blackwood River. There is also Geographe Bay-Busselton, Bunbury Harbour, and Stockton open pit and Glen Mervyn Dam at Collie. Given the better road conditions, the travel times to sites such as Glen Mervyn Dam (a forest setting comparable to Lake Jasper) or Molloy Island would be similar to travelling to Lake Jasper. There is also the potential for a commercial operation in the south-west to provide a water-skiing venue on private property.

Boating – Key Points

- Most boating in the parks occur in Broke Inlet (the shores and islands of the inlet are in the parks), the Warren, Gardner and Donnelly rivers, Shannon Dam and Lake Jasper.
- Power-craft can have negative effects on other users, flora and fauna, water quality and may cause bank erosion or sediment disturbance.
- Lake Jasper's conservation values have been formally recognised by Environment Australia and the former Water and Rivers Commission.
- Submerged Aboriginal sites have been discovered at Lake Jasper since the publication of the last management plan for the area and local Aboriginal people find the continued use of power-craft to be disrespectful to these sites and their culture.

The objective is to provide for boating recreation activities that are compatible with protecting and maintaining conservation values and without impairing other recreation activities.

This will be achieved by:

1. Applying to the Department of Transport to rescind the gazettal of Lake Jasper for power-craft use.
2. Prohibiting the use of jet-skis (and other personal water-craft) on Lake Jasper and other water bodies within the parks, and providing adequate signposting and information regarding this at the start of major access roads, in particular to Lake Jasper.
3. Removing the boat ramp and rehabilitating the boat ramp area at Lake Jasper.
4. Providing information about alternative boating areas in the region.
5. Providing new boating facilities related to activities only where they are directed toward the appreciation of the parks' natural values, and are carefully selected and planned to minimise compaction, erosion, removal of vegetation and littering.
6. Permitting the use of non-motorised craft on the Shannon Dam, Lake Jasper and all of the rivers within the parks, and prohibiting use in all other water bodies of the park.
7. Providing appropriate information on river difficulty and water levels for water-craft users including power-boats as appropriate but in particular for canoeists and paddlers.
8. Allowing public power-boat use of navigable reaches of the Donnelly River and Gardner River as long as physical, biological and social impacts are minimised.
9. Permitting one commercial operator to run power-craft tours of Donnelly River subject to relevant monitoring and licensing conditions (see Section 28 *Commercial Tourism Operations*), which will include level of use.

10. Providing written information and signs at popular boat launching areas regarding hazards and boating regulations for boat users in liaison with the Department of Transport.

Key Performance Indicator (see also Appendix 2)

Performance Measure	Target	Reporting requirements
27.3 Condition of the navigable reaches of Donnelly and Gardner rivers	Shoreline condition maintained or improved	5-yearly

Marroning and Fishing

Recreational fishing is managed by the Department of Fisheries throughout the State in accordance with the Fish Resources Management Act. However, access to fishing sites is managed by the Department to prevent or manage environmental degradation of riverbanks and foreshores.

Marron (*Cherax tenuimanus*) is a large freshwater crayfish species endemic to the south-west of Western Australia, although it has been translocated to other areas (Molony and Bird 2002). Due to agricultural development and associated factors such as stream salinity and eutrophication, marron distribution is now restricted to the streams and pools in forested areas of the south-west, where water quality is higher. It is possible that increased land use pressures could result in a further loss of marron habitat in the forested areas, which currently provide all of the marron catch from wild (natural) populations. Predation by introduced species such as trout, redfin perch and laughing kookaburras has added to the problems created by increased harvesting and reduced habitat (Morrisey 1978).

Marroning is a popular activity in the parks requiring a licence from the Department of Fisheries, during an open season usually a short period in summer. In 2008 the open season was 23 days from the last Friday in January (Department of Fisheries 2006b). Marron occur in the rivers and most of the permanent freshwater lakes in the parks. Although the species has a high reproductive capacity, most marron populations have declined to the point where it is becoming more difficult to catch specimens of legal size.

Impacts caused by marroning include disturbance of riverbanks and shoreline vegetation, littering and escapes from campfires. Some marroners are responsible for making new tracks or removing or avoiding barriers. Some of the closed vehicle tracks in the park continue to be used to gain seasonal access to marroning sites. Those on the Windy Harbour Road in particular are poorly located, and have created substantial visual scars in an otherwise natural landscape. These marroning tracks are often located in low-lying inundated areas, where the potential for disease spread is high.

There is also a small number of people who access the park to fish for gilgies and koonacs. The issues associated with these activities are similar to that of marron fishing.

In 1990 the Shannon River was declared a 'snare-only' fishery to reduce the effects of high levels of fishing pressure. Due to its isolation and inaccessibility and the fact that the Shannon River is not actually suited to snare fishing, the take of marron from the river was not thought to be significant. Following on from recommendations from the Recreational Freshwater Fisheries Stakeholder Sub-Committee of the Recreational Fishing Advisory Committee (Department of Fisheries 2006a), the Shannon River and all its tributaries were closed to marron fishing from January 2007 (Department of Fisheries 2006b). The recommendation was based on the fact that the Shannon catchment, unlike other river catchments in the south-west, provides a buffer zone that shields the river from agricultural and rural practices that may impact on water quality. Therefore, closing the entire river system would be in keeping with the conservation values of the Shannon National Park and would also provide the Department of Fisheries' research scientists with an area for assessing the impact of environmental factors such as climatic changes and variations of rainfall on marron populations in the absence of fishing pressure.

The closure is for an initial five-year period and is to be re-evaluated with the possibility of re-opening the river after five years.

Another recommendation of the Recreational Freshwater Fisheries Stakeholder Sub-Committee was to allow the transportation of marron drop nets and scoop nets by boat on the Donnelly River downstream of Boat Landing. The Department has concerns that the limited opportunity to fish from the banks of the Donnelly would encourage the use of drop nets and scoops from boats and that there would not be the Department of Fisheries' resources to monitor and manage the illegal use from boats. However, the Minister for Fisheries implemented the recommendation on a five-year trial basis commencing January 2007. The Department of Fisheries is to

monitor this area during the marron season and if non-compliance is observed, then the privilege is to be revoked.

The land-based impacts of freshwater fishing are also similar to marron fishing and are mostly related to access tracks (both vehicle and foot), vegetation disturbance and ancillary activities such as camping, rubbish disposal and campfires. Lake Maringup and Lake Quitjup are closed to fishing and kept as biological reference areas (see Section 18 *Species and Communities of Conservation Significance*).

A number of native and introduced fish species are found in the lakes, rivers and wetlands of the parks (see Section 17 *Native Animals and Habitats*). Fish sought by anglers include native species such as the freshwater cobbler and introduced species such as brown trout, rainbow trout and redfin perch.

Trout are not stocked in the waters of the parks, although the Shannon River has been stocked in the past and the upper reaches of the Warren and Donnelly rivers, which lie outside the parks, are regularly re-stocked (see Section 20 *Introduced and Other Problem Animals*). The Warren and Donnelly rivers have high conservation value and are partly within the conservation estate, therefore it is a concern that non-native fish are being introduced to the upper reaches of these rivers. Trout are thought to be responsible for impacting on the populations of native fish, frogs, aquatic snails, aquatic insects and crustaceans such as marron, koonacs and gilgies (see Section 20 *Introduced and Other Problem Animals*).

There are two main types of coastal fishing in the parks: beach fishing, where most access is gained directly to the beach by vehicle, and rock or reef fishing. Rock and reef fishing sites usually have foot access tracks, some of which traverse steep cliffs or sensitive landforms prone to erosion or compaction. Some of these tracks are poorly located and constitute a threat to users, the environment or both. Rock and reef fishers will often go to extreme lengths and take great risks to access favoured fishing sites (see Section 29 *Visitor Safety*).

Beach fishing is one of the most popular recreational activities in the parks and is often associated with four-wheel drive access. However, some beach fishing sites are only accessible by foot, such as Doggerup Beach and Salmon Beach (although there is two-wheel access to a car park a short walk from Salmon Beach). Typically, beach fishers access a beach by four-wheel drive vehicle, stay for a day or overnight on the beach (weather permitting). During salmon fishing season (usually March to May) over 200 vehicles have been counted on one beach (Yeagarup Beach, Easter 1999).

Marroning and Fishing – Key Points

- Marroning is a popular activity in the parks during open season but the fishable stocks have declined.
- Impacts of marroning and fishing in general include disturbance to riverbanks and shoreline vegetation, rubbish disposal, campfire escapes, and uncontrolled access. Controlling access tracks to marroning and fishing sites is also a significant problem.
- There are a number of introduced species of fish within the parks from past stocking practices and the current practice to stock the upper reaches of rivers that flow to the coast through the parks.
- The Warren and Donnelly rivers have high conservation value and are partly within conservation estate. Trout are thought to be responsible for impacting on the populations of native fish, frogs, aquatic snails, aquatic insects and crustaceans such as marron, koonacs and gilgies.
- Rock/reef fishing is a high risk activity undertaken by users of the parks with some walking tracks that access rock or reef fishing sites poorly located and posing a threat to users and/or the environment.
- Beach fishing is one of the most popular recreational activities within the parks, adding additional pressure on the parks through the use of four-wheel drive vehicles to access fishing sites.

The objective is to allow sustainable marroning and fishing where this does not lead to degradation of the environment.

This will be achieved by:

1. Allowing fishing and marroning in all water bodies in the parks (subject to knowledge about impacts), except Lake Maringup and Lake Quitjup, subject to Fisheries Regulations.
2. Prohibiting fishing on Lake Maringup and Lake Quitjup (and any other water body, if impacts are deemed by the Department to be unacceptable, after public consultation) under the Conservation and Land Management Regulations.
3. Continuing to prohibit stocking of non-native species in all water bodies in the parks (see Section 20 *Introduced and Other Problem Animals*).
4. Continuing to work with the Department of Fisheries to obtain adequate conservation outcomes for all

waterways in conservation reserves including the issue of restocking of non-native species in rivers that are upstream of D'Entrecasteaux National Park (see Section 20 *Introduced and Other Problem Animals*).
5. Continuing to seek ways of preventing continued use of closed tracks by marroners (see Section 26 *Visitor Access* and Appendix 11).
6. Ensuring that any fishing access walking tracks are safely located and do not pose a risk to users or the environment. Inappropriately located fishing access tracks will be relocated, or closed and rehabilitated.
7. Allowing beach camping as part of recreational fishing activities within the parks (see Section 27 *Recreational Use – Recreational Sites*).
8. Providing information about beach and rock fishing, especially about safe access points to the coast (see Section 29 *Visitor Safety*).

Surfing and Swimming

Surfing is popular at Black Point and Salmon Beach within D'Entrecasteaux National Park. When conditions on the west coast are 'blown out' surfing conditions at Black Point are often ideal resulting in it becoming extremely popular with surfers. However, since there is often a large swell working over the reef it can be dangerous for inexperienced surfers. Salmon Beach has a range of surfing breaks from reef to sand bar breaks and attracts a wider range of surfers from beginners to very experienced.

The activity of surfing poses few threats to the park environment although the ancillary activities of the users of surf beaches can have large impacts. Camping and picnic sites near popular surfing places seem to have a higher incidence of conflict between campers, vandalism to park furniture, damage to the environment and occurrences of dogs being brought into the park. Surfers prefer convenient tracks to the beach and require vantage points to assess conditions.

Careful management of areas adjacent to surfing beaches is required to minimise the impact on the environment. For example, camping in a fragile area such as Black Point has had an unacceptable impact on the environment. The existing camping area is to be relocated due to the current impacts and increasing use. Due to the limited access and camping opportunities and the remote nature of D'Entrecasteaux National Park, surf competitions generally will be prohibited.

Swimming occurs in the parks at Lake Jasper, Lake Yeagarup, the rivers, the ocean, inlets and in Shannon Dam. Some of the beaches adjoining the parks are not appropriate for swimming due to the strong rips and deep channels close to the shore. Ocean conditions can also change quickly and unexpectedly.

Surfing and Swimming – Key Points

- Popular surf beaches in the parks include Black Point and Salmon Beach.
- The impacts on camping and picnic sites near surf beaches include conflict between users, vandalism to park furniture, damage to the environment, proliferation of access tracks, and the effects of domestic animals being constantly brought into the parks.
- Swimming along the coast of the parks can sometimes be dangerous due to the strong rips and deep channel close to shore.

The objective is to allow for beach activities such as surfing and swimming in the parks except where there is a threat to the environment or a risk to public health or visitor safety.

This will be achieved by:
1. Providing different camping areas for specific user groups to minimise conflicts.
2. Providing and clearly signposting camping areas that have noise curfews and if there are areas able to sustain them; curfew free areas close to popular surfing beaches (see Section 27 *Recreational Use – Recreational Sites*).
3. Providing access tracks and vantage points at surfing areas where appropriate.
4. Providing risk management signs or other information as appropriate at surfing beaches.
5. Consulting with and, as appropriate, involving surfers in aspects of management of the parks that affect surfing including camping, access and specific environmental impact problems.
6. Prohibiting surfing competitions in D'Entrecasteaux National Park unless it can be shown that all the impacts can be acceptably managed.
7. Providing, as appropriate, a range of information to visitors about hazards associated with swimming.

Sandboarding

Sandboarding involves the use of a specialised board to 'surf' down steep sand dunes. Sandboarding has become increasingly popular amongst young age groups. However, according to Departmental policy, sandboarding is generally an unacceptable recreation activity on public conservation lands, particularly in coastal areas of high conservation value. Impacts include:

- the activity itself plus the ascent of the dune (often on top of the fringing surviving vegetation) is particularly destructive of vegetation;
- the Department does not have the resources to manage and monitor the activity in D'Entrecasteaux National Park so it is very hard to keep sandboarders in a single designated area of dunes;
- access to a suitably steep site in the dunes by vehicle can be dangerous and leaving the marked tracks is not permitted (see Section 26 *Visitor Access*); and
- the dune topography constantly changes and a designated sandboarding area may quickly become unsuitable or dangerous.

Sandboarding – Key Points

- Departmental policy is that sandboarding is generally unacceptable on public conservation lands.
- Sandboarding can have impacts on dune vegetation and access to sandboarding areas can be dangerous.

The objective is to protect the sand dune environment and minimise risk to public health and visitor safety.

This will be achieved by:
1. Prohibiting sandboarding in the parks.
2. Providing signage and/or information as to why sandboarding is prohibited in the parks.

Abseiling and Rock Climbing

In recent years there has been a marked increase in abseiling in Western Australia (and to a much lesser extent, rock climbing) by organised groups, often on a commercial basis (see Section 28 *Commercial Tourism Operations*). Abseiling as a motivational or team building exercise is also becoming more common. This, plus the rise in the number of adventure tourism companies, has led to an increase in requests for access to the cliffs and granite monadnocks within the parks for these activities.

Abseiling can involve large groups of beginners under instruction. The participants may not necessarily have experience in mountain safety and climbing, and group instructors have a responsibility to ensure that all members of the group observe safety, environmental and ethical standards. This requires certain minimum standards of experience and competency in instructors and acceptable student to instructor ratios.

In the parks, the impacts made by abseiling parties have related predominantly to access to sites. In the Donnelly River and Long Point area, some access tracks have proven very hard to stabilise and wind and water erosion has caused problems. In addition, the only granite areas suitable for these activities are diverse ecotones that often contain rare and priority flora (see Section 18 *Species and Communities of Conservation Significance*).

Due to the fragile and sensitive nature of the limestone cliffs and granite monadnocks favoured for abseiling or climbing in the parks there are few, if any, areas environmentally suitable for these activities. Therefore, abseiling and rock climbing on cliffs or monadnocks will not be permitted in the parks. Groups and individuals will be directed to seek locations outside the parks.

The only case where abseiling may be permitted in the parks is as part of other licensed adventure activities (see Section 28 *Commercial Tourism Operations*). Some companies have already set up abseil trees in the parks where participants climb a tree by using a rope or steel ladder then abseil to the ground. As there is little impact on the tree, these trees will be the only sites for abseiling activities as part of other licensed adventure activities in the parks.

Abseiling and Rock Climbing – Key Points

- There are few, if any, environmentally suitable areas for abseiling or climbing within the parks.
- Occasional enquires are made to abseil or climb the limestone cliffs and granite monadnocks in the parks.
- Some companies have set up abseil trees in the parks.

The objective is to prevent adverse impacts from abseiling and climbing on conservation, landscape and other park values.

This will be achieved by:
1. Allowing the use of abseil trees in the parks where part of a licensed adventure activity program but encouraging groups to use trees outside the parks.
2. Prohibiting abseiling and climbing on limestone cliffs and granite monadnocks in the parks.

Caving

In comparison to other cave and karst features in Western Australia, the caves in the parks are small and shallow. Some of these caves have unique geological or geomorphological features and others have Aboriginal cultural significance (Appendix 3 and Section 23 *Indigenous Heritage*). While caving is not a popular activity in the parks, some use of the caves does occur, often as a side activity related to illegal camping in caves. Some caves pose a visitor risk and require closure, or signs to make visitors aware of these hazards.

Cave values require special protection, as once damaged, cave formations may never reform or take thousands of years to re-establish. Cave ecosystems can also support unique relict ecological communities. Little is known about the ecological communities in the caves of the parks and further research is required.

Therefore, access to caves within the parks will only be allowed to registered speleological clubs or certified tour operators that carry public indemnity insurance. A cave classification system has been developed as part of Policy Statement No. 18, in consultation with the Western Australian Speleological Group and the Australian Speleological Federation. Classification includes 'tourist cave', 'adventure cave' and 'restricted access' and details for recommended management. The caves within the parks should be classified and managed accordingly. However, all caves within the parks should be considered restricted access until an assessment has been made of the values and level of risk.

Caving – Key Points

- Caving is not a popular activity in the parks, but caves are occasionally used for illegal camping.
- Once damaged, cave formations may never reform or take thousands of years to re-establish. Cave ecosystems can also support unique relict ecological communities.

The objective is to sustainably manage the caves and karst systems in the parks for their intrinsic, ecological, and cultural values.

This will be achieved by:
1. Only allowing registered speleological clubs or certified tour operators that carry public indemnity insurance to access caves within the parks.
2. Alerting park users to the potential hazards within caves.
3. Classifying caves in the parks according to the Department's cave management classification system in Policy Statement No. 18.
4. Considering possible adverse impacts on cave features when undertaking surface management operations.
5. Not divulging cave locations in the parks on Departmental maps or publications.
6. Gating and locking caves (temporarily or permanently) if:
   - there is no practical alternative to preventing damage to the cave formations, flora, fauna, or the cave itself;
   - there is no practical alternative to protecting significant decoration, scientific work undertaken, rehabilitation or protecting the general public from a particularly dangerous area;
   - it is practical to do so without damaging the cave; and
   - it is practical to do so without disturbing essential airflow and/or waterflow for cave fauna (such as bats).

Flying and Hang Gliding

Aircraft activities undertaken in the parks are currently confined to chartered or private flights over the parks and occasional landings in the parks. The Department's fire detection aircraft also regularly fly over the parks between November and May each year. There is a gravel airstrip in close proximity to Shannon National Park, which is sometimes used. Ultralight aircraft flying from Manjimup at times land in the park on the beach at the mouth of the Warren River and in the Yeagarup Dunes.

According to Departmental policy (see Section 25 *Recreational Opportunities – Wilderness*), the landing of motorised and non-motorised aircraft within wilderness will not be permitted, with the exception of non-fixed wing aircraft access for emergency (requires approval from the CALM Executive Body) and essential research and management operations (requires approval of Conservation Commission). Departmental policy also specifies that the relevant authorities will be asked to control aircraft movements over wilderness (under 610 metres for fixed wing aircraft and under 460 metres for helicopters) except for emergency and management operations. As the wilderness areas are gazetted within the parks, Departmental policy will apply.

Hang gliding in the parks occurs at Salmon Beach and Cliffy Head on an irregular basis. Hang gliding from both these points requires a cliff top launch with a cliff top landing at Cliffy Head and a beach landing at Salmon Beach. The opportunity for using the same sites for parapenting (which is similar to hang gliding but utilises a fully controllable parachute to soar once launched from a cliff top) also exists.

Due in part to the infrequency of hang gliding within the parks, the impacts of the activity have been limited. In general, the use of access tracks and the trampling of vegetation at the launch sites are the key environmental impacts likely to occur. Any increased demand for hang gliding use of the parks would need an assessment of the potential impacts and safety concerns before being approved.

Flying and Hang Gliding – Key Points

- There are only occasional ultralight aircraft landings in the Yeagarup area and irregular hang gliding activity at Salmon Beach and Cliffy Head.
- There would be restrictions on aircraft landing in or flying over gazetted wilderness areas of the parks.

The objective is to allow for safe flights over and within the parks without damaging the environment or the public enjoyment of the parks.

This will be achieved by:

1. The operation of all aircraft on or over the parks complying with the relevant Federal and State air safety regulations and procedures.
2. Prohibiting all non-emergency aircraft (including ultra-light) use unless on established airstrips and where the purpose is considered to be consistent with the objectives of this management plan.
3. Restricting aircraft landing within gazetted wilderness areas of the parks according to Departmental policy. Liaising with the relevant authorities to control aircraft movements under 2000 feet (approximately 610 metres) for fixed wing and 1500 feet (approximately 460 metres) for helicopters over gazetted wilderness except for emergency and management operations.
4. Continuing to allow hang gliding at Cliffy Head and Salmon Beach provided environmental impacts or conflicts with other users are minimised.
5. If demand increases for launch areas for hang gliding, erect ramps, safety barriers, railings and/or safety signs to protect environmental values and the safety of visitors if required and in consultation with users.
6. Ensuring that all hang gliding in the parks is in accordance with the rules and regulations of the Civil Aviation Safety Authority and the Hang Gliding Federation of Australia.

Special Events

It is possible that during the life of this plan that 'one-off' special events are proposed within the parks. These could involve large groups of people and camping in the parks. Special events have the potential to have a significant impact on the parks and on the experience of other visitors. In general, many group activities and events are an acceptable use of conservation estate, provided that they are:

- sensitively located to maintain values;
- properly planned and managed;
- do not interfere with other forms of recreation; and
- are not resource-demanding on the Department.

Special events must be consistent with the Department's Policy Statement No. 18 *Recreation, Tourism and Visitor Services*—where requests are made to conduct special events for activities that are inconsistent with the policy, the event must be of national significance and approval is required from the Conservation Commission.

The following general criteria apply:

- the event must be consistent with the visitor management setting in which it is to be held (see Section 25 *Recreation Opportunities – Visitor Management Settings*);
- strict hygiene controls must be enforced to eliminate the risk of disease spreading further in the parks;
- any permitted temporary fixtures or facilities constructed for the event must be removed at the completion of the event; and
- any site disturbance such as trail markings must be removed and the site rehabilitated at the completion of the event.

Before events are approved, the availability of suitable areas outside the parks will be considered. Similarly, the potential impacts on the environment and other visitors, the safety risks to the people involved in the event and the cost-benefits for the management of the area will also be considered. Competitive car rallies and other motor sports will not be permitted.

Special Events – Key Points

- Occasionally permission will be sought to allow special events to take place wholly or partly in the parks.
- Before any special event is allowed in the parks it will be assessed on a case-by-case basis.

The objective is to permit special events that do not adversely impact on environmental values or visitor experiences, are carried out in a safe manner and are cost-neutral to the Department.

This will be achieved by:

1. Allowing special events subject to approval and conditions stipulated by the Department and/or in some cases the Conservation Commission.
2. Ensuring that special events are held only within an appropriate visitor management setting according to the proposed activity and pose no adverse impact on the environment, and there is no suitable alternative outside the parks.

Non-Commercial, Education and Not-for-Profit Activities

Non-commercial, educational and not-for-profit groups use the parks on a regular basis to conduct bushwalking, camping, leadership, outdoor education and personal development programs. Over the last 10 years the number and scale of operations by such groups has grown considerably and is expected to continue as the parks continue to provide large, relatively undisturbed areas that have fairly limited vehicle access.

Non-commercial, educational and not-for-profit groups have the potential to offer experiences and services to park visitors that would not otherwise be available. They may also be able to provide access to visitors with special needs (e.g. visitors with physical disabilities), deliver interpretation and education messages that foster appreciation and understanding of the parks or assist with other park operations. For example, several four-wheel drive clubs have assisted the Department in carrying out park maintenance and management works in D'Entrecasteaux National Park.

These groups range from well-organised multi-national organisations that have trained staff and codes of practice to small school groups with varying levels of preparation and expertise. The level of impact on the environment and level of management input also varies.

Areas within the parks that offer the best conditions for such activities generally coincide with areas favoured by other user groups (e.g. the section of the Bibbulmun Track that goes through the parks). This can lead to competition or conflict between groups wanting to use the same area.

Although these groups usually favour 'bush' camping with no facilities, there has become a need to develop larger group base camps that are more hardened and have more facilities such as toilets and fire rings (see Section 27 *Recreational Use – Recreational Sites*).

The Department requires all organised non-commercial, educational and not-for-profit groups to gain permission from the local regional or district office prior to undertaking their activities. Guidelines and forms have been prepared for groups seeking Departmental permission for such activities.

Non-Commercial, Education and Not-for-Profit Activities – Key Points

- The parks are used regularly by non-commercial, education and not-for-profit groups to take advantage of the relatively undisturbed areas and camping facilities.
- These groups have the opportunity to provide visitors with experiences that would not be available otherwise.
- The level of impact varies with the level of preparation and expertise of the groups.
- Groups may need for more formal camping areas, which can conflict with other user groups.

The objective is to ensure that non-commercial, education and not-for-profit activities are compatible with other park management objectives.

This will be achieved by:

1. Ensuring that all non-commercial, educational and not-for-profit groups gain permission before undertaking activities in the parks.
2. Developing a booking and entry permit system for non-commercial, educational and non-profit groups to avoid overuse and conflict between users.
3. Ensuring strategically located hardened group camping areas are provided that can be used by non-commercial, educational and not-for-profit groups as well as the general public (see Section 27 *Recreational Use – Recreational Sites*).
4. Developing specific codes of practice and guidelines for non-commercial, educational and not-for-profit groups using the parks.
5. Exploring opportunities for non-commercial, educational and not-for-profit groups to contribute to park management by organising or participating in service projects such as rehabilitation, weed control, rubbish collection or other activities.
6. Investigating partnerships between the Department and non-commercial, educational and not-for-profit groups that provide opportunities for the delivery of education and interpretation programs for park visitors.
7. Only allowing the use of management access tracks for vehicle use by non-commercial, educational and not-for-profit groups strictly in emergency situations, or where assisting the Department with management activities.

Recreational Sites

Day Use Sites

A day use area is any recreation site that is designed specifically for day visits only. This includes picnic and barbecue sites, lookouts, interpretive stops, short walks and nature viewing sites. Day use sites range from primitive sites such as small clearings with no facilities to well developed sites with many facilities which are generally provided in the more developed settings (see Section 25 Recreational Opportunities – Visitor Management Settings and Appendix 10). Day use sites can also be associated with camping areas.

Existing and proposed day use sites are shown in Table 9 and have been classified as either high, medium or low as per definitions in Appendix 12. Other sites may be provided as demand increases as long as key values are protected and after detailed planning, review of the management setting implications, and public and Conservation Commission consultation.

Table 9: Day Use Sites for Recreation within the Planning Area

Site	Park Info	Toilet	BBQ	Picnic Table	Shelter	Vista Point	H/ M/L	Visitor Management Setting
D'Entrecasteaux National Park								
Tookulup		E				E	M	Highly Modified
Salmon Beach		E		E	E		M	
Pt D'Entrecasteaux	E					E	M	
Salmon Beach Lookout						E	L	
Cathedral Rocks* (in Windy Harbour	P					E	M	

Site	Park Info	Toilet	BBQ	Picnic Table	Shelter	Vista Point	H/ M/L	Visitor Management Setting
reserve)								
Windy Harbour* (Shire reserve)	P	E	E	E	E	E	M	
Black Point Beach	P	E	E	E	P	E	M	Recreation
Twin Karri's Beach (Quannup Pastoral Lease)	P					P	L	
Donnelly Boat Landing	E	E	E	E	E		M	
Lake Yeagarup*	P	E	E	E	E	E	M	
Mt Chudalup	E	E	E	E	E	E	M	
Mandalay Beach	E	E				E	M	
Lake Jasper Eastern Beach	P	P	E	P		E	L	Natural – Recreation
Lake Wilson	P						L	
Lake Smith	P						L	
Broke Inlet Mouth							L	
Bottleneck Bay							L	
Bald Rock/ Horseshoe Beach							L	
Banksia Beach							L	
Coal Point Camp 1							L	
Coal Point Camp 2							L	
Broke South							L	
Mt Pingerup	E					E	L	
Cliffy Head							L	
Little Long Point							L	
Red Rock							L	
Lost Beach							L	
Shannon National Park								
Shannon Picnic Area	P	E	E	E	E		M	Highly Modified
Shannon Day Use	E			E	E		M	
Shannon Dam	P		E	E		E	L	
GFTD – Upper Shannon Rd	E			E	E		M	Recreation
GFTD – Big Tree Grove	E					E	M	
GFTD – Snake Gully Lookout	E					E	M	
Trees Walk Turnaround	E						L	
GFTD – Curtin Tank Site	E			E			L	
GFTD – Which Tree is That?	E			E		E	L	
GFTD – Cow Bells	E					E	M	
Shannon River							L	
O'Sullivan Pool – Preston Road				E			L	
O'Sullivan Memorial – Nelson Road	P						L	

* Outside the planning area but would be an entry point to D'Entrecasteaux National Park
E Existing, P Proposed, GFTD Great Forest Trees Drive

If unmanaged, picnicking and barbecuing can result in various localised impacts including the trampling and loss of understorey plants, soil compaction and erosion, littering, and removal of both live and dead vegetation for

campfires. These impacts can be minimised through careful site selection, facility placement and design, and the provision of firewood or alternative cooking facilities.

Site selection and development is influenced by environmental considerations, the role the site plays in providing a range of opportunities for the visitor to appreciate the natural values of the parks, fire management and the visitor management setting of the area. There are often day use components of camping areas however they are covered in the following section.

Day Use Sites – Key Points

- A day-use area is any recreation site designed specifically for day visits only and includes picnic and barbecue sites, lookouts, interpretive stops, short walks and nature viewing sites.
- Impacts of picnicking and barbecuing are similar to camping and include trampling, soil compaction and erosion, littering and firewood collection.
- Day use sites are also found at camping areas across the parks.

The objective is to provide day-use facilities appropriate to the environment and desired management setting that encourage visitor enjoyment and understanding of park values.

This will be achieved by:

1. Designing and developing day use sites in accordance with Departmental policy and design standards, site capability, environmental impact assessment, Table 9, the visitor management setting of the area and recreational site classification.
2. Provide rubbish bins at selected sites depending on high use or demand but encouraging visitors to remove their own litter.
3. Prohibiting campfires, unless firewood is provided by the Department or brought in from outside the parks and lit only in provided fire rings (see Section 27 *Recreational Use – Recreational Sites – Campfires*).
4. Providing fire rings or gas/electric barbecues at day use sites where necessary.

Built Accommodation Sites

Built accommodation in the parks is provided for walkers in the Bibbulmun Track shelters, the Shannon Lodge and other huts at the Shannon townsite and in various huts in the D'Entrecasteaux National Park (see Section 27 *Recreational Use – Recreational Sites – Huts*). Use of built accommodation in the parks as overnight accommodation dates back to cattlemen in the 1880s (see Section 24 *Non-Indigenous Heritage*). More recently, huts have been built by holiday-makers and have a range of building styles and standards.

The Shannon townsite, the proposed land exchange north of Lake Jasper (see sections 3 *Management Plan Area* and 32 *Mining*) and the Donnelly River mouth in particular, offer opportunities to further develop a range of built accommodation in the parks (and camping areas), to be provided either by the Department or by way of commercial concession (see Section 28 *Commercial Tourism Operations*). Shannon townsite is considered suitable for further built accommodation as the area already supports significant development and good two-wheel drive access to the area exists.

The range of built accommodation to be considered include basic shelters, such as styles reflective of Aboriginal culture or the three-sided structures used for the Bibbulmun Track, to more developed facilities such as huts, lodges or chalets in a natural bush/stockman style. Built accommodation may only be provided within the Recreation and the Highly Modified settings of the parks (see Section 25 *Recreational Opportunities – Visitor Management Settings* and Appendix 10).

Other basic shelters may also be considered to support long-distance walking or cycling in the parks (see Section 27 *Recreational Use – Recreational Activities*).

It is proposed to provide the following built accommodation in the planning area (Table 10). Other built accommodation may be provided as demand increases as long as key values are protected and after detailed planning, review of the management setting implications and public and Conservation Commission consultation. However, the Department aims to only provide opportunities that are not otherwise provided adjacent to the parks.

Table 10: Built Accommodation for Recreation within the Planning Area

Site	Type	Access	Visitor Management Setting
Existing sites			
Inverary Homestead area	Developed – hut	4wd	Highly Modified
Windy Harbour* (Shire reserve)	Developed – huts	2wd	
Camfield* (Shire reserve)	Developed – hut	2wd	
Banksia Camp site	Developed – hut	4wd	
Bibbulmun Track – Gardner	Basic – 3 sided shelter	Walking	Recreation
Bibbulmun Track – Lake Maringup	Basic – 3 sided shelter	Walking	
Bibbulmun Track – Dog Pool	Basic – 3 sided shelter	Walking	
Mottram's Hut area	Basic – 3 sided shelter	4wd	
Bibbulmun Track – Mt Chance	Basic – 3 sided shelter	Walking	
Bibbulmun Track – Long Point	Basic – 3 sided shelter	Walking	
Bibbulmun Track – Woolbales	Basic – 3 sided shelter	Walking	
Existing sites that may be considered for redevelopment			
Scott Road Huts (Quannup pastoral lease)	Developed – huts	4wd	Highly Modified
Donnelly River Huts/Donnelly River mouth	Developed – huts	Boat	
East's Hut/Gardner River mouth	Developed – hut	4wd	
May's Hut	Developed – hut	4wd	
Wauchope's Hut	Developed – hut	4wd	
Scanlon's Hut	Developed – hut	4wd	
Coodamurrup (Moore's) Hut area	Developed – lodge or hut	4wd	
Tuckett's Hut	Developed – hut	4wd	
Wheatley Stockman's Hut	Developed – hut	4wd	
Crystal Springs	Developed - hut	2wd	
Mottrams Hut	Developed - camping	4wd	
Rooney's Hut	Developed – hut	Boat	
Fisherman's Hut	Developed – hut	4wd	
Kanny's Hut	Developed – hut	4wd	
Cranker's Hut	Developed – hut	Boat	
Shannon Campground	Developed – lodges or chalets	2wd	
Opportunities for additional sites			
Quannup pastoral lease	Developed – hut	4wd	Highly Modified
Malimup Beach	Basic shelter	4wd	Recreation
Proposed Munda Biddi Trail	Basic shelters as necessary along the length of the trail	Bike	

* Outside the planning area but would be an entry point to D'Entrecasteaux National Park

Built Accommodation Sites – Key Points

- There is built accommodation within the parks along the Bibbulmun Track, at Shannon Lodge and throughout D'Entrecasteaux National Park in privately occupied huts.
- There are further opportunities to develop built accommodation at Shannon townsite and at the mouth of the Donnelly River.

The objective is to provide a range of opportunities for park visitors to stay overnight in the parks in appropriately located and designed built accommodation with due consideration to the commercial interest adjacent or near the parks.

This will be achieved by:

1. Providing a range of visitor accommodation as per Table 10 and after more detailed site planning has been undertaken.
2. Ensuring built accommodation is:
   - built to a safe structural standard;
   - environmentally sensitive and energy efficient;
   - ensures a sense of place and reflects vernacular architecture;
   - low maintenance;
   - commercially viable; and
   - constructed and maintained to minimise fire risks.
3. Considering a booking system for any built accommodation with restricted access, or accommodation that requires numbers to be limited.
4. Investigating opportunities for partnerships with commercial concessionaires to provide built accommodation within the parks (see Section 28 *Commercial Tourism Operations*).

Camping Sites

Camping within the parks varies from camping in large camping grounds with facilities such as at the Shannon townsite, to remote, informal camping sites as along the coast of D'Entrecasteaux National Park. Some of the informal sites are rapidly expanding and consequently being degraded. Increasingly, large organised groups with up to 30 vehicles are seeking places to camp close to the coast. With no suitable planned campgrounds available, such groups have had a severe impact on the environment with regards to toilet waste, rubbish disposal, firewood collection, vegetation removal, erosion and soil compaction.

Most camping within the parks is associated with some other form of recreation activity such as fishing and is usually associated with a vehicle. Most camping within the parks is located along the coast or along various rivers and streams. The majority of camping sites in the parks have few facilities, with the exception of the Shannon townsite and the Shire of Manjimup's Windy Harbour townsite. Outside the parks there are camping areas in the adjacent Walpole-Nornalup National Park and Warren National Park. The towns of Walpole, Pemberton, Northcliffe, Manjimup, Quinninup and Nannup also provide camping facilities.

Education and not-for-profit groups camp throughout the parks, generally at informal or remote sites not accessible by vehicle (see Section 27 *Recreational Use – Recreational Activities*). The standards and camping methods employed by these groups vary dramatically, as some employ minimum impact practices whilst others do not. These groups also require base camp sites capable of accommodating larger numbers. There are currently no established guidelines for managing camping of these groups.

Camping in its current form in the parks, particularly coastal camping, is not sustainable. In some instances it may be necessary or desirable to redesign sites or limit access/visitor numbers at particular camp sites in order to protect the environment and experience. There is currently no camping booking system in the parks.

At some of the larger camp sites in the parks, there is often conflict between camping groups because of the lack of defined camp sites—groups often end up in close proximity to each other. Conflict often arises over noise, either from generators, other camping appliances or campers themselves. To ensure all visitors have an enjoyable camping experience, there is a need to separate campers who are seeking different experiences, regulate use of generators and implement curfews at certain sites to improve visitor experiences in the parks (see Section 27 Recreational Use – Recreational Activities – Surfing and Swimming).

Proposals for camping in the parks acknowledge that a range of camping opportunities is appropriate, providing visitors with more diversity and choice, and allowing visitors to be directed away from sites unable to sustain heavy use. All camping within the parks will be either one of five classes of camping areas as described in Appendix 12. These areas will be provided throughout the planning area as per Table 11. Other camping areas may be provided as demand increases as long as key values are protected and after detailed planning, review of the management setting implications and public and Conservation Commission consultation.

Table 11: Camping Areas within the Planning Area

Camp site	Classification	Access	Visitor Management Setting
Existing sites			
Inverary Station Camp	Medium	4wd	Highly Modified
Windy Harbour* (Shire reserve)	High	2wd	
Moore's Track Camp site	Medium	4wd	
Wheatley Stockman's Hut	Low	4wd	
Shannon Campground	High	2wd	
Camfield* (Shire reserve)	Low	2wd	
Yeagarup Beach Track	No Facilities - Beach Camping	4wd	Recreation
Yeagarup Dunes Camp 3 & 4	Low	4wd	
Warren Beach	Low	4wd	
Warren River Mouth	Low	4wd/Canoe	
Warren Beach Road	Low	4wd	
Lake Yeagarup*	Medium	2wd	
Malimup Beach	No Facilities - Beach Camping	4wd	
West Firebreak Track	Low	4wd	
Bibbulmun Track – Gardner	Low	Walking	
Bibbulmun Track – Lake Maringup	Low	Walking	
Coodamurrup Beach	No Facilities - Beach Camping	4wd	
Bibbulmun Track – Dog Pool	Low	Walking	
Bibbulmun Track – Mt Chance	Low	Walking	
Bibbulmun Track – Woolbales	Low	Walking	
Bibbulmun Track – Long Point*	Low	Walking	
Oilwell Track**	Low	4wd	Natural-Recreation
Bald Island	Low	4wd	
Broke Inlet mouth	No Facilities - Beach Camping	4wd & boat	
Coal Point Camp 1 & 2	Low	4wd	
Broke South	Low	4wd	
Little Long Point	Low	4wd	
Existing sites that may require moving and/or upgrading of camp site type			
Donnelly River – Mouth	Low	Boat	Highly Modified
Gardner River mouth	Medium	4wd	
Coodamurrup (Moore's) Hut	Medium	4wd	
Tuckett's Hut	Low	4wd	
Fisherman's Hut	Low	4wd	
Banksia Camp site	Medium	4wd	
Crystal Springs	Medium	2wd	
Black Point Camp sites 1, 2 & 3	Medium	4wd	Recreation
Black Point Rd Camp sites	Medium	4wd	
Twin Karris Beach***	Low	4wd	
Twin Karris Camp site***	Low	4wd	
Lake Jasper	Medium	4wd	
Yeagarup Beach (Warren to Donnelly)	No Facilities - Beach Camping	4wd	
Kanny's Hut	Low	4wd	
Mottram's Lease Camp & Hut	Low	4wd	
Short Beach and camp sites	Low	4wd	Natural-Recreation
Fish Creek –The Window	Low	4wd	
Fish Creek –The Crack	Low	4wd	
Skippy Holes	Low	4wd	
Death's Descent – Warby's Hole	Low	4wd	
Anvil Reef	Low	4wd	
The Anvil	Low	4wd	

Camp site	Classification	Access	Visitor Management Setting
Peppermint Camp**	Low	4wd	
West Broke Beach (between Broke Inlet mouth and Fish Creek)	Low	4wd	
Opportunities			
Scott Road Hut area***	High	4wd	Highly Modified
Donnelly River – Scott Rd	Low	2wd and canoe	Recreation
Shannon River	No Facilities - Wild Camping	Walking	Natural

* Outside the planning area but would be an entry point to D'Entrecasteaux National Park
** Proposed to be permit only as per the access to the site.
*** Currently within Quannup Pastoral Lease which is due to revert to the park in 2015, camping in this area will need to be reassessed when lease is incorporated into the park.

The camp site at Lake Jasper is to be relocated away from the lake edge. Detailed site planning will determine if it is desirable and/or practical to retain a small number of "premium" camp sites near the lake.

It is intended to maintain boat only access to Donnelly River mouth. Future camping opportunities at the mouth of the Donnelly will be considered as part of the detailed site planning of the area. In general, where appropriate, the location of existing huts throughout the parks may be used for more formal camping opportunities.

Access to Oilwell Track is proposed to be "permit only" to minimise impacts at the site. Therefore camping will be developed at the nearby old Inverary Homestead. West Broke Beach is also proposed as permit only.

Camping Sites – Key Points

- There are many unplanned informal camp sites and formal camp sites at capacity within the parks with most of these being degraded by heavy use.
- Large organised groups require planned large camp sites to minimise environmental and social impacts.
- There is a need to separate campers who are seeking different experiences, manage use of generators and implement curfews at certain sites to improve visitor experiences in the parks.
- There is a booking system for a few of the 'permit' sites but otherwise no booking system for the majority of sites within the parks.
- A better range and quality of camping opportunities are required.

The objective is to provide a range of quality camping opportunities in the parks whilst minimising environmental impacts and conflicts between users.

This will be achieved by:

1. Providing a range of camping opportunities and settings with varying physical, social and managerial conditions as summarised in Table 11.
2. Monitoring informal camp sites to ensure park values are not compromised.
3. Restricting access to and rehabilitating any camp sites being impacted by inappropriate use and/or having an unacceptable environmental impact.
4. Considering a booking system for any camp sites with restricted access or for camp sites where the number of campers needs to be limited.
5. Reducing the impact of campfires by implementing the campfire strategies outlined in Section 27 *Recreational Use – Recreational Sites – Campfires.*
6. Prohibiting the use of or restricting the operating hours of portable generators or battery charging plants at some sites and implementing noise curfews at other camp sites when necessary.
7. Charging fees for camping at all 'formal' sites (not including 'informal' sites such as within wilderness areas or beach camping as per definitions in Appendix 12 Camping Area Definitions), where camping fees are provided for by the Minister.
8. Providing information on the location of designated (formal) camping sites, facilities available and fees and charges to the public.
9. Permitting overnight accommodation on boats subject to conditions appropriate to the waterways concerned.

Key Performance Indicator (see also Appendix 2)		
Performance Measure	**Target**	**Reporting requirements**
27.4 Tree condition at selected camp sites	27.4 Less than 10% of trees with damage Less than 10% of trees with root exposure	Annually
27.5 Cleanliness at selected camp sites	27.5 Minor levels of or no litter present	Annually

Campfires

Weather along the south coast is often cold, wet and windy. A campfire provides warmth and a focal point for groups and, to many campers, campfires are a traditional part of the camping experience. However, there are impacts caused by campfires, principally from the collection of firewood or the actual fire itself.

Firewood collection has detrimental effects on the natural environment, including loss of vegetation cover, reduction in habitat integrity, the spread of disease and possible changes to the nutrient balance of ecosystems. The area around fireplaces also suffer from vegetation loss and compaction, the accumulation of ash and the failure of groundcover to regenerate where there have been continuous campfires. Campfire escapes can lead to wildfires (see Section 22 *Fire – Fire History*). Sites impacted by campfires and firewood collection can take many years to recover and regenerate. Hot ash and coals left on beaches after illegal campfires can also be a public health risk as burial does not preclude the material being unearthed and burning unwitting beach users.

Within the parks, campfires can be lit in fire rings or appropriate containers. In the Shannon and D'Entrecasteaux national parks campers often light illegal and informal campfires even at formal camp sites. There is significant degradation at many camp sites including tree stumps from felled trees and large fire scars. The observed impact of campfires and projected increases in visitation to the parks requires action to reduce future impact on the park environment. Alternatives such as fuel stoves are available and these are more efficient, quicker and cleaner for cooking and are ideally suited for 'wild' camp sites. The provision of firewood for campfires at park entry (mill-ends, or by-products of roading or logging operations) greatly reduces firewood collection in the parks. However, there are significant management costs associated with firewood supply.

Campfires – Key Points

- Firewood collection can lead to significant loss of vegetation cover, reduction in habitats, the spread of disease and has the ability to change the nutrient balance of ecosystems.
- The lighting of campfires can impact site vegetation, be a public safety risk and can devastate large areas of the parks if campfire escapes occur.
- Campfires are only permitted in the parks in approved fire rings or containers.

The objective is to reduce the impact of campfires on the parks' environment.

This will be achieved by:

1. Prohibiting any campfire not lit in provided fire rings or barbeques except in the case of beach camping.
2. Allowing campfires on beaches in an approved container that completely contains the fire and lifts it from the ground, and so long as all containers, coals and fire wastes from fires are removed from the parks.
3. Prohibiting campfires at 'wild' camp sites (fuel stoves can still be used).
4. Prohibiting firewood collection by the public within the parks.
5. Providing pre-visit information for visitors regarding the campfire policy in the parks.
6. Signposting areas of State forest on the approaches to the parks where firewood collection is permitted.
7. Placing fire rings at designated camp sites where feasible.
8. Supplying firewood at entry points to the parks or at the more developed camping sites where feasible.
9. Prohibiting campfires on days of Very High or Extreme fire danger.
10. Providing gas or electric barbeques to selected overnight and day use sites where feasible.
11. Educating the public on the impacts of firewood collection on the parks' values.

Key Performance Indicator (see also Appendix 2)

Performance Measure	**Target**	**Reporting requirements**
27.6 Coarse woody debris	27.6 Quantities are not diminished by human usage from predetermined baseline at selected sites	Annually

Privately occupied huts

There are 63 privately occupied huts located throughout the planning area including 43 along the lower reaches of the Donnelly River, 18 scattered throughout D'Entrecasteaux National Park (seven of which are managed by the Department for recreation and/or heritage values) and two huts within Quannup Pastoral Lease. These huts were built on Crown land without legal tenure before the park was declared. Some of the older huts were built by pastoralists who brought cattle to the coast for summer grazing and by the former Forests Department for staff involved in forest assessment or manning fire lookouts.

Some huts have been surrendered to the Department and due to safety or environmental issues have been removed, moved or replaced. For example, Banksia Camp Hut has been rebuilt and is available for public use and two huts at the Warren River mouth have been removed. However, families or groups of friends currently use the majority of the huts on a private basis with only a few available to the general public.

Huts – Key Points

- There are 63 privately occupied huts in the planning area.
- Management of these huts needs to be in accordance with the CALM Act, Government policy and Departmental guidelines.

The objective is to retain huts for public use.

This will be achieved by:

1. Working with the Lower Donnelly River Conservation Association and other hut occupiers to retain huts for use by the public and members of the association/s, on the condition that the huts meet environmental, safety, health and building standards within three years of this plan being approved.
2. Removing huts that pose safety, health or environmental risks, in consultation with hut occupiers.

28. COMMERCIAL TOURISM OPERATIONS

A commercial concession is a right granted, in consultation with the Conservation Commission, by way of lease or licence for occupation or access and use (respectively) of an area of land or water managed by the Department. Commercial concessions can increase the range of recreation opportunities and facilities within national parks. Commercial concessions must be consistent with the purpose of the park, the protection of its values and with the objectives of this plan.

Leases

Leases, which allow a lessee to occupy a particular area of land, are granted under section 100 of the Conservation and Land Management Act. A lease provides security to protect significant investments and may be up to 21 years with an option of a further lease up to 21 years. The length of a lease is usually proportional to the level of investment and the return on that investment. At present, there are no commercial leases issued within the parks, although it is possible that future accommodation facilities will be developed through a lease arrangement. These may include development of overnight accommodation in the park (see Section 27 *Recreational Use – Recreational Sites*).

There may be other leases in the parks with uses other than recreation and tourism (e.g. utilities), and these are discussed in Section 36 *Public and Private Utilities and Services*.

Licences

Licences allow operators to access and use lands and waters managed by the Department. All private tour operators conducting commercial tourism activities on conservation reserves are required to obtain a commercial operations licence in accordance with the Conservation and Land Management Regulations. Licensing enables the Department to monitor access and use of lands and waters under its control, and ensure that the conservation values of these areas are maintained. By protecting these values, tour operators will be able to continue to visit areas maintained to the satisfaction of visitors.

The Department issues two types of commercial operation licences, depending on the nature of the activity, the security of the resource, and the risk to the participants. 'T' Class licences are issued when the activity is open to

many operators. In these circumstances, environmental and visitor management objectives can be achieved simply through appropriate licence conditions. The majority of tour operators fall into this category and examples include safari tours and guided walks. The term of the licence depends on the level of accepted tourism accreditation achieved by the operator. Currently the Department issues two-month and one-, three- and 5-year licences as follows:

- a two-month or 1-year licence is issued to an operator who is not accredited with any program; and
- a 3-year or 5-year licence is issued to an operator who is accredited with a tourism program.

The Department can grant a licence for up to 5 years and renew it for the same period. There are 123 different operators licensed within the parks; 116 operators in D'Entrecasteaux National Park and 116 for Shannon National Park, with 'T' Class licences (as of 27 February 2008). However, not all of these operators actually run tours in the parks. Those that do run tours in the parks mostly run vehicle-based tours across Yeagarup Dunes and/or stop at developed recreation sites. A few commercial tour operators use less accessible areas of the parks.

The other type of licence issued by the Department is the 'E' Class licence. 'E' Class licences are issued where there are safety, environmental or management concerns and the number of licences needs to be restricted, such as with boat tours in confined areas. Generally 'E' Class licences are issued following a formal 'Expression of Interest' process. There are currently no operators with 'E' Class licences in the parks.

Fees are associated with all commercial tourist activities conducted on lands or waters managed by the Department in the parks.

28. Commercial Tourism Operations – Key Points

- Tourism concessions can increase the range of services and recreational experiences within national parks.
- All commercial tour operators require a licence from the Department. Accreditation with a tourism program will enable a long-term licence to be issued.
- Leases may be issued to private operators to manage huts or other facilities on a commercial basis.

The objective is to ensure that commercial tourism activities are compatible with other park management objectives and to extend the range of services and recreational experiences available in the parks through the involvement of private enterprise.

This will be achieved by:

1. Considering tourism concessions that:
   - are consistent with the park vision (see Section 6 *Vision*) and management objectives;
   - facilitate park management; and
   - provide a service or facility to park visitors that the Department would not otherwise be able to provide.
2. Encouraging licence holders that operate in the parks to undertake tourism industry accreditation appropriate to their activities.
3. Investigating the establishment of camping and chalet accommodation locations as part of future commercial tourism leases at locations within the parks identified in Section 27 *Recreational Use – Recreational Sites* (e.g. at Shannon Townsite).
4. Not providing concessions within the parks if adequate facilities or services exist, or they can be developed outside the parks that meet visitor needs.
5. Ensuring any commercial recreation and tourism operations in the parks are cost-neutral to the Department.

29. VISITOR SAFETY

In addition to a genuine concern for visitor welfare, the Department has a legal responsibility to consider the personal safety and welfare of visitors to the public conservation estate. The Department aims to minimise the potential for injuries and misadventure to visitors, in a manner that does not render the environment sterile or unnecessarily diminish visitor use and enjoyment in the process. However, some activities (e.g. hang gliding, caving, abseiling and fishing from rocks) are considered high risk and are carried out at the visitor's own risk (see Section 27 *Recreational Use – Recreational Activities*).

The Department often manages areas that are remote from emergency services, hard to access by emergency vehicles and not within mobile phone network coverage. The Department manages the risks presented to visitors by the natural, cultural and developed environments by implementing a visitor risk management program (Policy Statement No. 53 *Visitor Risk Management*), which includes:

- carrying out periodic safety audits of all park recreation sites, facilities and visitor services to identify and assess risks and potential hazards, using this information as part of the basis for preparing and implementing recreation site and facility maintenance programs;
- developing and maintaining a database to monitor the hazard condition of sites and facilities and the frequency, situation and type of injury and misadventure incidents that occur in the parks; and
- promptly investigating all reported visitor accidents and injuries on Departmental managed lands and waters and implementing appropriate risk mitigation measures.

The Department also works closely with the State Emergency Service, the Western Australian Police Service, St Johns Ambulance and volunteer fire brigades in managing visitor risk within the parks.

Rock fishing from areas within the parks such as at Black Point has resulted in a number of deaths by drowning. Unfortunately signage highlighting the danger of rock fishing or walking along some coastal areas is not always enough to stop people from taking risks. In doing so, they also place others at risk who may attempt to save them. Consequently there have been calls to provide or allow buoyancy devices and/or anchor points in some of these areas.

Wildfire can pose a risk to visitors, especially those who are without access to a vehicle such as those who may be walking the Bibbulmun Track or are within wilderness areas. Information on what to do when there is a wildfire is included in some publications such as Bibbulmun Track maps. However, it will also be included in future updates of park specific information on the department's website and brochures such as "*Going to the Coast in D'Entrecasteaux National Park*".

29. Visitor Safety – Key Points

- Visiting and enjoying natural areas can involve visitor risks either through the activity itself or by natural events (e.g. wildfire).
- The Department has a moral and legal responsibility to minimise visitor risk. It does this by implementing Departmental policy and a visitor risk program.
- Recreation sites are regularly audited to identify visitor risks.

The objective is to minimise risks to public safety associated with visiting areas managed by the Department while maintaining a range of visitor experiences wherever possible.

This will be achieved by:

1. Preparing and disseminating visitor risk management guidelines and providing assistance and training for staff and volunteers.
2. Applying industry standards and utilising appropriate expertise and quality of materials in the design and construction of facilities and structures.
3. Continuing to implement the Department's visitor risk management program.
4. Continuing to provide information (including signs where those hazards associated with structures, facilities or natural attractions may not be obvious) to enable visitors to consider risks in planning their activities in the parks.
5. Adopting codes of safe conduct for recreational activities within the parks (such as four-wheel driving, hiking, swimming, fishing, diving, and canoeing, as well as abseiling and caving where permitted) and promoting and publicising them as appropriate.
6. Developing protocols for visitors on what to do and where to go if caught in a wildfire in the parks and including this in Departmental publications and websites.
7. Investigating methods of improved emergency communication within the parks for and between emergency services agencies when dealing with emergencies in the parks.
8. Discouraging inappropriate advertising of areas (e.g. photos of people standing on cliff edges or dangerous four-wheel driving).

Key Performance Indicator (see also Appendix 2)

Performance Measure	Target	Reporting requirements
29.1 Incidents reported to the	29.1 The number of incidents reported	Annually

Department	remain stable or decreases from 2012 levels	

30. DOMESTIC ANIMALS

Domestic animals such as cats, dogs[15] and horses are not allowed in the parks (see Section 20 *Introduced and Other Problem Animals* and Section 27 *Recreational Use – Recreational Activities*). However many people take their pets with them, particularly dogs, when they travel. This is a significant problem in D'Entrecasteaux National Park. It is important that dogs and other domestic pets are not taken into national parks as:

- domestic dogs and cats can prey on native fauna;
- the lasting scent left by dogs can scare some native fauna away. This can also affect the opportunity for visitors to interact with wildlife;
- domestic animals can increase the spread of weed species and also increase vegetation disturbance. For example, seed transmission through the digestion system of a horse can take up to 10 days (St John-Sweeting and Morris 1991);
- dog faeces carry diseases which can be harmful to wildlife and people;
- dogs can interfere with the enjoyment of other park visitors; and
- fox baits regularly used in national parks are poisonous to dogs (see Section 20 *Introduced and Other Problem Animals*).

Under special circumstances, domestic animals can be permitted in national parks under the Conservation and Land Management Regulations in 'designated areas'. There are no designated areas within the parks. The closest areas to the parks where dogs are permitted are in the dog exercise areas at Windy Harbour (managed by the Shire of Manjimup) and at Foul Bay Beach within Walpole-Nornalup National Park. Extending the Windy Harbour dog exercise area east into the national park may be investigated as there is a demand for additional dog exercise areas, however significant bird breeding areas near Gardner River need to be avoided. The implications on the fox baiting program also needs to be considered.

30. Domestic Animals – Key Points

- Although domestic animals are not allowed in the parks, visitors bringing dogs into D'Entrecasteaux National Park remain a problem.

The objective is to protect the parks and visitors from the impact of domestic animals.

This will be achieved by:

1. Prohibiting dogs and other domestic animals entering the parks as per this management plan.
2. Promoting the use of kennel facilities in neighbouring towns.
3. Investigating the feasibility of designating an area for dogs within D'Entrecasteaux National Park from the existing dog exercise area at Windy Harbour to 4 kilometres east of the township along the beach towards Gardner River.
4. Monitoring the impact of any designated dog area adjacent to Windy Harbour and remove designation if there are ongoing compliance issues, an unacceptable impact on park values/management or in the event that dogs are prohibited from Windy Harbour reserve.

[15] The exception is guide and hearing dogs for visually and hearing impaired visitors, specially trained dogs for search and rescue operations, and sniffer dogs as part of permitted feral animal programs e.g. pigs or deer or as part of threatened species programs which may be allowed as appropriate.

PART F. MANAGING RESOURCE USE

31. TRADITIONAL HUNTING AND GATHERING

Legislation recognises Aboriginal rights to hunt and fish for food. Under section 23 of the Wildlife Conservation Act, Aboriginal people are exempted from some of the provisions of the Act related to the taking of flora and fauna. Aboriginal people may take flora and fauna for food for themselves and their family from lands and waters, including Crown land, but not from nature reserves. The consent of the 'occupier' of the land is required. In the case of national parks and conservation parks, the consent of the Conservation Commission and the Department's Director General is necessary for Aboriginal people to hunt, fish or gather food for their own sustenance. Traditional burning will not be permitted in the parks to facilitate hunting. Other conditions associated with approval include:

- that the use of wildlife is sustainable;
- food is only taken by a cultural group associated with the parks or have permission from Aboriginal people who can speak for the country;
- special provisions may be applied to the taking of some species (e.g. threatened or specially protected species)
- food taken is not sold;
- the activity does not impinge on the safety of others; and
- the activity is consistent with other land management objectives.

Over the life of this plan the native title rights of Aboriginal people may change, including hunting and gathering. The Department will ensure conformity with any changes to legislation or Government policy during the life of the plan.

31. Traditional Hunting and Gathering – Key Points

- Aboriginal people may seek to hunt or gather from within the parks. Exemptions within the Wildlife Conservation Act allow this customary activity to occur provided certain conditions are in place.

The objective is to enable Aboriginal people to collect traditional foods within the parks where it is sustainable and does not pose a threat to the safety of other users.

This will be achieved by:

1. Allowing Aboriginal people to hunt and/or gather in the parks, provided:
   - they are either from a cultural group associated with the parks or have permission from Aboriginal people who can speak for the country;
   - have authorisation from the Conservation Commission and the Department's Director General; and
   - safety and sustainability issues have been discussed and addressed.
2. Ensuring that management conforms to any legislative or policy changes during the life of this plan.

32. MINING

Mining[16] on land and waters managed by the Department is subject to the Mining Act, the Petroleum and Geothermal Energy Resources Act, Petroleum Pipelines Act and Petroleum (Submerged Lands) Act, the Environmental Protection Act, the Wildlife Conservation Act and various State Agreement acts.

The Department of Mines and Petroleum (DMP) administers the Mining Act and the exploration for and subsequent development of minerals in Western Australia is undertaken through the granting of various tenements including prospecting licences, exploration licences, general purpose leases and mining leases. DMP also administers the Petroleum and Geothermal Energy Resources Act and the exploration for and subsequent extraction of petroleum resources is undertaken through the granting of exploration permits and production licences. The holders of such tenements, permits and licences are required to meet conditions to retain the right to explore and develop. The consent of the Minister responsible for the Mining Act or Petroleum and Geothermal Energy Resources Act is required for issuing various tenements, permits or licences.

[16] Mining includes exploration, fossicking, prospecting and mining operations, both mineral and petroleum.

Under the Mining Act, processes for approval of mining proposals depend on the Land Administration Act reserve classification. In national parks, mining can take place subject to the concurrence of the Minister for Environment and approval of both Houses of Parliament. For State forest, under the Mining Act mining can take place subject to the concurrence of the Minister for Environment only. For section 5(1)(g) and 5(1)(h) reserves, under the Mining Act mining can be undertaken subject to the recommendations of the Minister for Environment and the Conservation Commission.

Mining projects that potentially may cause significant environmental impacts can be referred to the Environmental Protection Authority (EPA) under section 38 of the Environmental Protection Act by the proponent, DMP, the Conservation Commission, the Department and individuals.

As of 8 July 2004, the Environmental Protection Act now provides for the protection of native vegetation and control of clearing. Any clearing of native vegetation will require a permit under Part V of the Act except where exemptions are granted under Schedule 6 of the Act or prescribed by regulation in the Environmental Protection (Clearing of Native Vegetation) Regulations 2004. For the mineral and petroleum industries, applications for any clearing associated with their exploration, production or development activities will require a permit in all cases except where granted an exemption.

The Conservation Commission provides advice to the Minister for Environment with regards to all mining tenement applications for all reserves.

The document, *Guidelines for Mineral Exploration and Mining within Conservation Reserves and other Environmentally Sensitive Areas* (DME 1998), outlines the procedures and conditions to be applied to applications for mining tenements. Under a 2004 MOU between the former Department of Industry and Resources and the EPA, all development type mining proposals within two kilometres of a national park, marine park, State forest or proposed conservation reserve will be automatically referred to the EPA for assessment.

In 2006 the EPA released Position Statement No. 9 *Environmental Offsets* (EPA 2006). Should mining or petroleum tenements be approved in proposed conservation estate, these should be subject to the principle of environmental offsets. Under the Mining Act there is an expectation that areas disturbed by mining should be rehabilitated and the costs borne by the organisation(s) responsible for the activity.

Mineral Resources and Prospectivity

Cable Sands (WA) Pty Ltd located an area of titanium mineralisation (mineral sands) in the Jangardup area adjacent to the boundary of the D'Entrecasteaux National Park in the early 1990s. Further exploration (200 kilometres of drilling within D'Entrecasteaux National Park) found that the orebody extended further south (referred to as 'Jangardup South'). The mineralisation is similar in size and relative value to the nearby Jangardup mine which opened in 1994 and is at the end of its productive life.

In 1994, Cable Sands proposed to the Government to excise Jangardup South (368 hectares) from D'Entrecasteaux National Park and create a section 5(1)(g) reserve along with 32 hectares of private property. The proposal is the subject of the *Reserves Bill 1995*, which was passed by State Parliament.

Part of the northern portion of the section 5(1)(g) reserve has been mined as part of the Jangardup mining activities and has since been rehabilitated. This land will be returned to D'Entrecasteaux National Park once the Environmental Protection Authority and the Department are satisfied with the standard of rehabilitation.

Approval has not yet been given for the mining of the remainder of the section 5(1)(g) reserve. In mid-2009 Cable Sands relinquished its mining tenements but the area is subject to a new exploration licence.

Much of the rehabilitation on the parcel of land is ultimately dependent on mining being approved or alternatively the ability of the Department to purchase the land if mining is not approved. The section 5(1)(g) reserve is managed as if it is national park and subject to the provisions of this management plan (see Section 3 Management Plan Area).

At Malimup, Cable Sands has also identified a large and extensive deposit in and below the frontal dunes. However, as the deposit is in such a sensitive situation there has been no further evaluation. The Minister

responsible for the Mining Act has created a Mining Act section 19 reservation over the deposit to prevent mining tenement applications over the area. The reservation has to be renewed every two years. The Department recommends that the section 19 reservation be maintained.

A small agricultural-lime quarry (1.3 hectares) located approximately 1.5 kilometres north-west of Windy Harbour has been operating since 1972 under the provisions of the former *Mining Act 1904* (Mineral Claim 70/13595) when the surrounding area was vested in the Shire of Manjimup for 'recreation and camping'. In 1984, the surrounding area was set aside as part of the D'Entrecasteaux National Park. Since then, various concerns about the operation have been raised with respect to the inability to apply appropriate conditions under the former Mining Act. It is estimated that the pit has a remaining life of 30 to 35 years with an approximate capacity of 3500 tonnes of lime per annum. In addition to the localised disturbances of the pit itself, other impacts associated with the quarry include management of the haulage roads through the parks to provide access to the minesite.

A transitional mining lease under the 1978 Mining Act was applied for in 1983, but has not been processed for various reasons including, most recently, the need for the proponents to obtain native title clearances. However, following the Miriuwung-Gajerrong Native Title High Court determination of August 2002, native title is considered to be extinguished on reserves vested under the *Land Act 1933*, prior to 23 December 1996. Therefore, the proponent should now be able to obtain a mining lease under the 1978 Mining Act. Grant (transition) of the mining lease requires the concurrence of the Minister for Environment and approval of both Houses of Parliament. Alternatively, the tenement could be excised from the park before the grant is made, but the Department does not consider this as desirable.

Two petroleum exploration titles cover those parts of the parks underlain by Perth Basin sediments. Three oil wells were drilled along the Warren River in 1902, which were the first oil wells in the State (see Section 24 *Non-Indigenous Heritage*). However limited seismic surveying has been conducted to evaluate the hydrocarbon potential of these areas.

Petroleum exploration licences and mining tenements in the parks are shown in Table 13 (as of August 2008).

Approvals for mining within or adjacent to the parks will be expected to include contributions to national park management in accordance with the net conservation benefit principles. Such benefits could include properties that are enclaves within the boundaries of D'Entrecasteaux National Park as additions to the National Park (see Section 3 *Management Plan Area*).

Basic raw materials including gravel, shale, sand, clay and limestone are sometimes sourced by the Department from within the parks and used for park maintenance activities. Others can only use basic raw materials sourced within the parks if no other resource is reasonably available and the work benefits the management of the parks.

32. Mining – Key Points

- Exploration, mining and petroleum/gas production activity within or adjacent to the parks may have a significant impact on national park natural, cultural and recreational values.
- There are many mining tenements and two petroleum exploration licences within the parks.
- There is a small lime quarry in D'Entrecasteaux National Park near Windy Harbour and a large mineral sands operation north of the park near Lake Jasper.
- Basic raw materials including gravel, shale, sand, clay and limestone are sometimes sourced from within the parks and used for park management activities.

The objective is to minimise the impact of exploration and resource extraction within and adjacent to the parks on values of the parks.

This will be achieved by:

1. Ensuring proposed mineral sands operations in the area do not adversely impact on the cultural, ecological and biological integrity of Lake Jasper Wetland System.
2. Providing formal advice to the Environmental Protection Authority and the Department of Mines and Petroleum in relation to environmental assessments of proposed exploration and mining activities within or adjacent to the planning area.
3. Ensuring that any mining or exploration activities that have the potential to impact on parks' values are subject to the Conservation and Land Management Regulations and other relevant Government policies are strictly adhered to for appropriate operating procedures.

4. Ensuring that all sites in which any mining activity occurs are rehabilitated according to Department rehabilitation standards and guidelines.
5. Ensuring all mining companies carry out stringent disease control.
6. Liaising with the Department of Mines and Petroleum and the holders of the agricultural-lime quarry north-west of Windy Harbour to bring their operations under the current mining protocols of the Mining Act.
7. Considering natural, cultural and landscape values in selecting sites for basic raw materials extraction.
8. Only allowing basic raw materials sourced within the parks to be used by others if no other resource is available and the work benefits the management of the parks.
9. Closing and rehabilitating existing exhausted pits.

33. COMMERCIAL FISHING

The commercial fishing industry relies on selected beaches along the south coast (ocean-based fishery) and a number of major inlets (estuarine-based fishery), including Broke Inlet. The estuaries along the south coast are usually fished commercially from May to October. However, within the parks there are no estuarine-based commercial fisheries, only adjacent within Broke Inlet. The ocean-based fishery is based on the salmon and herring season (February to April), rock lobster season (November to June) and shark, deep-sea and abalone fishing. The majority of operators hold several fishing licences and fish on a year-round basis.

While both these fishing operations take place outside the parks (off shore or in Broke Inlet), land-based operations such as power-boat servicing, launching and catch transfer may take place in the parks (or at Camfield for Broke Inlet). Therefore, the use of vehicles, power generators and other equipment can affect the natural values of the parks and the experience of other park users.

A commercial, ocean-based fishery operates from Windy Harbour and adjacent to Gardner Beach. Other fishing operations occur out of Windy Harbour on a seasonal basis. A salmon-fishing concession is held for the Gardner Beach area, which involves considerable use of vehicles on the beach. All operators mostly use Windy Harbour reserve for accommodation and do not camp in the parks.

The Department of Fisheries controls all fishing operations. The Department's Policy Statement No. 51 *Access for Commercial Fishing through CALM Lands* recognises that existing rights of access will be maintained unless problems related to environmental degradation or conflict with visitor access and use occur.

33. Commercial Fishing – Key Points

- The commercial fishing industry relies on selected beaches along the south coast including Gardner Beach and a number of major inlets, including Broke Inlet.
- The use of vehicles, power generators and other equipment can affect the natural values of the parks and the experience of other park users.
- The Department of Fisheries controls all fishing operations, however the Department controls access through the parks.

The objective is to continue to allow access for commercial ocean and estuarine fishing subject to conditions that minimise the on-shore impacts on values of the parks and park visitors.

This will be achieved by:
1. Ensuring the on-shore environmental and social impacts of fishing operations within the parks are minimised.
2. Using Departmental guidelines to control access for commercial fishermen through the parks.
3. Liaising with the Department of Fisheries to ensure that any changes to fishing operations do not adversely affect the values of the parks or experiences of the users.
4. Not permitting any new access tracks within the parks for commercial fishery use.

34. DEFENCE FORCE TRAINING

The policy on defence force training on Department-managed land recognises that it is an acceptable use of some lands and waters (Policy Statement No. 54 *Defence Force Training on CALM Managed Lands and Waters*). This can also apply to emergency services training. However, some activities can conflict with the conservation

objectives and recreation values of the Department-managed estate. For this reason, some activity types are not generally appropriate in certain categories of the Department-managed lands and waters such as nature reserves.

Activities that have occurred in the parks include survival and navigation exercises, driver training, leadership and search and rescue training. Generally, communication between the Department and the defence forces is good and the activities are carried out in appropriate areas and in a manner unlikely to cause damage to park values or disruption to visitors.

Defence force training activities will be assessed on an individual basis against the criteria detailed in the policy, so that the particular requirements of each exercise can be considered, impacts assessed and appropriate conditions applied. No defence force training will be permitted in any wilderness areas. In order for proper consideration to occur, the defence force unit or unit training coordinator must make written application to the District Manager at least three months before the proposed exercise.

34. Defence Force Training – Key Points

- Defence training is a legitimate activity but must be carried out in appropriate areas and in an environmentally sensitive manner.
- Activities will be assessed on an individual basis and a written application has to be made to the Department before any training exercise can be carried out in the parks

The objective is to minimise the impact of defence force and/or emergency service training exercises in the parks.

This will be achieved by:

1. Continuing to liaise with the defence forces, and other organisations likely to conduct emergency services training exercises in the parks, and encouraging them to seek alternative suitable venues outside the parks.
2. Ensuring any activities are carried out according to the prescriptions of Departmental policy.
3. Liaising with all organisations likely to conduct training exercises regarding the adoption of minimal impact techniques during training exercises in the parks.
4. Prohibiting training exercises in wilderness areas or other sensitive areas likely to be damaged by the activities.

35. EXTERNAL SCIENTIFIC AND RESEARCH USE

The natural and cultural values of national parks make them highly desirable sites for research. Research activities by external agencies or research centres are supported where they contribute to the understanding of natural or social processes within the area, and where such activities do not themselves threaten or disrupt these processes. This information is of value to the Department in refining management operations.

Wildlife research by external researchers operates under a permit system managed by the Department's Species and Communities Branch. It is a condition of the permit system that results are forwarded to the Department. However, occasionally research is undertaken by external researchers that does not require a wildlife research permit (e.g. social research).

The Department is working to further develop relationships with universities to conduct social research in the region, principally through the Nature-Based Tourism Research Reference Group. This group comprises representatives from the Department and all Western Australian universities. The group assists regions and districts of the Department find university researchers to deliver management solutions to recreation/tourism issues. Projects are usually put forward by field staff and listed on the Department's website.

For more information on scientific research to be undertaken by the Department see Section 44 *Research and Monitoring*.

35. External Scientific and Research Use – Key Points

- National parks are a valuable resource for a wide range of research projects undertaken in the state.
- Wildlife research within the parks requires a permit from the Department. The Nature-based Tourism Research Reference Group provides a link between universities and the Department in carrying out

recreation and tourism research.

The objective is to encourage and assist external researchers where the outcomes are relevant to the objectives of this management plan and/or other appropriate Departmental objectives.

This will be achieved by:

1. Assisting, wherever possible, external agencies and individuals where their research contributes directly to Departmental strategies, business plans and the assessment of this management plan.
2. Applying a permit system for research proposals from outside the Department that specifies conditions under which work may be carried out and results disseminated.
3. Continuing to issue permits for wildlife research within the parks as appropriate.
4. Proposing nature-based tourism research projects through the Nature-based Tourism Research Group for listing on the department's website.

36. PUBLIC AND PRIVATE UTILITIES AND SERVICES

Utility corridors are often requested so that electricity, gas, telephone and water services can be provided to enclaves of private property within the parks, or as the most direct route for these services to other nearby lands. It is the responsibility of the local shire to provide services to the private property enclaves and Shire-managed reserves. The construction and subsequent maintenance of these corridors, as with all access routes, can result in impacts on scenic quality, soil erosion, the introduction of weeds and disease as well as create problems for managing visitor access.

The Department would encourage where possible sustainable solutions such as alternate 'green' power sources on-site and water tanks to reduce demand for utility corridors within or adjacent to the parks, and to promote sustainable resource use. For example, a power easement through the park to Windy Harbour would not be supported on the grounds of visual impact, vegetation impacts and potential disease risk. Therefore, the Department would only support an underground option within the actual Windy Harbour Road reserve or various on-site solutions such as small-scale wind or solar energy generation. Currently the Shire of Manjimup does not plan to provide reticulated power to the settlement at Windy Harbour due to prohibitive costs and funding limitations.

The privatisation of telephone, power and gas services may lead to duplication of 'public' utility corridors in or adjacent to the parks. In addition, more requests for telecommunication towers and co-location on Departmental structures for radio and/or telecommunication communications are being made. It is recommended that no new non-Departmental structures are permitted within the parks. Co-location on existing structures may be allowed in the parks as long as any ancillary equipment shelters or ground works associated with the proposal are contained within an existing lease area or disturbed area, and any on-ground works can be managed without long-term impact on the parks' values.

An Infrasound Monitoring Facility within the Shannon National Park has been built on a permissive occupancy basis as part of an international network of stations monitoring a ban on nuclear testing. Requirements of the facility were that it had to be in a remote situation with dense undergrowth to reduce background noise and disturbance over the expected 100-year life of the project. The site will be managed through ongoing liaison with Commonwealth agencies and management of the area to ensure environmental impacts are minimised.

36. Public and Private Utilities and Services – Key Points

- Utility corridors provide power or telephone services to enclaves of private property within the parks, or are a direct route for these services to other nearby lands.
- Impacts of construction and maintenance of these corridors include degraded landscape values, soil erosion, weed introduction, disease spread and associated access problems.
- Specific sites may be sought within the parks to provide radio and/or telecommunications facilities to public or private agencies.
- An Infrasound Monitoring Facility has been built within the Shannon National Park.

The objective is to minimise the impact of public and private utilities and services on the values of the parks.

This will be achieved by:
1. Ensuring that public and private utilities can demonstrate that alternatives to corridors or sites within the parks, or adjacent to the parks, have been fully considered prior to seeking approval from the Department.
2. Applying Department assessment processes to ensure consistency with the Conservation and Land Management Act and purpose of the land for any proposal to construct non-Departmental communication towers within the parks.
3. Requiring that services are provided below ground, and within existing road reserves rather than within the parks.
4. Assessing other proposed corridors or sites for public and/or private utilities within the parks, or adjacent to the parks, against the potential impacts on landscape and natural values and only permitting those that have minimal impact if there is no feasible alternative, not excluding those options that may be more costly.
5. Permitting co-location on existing communication structures as long as any ancillary structures such as equipment housing and ground works do not impact in the long-term on the park's values.

37. REHABILITATION

Rehabilitation is the establishment of a stable, self-regulating ecosystem following disturbance, consistent with the purpose for which the area is managed. The requirement for rehabilitation on the public conservation estate derives from either an inherited situation in which disturbance occurred in the absence of any commitment to rehabilitate, or as part of a planned management program. Rehabilitation may be required following additions to the parks, gravel pit working, road works, recreation site closure or redevelopment, or activities associated with fire suppression. Some of the proposed wilderness areas may require rehabilitation to improve wilderness quality (see Section 25 *Recreational Opportunities*).

Some areas of the Shannon National Park were logged in the 1950s using a selective thinning silvicultural operation. These areas have not regenerated to the same pre-harvest density. These areas will be monitored and remedial action taken where required to ensure that in the longer term the forest structure and diversity is consistent with the conservation values and objectives of the National Park.

The Department's Policy Statement No. 10 *Rehabilitation of Disturbed Land* provides guidelines for the rehabilitation of lands managed by the Department based on the following principles:

1. land should be managed as far as possible to avoid disturbance;
2. rehabilitation should be the last option in a series of management decisions designed to protect environmental values; and
3. rehabilitation should aim to restore original values and help to enhance all potential uses provided the priority uses are not adversely affected.

Where possible, local native species should be used for rehabilitation purposes. This ensures the greatest degree of success, enables new vegetation to blend into the existing environment, and limits the introduction of exotic (non-local) plants and disease. Sources of brushing material (branches of trees and shrubs used to stabilise mobile dune systems) should also be free of disease.

37. Rehabilitation – Key Points

- Rehabilitation of lands managed by the Department can be either an inherited problem or the result of a planned activity.
- Use of local native species during rehabilitation ensures the greatest degree of success, and preserves the biodiversity and landscape of the area.

The objective is to restore degraded areas to as near a natural state as possible.

This will be achieved by:
1. Rehabilitating, closing or relocating roads, tracks and other disturbed areas that have the potential to erode or impact on visual amenity.
2. Monitoring logged areas of the karri forest within the Shannon National Park and rehabilitating as necessary to maintain conservation values of the forest.
3. Actively involving private and public groups and individuals in rehabilitation programs.
4. Ensuring local flora is used in rehabilitation schemes.

Key Performance Indicator (see also Appendix 2)		
Performance Measure	**Target**	**Reporting requirements**
37.1 Area of rehabilitation	37.1 All areas subject to mechanical disturbance related to wildfire suppression are rehabilitated within 12 months All disturbances related to recreation development are rehabilitated within 12 months of project completion All exhausted gravel pits are rehabilitated within 2 years Disturbances related to mining are rehabilitated according to permit conditions	Annually from second year of commencement of management plan

38. BEEKEEPING

Commercial beekeeping has developed into a small but significant industry in Western Australia, with an average annual total income for honey production of $9.3 million and a total worth (including pollination of agricultural and horticultural crops) of approximately $120 million per annum (Manning 1992). Apiarists in Western Australia have traditionally relied on large areas of native vegetation for honey production, and are increasingly dependent on lands managed by the Department as other areas are cleared for urban development and agriculture.

For all apiary sites on Crown land in Western Australia (including land not managed by the Department), the apiarist must obtain a permit from the Department. As of June 2008, there were 3402 permits for apiary sites on Crown land. The majority of these sites are in the jarrah forest between Mundaring and Collie, the sandplains north of Yanchep to Geraldton, the woodlands of the Goldfields and Ravensthorpe Range, and the southern forest between Donnybrook and Walpole. Forty-two per cent (690 sites) are currently on conservation reserves managed by the Department.

The Department's Policy Statement No. 41 *Beekeeping on Public Land* provides for general guidance for the management of apiculture on Crown land. This policy is currently under review. As part of current Departmental policy, a moratorium on new apiary sites in national parks has been in place since 1992. Under the draft policy the Department will maintain (and renew) current apiary site permits on all classes (tenures) of land, but permit no additional apiary sites on land currently or proposed to be reserved primarily for nature conservation purposes[17], until a management plan has been prepared. The Department, through the management planning process, will consider whether access for beekeeping is either retained at the current level, increased, decreased or phased out based on appropriate environmental and management criteria (Appendix 14). Thus the management planning process will identify suitable areas for beekeeping whilst minimising the potential impacts of honey bees (see Section 20 *Introduced and Other Problem Animals*).

Whilst it is recognised that feral honey bees are more of a threat to the values of conservation reserves than managed honey bees, there is little knowledge about the range of conditions under which honey bees leave the hive and become feral. It is suggested that feral populations can be eliminated from areas after unfavourable conditions, such as drought or fire, as long as there is not a constant supply of managed hive bees swarming into the wild (Scheltema 1981).

When allowing an introduced pollinator to persist within a conservation reserve, the dynamics between the native pollinators (which includes mammals, birds and insects) and the native flora and dependent fauna need to be considered. The abundance of the native bee species in the south-west (estimated in the 1000s) reflect the diversity and complexity of pollination mechanisms of the flora of the region, with almost half the plant species being primarily bee pollinated (Scheltema 1981). Further monitoring and research is required in the south-west to quantify the impacts of managed and feral honey bees within the natural environment.

[17] Lands reserved primarily for nature conservation includes national parks, conservation parks, nature reserves and 5(1)(g) and (h) reserves.

There are currently 34 apiary sites in the Shannon National Park and eight in the D'Entrecasteaux National Park including proposed additions (April 2004 data). These sites are located approximately 3 kilometres apart. This distance, in use prior to the *Forest Management Regulations* 1993 and supported by the industry, minimises honey bee interaction between sites and the potential transfer of honey bee diseases.

Each apiarist usually has a network of sites between Geraldton and Albany and moves the hives according to nectar flow cycles. During periods of low nectar flow in the south-west forests, the apiarists place their hives in the northern sandplain country where there are enough resources to maintain hive strength and viability during winter. Therefore, the sites within the planning area often go many years without being utilised.

Predicted impact between honey bees and values within the planning area have been assessed using the environmental and management criteria (Appendix 14). Consequently, the planning area has been categorised as being either:

- 'suitable' for apiary sites;
- 'suitable but conditional'; or
- 'highly constrained'.

Predicted interaction between apiary sites and threatened flora and significant habitats and communities within the planning area were made by Departmental experts and based on the best available knowledge at the time of publication.

Subsequent to the planning area being categorised into either one of the three levels of suitability for apiary sites, a review was made of the current sites within the planning area (Appendix 14). This review showed that 37 of the 42 current sites were within suitable but conditional areas and five within highly constrained areas. Three of the highly constrained sites are in close proximity to a threatened ecological community which has flowering plants that have been evaluated as being potentially impacted by honey bees on a year-round basis. One other site is in close proximity to a recreation site and the remaining site is in close proximity to a Class 1 or 2 walktrail as well as an environmental weed infestation that honey bees have been evaluated as assisting in increasing seed set.

Only a small part of the planning area was categorised as being suitable without additional conditions. New sites are permitted within these areas as long as there is existing access and according to the standard apiary permit conditions.

The 37 sites within suitable but conditional areas, may have additional conditions placed on the permit, to be determined by the District, and the Department's Nature Conservation, Science, and Parks and Visitor Services divisions. Examples of additional conditions may include seasonal restrictions, hive limits, structural modifications to the hives to restrict the queen, increased disease hygiene control and/or regular monitoring of the apiary site. New sites are permitted within these areas, subject to there being existing access.

The five sites that are highly constrained (867, 3085, 4264, 5081 and 5217) will be cancelled and relocated, where possible, in negotiation with the apiarists. This may include sites within the parks within areas evaluated as being suitable, or suitable but conditional or in an area outside of the planning area. No new sites are permitted within the highly constrained areas.

The current sites on Crown land within 2 kilometres of the planning area boundary were also assessed during the planning process. One site was found to be within 2 kilometres of a threatened ecological community within D'Entrecasteaux National Park. This site (5950) is recommended to be closed and relocated. Twenty other sites outside the planning area were identified that require additional conditions to protect the values of the planning area. Some of these sites have been addressed by the planning process for the adjacent *Walpole Wilderness and Adjacent Parks and Reserves Management Plan* (DEC 2008).

Whilst the approach outlined above will be maintained throughout the life of the plan, the methodology of categorising the planning area into classes of suitability will need to be adaptive over the life of this plan, to ensure that the criteria used are the best available, and the categorisation of the planning area remain in line with current knowledge of the planning area values. Any change in the categories of the planning area or criteria should ideally coincide with the time that the apiary permits are due for renewal.

Apiary sites adjoining the planning area and not on Crown land may also impact on its environmental values. Where a significant environmental impact to recognised values (e.g. threatened ecological communities) may occur, such proposals could be referred to the Environmental Protection Authority for assessment.

Further information on beekeeping, including the standard conditions for apiary sites, can be obtained from the Department's website.

38. Beekeeping – Key Points

- Beekeeping is a significant industry in the south-west and throughout Western Australia.
- Introduced honey bees may have an impact on the natural and recreational values of the parks, however feral honey bees are more of a threat to natural values than well managed honey bees.
- There are currently 34 apiary sites in the Shannon National Park and eight in the D'Entrecasteaux National Park and proposed additions.
- There will be a precautionary and pragmatic approach with regards to beekeeping in the parks.
- Areas of the parks have been assessed as being either suitable, suitable but conditional or highly constrained for apiary sites as per environmental and management criteria in Appendix 14.

The objective is to minimise the impact of introduced honey bees on values of the parks and park visitors whilst supporting the beekeeping industry within the State.

This will be achieved by:

1. Supporting research on the impact of beekeeping on native flora and fauna within natural ecosystems of the south-west and adapting management to incorporate new knowledge.
2. Renewing, with standard conditions, the permits for sites within areas identified as being suitable for apiary use and reviewing every 5 years.
3. Renewing, with additional conditions, the permits for sites within areas identified as being suitable but conditional for apiary use, and reviewing every 5 years.
4. Allowing new sites and transfer of sites within areas identified as being suitable or suitable but conditional, subject to the appropriate conditions.
5. Cancelling, and relocating where possible, apiary sites that are within the highly constrained areas, and not permitting any new sites in these areas.
6. Monitoring apiary use within the planning area and any corresponding impacts within the areas identified as suitable but conditional, to aid in the review process.
7. Controlling feral bees within the parks, where feasible (see Section 20 *Introduced and Other Problem Animals*).
8. Supporting research on preventing swarming from managed beehives.
9. Reviewing the criteria for determining suitability of areas, and consequently the categories of suitability within the planning area, used in this management plan, as new knowledge becomes available and/or as circumstances change.
10. Liaising with beekeepers (including through the Beekeepers Consultative Committee) and the Department of Agriculture and Food to ensure the most efficient and sustainable use of sites.
11. Referring to the Environmental Protection Authority any proposal for an apiary site on adjoining private land where significant impacts may occur on the parks' values if a suitable resolution cannot otherwise be reached.

39. FOREST PRODUCE

In accordance with section 99A of the Conservation and Land Management Act, the Director General can grant a licence to take forest produce[18], from national parks provided it is:

- to remove exotic trees;
- used for therapeutic, scientific or horticultural purposes; or
- for essential works.

Essential works include works that are required to establish or re-establish access to land or to provide a firebreak. Forest produce, including seed, that is taken in connection with essential works can be sold, or used by the Department. There are stands of introduced tree species such as yellow stringybark, which could be selectively logged from the parks and sold by the Department as forest produce.

The Department may choose to collect seed itself, for use within the parks. Using local seed and the subsequent regeneration of native vegetation is the preferred method of rehabilitation (see Section 37 *Rehabilitation*).

[18] 'Forest produce' includes trees, parts of trees, timber, sawdust, chips, firewood, charcoal, gum, kino, resin, sap, honey, seed, bees-wax, rocks, stone and soil.

39. Forest Produce – Key Points

- Various introduced species can be harvested and sold from the parks.

The objective is to allow the removal of forest produce in the parks for purposes permitted in the Conservation and Land Management Act.

This will be achieved by:

1. Prohibiting the removal of any native forest produce for commercial use from the parks except in accordance with section 99A of the Conservation and Land Management Act.
2. Harvesting introduced trees that do not have landscape value and retaining any net revenue for park operations.
3. Removing trees (or limbs) that pose a high risk to the safety of visitors or facilities (see Section 29 Visitor Safety) and there is no other option than to remove them, or that obstruct designated access tracks and using these trees as much as possible for park management and facilities.
4. Rehabilitating with native flora any area where forest produce is removed, where necessary.

40. WATER RESOURCES

The Department of Water is responsible for water resource protection and management, and licensing.

D'Entrecasteaux National Park has a purpose of 'national park and water' (see Section 3 *Management Plan Area*). Rivers of the D'Entrecasteaux National Park have been identified as being important future water resources in the region (I. Loh pers. comm. 2004).

Surface Water

In areas 'proclaimed' under the *Rights in Water and Irrigation Act 1914*, the Department of Water ensures that water use is within sustainable limits, through a system of issuing licences for approved users. Within the parks, the Donnelly and Warren river catchments are proclaimed under the Act. Water can be taken from a watercourse in unproclaimed areas without a licence so long as the flow is not 'sensibly' diminished, thereby affecting the rights of downstream users. There are no licensed users of the surface water within the parks. The water for Camfield is obtained from rainwater tanks and Shannon Dam is used for water for Shannon townsite.

Outside the parks, in the upper reaches of the Warren and Donnelly rivers and their tributaries, there are approximately 40 licensed farm dams servicing the agricultural region (totalling 15 to 20 gigalitres per year). However, as stock and domestic water abstraction under 1500 kilolitres per year are exempt from the licensing process, and unproclaimed areas do not require licensing, there can be no accurate picture of total water abstraction in the upper catchments. The monitoring that the Department of Water undertakes indicates that the current levels of abstraction are not producing significant effects on the environment.

Groundwater

Similarly, groundwater catchments are also proclaimed under the Rights in Water and Irrigation Act. The Blackwood Groundwater Area is a proclaimed groundwater area under the Act. Within the parks, the Blackwood Groundwater Area is in the Black Point/Lake Jasper area and east towards the Warren River area (Figure 16). Groundwater use in this area has the potential to impact on the values of the park and should be closely monitored and licensed by the Department of Water. Aquifers used in this groundwater area include the Leederville and the underlying South West Yarragadee (see Section 15 *Catchment Protection*). All abstraction is outside of the parks but there could be some drawdown impacts on the water resources of the parks, however this has not been quantified.

The Shire of Manjimup obtains water for Windy Harbour townsite from groundwater bores within D'Entrecasteaux National Park near Salmon Beach Road. The Department of Water, as yet, do not require the Shire to obtain a licence for this activity as it is in a non-proclaimed area. The Shire of Manjimup has indicated that they would like to obtain security with regards to this water abstraction. The Department is liaising with the Shire of Manjimup and Department of Water to ensure the water abstraction is sustainable in the long term with minimal impact on the park values. This should include base line studies of the groundwater resource and monitoring of water use and impact on vegetation. Rainwater tanks will be encouraged, as well as water sensitive designs within the townsite.

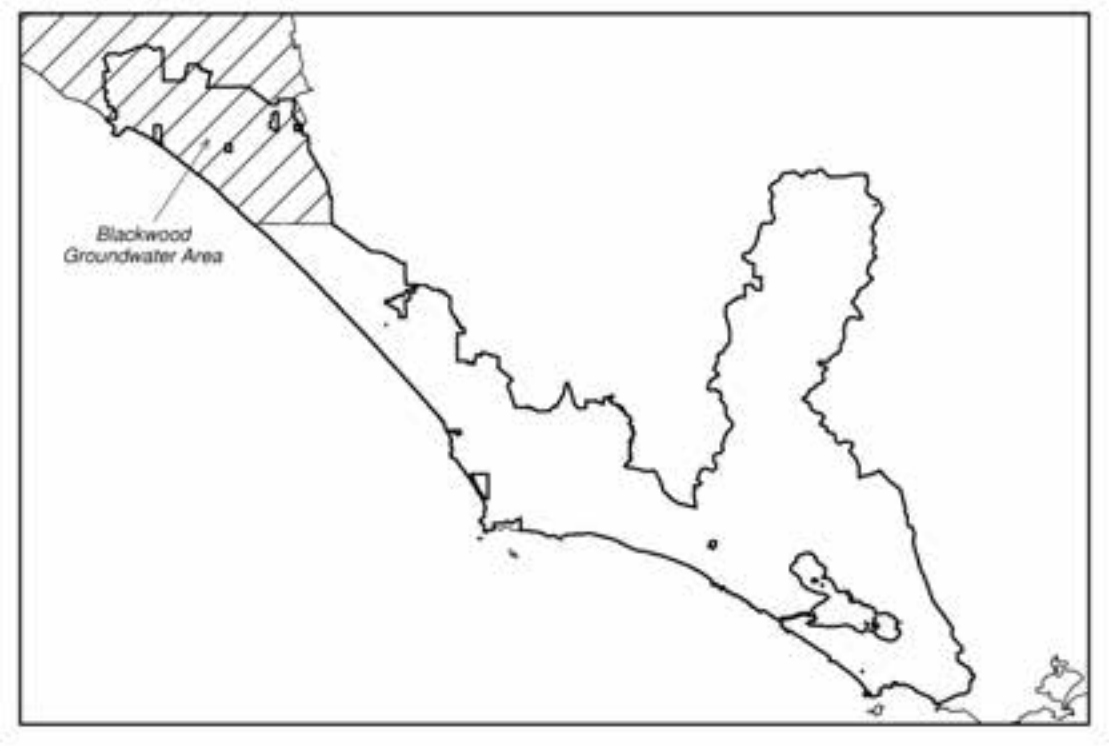


Figure 16: The Blackwood Groundwater Area within the Planning Area

Future Use

Whilst the purpose of D'Entrecasteaux National Park currently allows use of the water resources within the park, as part of the Department of Water licensing process, the proponent would need approval from the land 'owner' (in this case the Conservation Commission) to access the land. Unless the Conservation Commission agrees to allow access to the proponent, no licensed use of the water resources could take place in the park. However, as the Department of Water have the authority to investigate water resources, it is possible that exploration bores could be installed without the approval of the Conservation Commission or the Department.

There are several dairy farms in the Black Point area being planned (see Section 15 *Catchment Protection*) which will involve significant water abstraction and will be licensed by the Department of Water under the Rights in Water and Irrigation Act as they are in a proclaimed groundwater catchment area.

There are general plans to introduce new public water supply dams in one or more of the upper catchments of the Warren, Donnelly and Gardner rivers in the next 25 years (I. Loh pers. comm. 2004), which may greatly impact on the flows of the rivers within the park. However these plans are not formalised and no details exist at present other than the plan to dam the Donnelly River within part of the proposed Greater Beedelup National Park. This dam may have the capacity to supply up to approximately 60 gigalitres per year (I. Loh pers. comm. 2004) and would significantly affect the flow within the Donnelly River in the park.

If the water resources within the park or in the upper catchments of the rivers in the park are to be used for further major agriculture or public water supply purposes, it is recommended that proposals are formally assessed by the Environmental Protection Authority.

40. Water Resources – Key Points

- D'Entrecasteaux National Park is reserved for 'national park and water' purposes although there is no licensed water abstraction within the parks at present.
- Some water abstraction occurs in the Warren and Donnelly River catchments upstream of D'Entrecasteaux National Park.
- No water abstraction could occur in the D'Entrecasteaux National Park without the Conservation

Commission permitting access to the proponent.

- Long-term water abstraction proposals in the upper reaches of the rivers of D'Entrecasteaux National Park could affect flows in the park.
- The Blackwood Groundwater Area which covers the western part of D'Entrecasteaux National Park is a proclaimed groundwater area under the Rights in Water and Irrigation Act.
- Most of the Windy Harbour water supply comes from boreholes in D'Entrecasteaux National Park.

The objective is to minimise the impact of water resource use in the parks' catchments.

This will be achieved by:

1. Requesting that the Department of Water liaise with the Department when investigating future water resources and issues new licenses in and within the parks' catchment to ensure that environmental impacts are minimised.
2. Liaising with the Department of Water on minimising any current impact from abstraction from the Blackwood proclaimed groundwater area on the values of the parks.
3. Referring any proposals for significant use of the water resources of the parks or in the upper catchments, to the Environmental Protection Authority for formal assessment.
4. Liaising with the Department of Water to ensure sufficient environmental flows are maintained if damming occurs in the upper catchments, and that a monitoring program is instigated to determine environmental thresholds where abstraction is permitted.
5. Recommending to the Department of Water that unproclaimed areas are examined to determine impacts of unlicensed water use on the values of the parks' rivers and groundwater resources with a view to proclaiming these areas.
6. Liaising with Shire of Manjimup and Department of Water to ensure that water abstraction for Windy Harbour is sustainable and does not impact on park values, as well as promoting rainwater tanks and water sensitive designs within the townsite.

PART G. INVOLVING THE COMMUNITY

41. INFORMATION, EDUCATION AND INTERPRETATION

The parks provide a valuable opportunity for community education about coastal processes and landforms, wetlands, forests and cultural heritage. An effective information, education and interpretation program is vital to achieve the goals and objectives for the management of the parks. It informs the public of the attractions, facilities and recreational opportunities available, and assists the public to appreciate and understand the natural and cultural environments. It also fosters a sense of community ownership of the parks and engenders support for their management, while encouraging appropriate behaviour. For example, some facilities and signs within D'Entrecasteaux National Park are regularly vandalised, burnt or removed—appropriate education of park users on the values of the park and the need to manage the area to conserve these values for future generations could influence this antisocial behaviour.

The process of community education consists of three parts:

- Information – provides details of facilities, available activities, features and regulations and includes off-site promotion of the parks and brochures.
- Education – provides resources and programs designed specifically for various educational groups and include teacher's resource packs, student work sheets and support materials.
- Interpretation – explains natural and cultural features and management activities to enrich visitor experiences and includes on-site signs, information shelters, brochures, and guided interpretive activities.

Education and interpretation programs will concentrate on raising awareness of the parks' conservation values and their vulnerability to human impact and the positive actions visitors can take to support the management of the parks. In addition, visitor risk information and information to assist visitors to navigate their way around the parks will be developed.

Interpretation for the parks is being done on a regional basis with an encompassing theme of experiencing the dynamic nature of the Warren Region in the deep south, from river catchments and tall forest to the coast. An additional three primary themes have been developed:

- discover a diversity of places and the dynamic processes that shape this region;
- explore the interrelationships within a variety of forest and other wildlife communities; and
- contemplate the connection of the many faces of people caring for this country.

Sites identified so far within the parks that would be suitable for communicating these themes include Black Point, Lake Jasper, Yeagarup Dunes, Point D'Entrecasteaux, Mt Chudalup, Shannon River and Shannon townsite. More may be identified over the life of the management plan.

Existing education and interpretation programs include the Great Forest Trees Drive within Shannon National Park. The drive is assisted by radio and illustrated map-book and takes visitors through 48 kilometres of karri forest within the park (Map 13 Existing Recreation Use). There are six picnic and information stops provided, including details of the history of Shannon townsite, the birds, trees, flowers and mammals likely to be encountered within the park, and a brief history of logging, fire, disease and farming in the area. Education and interpretation programs linking the six parks within the Walpole Wilderness (including Shannon National Park) will also be developed.

41. Information, Education and Interpretation – Key Points

- The Shannon and D'Entrecasteaux national parks provide a valuable opportunity for community education about coastal processes and landforms, wetlands, forests, fire management and cultural heritage.
- Increased community ownership of the parks is needed to gain support for park management and to curb anti-social behaviour such as vandalism.

The objective is to promote community awareness and understanding of the natural, cultural and recreational values of the parks and engender support for effective management of the parks.

This will be achieved by:

1. Developing and implementing a communication plan for interpreting the parks' values.
2. Developing a range of interpretation and education programs, facilities and media that highlights the natural and cultural heritage and management issues.
3. Developing a range of activity specific information as required.
4. Liaising closely with other agencies, organisations and individuals (such as tourism agencies, tour operators, schools and museums) who have similar interests in interpretation of the parks' values.
5. Providing opportunities for visitors to make contact with Departmental staff and others involved with interpreting the parks' values.
6. Developing and implementing projects within the parks that will foster positive visitor attitudes to environmental issues.
7. Providing information at key access points to orientate and introduce visitors to the parks.
8. Disseminating 'Code of the Coast' information (see Section 26 *Visitor Access*) on park brochures, on appropriate information boards and tourist bureaux, and by erecting signs at the start of four-wheel drive tracks to the coast.

Key Performance Indicator (see also Appendix 2)

Performance Measure	Target	Reporting requirements
41.1 The level of participation in Departmental education programs	41.1 An increase from 2012 levels	Annually
41.2 Visitor compliance with regulations and policies within the parks	41.2 An increase from 2012 levels	Annually

42. WORKING WITH THE COMMUNITY

Community involvement is an integral component of the Department's operations. The community, as groups or individuals, is encouraged to be involved in both the planning and management of many of the Department's activities, including volunteer programs.

The community have been involved in preparing the management plan by providing initial comments on their perspective of the issues within the parks by way of written submissions and participation in issue workshops as well as commenting on the draft management plan during the 3 month submission period. Also, interested community members were invited to be part of the Shannon and D'Entrecasteaux Advisory Committee, which advised the Management Planning Team throughout the preparation of the draft management plan.

Ongoing community support is essential for the successful implementation of the management plan. The most important step will be to involve Aboriginal people, adjacent land owners, users, tour operators and interest groups.

Community groups are encouraged to take part in volunteer activities throughout the parks such as clean up days and help with management activities such as erosion control and track maintenance. Not only does the Department benefit from these activities, but the volunteers also gain meaningful and enjoyable experiences from these activities.

42. Working with the Community – Key Points

- The community have been involved in preparing this plan and ongoing community support is essential for the successful implementation of this management plan.
- The Department supports voluntary activities, which contribute to achieving nature conservation and management objectives, and which build community awareness, understanding and commitments to these objectives.

The objective is to facilitate effective community involvement in management of the national parks.

This will be achieved by:

1. Continuing to involve interested local individuals and organisations in conservation and land management programs within the parks.
2. Continuing to support volunteer involvement in the Departmental programs by providing meaningful work.
3. Supporting the maintenance of a volunteer database.
4. Recognising the value of volunteers through a rewards and recognition program.
5. Encouraging the formation of a 'friends of' group for the parks.

Key Performance Indicator (see also Appendix 2)

Performance Measure	Target	Reporting requirements
42.1 The number of registered volunteers and the level of volunteer hours contributed over the life of the plan	42.1 An increase from 2012 levels	Annually

PART H. MONITORING AND IMPLEMENTING THE PLAN

43. ADMINISTRATION

The Department delivers operations on the ground, principally through nine regional centres that are further sub-divided into districts. The parks extend across two districts (Frankland and Donnelly) of the Warren Region. The implementation of the management plan is the responsibility of the District Manager, Donnelly District.

The implementation of this management plan will be subject to budget allocation within the Department, determined annually but forecast over a 3-year period. The preparation of works programs including capital works should incorporate, where applicable, the recommendations for action within this management plan. Every effort will be made to attract external resources to assist in implementing this plan.

44. RESEARCH AND MONITORING

Research and monitoring are essential components of management, and are required to successfully implement this management plan. They can lead to a better understanding of the values of the planning area, increase knowledge, aid in performance assessment against the objectives of the management plan and provide a scientific basis for improving and adapting future management to achieve best practices.

The Department's Science Division undertakes research within the Region either with assistance from regional and district personnel or as part of larger state-wide projects. Additional internal research is conducted or facilitated by the Parks and Visitor Services, principally through the Visitor Satisfaction Survey, the Visitor Statistics Program, and the Nature-based Tourism Research Reference Group. The latter focuses on developing relationships with universities to facilitate nature-based tourism research (see Section 35 *External Scientific and Research Use*).

Research Requirements

It is appropriate that research and monitoring involves a wide range of organisations and groups. The involvement of volunteers, educational institutions and individual researchers can reduce research and monitoring costs, thereby helping to provide quality information for the benefit of the broader community.

Departmental research gives priority to:

- describing and documenting Western Australia's biological diversity;
- providing knowledge on how best to conserve the State's biodiversity; and
- increasing knowledge of visitor use patterns and profiles (e.g. demographics, level of use of recreation sites, visitor expectations and perceptions).

Allocating priority for research and monitoring may result in conducting programs that have relatively little direct management application to the planning area but significant direct application to the conservation estate and species or communities elsewhere.

Research itself has the potential to adversely impact upon the values of the planning area. Proposals for research should be assessed as to their suitability and be subject to appropriate conditions if necessary.

Research and Monitoring Projects in the Parks

In the case of this management plan, specific research projects should also assist in meeting the requirements of the Key Performance Indicators (Appendix 2). This will include gaining a better understanding of those values identified as being most at risk (sensitive to disturbance) and to management practices most likely to have adverse social and ecological impacts. Consideration of research projects that examine the impacts of unanticipated changes to conditions, such as adjoining land use, should also be given priority.

The following research and monitoring has been identified throughout the management plan.

- Research into the potential vulnerability of the parks' species and communities to climate change, including where practicable identifying climatic thresholds for threatened species and communities within the parks (see Section 12 *Climate Change*).
- An integrated catchment management approach will be important in researching patterns and processes within the parks' catchment area in areas such as hydrology, water quality, soil quality and erosion (see Section 15 *Catchment Protection*).
- Further fauna surveys are needed to determine whether the threatened and specially protected fauna are still present in sustainable numbers (see Section 18 *Species and Communities of Conservation Significance*). Management will need to ensure that their habitats are conserved and consider specific requirements for each species particularly in relation to predation, fire regimes and plant disease occurrence. More surveying in the parks would give a more accurate picture of the actual numbers and populations of threatened or priority species within the parks.
- The distribution and abundance of introduced animals and environmental weeds is important (see sections 19 *Environmental Weeds* and 20 *Introduced and Other Problem Animals*). These species are recognised as having an impact on conservation values, and monitoring in association with control should be escalated in co-operation with adjoining property owners, leaseholders and occupants.
- The distribution and spread of plant diseases within the parks requires further research (see Section 21 *Diseases*).
- Fire management research depends on preliminary assessments of flora and fauna to determine the burning regime for each fire landscape unit. The hydrological impact and impact on potential acid sulphate soils/organic rich wetlands of burning (if any) should also be assessed (see Section 22 *Fire*).
- Rehabilitation strategies for dune stabilisation and rehabilitation within the parks need to continue to evolve. These strategies may be undertaken effectively in association with community groups (see sections 35 *Rehabilitatio*n and 41 *Working with the Community*).
- Continuing social research is required to increase current knowledge by determining profiles of park visitors, the level of use of recreation sites, patterns of usage and visitor perceptions for future management.
- The impact of recreation and facilities on the environment of the parks should be monitored. The need for additional facilities will also need to be monitored, taking into consideration population changes in nearby areas, visitor management settings and access.
- Social research and monitoring projects should determine if recreation, environmental education and interpretation activities are meeting visitor needs. The impacts of key activities should be monitored, and appropriate changes made to the activity to resolve unacceptable impacts.

44. Research and Monitoring – Key Points

- In order to implement this management plan and achieve the objectives contained within, research and monitoring is required to improve understanding of the parks' values and aid in performance assessment.
- Future management of the parks will be adaptive based on increased knowledge and understanding of the values and processes within the parks.

The objective is to increase knowledge and understanding of flora, fauna, natural processes, and of visitor use to provide for better management of the parks and to measure the performance of this management plan.

This will be achieved by:

1. Conducting research and monitoring, as resources permit and according to priority, that focuses on issues and key values required to report on this management plan, the establishment of baseline information and in assisting the implementation of this management plan. This may include:
   - Monitoring indicator species for sensitivity against climate change (see Section 12 *Climate Change*).
   - Surveying native flora and fauna within the parks to develop more complete species lists (see sections 16 *Native Plants and Plant Communities*, and 17 *Native Animals and Habitats*).
   - Assessing the threats to the parks by surveying the extent of weeds, feral animals and plant diseases within the parks (see sections 19 *Environmental Weeds*, 20 *Introduced and Other Problem Animals*, 21 *Diseases*).
   - Supporting research programs into the control of feral animals (see Section 20 *Introduced and Other Problem Animals*).
   - Assessing the impact of fire on weeds, regeneration and wetlands (see Section 22 *Fire*).
   - Identifying the fire-sensitive flora within the parks and the minimum fire interval for different areas based on reducing the risk of extinctions (see Section 22 *Fire*).

- Determining fire tolerance of rare and priority flora (see Section 22 *Fire*).
- Conducting research into the specific habitat requirements of selected threatened or restricted fauna (see Section 18 *Species and Communities of Conservation Significance*).
- Researching the impacts of catchment land-use and management practices on ground and surface waters and soil quality within the parks (see Section 15 *Catchment Protection*).
- Conducting research into different rehabilitation strategies (see sections 15 *Catchment Protection* and 37 *Rehabilitation*).
- Monitoring the impact of recreation and facilities on the environment of the parks (see Section 27 *Recreational Use*).
- Implementing an integrated program of social research, survey and monitoring within the parks to determine visitor numbers, patterns, preferences and perceptions, and to assess levels of satisfaction with park management (see Section 25 *Recreational Opportunities – Visitor Numbers and Trends*).

2. Identifying and initiating other integrated research and monitoring programs, as resources permit and according to priority, that facilitate management of the parks.
3. Regional and District staff liaising with relevant staff from other Divisions to determine research priorities, and documenting these in works programs.
4. Providing information gained through research, monitoring and experience to the District and Region where it can be stored in Regional and District office libraries.
5. Developing and maintaining a database of historical, current and required research on the planning area.
6. Incorporating research and monitoring findings into interpretive and educational material where appropriate.
7. Encouraging and supporting, wherever possible, external agencies, institutions, volunteers, individuals and other organisations to carry out research and monitoring projects where this contributes directly to the management of the planning area or the delivery of Departmental strategies and Divisional business plans.
8. Ensuring that research and monitoring activities do not adversely impact on the values of the planning area.
9. Pursuing external funding sources to assist in achieving research and monitoring objectives.
10. Adapting management of the parks, as needs be, according to increases in knowledge of the values and processes of the parks and adjacent areas.

Key Performance Indicator (see also Appendix 2)

Performance Measure	Target	Reporting requirements
44.1 Research within the parks according to Departmental priorities and Government initiatives	44.1 Departmental research conducted within the parks is consistent with the priorities identified in this management plan	Annually

45. TERM OF THE PLAN

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

GLOSSARY

1080	A naturally occurring toxin (sodium fluoroacetate) found in many native south-west Western Australian plants known as 'poison peas' (*Gastrolobium* sp.)
Abstraction	Refers to the removal of water from a natural waterway, dam or Bore
Acid peat flat	A large level area with acidic, humus-rich soil that contains a large amount of peat
Acid Sulphate Soils	The common name given to soils containing iron sulphides
Adequate	In terms of a comprehensive, adequate and representative protected area reserve system; adequate enough to maintain the ecological viability and integrity of populations, species and communities
Aquatic	Living or growing in or on water
Aquifer	A layer of rock which holds and allows water to move through it, and from which water can be extracted
Autonomous	Existing or capable of existing independently
Benthic	Occurring at, or relating to, the bottom of a body of water
Biodiversity	The variety of all life forms: the different plants, animals and micro-organisms, the genes they contain and the ecosystems they form; often considered at three levels: genetic diversity, species diversity and ecosystem diversity
Biogeography	The study of both geography and biology including the relationships between plants, animals, soils, water, climate and humans
Biotic	Of, or relating to living things; caused or produced by living organisms
Calcarenite	Composed of or containing calcium compounds, particularly calcium carbonate
Catchment	The surface area from which water runs off to a river or any other collecting reservoir
Commercial concession	A lease or licence, administered by the Department to conduct commercial operations on lands or waters held by the Conservation Commission or the Marine Parks and Reserves Authority
Comprehensive	In terms of a comprehensive, adequate and representative protected area reserve system; comprehensive enough that the full range of ecosystems recognised at an appropriate scale are reserved
Conservation	The protection, maintenance, management, sustainable use, restoration and enhancement of the natural environment
Critical weight mammals	Mammals weighing between 35 grams and 5 kilograms. These Australian mammals have been the most affected by environmental changes following European settlement
Cryogenic storage	Storage at very low temperatures
Declared rare flora/fauna	Threatened flora or fauna gazetted under the Wildlife Conservation Act
Declared species	Either plants that are declared as weeds or animals that are declared as pests. A list of declared species, with their levels of declaration in various areas of the State is published annually in the Government Gazette pursuant to section 37 of the *Agricultural and Related Resources Protection Act 1976*
Dieback	A disease of plants caused by the infection by the soil-borne fungal-like water mould of the genus *Phytophthora*
Disjunct	Separated or disjoined populations of organisms. Populations are said to be disjunct when they are geographically separated from the main range
Ecological community	An integrated assemblage of species that inhabit a particular area
Ecosystem	A community or an assemblage of communities of organisms, interacting with one another and the environment in which they live
Ecotone	A sharp boundary between adjacent biological communities
Eco-tourism	Tourism focused on appreciation of ecological values, such as to see particular biota or to visit national parks and other reserves
Endemic	Flora or fauna that is confined in its natural occurrence to a particular region
Environmental weed	An unwanted plant species growing in natural ecosystems that modifies natural processes, usually adversely, resulting in the decline of the communities they invade; usually an introduced plant
Estuarine	Relating to a water passage where the tide meets a river current; especially an arm of the sea at the lower end of a river

Eutrophication	The enrichment of water by nutrients, such as compounds of nitrogen or phosphorus. It causes an accelerated growth of algae and higher forms of plant life. These consume more oxygen often leading to a oxygen deficit, which can have a major detrimental effect on the fish other aquatic organisms
Exotic	A species occurring in an area outside its historically known natural range as a result of intentional or accidental dispersal by human activities
Extant	Still existing
Fauna	The animals inhabiting an area; including mammals, birds, reptiles, amphibians and invertebrates. Usually restricted to animals occurring naturally and excluding feral or introduced animals
Feral	A domesticated species that has become wild
Fireline	A mineral earth break between wildfire and the area you are attempting to protect
Fire regime	The combination of season, intensity, interval, extent and patchiness of fire in a given area over time
Floodplain	A plain bordering a watercourse and subject to flooding
Flora	The plants growing in an area; including flowering and non flowering plants, ferns, mosses, lichens, algae and fungi (although fungi are strictly speaking not plants). Usually restricted to species occurring naturally and excluding weeds
Floristic diversity	Diversity relating to plants
Fungus	Saprophytic and parasitic spore-producing organisms usually referred to as plants that lack chlorophyll but actually a separate kingdom to plants and animals and include moulds, rusts, mildews, smuts, mushrooms, and yeasts
Genetic	To do with the hereditary units that are composed of sequences of DNA
Geodiversity	The variety of rocks, minerals and landforms and the processes which have formed these features throughout geological time
Geography	The science of the Earth's form, physical features, climate and population
Geoheritage	State-wide to nationally significant features of geology, including igneous, metamorphic, sedimentary, structural, palaeontologic, geomorphic, pedologic or hydrologic attributes that offer important information or insights into the formation or evolution of the continent; or that can be used for research, teaching or as a reference site
Geology	The study of the history of the earth and its life especially as recorded in rocks
Geomorphology	The study of the earth surface features and their formation
Geoprocesses	Natural and other processes that affect geodiversity features
Germplasm	The genetic material with its specific molecular and chemical makeup that comprises the physical foundation of the hereditary qualities
Groundwater	All free water below the surface in the layers of the Earth's crust
Habitat	The place where an animal or plant normally lives and reproduces
High Water Mark	In relation to tidal waters means highest level of water at spring tides
Holocene	The present geological time period commencing 12 000 years ago
Host	The organism from which a parasite obtains its nutrition or shelter
Hydrology	The scientific study of the characteristics of water, especially of its movement in relation to the land
Indigenous	Native or belonging naturally (to a place)
Inorganic	Involving neither organic life nor the products of organic life
Karst	A limestone region with underground streams and many cavities caused by dissolution of the rock
Introduced species	See *Exotic*
Invertebrate	Animals without backbones, for example, insects, worms, spiders and crustaceans
Landform	All the physical, recognisable, naturally formed features of land having a characteristic shape; includes major forms such as a plain, mountain or plateau, and minor forms such as a hill, valley or alluvial fan
Landscape	Appearance or visual quality of an area determined by its geology, soils, landforms, vegetation, water features and land use history
Landscape Character Type	A broad scale area of land with common visual characteristics based on landscape
Lithology	The study and description of the general, gross physical characteristics of a rock, especially sediments composed mainly of broken fragments of pre-existing minerals or rocks that have been transported from their places of origin, including colour, grain size, and composition

Low Water Mark	In relation to tidal waters means lowest level of water at spring tides
Macropod	A member of a superfamily which includes kangaroos, rat-kangaroos and wallabies
Mesic	Of, or adapted to, a temperate, moderately moist habitat
Microbes	Micro-organisms, especially bacteria that cause disease
Microbial	Involving or caused by microbes
Midden	A mound or deposit containing shells, animal bones, and other refuse that indicates the site of a human settlement
Morphology	The form and structure of an organism or one of its parts
Motile	Exhibiting or capable of movement
National Park	National parks have national or international significance for scenic, cultural or biological values, and can accommodate recreation without detracting from these values. They are managed to conserve wildlife and the landscape for scientific study and to preserve features of archaeological, historical or scientific interest. They are also managed to allow forms of recreation that do not adversely affect their ecosystems or landscapes
Naturalised species	Introduced plants that are well established in the wild i.e. producing offspring and colonising new areas. Compared with introduced plants that are not naturalised. (e.g. ornamental plants around abandoned forestry settlements such as Shannon townsite)
Nature-based tourism	Tourism that is dependent upon the resources of the natural environment and incorporates a range of tourism experiences including adventure tourism, eco-tourism and aspects of cultural and rural tourism
Obligate	Restricted to a single mode of behaviour or environmental condition, such as an obligate aerobe that is dependent on the presence of molecular oxygen to breathe
Organic	Of, relating to, or derived from living organisms
Palaeontology	The study of life in the geological past
Paluslopes	Paluslopes are hill slope wetlands created by hill side seepages. Peat Paluslopes have a sand and peat base rather than the saprolitic (clay) base
Pathogen	Any organism (bacterium or virus) or factor that causes disease within a host
Physiographic unit	A prominent landform as considered in relation to its origin, cause, or history
Pleistocene	The geological time period commencing about 2 million years ago and ending at the Holocene 12 000 years ago
Precipitation	Any form of water, such as rain, snow, sleet or hail, that falls to the Earth's surface
Priority species	A Departmental term for flora and fauna that may be rare or threatened but for which there is insufficient survey data available to accurately determine their true status. Priority species also include rare species that are currently not threatened. Species are grouped from 1 to 5 according to the perceived urgency for further survey
Quaternary	The present geological period commencing around 2 million years ago, includes the Pleistocene and recent Holocene time periods
Rehabilitation	The process necessary to return disturbed land to a predetermined state, in terms of surface, vegetational cover, land-use and/or productivity
Recreation	Generally considered in this management plan to be the day-use of the parks by locals
Relictual	A surviving individual, population, community or species that is characteristic of an earlier period in evolutionary history
Representative	In terms of a comprehensive, adequate and representative protected area reserve system; representative enough that the reserves reflect the biotic diversity of the ecosystems
Riparian	Relating to or growing on the bank of a natural watercourse
Sclerophyll forest	There are two types of sclerophyll forest, dry and wet, both of which have a canopy of eucalypts. Sclerophyllous plants have hard leaves with lignin which prevents the leaves from wilting in dry conditions. Dry sclerophyll are 10 to 30 metres tall and have a hard-leaved understorey, whereas wet sclerophyll forests are taller than 30 metres and have a soft-leaved understorey, such as tree ferns
Symbiotic	A biological relationship which benefits both parties
Soil erosion	A combination of processes in which soil is loosened, dissolved, or worn away, and transported from one place to another by climatic, biological or physical agents
Spores	Primitive, usually unicellular, reproductive body produced by plants and some micro-organisms and capable of development into a new individual either directly or after fusion with another spore

Statutory	Enacted or required by law
Stromatolitic	A sedimentary structure consisting of laminated carbonate or silicate rocks, produced over geological time by the trapping, binding or precipitating of sediment by groups of micro-organisms
Swamp	A wetland often partially or intermittently covered with water
Taxa	A defined unit (for example, species or genus) in the classification of plants and animals
Teleost	Of or belonging to the Teleostei – a large group of fishes with bony skeletons, including most common fishes
Temperate	Of mild temperature, the Temperate Zone is the area or region between the tropic of Cancer and the Arctic circle in the Northern Hemisphere or between the tropic of Capricorn and the Antarctic circle in the Southern Hemisphere
Tertiary	The geological period commencing around 65 million years ago and ending at the Quaternary period 2 million years ago, includes five defined time periods
Threatened ecological community	Threatened ecological communities are assessed by the Department and endorsed by the Minister for Environment. They are non-statutory (although some protection is afforded under the Environmental Protection Act) unless listed under the Commonwealth Environment Protection and Biodiversity Conservation Act. There are four categories of threatened ecological communities: presumed totally destroyed, critically endangered, endangered (may be destroyed within 20 years) and vulnerable (may be destroyed within 50 years). As with flora, there are also possible threatened ecological communities that are allocated Priority 1 to 5 within the Department.
Tourism	Generally considered in this management plan to be visitors from outside the area staying overnight in or adjacent to the parks
Tropical	A region or climate that is frost-free with temperatures high enough to support year-round plant growth given sufficient moisture, the Tropical Zone is the land between the tropic of Cancer and the tropic of Capricorn
Understorey	The shrubs and plants that grow beneath the main canopy of a forest
Vascular plants	Plants having a specialised conducting system that includes xylem and phloem
Vectors	An organism that transmits a pathogen
Vertebrate	Animals that have a spinal column which includes fish, amphibians, reptiles, birds and mammals
Wetland	Land or areas (as tidal flats or swamps) containing much soil moisture

REFERENCES

Abbott, I. (1999). The avifauna of the forests of southwest Western Australia: Changes in species composition, distribution and abundance following anthropogenic disturbance. *CALMScience Supplement* 5: 1-175. Corrigenda. *Conservation Science Western Australia* 5: 136 (2004).

Abbott, I. and Burrows, N. (eds.) (2003). *Fire in ecosystems of south-west Western Australia: Impacts and management*. Backhuys Publishers, Leiden, The Netherlands.

Abbott, I., Burbidge, T., Williams M. and Van Heurck, P. (1992). Arthropod fauna of jarrah (*Eucalyptus marginata*) foliage in Mediterranean forest of Western Australia: Spatial and temporal variation in abundance, biomass, guild structure and species composition. *Australian Journal of Ecology* (1992) 17: 263-274.

Abbott, I. (2003). Aboriginal fire regimes in south-west Western Australia: Evidence from historical documents. In: Abbott, I. and Burrows, N. (eds.) (2003). *Fire in Ecosystems of the South-West of Western Australia: Impacts And Management*: 119-146.

ANZECC and MCFFA (1997). *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia*. Commonwealth of Australia, Canberra.

Aplin, K. and Kirkpatrick, P. (2001). In the pursuit of the frog fungus. *Landscope* 16(3): Autumn 2001, 10-16. Department Conservation and Land Management, Kensington.

Aquatic Research Laboratory UWA (1992). *Survey of the Macroinvertebrate Fauna and Water Chemistry of Permanent Lakes of the South Coast of Western Australia*. Department of Zoology, UWA.

ARMCANZ and ANZECC (2000). *Weeds of National Significance Blackberry (Rubus fructicosus L.agg.) Strategic Plan*. National Weeds Strategy Executive Committee, Launceston.

Armstrong, R. (2004). Ecologically based fire management – Integration of multiple land use objectives. *11th Annual AFAC Conference and Inaugural Bushfire CRC Conference: 7-9 October, 2004, Perth.*

Arnell, N.W. (1999). Climate change and global water resources. *Global Environ. Change* 9: S31–S46.

Arthington, A.H. and McKenzie, F. (1997). *Review of Impacts of Displaced/Introduced Fauna Associated with Inland Waters*, Australia: State of the environment technical paper series (inland waters), Department of Environment, Canberra.

Austin, C.M. and Knott, B. (1996). Systematics of the freshwater crayfish Genus *Cherax erichson* (Decapoda: Parastacidae) in south-western Australia: Electrophoretic, morphological and habitat variation. *Australian Journal of Zoology* 44: 223-58.

Australian Nature Conservation Agency (1996). *A Directory of Important Wetlands in Australia* – Second Edition. ANCA, Canberra.

Barthell, J.F., Randall, J.M., Thorp, R.W., Wenner, A.M. (1994). Promotion of seed set in yellow star-thistle by honey bees: Evidence of an invasive mutualism. *Ecological Applications* 11(6): 1870-1883.

Barthell, J.F., Randall, J.M., Thorp, R.W., Wenner, A.M. (2000). *Yellow Star-Thistle, Gumplant, and Feral Honey Bees on Santa Cruz Island: A case of invaders assisting invaders.* Fifth California Islands Symposium (2000).

Beard, J.S. (1980). *A New Phytogeographic Map of Western Australia*. Western Australian Herbarium Research Notes 3: 37 – 58.

Beck, C. (1993). *Results of a Small Mammal Survey, Lake Jasper Area 17 – 27 May 1993*. Department of Conservation and Land Management, Kensington.

Benshemish, J. (1999). *National Recovery Plan for Malleefowl*. Environment Australia, Canberra.

Bougher, N.L. and Syme, K. (1998). *Fungi of Southern Australia*. University of Western Australia Press.

Bradshaw, F.J. (2000). *Recommendations for the Regeneration and Maintenance of the Tuart Forest in the Yalgorup National Park*. Consultant's Report.

Bradshaw, J. and Mattiske, E. (1997). *Forest Ecosystems Mapping for the Western Australian RFA.* Report to the Steering Committee for the Regional Forest Agreement in Western Australia.

Brown, A., Thomson-Dans, C. and Marchant, N. (eds.) (1998). *Western Australia's Threatened Flora.* Department of Conservation and Land Management, Kensington.

Burbidge, A.H., Blyth, J., Danks, A., Gillen, K. and Newbey, B. (1996). *Western Ground Parrot (Pezoporus wallicus flaviventris) Interim Recovery Plan, 1996-1999*. Department of Conservation and Land Management, Kensington.

Burbidge, A.A. and McKenzie, N.L. (1989). Patterns in the modern decline of Western Australia's vertebrate fauna: Causes and conservation implications. *Biological Conservation* 50: 143-198.

Burrows, N.D. (1994). *Experimental Development of a Fire Management Model for Jarrah (Eucalyptus marginata Donn ex Sm.) Forest*. PhD thesis, Australian National University, Canberra.

Burrows, N.D. (2008). Linking fire ecology and fire management in south-west Australian forest landscapes. *Forest Ecology and Management* 225(7):2394-2406.

Burrows, N.D. and Friend, G. (1998). Biological indicators of appropriate fire regimes in southwest Australian ecosystems. In: Pruden, T. and Brennan, L. (eds.) *Fire in Ecosystem Management: Shifting the paradigm from suppression to prescription.* Tall Timbers Fire Ecology Conference Proceedings, No. 20. Tall Timbers Research Station, Tallahasse.

Burrows, N.D. and Liddelow, G. (2004). *Adaptive Fire Management: Interim guidelines for forest populations of quokka (Setonix brachyurus).* Internal Report. Department of Conservation and Land Management, Kensington.

Burrows, N.D., Ward, B. and Robinson, A.D. (1995). Jarrah forest fire history from stem analysis and anthropological evidence. *Australian Forestry* 58(1): 7-16.

Burrows, N.D., Ward, B. and Robinson, A.D. (1999). *The Role of Indicators in Developing Appropriate Fire Regimes.* Proceedings from the Australian Bush Fire Conference, 7-9 July 1999, Albury, Australia.

Burrows, N. and Wardell-Johnson, G. (2003). Fire and plant interactions in forested ecosystems of south-western Western Australia. In: Abbott, I. and Burrows, N. *Fire in Ecosystems of the South-West of Western Australia: Impacts and management:* 225-268.

Burrows N.D., Wardell-Johnson G., Ward B. (2008). Post-fire juvenile period of plants in south-west Australia forests and implications for fire management. *Journal of the Royal Society of Western Australia* 91:163–174.

Cadwallader, P.L. (1996). *Overview of the Impacts of Introduced Salmonids on Australian Native Fauna*. Australia Nature Conservation Agency, Canberra.

Cale, B. (2003*). Carnaby's Black Cockatoo (Calyptorhynchus latirostris) Recovery Plan*. Department of Conservation and Land Management, Kensington.

CALM (1987). *Shannon Park and D'Entrecasteaux National Park Management Plan 1987 – 1997*. Department of Conservation and Land Management, Kensington.

CALM (1994a). *A Representative Marine Reserve System for Western Australia. Report of the Marine Parks and Reserves Selection Group*. Department of Conservation and Land Management, Kensington.

CALM (1994b). *Reading the Remote: Landscape Characters of Western Australia*. Department of Conservation and Land Management, Kensington.

CALM (1994c). *Western Australian Wildlife Management Program No.13 – Chuditch Recovery Plan 1992 – 2001*. Department of Conservation and Land Management, Kensington.

CALM (1995). *Western Australian Wildlife Management Program No.16 – Woylie Recovery Plan.* Department of Conservation and Land Management, Kensington.

CALM (1999a). *Environmental Weed Strategy for Western Australia*. Department of Conservation and Land Management, Kensington.

CALM (2000). *Phytophthora cinnamomi and disease caused by it*. Volumes 1-3. Department of Conservation and Land Management, Kensington.

CALM (2003). *Establishment of Comprehensive, Adequate and Representative Terrestrial Conservation Reserve System in Western Australia*. Department of Conservation and Land Management, Kensington.

CALM (2004). *Draft Paddling Management Strategy for the Warren Region*. Department of Conservation and Land Management, Manjimup.

CALM (2005a). *Feral Pig Management Strategy for Departmental Managed Land* 2005-2009 (Draft). Department of Conservation and Land Management, Kensington.

CALM (2005b). *Shannon and D'Entrecasteaux National Parks Draft Management Plan*. Department of Conservation and Land Management, Kensington.

Carlsen, J. and Wood, D. (2004). *Assessment of the Economic Value of Recreation and Tourism in Western Australia's National Parks, Marine Parks and Forests*. CRC for Sustainable Tourism, Gold Coast.

Carter, J.D. (1987*). Important Geological Localities beyond the Perth Region, their Significance and Value, Protection and Presentation*. Geological Society of Australia, WA Division, Perth.

Catling, P.C., Coops, N.C. and Burt, R.J. (2001). The distribution and abundance of ground dwelling mammals in relation to time since wildfire and vegetation structure in south-eastern Australia. *Wildlife Research* 28: 555-564.

Caughley, G. (1994). Directions in Conservation Biology. *Journal of Animal Ecology* 63: 215-244.

Chapman, T. (2007). *Forest Black Cockatoo (Baudin's Cockatoo Calyptorhynchus baudinii and Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso) Recovery Plan*. Department of Environment and Conservation, Kensington.

Cheney, N.P. (1994). The effectiveness of fuel reduction burning for fire management. In: *Fire and Biodiversity: The effects and effectiveness of fire management*. Proceedings of a Conference held 8-9 October 1994, Melbourne Australia.

Christensen, P. (1992). *The Karri Forest – its Conservation Significance and Management*. Department of Conservation and Land Management, Kensington.

Christensen, P., Annels, A., Liddelow, G. and Skinner, P. (1985). *Vertebrate Fauna in the Southern Forests of Western Australia – a Survey*. Forests Department of Western Australia, Bulletin 94, Perth.

Christensen, P. and Burrows, N.D. (1994). Project Desert Dreaming: The reintroduction of mammals to the Gibson Desert. In: Serena, M. (ed.). *Reintroduction Biology of Australian and New Zealand Fauna*: 199-207. Surrey Beatty and Sons, Chipping Norton.

Churchill, D.M. (1968). The distribution and prehistory of *Eucalyptus diversicolor* F. Muell., *E. marginata* Donn ex S. M., and *E. calophylla* R. Br. in relation to rainfall. *Aust. J. of Botany* 16: 125-151.

Churchward, H.M. (1992). *Soils and Landforms of the Manjimup Area, Western Australia*. Land Resources Series No. 10. Department of Agriculture, Perth.

Churchward, H.M., McArthur, W.M., Sewell, P.L. and Bartle, G.A. (1988). *Landforms and Soils of the South Coast and Hinterland, Western Australia. Northcliffe to Manypeaks*. Division of Water Resources, Divisional Report 88/1. CSIRO, Australia.

Clark, R.N. and Stankey, G.H. (1979). Determining the acceptability of recreational impacts, an application of the outdoor recreation opportunity spectrum. *Recreational Impact on Wildlands*: Conference proceedings: 32-42. US Dept. of Agriculture, Portland, Oregon.

Collins, D.A., Della-Marta, P.M., Plummer, N. and Trewin, B.C. (2000). Trends in annual frequencies of extreme temperature events in Australia. *Aust. Meteorol. Mag.* 49: 277–92.

Commonwealth Government of Australia (2001). *The National Land and Water Resources Audit – A program of the Natural Heritage Trust*. <http://www.nlwra.gov.au/full/index.html>

Commonwealth of Australia and the State of Western Australia (1998). *Economic Profile of the Tourism and Recreation Industries in the Regional Forest Agreement Area*. Vol. 1 & 11. Commonwealth and Western Australian Regional Forest Agreement Steering Committee, Canberra.

Commonwealth of Australia and the State of Western Australia (1999). *Regional Forest Agreement for South-West Forest Region of Western Australia.* Commonwealth and Western Australian Regional Forest Agreement Steering Committee, Canberra.

Conservation Commission (2004). *Forest Management Plan 2004-2013*. Conservation Commission, Perth.

Conservation Through Reserves Committee (1974). *Conservation Reserves in Western Australia: A report to the Environmental Protection Authority*. Department of Conservation and Environment, Perth.

Cope, R.N. (1975). Tertiary epeirogeny in southern part of Western Australia. *Geological Survey of Western Australia Annual Report* 1974: 40-46.

Crawford, I. and Crawford, P. (2003). *Contested Country: A history of the Northcliffe area*, Western Australia. UWA Press.

Cross, J. (1833). *Journals of Several Expeditions made in Western Australia, during the years 1829, 1830, 1831 and 1832: Under the sanction of the Governor, Sir James Stirling, containing the latest authentic information relative to that country*. J. Cross (editor & publisher) (1980) Royal Western Australian Historical Society, Perth.

CSIRO (2000). *Diseases and Pathogens of Eucalypts*. Keane *et al*. (eds.) CSIRO, Victoria.

CSIRO (2001). *Climate Change: Projections for Australia*. CSIRO Climate Impact Group, Aspendale, Vic. <www.dar.csiro.au/publications/projections2001.pdf>

Curry, S.J., Humphrey, C.W.F., Koch, L.E. and Main, B.Y. (1985). Changes in arachnid communities resulting from forestry practices in karri forest, south-west Western Australia. *Australian Forestry Research* 15: 469-480.

Danks, A., Burbidge, A.A., Burbidge, A.H. and Smith, G.C. (1996). *Noisy Scrub-bird Recovery Plan, Wildlife Management Program No.12*. Department of Conservation and Land Management, Kensington.

DEC (2006). *A 100-year Biodiversity Conservation Strategy for Western Australia (Draft): Phase One: Blueprint to the Bicentenary in 2029.* Department of Environment and Conservation.

DEC (2007a). *Corporate Plan 2007 – 2009*. Department of Environment and Conservation, Kensington.

DEC (2007b). *Good Neighbour Policy*. Department of Environment and Conservation, Kensington.

DEC (2007c). *Fire Management Guideline No. E1 Organic-Rich Soils (Peatlands)*. Department of Environment and Conservation, Kensington.

DEC (2007d). *Fire Management Guideline No. E3 Habitat Protection (Birds) within Reeds and Rushes*. Department of Environment and Conservation, Kensington.

DEC (2007e). *Fire Management Guideline No. E5 Granite Outcrops*. Department of Environment and Conservation, Kensington.

DEC (2007f). *Fire Management Guideline No. E7 South West Coastal Plain*. Department of Environment and Conservation, Kensington.

DEC (2007g). *Fire Management Guideline No. S5 Quokka*. Department of Environment and Conservation, Kensington.

DEC (2007h). *Fire Management Guideline No. S10 Black Cockatoos.* Department of Environment and Conservation, Kensington.

Department of Environment (2003a). *General Guidance on Managing Acid Sulfate Soils*. Department of Environment, Perth. http://portal.environment.wa.gov.au/portal/page?_pageid=53,84383&_dad=portal&_schema=PORTAL

Department of Environment (2003b). *Preparation of an Acid Sulfate Soil Management Plan*. Department of Environment, Perth.

Department of Environment (2004). Treatment and Management of Disturbed Acid Sulfate Soils. Department of Environment, Perth.

Department of Environment (2006). *Draft Identification and Investigation of Acid Sulfate Soils*. Department of Environment, Perth.

Department of Environment and Heritage (2003). *Draft Threat abatement Plan for Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs*. Commonwealth of Australia, Canberra.

Department of Fisheries (2002). *The Translocation of Brown Trout (Salmo trutta) and Rainbow Trout (Oncorhynchus mykiss) into and within Western Australia*. Fisheries Management Paper No. 156.

Department of Fisheries (2006a). *A Five-Year Management Strategy for the Recreational Marron Fishery: Final report of the RFAC Recreational Freshwater Fisheries Stakeholder Sub-Committee.* Fisheries Management Paper No. 213.

Department of Fisheries (2006b). *A Five-Year Management Strategy for the Recreational Marron Fishery: The Minister for Fisheries' decisions in response to the final report of the RFAC Recreational Freshwater Fisheries Stakeholder Sub-Committee (Fisheries Management Paper No. 213).* Fisheries Management Paper No. 217.

Department of Minerals and Energy (1998). *Guidelines for Mineral Exploration and Mining within Conservation Reserves and other Environmentally Sensitive Areas.* Department of Minerals and Energy, Perth.

Dickman, C.R. (1996). *Overview of the Impacts of Feral Cats on Australian Native Fauna*. Australian Nature Conservation Agency, Canberra.

Dodson, J.R. and Lu, J.J. (2000). A late Holocene vegetation and environmental record from Byenup Lagoon, south-western Australia. *Australian Geographer* 31: 41-54.

Dodson, J.R. and Ramrath, A. (2001). An Upper Pliocene lacustrine environmental record from south-western Australia. *Palaeogeography, Palaeoclimatology and Palaeoecology* 167: 309-320.

Dortch, C. (1990). *Assessment of Development Impact on Aboriginal Sites: Lake Jasper, D'Entrecasteaux National Park, 2 – 8 May 1990*. Report to Department of Conservation and Land Management. WA Museum, Perth.

Dortch, C. (1995). *Archaeological Investigation of Aboriginal Sites, Doggerup Creek, Black Head and Malimup Localities: D'Entrecasteaux National Park, Western Australia.* Anthropology Department, WA Museum, Perth.

Dortch, C. (1996). Prehistory down under: Archaeological investigations of submerged Aboriginal sites at Lake Jasper, Western Australia. *Antiquity* 70: 116-123.

Dortch, C.E. and Godfrey, I.M. (1990). Aboriginal sites in a submerged landscape at Lake Jasper, southwestern Australia. *Australian Archaeology* 31: 28-33.

Edwards, D.H.D., Gazey, P. and Davies, P.M. (1994). Invertebrate community structure related to physio-chemical parameters of permanent lakes of the south coast of Western Australia. *Journal of the Royal Society of Western Australia* 77: 51-63.

Enright, N.J., Lamont, B.B. and Miller, B.P. (2005). Anomalies in grasstree fire history reconstruction for southwestern Australian vegetation. *Austral. Ecology* 30: 668-673.

Environment Australia (1996a). *Action Plan for Australian Marsupials and Monotremes*. Australasian Marsupial and Monotreme Specialist Group, IUCN Species Survival Commission, Canberra.

Environment Australia (1996b). *Conservation Guidelines for the Management of Wild River Values.* Environment Australia, Canberra.

Environment Australia (1999a). *Threat Abatement Plan for Competition and Land Degradation by Feral Rabbits.* Environment Australia, Canberra.

Environment Australia (1999b). *Threat Abatement Plan for Predation by Feral Cats.* Environment Australia, Canberra.

Environment Australia (1999c). *Threat Abatement Plan for Predation by the European Red Fox.* Environment Australia, Canberra.

Environment Australia (2001a). *A Directory of Important Wetlands in Australia* – Third Edition. Environment Australia, Canberra.

Environment Australia (2001b). *Australia State of the Environment Report 2001*. Environment Australia, Canberra.

Environment Australia (2001c). *Threat Abatement Plan for Dieback caused by the Root-rot Fungus.* Environment Australia, Canberra.

Environment Australia (2001d). *Commonwealth Listing Advice on Loss of Habitat caused by Anthropogenic Emissions of Greenhouse Gases.* Environment Australia, Canberra.

Environment Australia (2002). *Commonwealth Listing Advice on Infection of Amphibians with Chytrid Fungus resulting in Chytridiomycosis.* Environment Australia, Canberra.

Fernie, L. and Fernie, G. (1989). *In Praise of a National Park: The origins and history of the Walpole-Nornalup National Park.* Self-published, Walpole.

Fire Ecology Working Group (1999). *Management of Fire for the Conservation of Biodiversity: Workshop proceedings*. Department of Natural Resources and Environment, Melbourne.

Friend, G. (1995). Fire and invertebrates: A review of research methodology and the predictability of post-fire response patterns. In: McCaw, W.L., Burrows, N.D., Friend, G.R. and Gill, A.M (eds.) *Landscape Fires '93: Proceedings of an Australian Bushfire Conference 1993*: 165-174. CALMScience Suppl. No. 4. Department of Conservation and Land Management, Kensington.

Friend, G. (1999). Fire and faunal response patterns: A summary of research findings. In: Friend, G., Leonard, M., MacLean, A. and Sieler, I. (eds.) *Management of Fire for the Conservation of Biodiversity: Workshop proceedings.* Fire Ecology Working Group, Department of Natural Resources and Environment, Victoria.

Garnett, S.T. and Crowley, G.M. (2000). *The Action Plan for Australian Birds*. Environment Australia, Canberra.

George, A.S. (1999). Banksia. In: Orchard, A.E., Thompson, H.S. and McCarthy, P.M. (eds.) *Flora of Australia*. 17B: 175-251. ABRS, Canberra/CSIRO, Melbourne.

Gill, A.M., Groves, A.H. and Noble I.R. (eds.) (1981). *Fire and the Australian Biota*. Australian Academy of Science, Canberra.

Goeft, U. and Alder, J. (2000). Mountain bike rider preferences and perceptions in the south-west of Western Australia. *CALMScience* 3(2): 261-275.

Green, J.W. (1985). *Census of the Vascular Plants of Western Australia.* Western Australian Herbarium, Department of Agriculture, Perth.

Gordon (1997a). *D'Entrecasteaux National Park Limestone Hazards: Assessment of limestone cliff hazards Pt D'Entrecasteaux Westcliffe locality – Fish Creek.* Gordon Geological Consultants.

Gordon (1997b). *Limestone Hazards D'Entrecasteaux National Park Part 2: Assessment Short Beach – Fish Creek locality.* Gordon Geological Consultants.

Gordon (1998a). *D'Entrecasteaux National Park Walktrail Survey, August 7, 1998: Inspection and geo technical report of features, VRM, D'Entrecasteaux Drive alignment, totally accessible trail Pt D'Entrecasteaux and coastal trail linking Pt D'Entrecasteaux and Tookalup*. Gordon Geological Consultants.

Gordon (1998b). *Limestone Hazards of Black Point*. Gordon Geological Consultants.

Gordon (1999). *The Lighthouse Tookalup Lookout Walk Trail Geotechnical Report March 23, 1999: Walk trail and viewing platform access at the Windows and Pt D'Entrecasteaux*. Gordon Geological Consultant.

Gordon (2000). *Beach access Fish Creek Skippy Hole and Teds Head: Beach access Skippy Hole and Ted's Head – Fish Creek locality*. Gordon Geological Consultants.

Gross, C.L. (2001). The effect of introduced honeybees on native bee visitation and fruit-set in *Dillwynia juniperina* (Fabaceae) in a fragmented ecosystem. *Biological Conservation* 102: 89-95.

Gross, C.L. and Mackay, D. (1998). Honeybees reduce fitness in the pioneer shrub *Melastoma affine* (Melastomataceae). *Biological Conservation* 86: 169-178.

Hallam, S.J. (1975). *Fire and Hearth: A study of Aboriginal usage and European usurpation in south-western Australia*. Australian Institute of Aboriginal Studies, Canberra.

Hallam, S.J. (2002). *Peopled Landscapes in South Western Australia in the early 1800s: Aboriginal burning off in the light of Western Australian historical documents*. Talk to the Royal Western Australian Historical Society.

Hancock, A. (1994). An approach to classifying and managing caves in the Southern Forest Region, Western Australia. *Environmental Science Report* 95/8. Murdoch University, Perth.

Handol, D., Stukely, M. and Randles, J.W. (2002). Mundulla yellows: A new tree-dieback threat. *Landscope* 17(4) Winter 2002 41-47. Department of Conservation and Land Management, Kensington.

Hassan, L.Y. (1998). Mineral Occurrences and Exploration Potential of Southwestern Australia: Geological Survey of Western Australia Report 65. Department of Minerals and Energy, Perth.

Hassell, C.W. and Dodson, J.R. (2003). The fire history of south-west Western Australia prior to European settlement in 1826-1829. Abbott, I. and Burrows, N. *Fire in Ecosystems of the South-west of Western Australia: Impacts and management:* 71-85.

Havel, J.J. (1989). Conservation in the northern jarrah forest. In: Dell, B., Havel, J.J. and Malajczuk, N.(eds.) *The Jarrah Forest*: 379-399.

Havel, J.J. and Mattiske, E.M. (2000). Vegetation Mapping of South-West Forest Regions of Western Australia. Reprint to CALMScience for the Regional Forest Agreement, Department of Conservation and Land Management, Kensington.

Hayward, M.W., de Tores, P.J., Dillon, M.J. and Fox, B.J. (2003). Local population structure of a naturally occurring metapopulation of the quokka (*Setonix brachyurus* Macropodidae: Marsupialia). *Biol. Cons.* 110: 343-355.

Hearn, R., Stoneman, G.L., Keighery, G., Burrows, N., Yates, C., and Hopper, S. (2003). *Management of Significant Flora Values in South-West Forests and Associated Ecosystems*.

Heritage and Conservation Professionals (2000). *Huts in the D'Entrecasteaux National Park: Heritage assessment and conservation recommendations*.

Hilton, R.N. (1982). A census of the larger fungi of Western Australia. *Journal of the Royal Society of Western Australia* 65:1-15.

Hopkins, A.J.M. (1985). Planning the use of fire on conservation lands in southwestern Australia. In: Ford, J.R. (ed) *Fire Ecology and Management in Western Australian Ecosystems*: 203-205. Western Australian Institute of Technology Environmental Studies Group Report No. 14.

Hopkins, A., Morgan, R. and Shepherd, D. (2000). *Bush and Biodiversity – A preliminary assessment of biodiversity values in the south west catchments natural resource management region*. Department of Conservation and Land Management and Agriculture Western Australia, Perth.

Hopper, S.D. (1992). Patterns of plant diversity at the population and species levels in south-west Australian Mediterranean ecosystems. In: Hobbs, R.J. (ed) *Biodiversity of Mediterranean Ecosystems in Australia.* Surrey Beatty and Sons, Chipping Norton.

Hopper, S.D. (1994). Session 2: Impact on ecology. In: Plant diseases in ecosystems: Threats and impacts in south-western Australia. *Journal of the Royal Society of Western Australia* 77: 103-104.

Hopper, S.D. (2000). Creation of conservation reserves and managing fire on granite outcrops—a case study from Chiddarcooping Nature Reserve in the Western Australian wheatbelt. *Journal of the Royal Society of Western Australia* 83(3): 173-186.

Hopper, S.D. (2003). An evolutionary perspective on south-west Western Australian landscapes, biodiversity and fire: A review and management implications. In: Abbott, I. and Burrows, N. (eds.) (2003). *Fire in Ecosystems of the South-West of Western Australia: Impacts And Management*: 9-35.

Hopper, S.D., Brown, A.P. and Marchant, N.G. (1997). Plants of the Western Australian granite outcrops. *Journal of the Royal Society of Western Australia*, 80: 141-158.

Hopper, S.D., Harvey, M.S., Chappill, J.A., Main, A.R. and Main, B.Y. (1996). The Western Australian biota as Gondwanan heritage – A review. In: Hopper, S.D., Chappill, J.A, Harvey, M.S. and George, A.S. (eds.) *Gondwanan Heritage: Past, present and future of the Western Australian Biota*. Surrey Beatty and Sons, Chipping Norton.

Hopper, S.D., Keighery, G.J. and Wardell-Johnson, G. (1992). Flora of the karri forest and other communities in the Warren Botanical Subdistrict of Western Australia *Occasional Paper* 2/92: 1-32. Department of Conservation, Kensington.

Horwitz, P. (1997). Comparative endemism and richness of the aquatic invertebrate fauna in peatlands and shrublands of far south-western Australia. *Memoirs of the Museum of Victoria* 56(2): 313-321.

Horwitz, P. and Adams, M. (2000). The systematics, biogeography and conservation status of species in the freshwater crayfish genus *Engaewa* Riek (Decapoda: Parastacidae) from south-western Australia. *Invertebrate Taxonomy* 14(5): 655-680.

Horwitz, P., Judd, S. and Sommer, B. (2003). Fire and organic substrates: Soil structure, water quality and biodiversity in far south-west Western Australia. In: Abbott, I. and Burrows, N. *Fire in Ecosystems of the South-West of Western Australia: Impacts and management*: 381-393.

How, Dell and Humphreys (1987). *The Ground Vertebrate Fauna of Coastal Areas between Busselton and Albany, Western Australia*. Records of the WA Museum, 13(4): 553-574.

Howden, M., Hughes, L., Dunlop, M., Zethoven, I., Hilbert, D., and Chilcott, C. (2003). *Climate Change Impacts on Biodiversity in Australia*. Outcomes of a workshop sponsored by the Biological Diversity Advisory Committee, 1-2 October. Commonwealth of Australia, Canberra.

Hughes, L. (2003). Climate change and Australia: Trends, projections and impacts. *Austral Ecology* 28: 423–443.

Hussey, B.M.J., Keighery, G.J., Cousens, R.D., Dodd J. and Lloyd, S.G. (1997). *Western Weeds – a guide to the weeds of Western Australia*. The Plant Society of Western Australia, Perth. <http://members.iinet.net.au/~weeds/western_weeds/>

Indian Ocean Climate Initiative (2002). *Climate Variability and Change in the South West*. Indian Ocean Climate Initiative, Perth.

Inions, G.B., Tanton, M.T. and Davey, S. (1989). Effect of fire on the availability of hollows in trees used by the common brushtail possum, *Trichosurus vulpecula* Kerr, 1792, and the ringtail possum, *Pseudocheirus peregrinus* Boddaerts, 1785. *Australian Wildlife Research* 16: 449-458.

IPCC (2001a). *Climate Change 2001: The scientific basis.* Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K. and Johnson C.A. (eds.) Cambridge University Press, Cambridge and New York. <http://www.grida.no/climate/ipcc_tar/wg1/index.htm\>

IPCC (2001b). *Climate Change 2001: Impacts, adaptation, and vulnerability.* Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J. and White, K.S. (eds.) Cambridge University Press, Cambridge. <http://www.grida.no/climate/ipcc_tar/wg2/index.htm>

Ipsen, W. (2000). *Follow that Bell*. Self-published, Bunbury.

Jackson, J.J., Raadik, T.A., Lintermans, M. and Hammer, M. (2004). Alien salmonids in Australia: Impediments to effective impact management, and future directions. *New Zealand Journal of Marine and Freshwater Research* 38:447-455.

Jaensch, R.P. (1992). *Fishes in Wetlands of the South Coast of Western Australia – Autumn 1992.* Department of Conservation and Land Management, Woodvale.

Jaensch, R.P. (1992b). *Waterbirds in Wetlands of the South Coast of Western Australia – Summer 1991-2*. Department of Conservation and Land Management, Woodvale.

Jaensch, R.P. (1992c). *Fishes in Wetlands on the South Coast of Western Australia*. Unpublished Technical Paper. Department of Conservation and Land Management, Woodvale.

Jaensch, R.P. (1993). *A Survey of Frogs in Wetlands on the South Coast of Western Australia*. Department of Conservation and Land Management, Woodvale.

Kammann (1993). *Introduced Plants at Shannon Townsite*. Unpublished report to the Department of Conservation and Land Management.

Kanowski, P.J., Cork, S.J., Lamb, D. and Dudley, N. (2001). Assessing success of off-reserve forest management in contributing to biodiversity conservation. In: Raison, R.J., Brown, A.G. and Flinn, D.W. (eds.) *Criteria and Indicators for Sustainable Forest Management*. IUFRO 7 Research Series CABI Publishing, United Kingdom.

Kelly, G., Bennell, B. and McFeeteri, S. (1999). *A Draft Report into the Management of the Aboriginal Heritage Values of the D'Entrecasteaux and Shannon National Park.*

Kelly, A. and Coates, D. (1995). *Population Dynamics, Reproductive Biology and Conservation of Banksia brownii and Banksia verticillatta*. ANCA ESP Project No. 352. Department of Conservation and Land Management, Kensington.

Kershaw, A.P. (1986). Climate change and Aboriginal burning in north-east Australia during the last two glacial/interglacial cycles. *Nature* 322: 47-49.

Kershaw, A.P., Clarke, J.S., Gill, A.M. and D'Costa, D.M. (2002). A history of fire in Australia. In: Bradstock, R. A., Williams, J.E. and Gill, A. M. (eds.) *Flammable Australia: The fire regimes and biodiversity of a continent*: 3-25. Cambridge University Press, Cambridge.

Kitchener, D.J. (1995). Quokka. In Strahan, R. (ed) *The Mammals of Australia*. Australian Museum and Reed Books, Chatswood.

Kothavala, Z. (1999). The duration and severity of drought over eastern Australia simulated by a coupled ocean-atmosphere GCM with a transient increase in CO2. *Environ. Modelling Software* 14: 243–52.

Lafleur, P.M., Roulet, N.T., Bubier, J.L., Frockling, S., Moore, T.R. (2003). Interannual variability in the peatland-atmosphere carbon-dioide exchange in an ombrotrophic bog. *Global Biogeochemical Cylces* 17: 5-14.

Lee, A.K. (1995). *The Action Plan for Australian Rodents*. Australian Section of the IUCN/SSC Rodent Specialist Group, Environment Australia. Canberra.

Long, J. (1981). *Introduced Birds of the World: The worldwide history, distribution and influence of birds introduced to new environments*. Reed, Sydney.

Long, J. (1988). *Introduced Birds and Mammals in Western Australia*. 2nd Ed. Agriculture Protection Board, Perth.

Long, J. (2003). *Introduced Mammals of the World: Their history, distribution and influence*. CSIRO Publishing, Melbourne.

Lyons, M.N., Keighery G.J., Gibson, N. and Wardell-Johnson, G. (2000). The vascular flora of the Warren bioregion, south-west Western Australia: Composition, reservation status and endemism. *CALMScience* 3: 181-250.

Main, A. R. (1996). Ghosts of the past: Where does environmental history begin? *Environment and History* 2: 97-114.

MRWA (1997) *Roads 2020; Regional Road Development Strategy*, Main Roads Western Australia, Perth.

Manning, R. (1992). *Honey Production, Economic Value and Geographical Significance of Apiary Sites in Western Australia*. Department of Agriculture, Perth.

Marchant, S. and Higgins, P.J. (eds.) (1990). *The Handbook of Australian, New Zealand and Antarctic Birds*. Oxford University Press, Melbourne.

Martinick and Associates (1994). *Vertebrate Survey North of Lake Jasper, Nelson Location 12897*. Cable Sands, Perth.

Matthews, E. (1984). *To bee or not....?! Bees in National Parks?* Australian National Parks Association Magazine, Adelaide.

Mattiske, E.M., and Havel, J.J. (1998). *Regional Forest Agreement Vegetation Complexes.* Department of Conservation and Land Management, Kensington.

McArthur, W.M. and Clifton, A.L. (1975). *Forestry and Agriculture in Relation to Soils in the Pemberton Area of Western Australia,* Soils and Land Use Series No. 54. CSIRO Division of Soils Perth.

Mawson, P. and Johnstone, R.E. (1997). Conservation status of parrots and cockatoos in Western Australia. *Eclectus* 2: 4-9.

Miller, B.P., Walshe, T., Enright, N.J. and Lamont, B.B. (2007). Error in the inference if fire history from grasstrees. *Austral. Ecology* 32: 908-916.

Molony, B. and Bird, C. (2002). *Annual Report on the Monitoring of the Recreational Marron Fisheries in 2000, with an analysis of Long-Term Data and Changes within this Fishery*. Fisheries Research Report No. 137, 2002.

Molyneux, I. (2002). *Conservation Plan for Bolghinup Hut D'Entrecasteaux National Park.*

Morgan, D.L., Gill, H.S. and Potter, I.C. (1995). Life cycle, growth and diet of Balston's pygmy perch in its natural habitat of acidic pools in south-western Australia. *Journal of Fish Biology* 47(5).

Morgan, D.L., Gill, H.S. and Potter, I.C. (1998). *Distribution, Identification and Biology of Freshwater Fishes in South-Western Australia.* Records of the Western Australian Museum. Supplement No. 56. Perth.

Morgan, D.L., Gill, H.S., Maddern, M.G. and Beatty, S.J. (2004). Distribution and impacts of introduced freshwater fishes in Western Australia. *New Zealand Journal of Marine and Freshwater Research* 38: 511-523.

Muir, B.G. (1981). *D'Entrecasteaux National Park Resource Study*. National Parks Authority of Western Australia, Perth.

Muir, G. (undated). *Coodamurrup Hut (Moore's Hut; Wheatley House): Redesign and management proposal*.

Munroe, J. (2006). *Donnelly River Action Plan*. Manjimup Land Conservation District Committee.

National Working Party on Acid Sulfate Soils (1999). *National Strategy for the Management of Coastal Acid Sulfate Soils*. NSW Agriculture, Wollongbar.

National Reserve System Task Group 2009 *Australia's Strategy for the National Reserve System 2009–2030*, Comonwealth of Australia.

Natural Resource Management Ministerial Council (2004). *National Biodiversity and Climate Action Plan 2004-2007.* Department of the Environment and Heritage, Canberra. http://www.deh.gov.au/biodiversity/publications/nbccap

Newsome, D., Cole, D.N. and Marion, J.L. (2004). Environmental impacts associated with recreational horse-riding. In: Buckley, R. (ed.) *Environmental Impacts of Ecotourism* pp: 61-82. CABI Publishing, Wallingford, UK.

Newsome, D. and Phillips, N. (2002). Effects of horse riding on national parks and other natural ecosystems in Australia: Implications for management. *Journal of Ecotourism* 1(1): 52-74.

New South Wales National Parks and Wildlife Service (2002). *Competition from Feral Honeybees as a Key Threatening Process – An overview.*

Olroyd B.P., Lawley S.H. and Crozier R.H. (1994). Do feral honey bees (*Apis mellifera*) and regent parrots (*Polytelis anthopeplus*) compete for nest sites? *Australian Journal of Ecology* 19: 444-450.

Pascoe, I.G. (1991). History of systematic mycology in Australia. In: Short, P.S. (ed.) *History of Systematic Botany in Australasia*: 259-264. Australian Systematic Botany Society Inc., South Yarra.

Paton, D.C. (1993). Honeybees in the Australian environment: Does *Apis mellifera* disrupt or benefit the native biota? *BioScience* 43: 95-103.

Paton, D.C. (1996). *Overview of Feral and Managed Honeybees in Australia: Distribution, abundance, extent of interactions with native biota, evidence of impacts and future research*. ANCA, Canberra.

Paton, D.C. (1997). Honeybees *Apis mellifera* and the disruption of plant-pollinator systems in Australia. *Victorian Naturalist* 114: 23-29.

Paton, D.C. (2000). Disruption of bird-plant pollination systems in southern Australia. *Conservation Biology* 14: 1232-1234.

Pearce, M.H., Malajczuk, N., and Kile, G.A. (1986). The occurrence and effects of *Armillaria luteobubalina* in the karri (*Eucalyptus diversicolor* F. Muell.) forests of Western Australia. *Australian Forest Research* 16: 243-259.

Pen, L. (1997). *A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton-Walpole Region*. Water and Rivers Commission, Perth.

Phillips, N. (2000). *A Field Experiment to Quantify the Environmental Impacts of Horse-Riding in the D'Entrecasteaux National Park, Western Australia*. Unpublished Honours thesis, School Of Environmental Science, Murdoch University, Perth.

Phillips, N. and Newsome, D. (2002). The impacts of recreation in Australian protected areas: Quantifying damage caused by horse riding in D'Entrecasteaux National Park, Western Australia. *Journal of Pacific Conservation Biology* 7(4): 256-273. Surrey Beatty & Sons, Sydney.

Pouliquen-Young O. and Newman P. (2000). *The Implications of Climate Change for Land-Based Nature Conservation Strategies*. Final Report 96/1306. Australian Greenhouse Office, Environment Australia, Canberra; Institute for Sustainability and Technology Policy, Murdoch University, Perth.

Prosser, G. (1986). The limits of acceptable change: An introduction to a framework for natural area planning. *Australia Parks and Recreation*. Summer 1986.

Pusey, B.J. and Edwards, D.H. (1990). Limnology of the southern acid peaty flats, south-western Australia. *Journal of the Royal Society of Western Australia* 73: 29-46.

Pyke, G.H. (1999). The introduced honeybee *Apis mellifera* and the precautionary principle: Reducing the conflict. *Australian Zoologist* 31: 181-186.

Pyne, S.J. (1991). *Burning bush: a fire history of Australia*. Holt, New York.

Report of the Marine Parks and Reserves Selection Working Group (1994). *A Representative Marine Reserve System for Western Australia*. Department of Conservation and Land Management, Perth.

Robinson, C.J. and Coates, D.J. (1995). *Declared Rare and Poorly Known Flora in the Albany District*. Perth: WA Wildlife Management Program.

Scheltema, M. (1981). *To bee or not to bee: Honey bee utilisation of national parks in Western Australia.* Perth.

Schreider, S.Y., Jakeman, A.J., Whetton, P.H. and Pittock, A.B. (1997). Estimation of climate impact on water availability and extreme events for snow-free and snow-affected catchments of the Murray–Darling Basin. *Aust. J. Water Res* 2: 35–45.

Semeniuk (1997). *Identifying Sites of Geoheritage in the Region of the RFA, Southwestern Australia – A Discussion*. Department of Conservation and Land Management, Perth.

Shearer, B.L. (1994). The major plant pathogens occurring in native ecosystems of south-west Australia. In: Plant diseases in ecosystems: Threats and impacts in south-western Australia. *Journal of the Royal Society of Western Australia* 77: 113-122.

Shearer, B.L. and Tippett, J.T. (1988). Distribution and impact of *Armillaria luteobubalina* in the *Eucalyptus marginata* forest of south-western Australia. *Australian Journal of Botany* 36: 433-445. CSIRO, East Melbourne.

Shearer, B.A., Byrne, A., Dillon, M. and Buehrig, R. (1997a). Distribution of *Armillaria luteobubalina* and its impact on community diversity and structure in *Eucalyptus wandoo* woodland of southern Western Australia. *Australian Journal of Botany* 45: 151-165.

Shearer, B.L., Crane, C.E., Fairman, R.G. and Grant, M.J. (1997b). Occurrence of *Armillaria luteobubalina* and pathogen-mediated changes in coastal dune vegetation of south-western Australia. *Australian Journal of Botany* 45: 905-917.

Shearer, B.L., Crane, C.E., Fairman, R.G., and Grant, M.J. (1998). Susceptibility of plant species in coastal dune vegetation of south-western Australia to killing by *Armillaria luteobubalina*. *Australian Journal of Botany* 46: 321-334.

Singh, G., Kershaw, A.P. and Clarke, R. (1981). Quaternary vegetation and fire history in Australia. In: Gill, A.M., Groves, R.H. and Noble, I. R. (eds.) *Fire and the Australian Biota*. Australian Academy of Science, Canberra.

Smith, G.T. (1987). Observations on the biology of the western bristle-bird *Dasyornis longirostris*. *Emu* 87: 111-118.

Sneeuwjagt, R. J. and Peet, G. B. (1985). *Forest Fire Behaviour Tables for Western Australia*. 3rd Edition. Department of Conservation and Land Management, Kensington.

St John-Sweeting, R.S. and Morris, K.A. (1991). Seed transmission through the digestive tract of the horse. In: *Plant Invasions – The occurrence of environmental weeds in Australia.* ANPWS, Canberra 170-2.

South West Development Commission (2011). *Annual Report 2010 – 2011*. SWDC, Perth

South West Development Commission (2008). *Economic Activity Gross Regional Product*. <http://www.swdc.wa.gov.au/index.php?pageid=68>

Schwarz, M.P. and Hogendoorn, K. (1999). Biodiversity and conservation of Australian native bees. In: Ponder, W. and Lunney, D. (eds.) *The Other 99% – The conservation and biodiversity of invertebrates*: 388-393. Royal Zoological Society of New South Wales, Mosman.

Schwarz, M.P. and Hurst, P.S. (1997). Effects of introduced honey bees on Australia's bee fauna. *Victorian Naturalist* 114: 7-12.

Standards Australia (2001). *Australian Standard Walking Tracks: Part 1 classification and signage.* Standards Australia, Sydney.

Stoneburner, A. and Wyatt, R. (1996). Ecological and phytogeographical characteristics of the mosses of Western Australia. In: Hopper, S.D., Chappill, J.A, Harvey, M.S. and George, A.S. (eds.) *Gondwanan Heritage: Past, present and future of the Western Australian Biota*. Surrey Beatty and Sons, Chipping Norton.

Sugden, E.A., Thorp, R.W. and Buchmann, S.L. (1996). Honeybee-native bee competition: Focal point for environmental change and apicultural response in Australia. *Bee World* 77: 26-44.

Thackway, R. and Cresswell, I.D. (eds.) (1995). *An Interim Biogeographic Regionalisation of Australia: A framework for setting priorities in the national reserves system cooperative program, Version 4.0*. Australian Nature Conservation Agency, Canberra.

Thackway, R. and Cresswell, I.D. (eds.) (1998). *Interim Marine and Coastal Regionalisations for Australia: An ecosystem-based classification for marine and coastal environments*. Environment Australia, Canberra.

Tolhurst, K.G. and Friend, G.R. (2001). *An Objective Basis for Ecological Fire Management*. Australian Bushfire Conference: 3-6 July 2001, Christchurch, New Zealand.

Trayler, K.M., Davies, J.A., Horwitz, P. and Morgan, D. (1996). Aquatic fauna of the Warren bioregion, south-west Western Australia: Does reservation guarantee preservation? *Journal of the Royal Society of Western Australia* 79: 281-291.

Underwood, R.J., Sneeuwjagt, R.J. and Styles, G. (1985). The contribution of prescribed burning to forest fire control in Western Australia: case studies. In: Ford, J.R. (ed.), *Fire Ecology and Management in Western Australian Ecosystems*: 153-170. Western Australian Institute of Technology Environmental Studies Group Report No. 14.

van Didden, G.W. (1983). *A New Incendiary Machine for Aerial Prescribed Burning*. Technical Paper No. 4, Forests Department of Western Australia.

Wager, R. and Jackson, P. (1993). *Action Plan for the Australian Freshwater Fishes*. Environment Australia, Canberra.

Walsh, K.J.E., Hennessy, K.J., McInnes, R.N. (2001). *Climate Change in Queensland under Enhanced Greenhouse Conditions: Third annual report, 1999–2000.* CSIRO Atmospheric Research, Aspendale.

Water Corporation and the WA Museum (2003). *Review of Cockatoo Research project and Cockatoo Care.* Water Corporation and the WA Museum, Western Australia.

Wardell-Johnson, G. and Christensen, P. (1992). A review of the effects of disturbance on wildlife of the karri forest. In*: Research on the Impact of Forest Management in South-West Western Australia*. Department of Conservation and Land management, Perth.

Water and Rivers Commission (2003). *State Water Quality Management Strategy – Framework for implementation,* Report SWQ 1. Water and Rivers Commission, Perth.

Ward, D.J., Lamont, B.B. and Burrows, C.L. (2001). Grasstrees reveal contrasting fire regimes in Eucalypt forest before and after European settlement of southwestern Australia. *Forest Ecology and Management* 150: 323-329.

Weir, J.M.H., Johnson, E.A. and Miyanish, K. (2000). Fire frequency and the spatial age mosaic of the mixed-wood boreal forests in western Canada. *Ecological Applications* 10: 1162-1177.

Wells, G., Hopper, S.D. and Dixon, K. W. (2004). *Fire Regimes and Biodiversity Conservation: A brief review of scientific literature with particular emphasis on southwest Australian studies*. Consultant report commissioned as part of the EPA's review of CALM's fire policies and management practices. Environmental Protection Authority, Perth, Western Australia.

Western Australian Planning Commission (2003). *Coastal Planning and Management Manual.* Western Australian Planning Commission, Perth.

Wilde, S.A. (1981). A Brief Review of the Geology of Southwestern Australia. In: Excursion guide mineral fields of the southwest. Geological Society of Australia 5th Annual Convention, 3-21.

Wilde, S.A. and Walker, I.W. (1984). *Pemberton-Irwin Inlet of Western Australia*: 1:250 000 geological series – explanatory notes. Geological Survey of Western Australia, Perth.

Williams P.J, Pen, L.J and Alford J.J. (1999). *Wild Rivers of Western Australia: The findings of the GIS preliminary identification and field verification phases of the Wild Rivers Project*. unpublished report, Water and Rivers Commission, Perth.

Wills, R.T. and Keighery, G.J. (1994). Ecological impact of plant disease on plant communities. In: Plant diseases in ecosytems – Threats and impacts in south-western Australia. *Journal of the Royal Society of Western Australia* 77: 127-131.

Wilson, B.A., Newell, G., Laidlaw, W.S. and Friend, G. (1994). Impact of plant diseases on faunal communities. In: Plant diseases in ecosystems – Threats and impacts in south-western Australia. *Journal of the Royal Society of Western Australia* 77: 139-143.

PERSONAL COMMUNICATIONS

Department of Environment and Conservation (formerly Department of Conservation and Land Management)

Dr David Algar, Senior Research Scientist, Woodvale Research, Science Division.
Rod Annear – Ranger in Charge 1996-2003, Donnelly District, Regional Services Division.
John Blyth – former Acting Manager, WA Threatened Species and Communities Unit, Nature Conservation Division.
Dr Neil Burrows – Director, Science Division.
John Gillard – District Manager, Donnelly District, Regional Services Division.
Roger Hearn – Regional Ecologist, Warren Region, Regional Services Division.
Mike Lyons – Research Scientist, Woodvale Research, Science Division.

Dr Peter Mawson – Senior Zoologist, Species and Communities Branch, Nature Conservation Division.
Norm McKenzie – Principal Research Scientist, Woodvale Research, Science Division.
Kevin Vear – Phytophthora Co-ordinator, Nature Conservation Division.
Ian Loh – Strategic Projects Branch, Department of Water

Department of Industry and Resources

Mike Freeman – Senior Land Use Planning Geologist.

Department of Water

Brad Degens – Senior Soil Scientist, Water Resource Management Division, Aquatic Science Branch.
Ian Loh – Program Manager, Water Resource Use Division, Water Allocation Planning Branch.

Wetlands International – Oceania

Roger Jaensch – Senior Program Officer.