Draft forest management plan 2014–2023

Conservation Commission of Western Australia

AUGUST 2012

Conservation Commission
WESTERN AUSTRALIA

Department of
Environment and Conservation

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Cover

Main picture:
Boranup forest. Photo – Tourism WA
Insets, from left to right:
Scarlet bracket fungus (*Pycnoporus coccineus*). Photo – Richard Robinson/DEC
Numbat (*Myrmecobius fasciatus*). Photo – DEC
Jarrah chair. Photo – Jahroc Furniture Gallery, Margaret River
Bushwalkers in Gloucester National Park. Photo – Tourism WA

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Invitation to comment

You are invited to have your say on how the south-west forests will be managed over the 10 years from 2014.

The Conservation Commission of Western Australia (the Conservation Commission) has prepared this *Draft Forest Management Plan 2014-2023* (Draft plan) through the agency of the Department of Environment and Conservation (the Department). The Draft plan is being advertised concurrently under the *Conservation and Land Management Act 1984* (CALM Act) and *Environmental Protection Act 1986* (EP Act) (see the *process for development of the next Forest Management Plan 2014-2023* (next FMP) for further information).

All submissions received will be considered by the Conservation Commission and the Environmental Protection Authority (EPA). The period for submissions on the Draft plan is 12 weeks, closing on 7 November 2012. Section 58 of the CALM Act also requires that all submissions be copied to the Forest Products Commission (FPC), for draft management plans covering State forest and timber reserves, and to the Minister for Water and relevant water utilities, for draft management plans covering land that is or includes a public water catchment area.

Submissions received will be acknowledged. All submissions are treated as public documents unless the submitter clearly indicates to the contrary by marking all or part of the submission as ‗confidential'. It is important to note that confidence cannot be guaranteed under the *Freedom of Information Act 1992*.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action – including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal. The Draft plan will be reviewed in the light of submissions and will help the Conservation Commission prepare its proposed Forest Management Plan and the EPA prepare an assessment report, in which it will make recommendations to the Minister for Environment.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining a group interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the Draft plan or the specific proposal. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more acceptable. When making comments on specific elements of the Draft plan:

- clearly state your point of view
- indicate the source of your information or argument if this is applicable
- suggest recommendations, safeguards or alternatives.

How submissions are taken into account

A summary of all the pertinent issues raised in submissions will be prepared in 2013 and the Conservation Commission will provide a written response to all issues in the summary, to the satisfaction of the EPA. In responding, the Conservation Commission may make changes to the Draft plan. The Conservation Commission's initial position on the need, or otherwise, to amend the Draft plan is set out below.

This Draft plan may be amended if a submission:

- provides additional resource information of direct relevance to management
- provides additional information on affected user groups of direct relevance to management
- indicates a change in (or clarifies) legislation, management commitment or management policy
- proposes strategies that would better achieve management goals, or
- indicates omissions, inaccuracies or a lack of clarity.

This Draft plan may *not* be amended if a submission:

- clearly supports the draft proposals
- offers a neutral statement or no change is sought
- addresses issues beyond the scope of the Draft plan
- makes points that are already in the Draft plan or were considered during its preparation
- is one among several widely divergent viewpoints received on the topic and the proposal in the Draft plan is still considered the best approach, or
- contributes options that are not possible (generally due to some aspect of existing legislation or government policy).

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear - a summary of your submission is helpful
- refer each point to the appropriate section, chapter or recommendation in the Draft plan
- if you discuss different sections of the Draft plan, keep them distinct and separate, so there is no confusion as to which section you are considering
- attach any factual information you may wish to provide and give details of the source, making sure your information is accurate.

Remember to include your name, address, date, whether and the reason why you want your submission to be confidential.

Send your written submission to:

Email: forestmanagementplan@conservation.wa.gov.au

OR

Mr Gordon Graham
Director
Conservation Commission of Western Australia
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Bentley Delivery Centre, Western Australia, 6983

By close of business on 7 November 2012.

Contents

[1] Development of the 1999 Western Australian Regional Forest Agreement (RFA) included forest ecosystem mapping within the RFA boundary. This Draft plan covers a broader area (see Map 1) and Appendix 11 refers to the only vegetation association mapping that covers the whole plan area.

Figures

Maps

Executive summary

All the State's national parks, conservation parks, nature reserves, State forests and timber reserves are vested in the Conservation Commission. These lands are managed under 10-year plans developed in consultation with the community. Management plans can be prepared for individual reserves, a group of neighbouring reserves, or for a region.

A plan allows issues to be identified so priority can be given to actions required and resources allocated accordingly. A plan also allows competing land uses to be considered. Access to Western Australia's south-west forests, for example, is sought for mining, recreation, timber production, water catchments, infrastructure for utilities, wildflower picking, removing gravel, honey production and more.

As the *Forest Management Plan 2004-2013* (the current FMP) is nearing the end of its term, the process for developing a new plan set out in the CALM Act is underway. This includes the release of this Draft plan for public comment.

The CALM Act also describes five principles of ecologically sustainable forest management (ESFM) and requires the Conservation Commission to advise the Minister for Environment on their application. These principles are used as the basic structure of this document and are explained in detail in the 'Background' chapter.

This Draft plan is for the management of lands vested in the Conservation Commission across south-west Western Australia (see Map 1). These lands cover a total area of nearly 2.5 million hectares and include national parks, conservation parks and State forest.

The Conservation Commission's main goals in formulating this Draft plan are for:

- biodiversity to be conserved
- Aboriginal and other Australian cultural heritage to be recognised and protected
- the health, vitality and productive capacity of ecosystems to be sustained
- soil and water resources to be protected
- the contribution to global carbon cycles to be sustained
- the wide range of social, cultural and economic benefits valued by the community to be produced in line with the principles of ESFM.

Contributing processes

Technical input

The plan and ongoing forest management are supported by a suite of subsidiary manuals, guidelines, policies and approval processes, which in turn depend on the vast volume of scientific research and investigation carried out by staff from the Department and other research institutions, and draw on science and management experience from other jurisdictions and countries.

In addition, a number of formal technical reviews have been undertaken specifically to provide input to the development of this Draft plan, and these are referred to in various places throughout the document, with weblinks and/or references provided for further reading.

Key reports and studies used to inform development of this Draft plan include:

- the 2008 *Forest Management Plan 2004-2013 Mid-term audit of performance report* by the Conservation Commission (see *mid-term audit current FMP*), and the corresponding EPA report (see *EPA report 1362 on mid-term audit current FMP*)
- the 2012 *Forest Management Plan 2004-2013 End-of-term audit of performance report* by the Conservation Commission (see *end-of-term audit current FMP*), and the corresponding EPA report (see *EPA report 1443 on end-of-term audit current FMP*)
- the 2011 *Review of Silviculture in Forests of South-west Western Australia* by *Burrows et al. (2011)*.

Other key assessments will also help develop the next FMP:

- a *social and economic impact study* (URS 2012), which is available for information during the statutory public consultation phase for this Draft plan
- an independent panel will review the process for calculation of sustained yield of timber (as agreed in the 1999 Regional Forest Agreement (RFA) process), prior to the EPA assessment of the proposed FMP.

Input from preliminary consultation

Preliminary consultation was undertaken with key stakeholders both within and outside of Government and a number of submissions were received. This has helped inform development of this Draft plan. Further submissions are invited as part of the statutory consultation process and these will inform preparation of the proposed FMP for assessment by the EPA.

What's new in this plan?

The Draft plan proposes a number of key changes from the current FMP:

- adding to the formal conservation reserve system in the Whicher Scarp area
- introducing improvements to silviculture guidelines, including greater protection of marri trees as habitat for black cockatoos
- revising travel route zones in the Department's Warren Region
- publishing a map on the Department's website each year of old-growth forest status and extent, identifying any variations
- reviewing the processes for planning for all disturbance operations, on all land categories, to ensure a consistent approach for checking for old-growth forest
- those areas previously classified as old-growth forest but which are confirmed not to be old-growth forest are no longer to be recognised as an informal reserve type
- removing the phased harvesting requirement in the Department's Swan and South West regions, and parts of the Warren Region, because of the reduced risk of salinity
- making basic raw materials (BRM) available from a network of (fewer) strategic pits
- formalising the inter-agency arrangements between the Department and the FPC.

Further changes are considered for the following issues where alternative management options are put forward for comment:

- the process for public nomination of previously unmapped old-growth forest (three management options)
- informal reserves for the Munda Biddi Trail (two management options)
- settings for fauna habitat zones (two management options)
- ‗silviculture for water production' in selected catchments (two management options)
- the accounting of wood products salvaged after disturbances (two management options)
- arrangements for public firewood collection (three management options).

Some proposed changes and management options will have the potential to alter the sustained yields from the volumes allowed under the current FMP (see page 106 and Table 7). Given various combinations of these factors, two scenarios for the determination of the sustained yields are put forward for public comment. One includes settings that together provide for a higher sustained yield, while the other includes settings that provide a lower sustained yield. Both scenarios are based on updated forest inventory data and information on tree and stand growth rates and take into account expected climate change and related impacts.

Key aspects of the Draft plan are discussed below under the chapter headings based on the criteria for ESFM.

Biological diversity

The Draft plan carries forward those reserves proposals from the current FMP not yet implemented, as listed in Appendix 5 and shown on Map 4.

Additional information gathered since the current FMP came into effect in 2004 supports the recognition of the Whicher Scarp as a separate forest ecosystem. Map 4 highlights areas proposed to be reclassified as national park to protect this ecosystem. This proposal would increase the area of existing and proposed formal reserves by 4,010 hectares, including 2,370 hectares of the Whicher Scarp ecosystem.

All old-growth forest will continue to be protected in either formal or informal reserves (and the definition of old-growth forest under this Draft plan remains the same as for the current FMP). Since 2004, the status of some areas of forest has been reviewed, resulting in about 1,390 hectares of additional, previously unmapped old-growth forest being set aside in informal reserves. This Draft plan also includes management options for public nomination of old-growth forest.

The Department has reviewed travel routes in the Warren Region, and along the Munda Biddi Trail. Currently, there is no travel route associated with the Trail, and two management options are presented for comment. Together, the proposed changes would result in a net decrease of 50 hectares to the total area of travel routes.

Adding these changes to the existing system of formal and informal reserves and other protected areas means that within the RFA area, about 62 per cent of native forest ecosystems would be protected from a range of disturbance activities. In the remainder of the plan area, which is mostly on the Swan Coastal Plain, about 81 per cent of vegetation associations (not including plantations) on lands vested in the Conservation Commission is in existing or proposed reserves.

The Draft plan also seeks to maintain biodiversity through a range of other complementary measures, including where practicable, additional recovery plans for selected threatened species and ecological communities.

Mineral and petroleum operations in the plan area involve significant modification of the environment. Although many of these activities are approved and governed by processes managed by other government agencies under separate legislation, there is still considerable input required from the Conservation Commission and the Department in relation to processes associated with approvals and rehabilitation. Given the potential cumulative, long-term impacts from mining, this Draft plan includes a number of proposed mitigating activities.

As required by the current FMP, an expert panel has completed a review of silvicultural practices (in 2011), and based on their recommendations, modifications to current practices are proposed to enhance biodiversity outcomes. Changes include added protection of marri trees, which are key habitat for black cockatoos. Habitat requirements (such as nesting, roosting and foraging needs) for a range of fauna will be considered in selecting habitat trees and hollow logs for retention.

Fauna habitat zones were introduced in the current FMP to provide a source of fauna to help recolonise disturbed areas after timber harvesting. Comment is sought on two management options presented in the Draft plan: retaining the existing settings under the current FMP, or amending the fauna habitat zones by number, size and location.

Monitoring remains important, and through this Draft plan, the Department will seek to maintain and extend the key forest biodiversity monitoring program, *FORESTCHECK*.

Ecosystem health and vitality

The plan area is subject to a range of pressures affecting ecosystem health and vitality, including disease caused by *Phytophthora* species, altered fire regimes, insect outbreaks such as gum leaf skeletoniser, and foxes and cats that impact native fauna. Climate change may also affect ecosystem health and vitality directly, through drought deaths, or indirectly through increased impacts from weeds, pests or diseases.

The Draft plan proposes a renewed focus to prioritise the management of pests and diseases to complement the approach that has been adopted for weeds. This will minimise their impact on the health and vitality of ecosystems and reduce the risk of introduction or naturalisation of weeds, pests and exotic pathogens. The approach will consider the range of *Phytophthora* species and other diseases impacting ecosystems.

It is intended that the *Western Shield* program, which reduces predation pressure on threatened and priority species of fauna, be continued.

Management activities will be continued to use and respond to fire in a manner that mitigates the risk of adverse impacts of bushfire. Appropriate fire regimes will also benefit biodiversity and therefore promote ecosystem health and vitality, thereby promoting resilience to climate change.

Cleared areas such as mine sites and basic raw material pits will continue to be rehabilitated.

Soil and water

The approach developed for the current FMP to protect soil and water quality will be continued. This includes the approvals process for timber harvesting operations under moist soil conditions.

The Draft plan proposes silvicultural treatment to address threats to ecosystem health and vitality (referred to as ‗silviculture for ecosystem health'). An example of this approach is to increase the water available to identified areas, such as ecosystems that depend on surface water. A management option to enhance water production (referred to as ‗silviculture for water production') is also presented for comment. This involves silvicultural treatment in higher rainfall parts of particular water supply catchments to increase water supply, with ancillary benefits for ecosystem health and vitality.

Reduced rainfall and declining groundwater levels mean the risk to stream water quality from rising groundwater transporting salt stored in the soil profile (see Figure 2), has significantly reduced. It is proposed therefore to remove the phased harvesting requirement in the Department's Swan and South West regions and part of the Warren Region which were designed to address this risk– a change supported by the expert panel in their review of silvicultural practices. The phased harvesting requirement for other parts of the Warren Region will be retained.

Climate change and carbon cycles

Given current knowledge and uncertainties of the likely magnitude and result of changes to climate from increases in atmospheric levels of greenhouse gases, management activities proposed throughout this Draft plan encompass broad precautionary measures. Planning for climate change has been considered in developing the range of proposed operations (management activities) outlined in the ‗Biological diversity', ‗Ecosystem health and vitality', ‗Soil and water' and ‗Productive capacity' chapters. Some socio-economic benefits may also be affected.

Wood inventories within the south-west forests have measured the standing tree volume which has been used to provide an estimate of the above-ground biomass. Broad regional estimates of the above- and below-ground carbon stocks have been calculated from the biomass figures. Indicative estimates are provided in the ‗Climate change and carbon cycles' chapter, and periodic reporting on carbon stocks is proposed. The quantity of carbon stored in live trees in the forests is projected to increase by between three and five per cent under this Draft plan.

Adjustments for the potential impact of climate change on the growth rates of jarrah and karri trees and stands have been applied when projecting future sustained yields, as explained in the ‗Productive capacity' chapter.

It is proposed to periodically review guidelines for silviculture and fire management, with a view to incorporating techniques that recognise the contribution of the areas covered by the plan to global carbon cycles, consistent with other mitigation and adaptation strategies and achievement of other silvicultural objectives and goals for forest management. It is also proposed to investigate opportunities that may arise from an emerging carbon economy.

Productive capacity

This Draft plan focuses on the productive capacity of State forests and timber reserves within the plan area – including both native forests and plantations. Key forest products are sawlogs and other log grades, and other forest produce includes public firewood, burls, craftwood, wildflowers and seeds and honey.

Several issues have become more prominent during the term of the current FMP that have a bearing on wood production from forests, including:

- Climate change – to take account of potential effects, CSIRO (2007) projections of climate change to 2070 have been applied when modelling changes in forest productive capacity for this Draft plan.

- Degradation of forest – given the expected changes in the south-west climate, there may be an increase in bushfire frequency, intensity and scale, and prolonged droughts, potentially affecting more areas of native forest and plantations. Infestation by *Phytophthora* dieback can also have dramatic long-term impacts on the productive capacity of areas of native vegetation.
- Log product mix – harvesting in old-growth forest ended in 2001 (prior to the current FMP). A progressive shift to a higher proportion of smaller sized and lower quality logs from regrowth forests has occurred since, and some variation between predicted and realised jarrah sawlog yields was reported in the mid-term audit of the current FMP.

These matters have been factored into calculations of sustained timber yield from native forests. In the case of natural disturbances that lead to the death of trees, the expected level of future disturbance is modelled on past observations. Two management options are put forward on how to account for the level of wood salvaged from more significant disturbances that occur.

This Draft plan outlines proposed changes and possible management options which have the potential to impact the sustained yields, as summarised on page 107. Arising from proposed combinations of these factors, two scenarios for the determination of the sustained yield are described for public comment (see page 106 and Table 7). Both scenarios are based on various updates to forest inventory data. The indicative figures for the sustained yield of first and second grade jarrah and karri sawlogs under the two scenarios range from 95,000 to 137,000 cubic metres per annum for jarrah, and from 44,000 to 70,000 cubic metres per annum for karri. This in turn would make available between 463,000 and 710,000 cubic metres per annum of other bole logs of jarrah, 160,000 and 240,000 cubic metres per annum of other bole logs of karri, and 140,000 and 270,000 cubic metres per annum of all bole logs of marri.

The purpose of the range is to focus public comment on the proposals and management options that give rise to the range, and what they mean for ESFM, as well as the sustained yield figure itself, which is important for the socio-economic benefits derived from timber harvesting. Comments received will be considered in determining the settings adopted for the proposed FMP.

State forest and timber reserves also provide other forest produce such as public firewood, burls, craftwood, wildflowers, seeds and honey, which will continue to be managed and regulated by licensing arrangements. Community demand for collection of public firewood from lands covered by the plan remains strong. Given the supply, demand and environmental impacts associated with this activity, three management options are detailed for comment.

This Draft plan also covers plantations, and areas of ‗other exotics', with the latter largely being associated with mine site rehabilitation.

Heritage

Amendments to the CALM Act passed in 2011 require that the Department's management of lands and waters includes the objective to protect and conserve the value of the land to the culture and heritage of Aboriginal people in a manner that does not have an adverse effect on the protection and conservation of the land's fauna and flora (see Appendix 2). The new provisions of the CALM Act and *Wildlife Conservation Act 1950* (WC Act) also provide for joint management of some areas, and will enable Aboriginal people to undertake customary activities, such as preparing and consuming food, preparing or using medicine, and engaging in artistic, ceremonial or other customary activities.

It is proposed that the Department progressively assess areas within the plan area for their importance for Aboriginal heritage, in consultation with relevant stakeholders and agencies.

The Draft plan also seeks to protect and conserve the known other Australian heritage values and recognise and determine the significance of other Australian heritage values.

Socio-economic benefits

The Draft plan addresses the management of the socio-economic benefits flowing from the use of the plan area, including recreation and tourism, timber harvesting, access via roads and bridges, basic raw materials extraction and bioprospecting.

The Draft plan proposes that basic raw materials be sourced from a network of (fewer) strategic pits, which will be identified in consultation with relevant government agencies and basic raw material users; that strategic infrastructure, including roads and bridges, be identified to help in seeking funding for their construction and maintenance; and, in order to increase the socio-economic benefits from improved use of non-sawlog material, that the Department work with the FPC to plan for a log product and wood quality mix that supports a viable forest products industry.

Mineral and petroleum operations on land to which the Draft plan applies provide significant economic and social benefits to the State, but are approved and largely governed by processes managed by other government agencies under legislation such as the EP Act, *Mining Act 1978* and State Agreements (see ‗Background', which follows).

Plan implementation and management

This chapter looks at processes to monitor and evaluate the implementation of the next FMP. It is proposed that the interagency arrangements between the Department and the FPC be formalised in writing to clarify and improve the current arrangements.

Further review and analysis of key performance indicators will occur in the period between this Draft plan and the proposed FMP, and comment on the key performance indicators included in this Draft plan is welcomed.

Stakeholder engagement is important and the Draft plan sets out activities to provide opportunities for the community, and relevant non-government organisations and government agencies, to participate.

Background

Principles of ecologically sustainable forest management

The Conservation Commission's overall goal in formulating this Draft plan is for biodiversity to be conserved; Aboriginal and other Australian cultural heritage to be recognised and protected; the health, vitality and productive capacity of ecosystems to be sustained; soil and water resources to be protected; and the contribution to global carbon cycles to be sustained. Further, the social, cultural and economic benefits valued by the community are to be produced in a manner taking account of the principles of ESFM.

Within the plan area (see Map 1), there are about three million hectares of native vegetation across private and public land, of which about 79 per cent is forest. On lands vested and proposed to be vested in the Conservation Commission within the plan area, there are about 2.38 million hectares of native vegetation, of which about 81 per cent is forest. In other words, this Draft plan deals with the management of around 80 per cent of native vegetation and 81 per cent of native forest across private and public land within the plan area.

Conservation of biodiversity is one of the purposes for which State forest and timber reserves are managed, and a fundamental consideration in ESFM. The existing and proposed conservation reserves will be managed in an integrated way with State forest and timber reserves, to achieve biodiversity objectives that are consistent with the *National Strategy for the Conservation of Australia's Biological Diversity* (Commonwealth of Australia 1996). This strategy has since been reviewed to produce *Australia's Biodiversity Conservation Strategy 2010-2030* (Commonwealth of Australia 2010a), which, together with *Australia's Strategy for the National Reserve System 2009-2030* (Commonwealth of Australia 2010b) has been endorsed by the Natural Resource Management Ministerial Council. The 2010 strategy recognises that much of the 1996 strategy remains relevant.

A key principle from the 1996 strategy is that:

> *Central to the conservation of Australia's biological diversity is the establishment of a comprehensive, representative and adequate* (CAR) *system of ecologically viable protected areas integrated with the sympathetic management of all other areas, including agricultural and other resource production systems.*

In forest areas, the concept of maintaining sympathetic (or complementary) management across production land-uses was recognised in the RFA (Commonwealth of Australia and State of Western Australia 1999) in the following statement:

> *The strategy for conserving biodiversity relies not just on a CAR reserve system, but also on the application of ecologically sustainable forest management across all land categories.*

Significant additions to the reserve system were a feature of the current FMP and resulted in a reserve system that generally exceeds the minimum standards under the *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia* (Commonwealth of Australia 1997). This Draft plan includes limited proposals for some further additions to the conservation reserve system, beyond those identified by the current FMP, and provides added emphasis on the requirements for ESFM across production land uses, as part of a commitment to seek to ensure that biodiversity is effectively conserved at the whole of forest level and across the plan area[2].

[2] For example, refer to the 2011 *Review of Silviculture in Forests of South-west Western Australia* (Burrows *et al.* 2011).


Map 1
Draft Forest Management Plan
Area covered by the plan
N
0
40
80km
Legend
Forest Management Plan area
Regional Forest Agreement boundary
DEC region boundary
MIDWEST
LANCELIN
GINGIN
TOODYAY
WANNEROO
YORK
PERTH
SWAN
INDIAN OCEAN
MANDURAH
DWELLINGUP
HARVEY
WHEATBELT
BUNBURY
COLLIE
DONNYBROOK
BUSSELTON
SOUTH WEST
MARGARET RIVER
BRIDGETOWN
MANJIMUP
AUGUSTA
PEMBERTON
SOUTH COAST
WARREN
MOUNT BARKER
SOUTHERN OCEAN
WALPOLE
DENMARK
Redmond Block Area
ALBANY

ESFM is defined in various ways. In broad terms, ESFM is a management system that seeks to sustain ecosystem integrity, while continuing to provide ongoing social and economic benefits to the community through the sustainable access to wood and non-wood forest resources and enjoyment of other forest values, including its use as a place for recreation. Essentially, the plan seeks to achieve a balance between different values and uses.

The proposed operations (management activities) included in this Draft plan are guided by the principles of ESFM, as described in section 19(2) of the CALM Act, which are highlighted here in boxes.

That the decision-making process should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. (Sustainability)

Decision-making that integrates both long-term and short-term economic, environmental, social and equitable considerations is commonly recognised as sustainable development, or as complying with principles of sustainability. This Draft plan includes a number of sections where in particular, public comment is sought to help determine the appropriate balance between competing outcomes.

That if there are threats of serious or irreversible environmental damage, the lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. (Precautionary Principle)

The precautionary principle is concerned with decision-making under uncertainty. The precautionary principle recognises that sometimes action should be taken to prevent damage even where there is no absolute certainty that damage will occur. The extent of caution built into management is a matter of judgement and will depend on the level of risk – that is the likelihood and consequences of environmental harm occurring in the absence of the guidance or as a result of a less restrictive guidance.

That the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. (Intergenerational Equity)

This is commonly known as the principle of intergenerational equity. It means that decisions taken today should ensure that at least an equal set of opportunities is available to succeeding generations. Along with the rights to use the resources available, it imposes certain obligations to care for ecosystems so that they retain their health and productive capacity. Again this is a fundamental component of sustainable use and, in relation to the timber industry, specifically the concept of sustained yield. However, it is acknowledged that some uses such as mining are non-renewable.

That the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making. (Conservation of Biodiversity and Ecological Integrity)

Australia's Biodiversity Conservation Strategy 2010-2030 (Commonwealth of Australia 2010a) contains eight principles that are relevant to the application of the above principle in the plan, including:

- biodiversity is best conserved by protecting existing natural habitats
- effective conservation of biodiversity operates at the landscape scale across public and private tenures; natural ecosystems are dynamic but have a finite capacity to recover from external threats, impacts and pressures
- knowing that our knowledge is limited, we should apply the precautionary principle while employing adaptive management approaches using new science and practical experience.

Central to the conservation of Australia's biological diversity is the establishment and management of a CAR system of ecologically viable protected areas integrated with the sympathetic management of all other areas, including agricultural and other resource production systems.

This principle is inherent in the creation and management of national parks for the conservation of the natural landscape and ecological systems and for compatible recreation and appreciation in perpetuity. It is therefore important that these core reserves are also managed in such a way as to retain their values over the very long term.

That improved valuation, pricing and incentive mechanisms should be promoted.

The Conservation Commission has a statutory role to provide advice on the application of the above principles to the Minister for Environment (see section 19 of the CALM Act). In addition, this Draft plan seeks to ensure that proponents causing disturbance bear the cost of measures to minimise any adverse environmental impacts and it also seeks to achieve environmental goals in the most cost effective way.

Scales of management

As in the current FMP, this Draft plan seeks to address management goals using three scales of management, which are defined as follows:

Whole of forest

All land categories that are subject to the plan (see Table 1)[3].

Landscape

A mosaic where the mix of local ecosystems and landforms is repeated in a similar form over a kilometres-wide area. Several attributes including geology, soil types, vegetation types, local flora and fauna, climate and natural disturbance regimes tend to be similar and repeated across the whole area. It could be a (sub) catchment or, for convenience, an administrative management unit such as a forest block or an aggregation of forest blocks. Landscape scale could span a few thousand to more than many tens of thousands of hectares.

In this Draft plan, reference is sometimes made to Landscape Management Units (LMUs), which are based on mapping of vegetation complexes (see Mattiske Consulting and Havel Land Consultants 2002), to provide a current indication of particular management emphases across the plan area. Further details are included in Appendix 1. Of course, values, threats and priorities will vary from place to place and over time as circumstances change and these will be revisited and amended as required.

Local

A discrete area of land to which one or more operations have been or are planned to be applied. It could span tens of hectares to perhaps a few thousand hectares.

Additionally, some places within areas covered by this Draft plan have been planted with exotic species. **Plantations** are defined as those areas that are predominantly pine species. **Other exotics** are defined as areas of exotics within smaller arboreta and trial plots, or that have resulted from past mine site rehabilitation (see Map 5, the ‗Glossary' and the ‗Productive capacity' chapter).

[3] This Draft plan will defer to existing area management plans where they exist, but also function as a management plan for areas where no specific area management plan exists.

Legislative framework

The Conservation Commission is a controlling body established under the CALM Act. Among the functions of the Conservation Commission are: to have State forest, timber reserves and conservation reserves vested in it; and to prepare management plans for those lands as prescribed in Part V of the CALM Act, according to certain purposes and objectives (see Appendix 2). The Conservation Commission has developed this Draft plan through the agency of the Department, in consultation with the FPC in respect of State forest and timber reserves, and the Department of Water and the Water Corporation in respect of public water catchment areas. While it is not a requirement of legislation to do so prior to the statutory public consultation phase, the Conservation Commission and the Department have consulted with several other agencies and key stakeholders to help inform development of this Draft plan.

Other relevant legislation

The WC Act, administered by the Department, provides for the conservation of flora and fauna throughout the State. The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) also contains provisions relating to the protection of nationally-listed threatened species and ecological communities. In that part of the plan area covered by the RFA (see Map 1), the Commonwealth and State governments have agreed that the CAR reserve system, and the forest management system, meet the requirements of that Act for the protection of threatened flora and fauna and ecological communities (RFA clause 56). Therefore, the provisions of the EPBC Act for environmental assessment are not triggered for forestry operations.

The *Bush Fires Act 1954* provides regulation of the control of bushfire and the use of prescribed fire, however, it is not aimed at biodiversity conservation. The *Emergency Management Act 2005* sets out the emergency management arrangements for the State and requires that a number of emergency response plans be maintained. The response plan for bushfire is Westplan Bushfire, which sets out the Department's role in bushfire suppression operations as a 'Controlling Agency'.

The *Soil and Land Conservation Act 1945* provides mechanisms for the conservation of soil and land resources principally through mitigation of the effects of erosion, salinity and flooding.

Activities of the Department and other agencies are planned and conducted to afford protection to particular sites and values as required by the *Aboriginal Heritage Act 1972* and the *Heritage of Western Australia Act 1990*.

Water allocation plans prepared by the Department of Water, and source protection plans prepared by the Department of Water in liaison with the Water Corporation, include objectives and policies that the Department takes into account when planning at strategic and operational levels. The use of water in the plan area is covered under the *Rights in Water and Irrigation Act 1914*. Permits (related to the disturbance of beds and banks) and licences (for the taking and use of water) are required within proclaimed areas. The protection of water resources in the plan area (such as surface water catchments – see Map 2) is covered under the *Country Areas Water Supply Act 1947* and the *Metropolitan Water Supply Sewerage and Drainage Act 1909*.

The Acts identified above are the major ones relevant to water resource management, but additional measures are possible through the *Water Agencies (Powers) Act 1984*, which enables the responsible Minister to make regulations for water resources protection and water quality, among other matters. Also, under the *Waterways Conservation Act 1976*, which focuses principally on estuarine waterways, the ability to construct infrastructure such as jetties and the like can be controlled by the issue of permits. Under this Act, the responsible Minister can also control the disposal of material into waterways via a licensing system.

The Department of State Development (DSD) administers State Agreement Acts and associated projects. State Agreements are in force for major mining projects operating on lands covered by this plan (mostly State forest), including the bauxite/alumina operations of Alcoa and Worsley, and the coal mining operations of Griffin and Premier Coal, affecting smaller areas near Collie (see Map 2).

The CALM Act does not generally preclude land vested in the Conservation Commission from mining or development projects. Section 4(1) of the CALM Act provides that, with some exceptions, nothing in the CALM Act will derogate from the operation of any other Act relating to minerals or petroleum or any State Agreement for a development project. However, concurrence of the Minister for Environment is required for most lands managed by the Department within the plan area (see below). In addition, all mining and industrial development projects are required to undergo environmental, heritage and native title assessments, and address State initiatives such as this plan. State Agreement project companies are typically required to provide written reports annually and triennially on their environmental management programs, which are provided to relevant government agencies for review and comment. Government agencies provide advice to the companies on issues that may arise. Mining activities within the Alcoa and Worsley leases are administered by DSD under Ministerial conditions through respective liaison groups and via the relevant departmental-company working arrangements.

The State also supplies pine log timber under other State Agreements. These will largely determine the level of production from pine plantations during the life of the plan.

The Mining Act controls mineral exploration activities (including fossicking and prospecting) and mining operations other than those within State Agreement areas. Petroleum (which includes oil, gas and geothermal energy) exploration and production within State land and onshore waters is authorised under the *Petroleum and Geothermal Energy Resources Act 1967*. This Act may soon be amended to also cover the geological storage of greenhouse gases. The Department of Mines and Petroleum (DMP) is the State's lead agency for related assessment and approvals under both Acts and is a decision-making authority for non-State Agreement Act projects.

Sections 24, 24A and 25 of the Mining Act define the type of consultation the Minister for Mines undertakes with the Minister for Environment, who is advised by the Conservation Commission (which in turn is advised by the Department, as the land manager). This varies according to activity and reserve tenure, as follows:

- national parks and class A reserves – the Minister for Mines shall first consult and obtain the concurrence of the Minister for Environment, and for Mining Leases and General Purpose Leases, must be approved by both Houses of Parliament
- other land reserved under Part 4 of the *Land Administration Act 1997*, including non-class A conservation parks and nature reserves – shall first consult and obtain the recommendations of the Minister for Environment
- State forests and timber reserves within the south-west mineral field – shall first consult with and obtain the concurrence of the Minister for Environment
- State forests and timber reserves *outside* the south-west mineral field – shall first consult and obtain the recommendations of the Minister for Environment.

Under the Petroleum and Geothermal Energy Resources Act, the Minister for Mines shall consult with and obtain the recommendations of the Minister for Environment on the conditions for entry into reserved land (section 15A).

In addition, under a memorandum of understanding between DMP and the EPA, 'significant' mineral and petroleum proposals can be referred to the EPA for its assessment under Part IV of the EP Act. Also under section 38 of the EP Act, all projects can be referred to the EPA for assessment by a proponent, the decision-making authority (for example, DMP), the Department, the Conservation

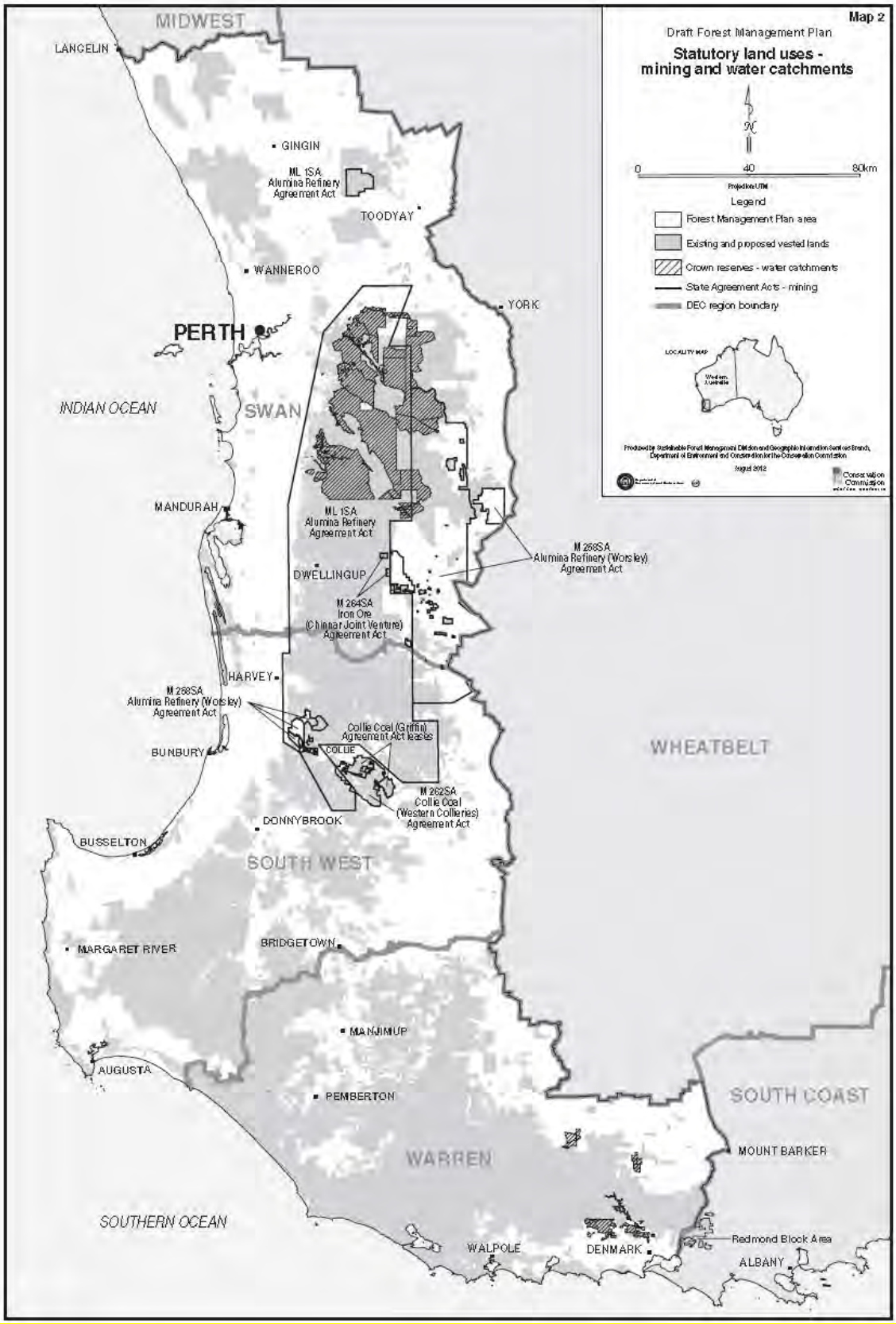
Commission, or a member of the public. Triggers for significance are usually based on EPA guidance material and the *Environmental Impact Assessment Administrative Procedures*.

The Aboriginal Heritage Act and the Heritage of Western Australia Act are also relevant. Exploration activities are subject to conditions intended to protect the environment and cultural heritage through specific approvals under section 24 of the Mining Act. Mineral and petroleum extraction operations are allowed only after approval is granted for each specific proposal submitted to DMP, which consults with the Department and other relevant agencies.

It is important to note that in those instances where consultation with the Minister for Environment is not required under the Mining Act, the Conservation Commission still has an essential advisory role as part of its functions under section 19 of the CALM Act, where proposals potentially impact lands vested in it.

The Department has certain statutory obligations under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) concerning biosecurity matters generally, and particularly with respect to the management of pathogens that cause forest diseases, through the CALM Act. The management and control of weeds in Western Australia is guided by the BAM Act and the *Agriculture and Related Resources Protection Act 1976*, which is administered by the Department of Agriculture and Food (and note it is intended that the BAM Act will replace the Agriculture and Related Resources Protection Act and some other Acts in the near future, which may bring some changes to management requirements).

The *Agricultural and Veterinary Chemicals (Western Australia) Act 1995* covers the use and control of pesticides, including the requirement to use pesticides in accordance with label requirements or approved ‗off label' permits. The *Health Act 1911* is applicable to pesticides used by the Crown within a Public Drinking Water Supply Area. The conditions for pesticide use in these areas are specified in the Department of Health *Public Service Circular 88 Use of herbicides in catchment areas*. The *Contaminated Sites Act 2003* provides for the identification, recording, management and remediation of contaminated sites. Sites contaminated with hydrocarbons, fertilisers or pesticides will fall within this Act. However, contaminated sites do not include areas where fertiliser or pesticide is applied correctly.


Map 2
Draft Forest Management Plan
Statutory land uses - mining and water catchments
N
0
40
80km
Legend
Forest Management Plan area
Existing and proposed vested lands
Crown reserves - water catchments
State Agreement Acts - mining
DEC region boundary
LOCALITY MAP
August 2012
MIDWEST
LANCELIN
GINGIN
ML 1SA Alumina Refinery Agreement Act
TOODYAY
WANNEROO
YORK
PERTH
INDIAN OCEAN
SWAN
MANDURAH
ML 1SA Alumina Refinery Agreement Act
M 268SA Alumina Refinery (Worsley) Agreement Act
DWELLINGUP
M 264SA Iron Ore (Chinnar Joint Venture) Agreement Act
HARVEY
M 268SA Alumina Refinery (Worsley) Agreement Act
Collie Coal (Griffin) Agreement Act leases
COLLIE
BUNBURY
WHEATBELT
M 262SA Collie Coal (Western Collieries) Agreement Act
DONNYBROOK
BUSSELTON
SOUTH WEST
MARGARET RIVER
BRIDGETOWN
MANJIMUP
AUGUSTA
PEMBERTON
SOUTH COAST
WARREN
MOUNT BARKER
SOUTHERN OCEAN
WALPOLE
DENMARK
Redmond Block Area
ALBANY

Application of the plan

Structure

The proposed operations (management activities) in this Draft plan are set out under the seven criteria for sustainability developed in the Montreal Process. Australia and 12 other countries participating in the Montreal Process agreed in 1995 that the criteria and indicators they had developed provided a common understanding of sustainable forest management at a whole of forest scale.

Some issues are relevant to a number of the Montreal Criteria which serve as the framework of this Draft plan, as they do in the current FMP. Generally, each issue is addressed under the criterion most relevant to that issue, although it is appropriate and has been necessary to address some issues under a number of criteria. Management challenges associated with climate change are of particular importance (EPA 2012) and this is covered mainly, but not only, in the ‗Biological diversity', ‗Ecosystem health and vitality', ‗Soil and water', ‗Climate change and carbon cycles', and ‗Productive capacity' chapters.

Chapters based on the Montreal Criteria include the following (as relevant):

- *Background* – text to provide an introduction to the matters in the chapter and any links to the management of other sections. This section highlights key issues of relevance to the particular chapter, including those that may have gained greater importance during the term of the current FMP, and where circumstances may have changed.
- *Goal(s)* – a statement of the desired outcome(s).
- *Identified values and threats* – a listing of the values identified that the Draft plan seeks to manage and a listing of identified threats to those values.
- *Relevant policies and guidelines of the Department* – a listing of the policies, guidelines, manuals and other documents which the Department, and other proponents where required by the Department (such as the FPC), will have regard to in conducting the proposed operations.
- *Operations proposed to the undertaken (management activities)* – activities proposed that seek to achieve goals by protecting identified values and/or addressing identified threats.
- *Key performance indicators* – performance targets for key goals (where appropriate). Associated standard reporting measures are covered through the proposed operations (management activities) 119 to 121.

The goal statements which reflect the Conservation Commission's purpose in proposing operations (management activities) are not intended to impose any legal obligation on, or prescribe any action to be taken by, the Department, the FPC or others. The Department and the FPC will act in accordance with the plan by undertaking the operations (management activities) proposed. In doing so, the Department, and others, where required by the Department, will have regard to certain policy, guidelines and/or other documents, as identified.

Scope

This Draft plan applies within the geographic area of the Department's Swan, South West and Warren regions, and the lands collectively referred to as ‗Redmond' forest block within the South Coast Region (Map 1), other than marine waters.

This Draft plan covers the management of lands vested in the Conservation Commission:

- Indigenous State forest and timber reserves (Map 3 existing, Map 4 proposed through this Draft plan), including State forest classified as a forest conservation area through section 62(1) of the CALM Act.
- Nature reserves, national parks, conservation parks and other land referred to in section 5(1)(g) and (h) of the CALM Act that has a conservation purpose (Map 3 existing, Map 4 proposed through this Draft plan), recognising the whole of forest context and the role of the formal reserve system in the development of the approach to ESFM.
- State forest and timber reserves planted with exotic species (Map 5 shows the major areas). The application of the plan to these areas is limited to specific proposed operations (management activities) labelled for **Plantations** and **'Other exotics'**.

Of the 2,498,300 hectares of lands vested in the Conservation Commission under this Draft FMP, 1,293,800 hectares are in existing or proposed formal reserves or forest conservation areas (see Table 1). In addition, under this Draft FMP there is between 194,770 and 195,980 hectares of informal reserves, and between 43,960 and 52,170 hectares of fauna habitat zones. In total, under this Draft plan, there is a range between 1,532,530 and 1,541, 950 hectares of protected areas, representing between 61.3 and 61.7 per cent of lands vested in the Conservation Commission within the plan area. The remaining 956,350 to 965,770 hectares are State forest and timber reserve, where a range of disturbance activities may take place.

More detailed requirements for management activities on these land categories may flow from:

- the requirements of the CALM Act, the WC Act, and other relevant State and Commonwealth legislation
- existing area management plans or those developed in the life of the plan applicable to the particular area (this Draft plan will defer to existing area management plans where they exist (see Appendix 3), but also function as a management plan for areas where no specific area management plan exists)
- relevant position statements of the Conservation Commission, and policies and subsidiary guidance documents of the Department, and where applicable, those of others (see Appendix 4).

This Draft plan has no relevance for CALM Act marine conservation reserves within the defined geographic area, as these are not vested in the Conservation Commission.

The pricing and allocation of harvested forest products is outside the scope of the plan.

Table 1: Area of land categories covered by the Draft plan
(As at December 2011; figures in brackets include proposed changes in land categories)

<table>
<tr><th>State forest

(ha)</th><th>Timber reserve

(ha)</th><th>Existing and proposed nature reserves, national parks, conservation parks, CALM Act section 5(1)(g) and 5(1)(h) lands, and State forest classified as forest conservation area

(ha)</th></tr>
<tr><td>1,164,000
(1,160,000)*</td><td>44,500</td><td rowspan="2">1,289,000
(1,293,800)*</td></tr>
<tr><td colspan="2">1,208,500
(1,204,500)*</td></tr>
</table>

Notes:

1. Areas of State forest and timber reserve are exclusive of those areas proposed for addition to reserves.
2. There are 50,500 hectares set aside as pine plantation on State forest and timber reserve and a further 12,100 hectares on freehold land held in the name of the CALM Executive Body (not covered by this plan) within the Department's Swan, South West and Warren regions. Parts of this area contribute to the sustained yield from native forests.
3. There are also 3,400 hectares of forest dominated by exotic eucalypt species on State forest and timber reserves, mainly within rehabilitated mining areas.

* Includes the proposed additions to Whicher National Park – see the 'Biological diversity' chapter.

Purposes for reservation of indigenous State forest and timber reserves

Section 55(1a) of the CALM Act requires the plan to specify the purpose, or combination of purposes, for which an indigenous State forest or timber reserve is reserved, being one or more of the purposes identified in that subsection.

Current areas of State forest and timber reserves are shown on Map 3. All areas of indigenous State forest and timber reserves within the Swan, South West and Warren regions, other than those identified in Appendix 5, are reserved for the purposes of conservation, recreation, timber production on a sustained yield basis, water catchment protection and other purposes, being a purpose prescribed by the regulations (see Appendix 2). In 2004, a Conservation and Land Management Regulation (CALM Regulation) was gazetted that allowed State forest and timber reserves to be used for the storage and taking of water (dam sites) and in 2008, the same regulation was amended by the inclusion of an additional use, being the location of infrastructure, and other similar facilities, that serve the public interest, to the extent to which locating such infrastructure and facilities would not be inconsistent with achieving the other purposes for which the area is reserved.

However, this Draft plan proposes that some areas (such as unallocated Crown land) be reserved as State forest, and that some State forest and timber reserves be reclassified as national park, conservation park, nature reserve or forest conservation area (as carried forward from the current FMP; and as proposed in this Draft plan, mainly for the Whicher Scarp area – see the 'Biological diversity' chapter). These areas are identified in Map 4 and Appendix 5. The purposes for reservation of proposed State forest, timber reserves, national parks, conservation parks and nature reserves is as described in Appendix 2, and it is proposed that this statement of the purpose of reservation of these areas will have effect from gazettal of the next FMP, until they have been formally reclassified as proposed by this Draft plan. The purpose for reservation of proposed forest conservation areas is as per other areas of State forest and timber reserves, except that timber production on a sustained yield basis is not included.

Operation of the plan

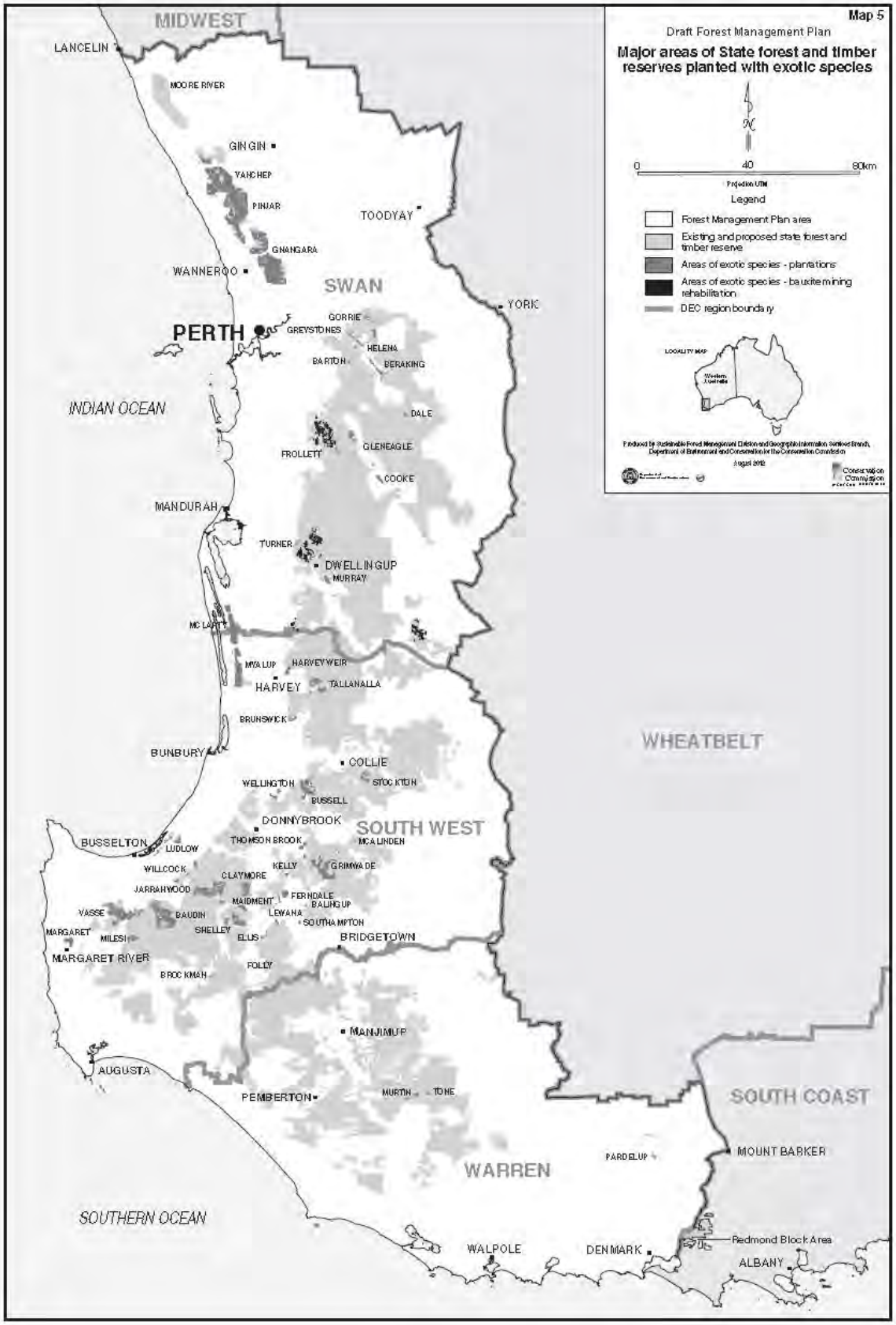
Subject to approval by the Minister for Environment, the next FMP will come into operation on 1 January 2014 and continue to operate until 31 December 2023. The approved plan will then revoke the current FMP (2004-2013). As many of the requirements of the plan are complex, the various parts of the overall plan will be implemented progressively according to available resources.

The current FMP had certain Ministerial conditions and commitments attached to its implementation pursuant to the EP Act. On approval of the next plan, the current FMP will be revoked, so that those Ministerial conditions and commitments attached to its implementation will no longer be in force. However, issues to which those Ministerial conditions relate that have ongoing relevance to forest management have been addressed in this Draft plan. The next FMP is a separate proposal which following public consultation, will be assessed by the EPA under the EP Act and as a consequence may have a set of Ministerial conditions attached to its implementation.

In the following parts of this Draft plan, reference is made to various existing or proposed policies and guidelines of the Department[4]. These may be revised from time to time, or be replaced during the life of the plan. Other relevant policies and guidelines may be developed during the term of the plan that the Department (and others, where required) may also need to have regard to when undertaking particular proposed operations (management activities). It is intended that the Department's key documents will be prepared and/or reviewed in accordance with the Department's Policy Statement 1: *Department of Environment and Conservation – Key documents*.

Note there is a considerable range of other regional, state and national policies and strategies that may be relevant to the plan, and where required, and otherwise where appropriate, the Conservation Commission and Department endeavour to ensure they align their activities with these. These other documents are not necessarily identified within this Draft plan.

[4] And in some cases, where relevant, those of others, endorsed by the Department.


Map 5
Draft Forest Management Plan
Major areas of State forest and timber reserves planted with exotic species
N
0
40
80km
Projection UTM
Legend
Forest Management Plan area
Existing and proposed state forest and timber reserve
Areas of exotic species - plantations
Areas of exotic species - bauxite mining rehabilitation
DEC region boundary
LOCALITY MAP
Western Australia
Produced by Sustainable Forest Management Division and Geographic Information Services Branch, Department of Environment and Conservation for the Conservation Commission
August 2012
Conservation Commission
MIDWEST
LANCELIN
MOORE RIVER
GINGIN
YANCHEP
PINJAR
TOODYAY
GNANGARA
WANNEROO
SWAN
YORK
PERTH
GORRIE
GREYSTONES
HELENA
BARTON
BERAKING
INDIAN OCEAN
DALE
FROLLETT
GLENEAGLE
COOKE
MANDURAH
TURNER
DWELLINGUP
MURRAY
MC LARTY
MYALUP
HARVEY WEIR
HARVEY
TALLANALLA
BRUNSWICK
BUNBURY
WHEATBELT
COLLIE
STOCKTON
WELLINGTON
BUSSELL
DONNYBROOK
SOUTH WEST
BUSSELTON
LUDLOW
THOMSON BROOK
MCALINDEN
WILLCOCK
KELLY
GRIMWADE
CLAYMORE
JARRAHWOOD
MAIDMENT
FERNDALE
BALINGUP
VASSE
BAUDIN
LEWANA
SOUTHAMPTON
MARGARET
MILESI
SHELLEY
ELLIS
BRIDGETOWN
MARGARET RIVER
FOLLY
BROCKMAN
MANJIMUP
AUGUSTA
PEMBERTON
MURTH
TONE
SOUTH COAST
PARDELUP
MOUNT BARKER
WARREN
SOUTHERN OCEAN
WALPOLE
DENMARK
Redmond Block Area
ALBANY

Biological diversity

Background

Biological diversity (biodiversity) refers to the variability in structure and function of living organisms and the ecosystems of which they are a part. It is measured or observed at five different levels: regions, landscapes, ecosystems, species (or taxa) and genes. The south-west of Western Australia, from Shark Bay to the western edge of the Great Australian Bight, is an internationally recognised megadiverse ‗hotspot' (Mittermeier *et al*. 1999) and accordingly, the conservation of biodiversity is a driving factor in shaping the proposals in this Draft plan. Conserving biodiversity requires maintenance of a diversity of habitats and ecological processes at various spatial scales, from entire forested landscapes to specific localised habitats. It also includes sustaining populations and maintaining their genetic diversity.

Biodiversity and biodiversity components are defined in Part I, section 3 of the CALM Act as follows:

> *'Biodiversity' means the variability among living biological entities and the ecosystems and ecological complexes of which those entities are a part and includes -*
>
> *(a) diversity within native species and between native species*
>
> *(b) diversity of ecosystems*
>
> *(c) diversity of other biodiversity components.*
>
> *'Biodiversity components' includes habitats, ecological communities, genes and ecological processes.*

Lindenmayer *et al*. (2006) propose five general principles for conservation of biodiversity in forested landscapes and a range of strategies that may assist in providing for these principles, with the overall goal being to prevent habitat loss. The five principles are identified below together with a pointer to where each is addressed in this Draft plan:

1. *Maintenance of connectivity*. The linkage of habitats, communities and ecological processes influences population persistence and recovery after disturbance. This is addressed through the establishment and management of formal reserves and forest conservation areas which serve to provide large areas of structurally complex patches of native vegetation; by the protection of riparian areas, other corridors and sensitive habitats in informal reserves; and by vegetation retention requirements in areas subject to timber harvesting. See sections on these below.
2. *Maintenance of landscape heterogeneity*. Landscape heterogeneity is a feature of natural forests as a result of natural environmental gradients and natural disturbance processes, which create habitat patches of importance for many species. This is addressed through the establishment and management of smaller formal reserves and forest conservation areas; the protection of riparian areas, other corridors and sensitive habitats in informal reserves; and by dispersion in space and time of areas subject to disturbance by timber harvesting and prescribed fire. Consideration of natural disturbance regimes also contributes to maintenance of landscape heterogeneity. See sections on these below.
3. *Maintenance of stand structural complexity*. This is also a feature of natural forests and again creates habitat patches of importance for some species, but at a much finer scale than the landscape. This is addressed in silviculture guidelines through retention of structures and organisms in timber harvesting or by their reintroduction following mining. Natural disturbance regimes and rotation lengths also contribute. See sections on these below.

4. *Maintenance of intact aquatic ecosystems*. Streams, rivers, wetlands, lakes and other water bodies are critically important to biodiversity and ecosystem function, particularly given the relatively dry climate experienced in the plan area and predicted impacts of future climate change. This is addressed through the establishment and management of informal reserves, as described below, and in the ‗Soil and water' chapter.
5. *Knowledge of natural disturbance regimes to inform human disturbance regimes*. This recognises that timber harvesting regimes and fire regimes should be informed by natural disturbance regimes. Timber harvesting is described below and silviculture is described further in the ‗Productive capacity' chapter. Fire management is described in the ‗Ecosystem health and vitality' chapter.

Additionally, Fischer *et al*. (2006) proposed broad strategies for the conservation of biodiversity, many of which are covered above. However, they also identified some additional strategies which are identified below, together with a pointer to where each is addressed in this Draft plan:

- control aggressive, over-abundant, and invasive species – this is addressed through the management of weeds, pests and diseases in the ‗Ecosystem health and vitality' chapter
- minimise threatening ecosystem-specific processes – this is addressed through the management of mining and infrastructure development and maintenance sections below
- protect species of particular concern – this is addressed through the management of threatened species and communities section below.

Conserving environmental heterogeneity and biodiversity helps ensure that ecosystems remain productive and resilient to disturbance. Resilience of natural areas and ecosystems is related to their ‗naturalness', which stems from their biological and structural diversity, size, connectivity and the nature of disturbances within and around them. Conserving broad genetic variability within populations retains greater scope for tolerance to a wider range of environmental conditions. In this respect, the possible impacts of climate change are of particular importance to biodiversity management (for example, see Climate Commission 2011a; *National Biodiversity and Climate Change Action Plan 2004-2007*, Commonwealth of Australia 2004). For example, where hotter conditions are expected, plants occurring at the warmer, northern limits of a species distribution could form the basis for viable future populations (Thompson *et al.* 2009). Diversity also promotes greater capacity for ecosystems to cope with various other environmental pressures, such as inappropriate fire regimes, and invasive weeds, pests and diseases. Further statements to address these issues are included in the ‗Ecosystem health and vitality' chapter.

In addition to temperature regimes, the availability of water is a key driver of biodiversity and ecosystem processes. In areas expected to be subject to warmer temperatures and further drying of the climate, such as south-west Western Australia (see the ‗Global carbon cycles' chapter), topographically restricted and/or hydrologically defined micro-habitats may provide refuge for certain water-dependent flora and fauna, and/or more reliable sources of water to assist the persistence of other fauna resident in the wider landscape. However, Dunlop *et al.* (in prep.) warn that there is a limit to the ‗buffering capacity' that refuges can provide to enduring environmental stress (such as from ongoing drying of the climate), noting there will probably be some unavoidable loss of biodiversity in some places. Some wetter areas may dry out and lose their value as habitat and refugia for some species. This may well include some areas in south-west Western Australia. For example, analysis conducted by the Department suggests that tingle forest found near the south coast may be particularly vulnerable to climate change impacts, as are some other forest areas at the margins of their current range. Further reading on this can be found at *Maher et al. (2010)*.

While a network of protected areas has long been recognised as a core component of strategies to conserve biodiversity, reserve design has not necessarily taken into account the possible impacts from climate change. To this end, the Department has begun work on modelling biodiversity response to investigate the potential vulnerability of native flora and fauna to climate change, and the

development of a ‗climate-biodiversity' strategy. Thompson *et al*. (2009) also reiterate the importance of maintaining connectivity across landscapes, by minimising fragmentation and retaining (or re-establishing) ecological corridors to allow movement of species. Within the plan area, there is a network of informal reserves that help serve this purpose, complemented by other measures to maintain habitat and minimise the impacts from disturbance operations in other areas (see ‗Integrating biodiversity management across the plan area', below, and the ‗Productive capacity' chapter; and activities to manage fire, weeds, pests and diseases outlined in the ‗Ecosystem health and vitality' chapter). Together, these measures seek to promote resilience and ensure that biodiversity is effectively conserved at the whole of forest level and across the plan area. Further discussion about possible additions to the formal reserve system and options for changes to the informal reserve network is included below.

Thompson *et al*. (2009) also point out that under changed conditions, species with previously ‗limited functions' and ‗lesser profiles' may become more prominent. A recent review by Dunlop *et al.* (in prep.) suggests that the magnitude and speed of change could be significant – for example, they predict a general pattern of decline in the extent (area) of environments that now favour trees and an increase in the extent of xeric environments favouring more open woodlands, shrublands and grasslands. However, the ‗tipping point' that will precipitate such changes is not well understood and changes may be gradual, manifesting over decades or longer timeframes, or conversely, could occur quite suddenly. Dunlop *et al.* (in prep.) suggest that future management will likely be focused on managing the changes to minimise loss, with choices having to be made between seeking to *preserve in situ* and *facilitating change*. The latter seeks to assist the adjustment to changing conditions and further, related discussion on this is included in the ‗Soil and water' chapter. Similarly, Steffen *et al.* (2009) note that more agile and flexible governance systems will be needed to deal with the challenges of climate change'. This is one of the reasons that this Draft plan is pitched a slightly higher level that the current FMP and why it is proposed that approval processes for subsidiary documents be streamlined, compared to the current FMP, to be consistent with those that normally apply within the Department.

Monitoring will also be important, and in this Draft plan, it is intended that the Department's key forest biodiversity monitoring program, *FORESTCHECK*, which was conducted during the current FMP, be continued. To date, *FORESTCHECK* has been applied within the jarrah forest (and comments on key findings are included later, under ‗Integrating biodiversity management across the plan area'). In the end-of-term audit of the current FMP (Conservation Commission 2012), it was suggested that *FORESTCHECK* be reviewed to fill gaps, including for example, extending it to cover areas where survey effort has been relatively low so far, and to provide a basis for monitoring the impacts of climate change on biodiversity. Further comments in relation to monitoring are included in the ‗Plan implementation and management' chapter.

In addition to the measures described in this Draft plan, there are a number of other initiatives and activities occurring within the geographic area covered by the plan that contribute to a broader effort to conserve biodiversity (for example, the *Bush Forever* program in the metropolitan area and work carried out through regional natural resource management groups and by volunteer organisations). A coordinated and focused approach across all land tenures is important to long-term success – for example, the importance of retaining ecological linkages between remaining remnants of native vegetation in cleared landscapes is well recognised (for example, see the EPA 2009a, Environment Protection Bulletin No 8). Related to this is the 2011 agreement between the Commonwealth and State governments to conduct a strategic assessment of future development in the Perth and Peel regions, under the EPBC Act. This work will focus on the likely urban, industrial and infrastructure developments required for future population growth in the area, and consider issues related to the protection of Carnaby's cockatoo, including the progressive removal of the Gnangara, Pinjar and Yanchep pine plantations and subsequent rehabilitation and land use in these areas.

Description of reserves, and options for possible additions and changes

Formal conservation reserves

Formal conservation reserves include national parks, nature reserves, conservation parks and CALM Act section 5(1)(g) and 5(1)(h) areas, the purpose of which is outlined in Appendix 2. The process for development of the reserve system is described in Appendix 6. Timber harvesting and a range of other disturbance activities are not permitted in these areas (although some restricted harvesting may be allowed on certain tenures with Ministerial approval, Conservation Commission endorsement and under permit, for example, for removal of smaller pine trial plots and other exotics).

As explained in the ‗Background' section of this Draft plan, the establishment and maintenance of a CAR reserve system is fundamental to the conservation of biodiversity in the plan area. This Draft plan carries forward proposals from the current FMP as listed in Appendix 5 and shown on Map 4, and includes some areas not currently vested in the Conservation Commission. These earlier proposals are being progressed and it may take some time to conclude the remaining administrative steps in the processes involved, which are mainly outside the control of the Department and the Conservation Commission. Appendix 7 and 8 provide the area and percentage reservation levels respectively for forest ecosystems within the RFA area[5], and Appendix 9 provides similar statistics for the reservation level of old-growth forest. Since the scope of the plan extends beyond the area covered by the RFA, Appendix 10 and 11 provide data for Beard-Hopkins vegetation associations (Hopkins *et al*. 1996) within and outside the RFA area.

Significant additions to the reserve system are a feature of the current FMP. When fully implemented this will result in a reserve system that generally exceeds the minimum standards set under the *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System* (CAR) *for Forests in Australia* (Commonwealth of Australia 1997; and see Figure 1, below). This Draft plan includes limited proposals for some further additions to the formal reserve system, beyond those identified by the current FMP, for areas within the Whicher Scarp, as indicated in Map 4, and discussed next.

Proposed additions to Whicher National Park

Results from *FORESTCHECK* show that the pattern of occurrence of a broad range of biodiversity is strongly related to vegetation systems, which has formed the basis for design of the existing formal reserve system. Additional information gathered since the commencement of the current FMP supports recognition of the flora and vegetation complexes associated with the Whicher Scarp (see Map 4) as a separate ‗forest ecosystem' (see the glossary for a definition of this), and further reading on the biodiversity values of these areas can be found at *Keighery et al. (2008)*. In summary, the biodiversity values of the Whicher Scarp forest ecosystem include a diverse and rich flora that includes many rare species, endemic species, species at the end of their range, restricted and rare wetland communities, and a diverse suite of woodland communities. As a consequence of the recognition of the Whicher Scarp as a separate forest ecosystem, additional formal reserves are required in this area if the reservation targets are to be achieved. As can be seen from Figure 1 and Appendix 8, the proposed additions would help achieve this. It is proposed that the areas be reclassified as national park, subject to legislative and government policy requirements, including consultation with the Department of Mines and Petroleum and the Minister for Mines and Petroleum.

Table 2 provides a summary of reservation of forest ecosystem types in formal conservation reserves, including this proposal for the Whicher Scarp.

[5] The design of the reserve system has been addressed in two separate parts because of the different level of vegetation mapping available. Map 1 shows the RFA boundary.

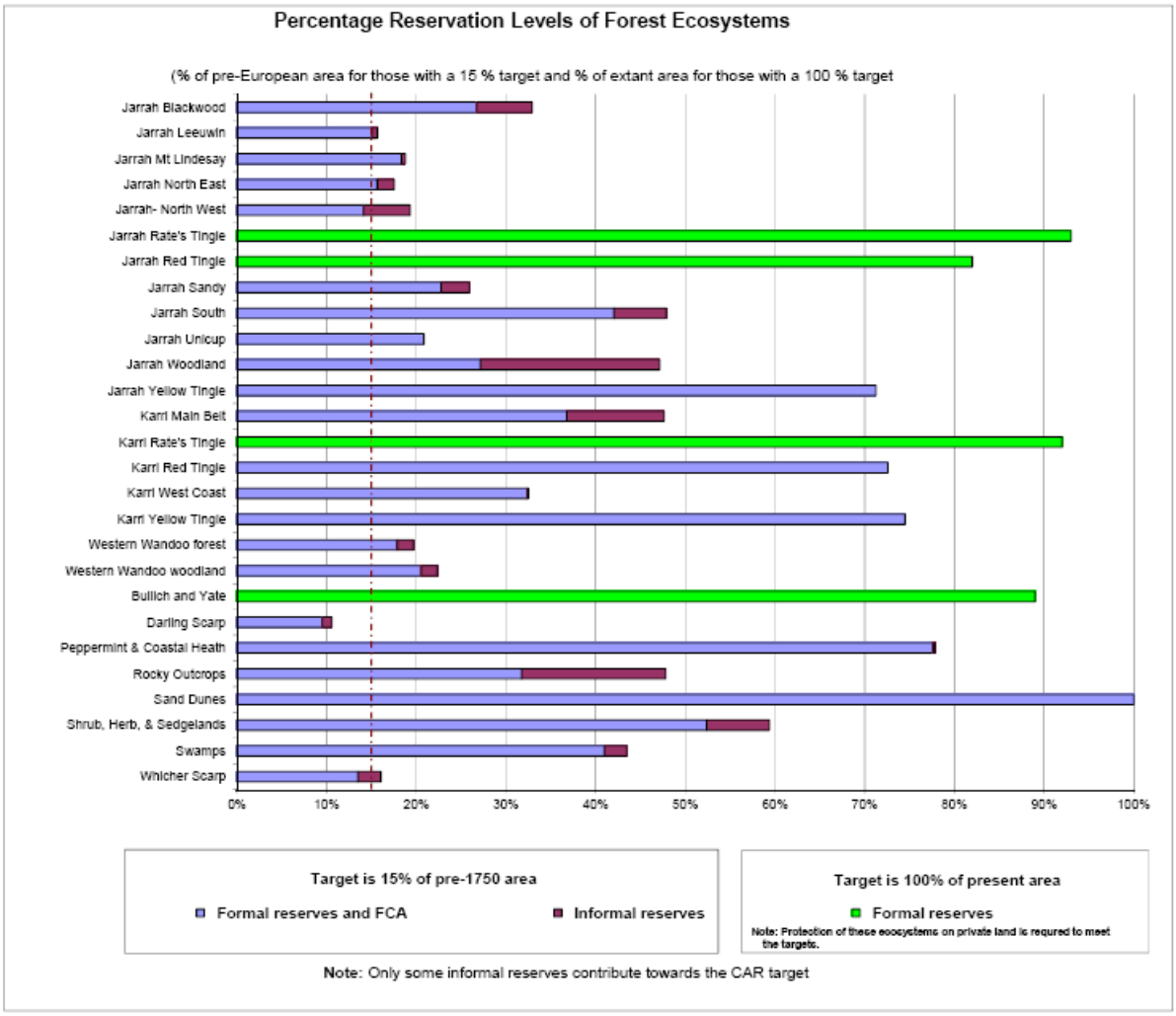


Figure 1: Reservation against CAR target for forest ecosystems

Note: reservation targets for forest ecosystems are in many cases well exceeded, except for Jarrah Rates Tingle, Jarrah Red Tingle, Karri Rates Tingle, Bullich and Yate, and Darling Scarp. In these cases, additional protection on private land would be required to meet the targets.

Table 2: Reservation levels of forest ecosystem categories

(Within the extended RFA area; figures in brackets include proposed changes in land categories)

Forest ecosystem category	Total pre-1750 extent (ha)	Present extent within the plan area (ha)	Formal conservation reserves				Forest Conservation Areas (proposed) (ha)
			Existing reserves (Additions proposed) (ha)				
			National park	Nature reserve	Conservation park	5(1)(g) & (h)	
Jarrah dominant	2,780,250	1,809,040	380,810 (75,780) (77,330)*	63,210 (9,840)	24,540 (47,130)	13,840 (250)	(27,960)
Karri dominant	231,600	190,160	89,930 (950)	270 (100)	10 (400)	40 (0)	(1,690)
Wandoo dominant	526,200	218,680	37,620 (14,260)	12,690 (1,110)	8,380 (24,270)	10 (10)	(50)
Other	625,800	425,590	274,780 (12,350) (14,720)*	16,280 (2,420)	750 (1,310)	970 (0)	(10,740)
TOTAL	**4,163,850**	**2,643,470**	**886,480 (890,400)***	**105,920**	**106,790**	**15,120**	**40,440**

Notes:

1. The RFA area has been extended to include the full extent of the Darling Scarp and Whicher Scarp ecosystems.
2. * Includes the proposed additions to Whicher National Park.
3. The table shows the full extent of forest ecosystems reported in Appendix 7. It does not show the total of each tenure category which may also include reservoirs, exotic species, and cleared land.

Forest conservation areas

This Draft plan identifies some areas that are proposed for classification as forest conservation areas under section 62(1) of the CALM Act (see Map 4), which are the same as was proposed under the current FMP (i.e. they are carried forward to this Draft plan). Forest conservation areas are proposed to provide a higher level of security of classification than informal reserves for areas that have some impediment (for example, mineral resources) to being considered for a formal reserve category. The priority for the management of these areas is the maintenance of biodiversity and they will not be available for timber harvesting, but may be available for other uses such as wildflower picking, apiculture, craftwood, and possibly firewood collection. The latter would be considered on an area by area basis. Otherwise, where an approved area management plan exists, whatever it sets out for particular forest conservation areas within its boundaries would apply (for example, see the *2008 Walpole Wilderness Management Plan*, Conservation Commission 2008a).

Informal reserves

Informal reserves provide a network of relatively undisturbed areas that are distributed across the plan area and provide linkages between formal reserves, thereby making an important contribution to conservation outcomes. Appendix 12 describes the types and purpose of informal reserves and Table 3 shows the area of each type that exists within State forest and timber reserves. Map 6 provides an example to illustrate the scale and configuration of the linkages provided by the informal reserves network within an area of State forest.

As with formal reserves, timber harvesting and a range of other disturbance activities are not permitted in these areas (although some restricted harvesting may be allowed in some areas under certain circumstances – see the *Guidelines for Protection of the Values of Informal Reserves and Fauna Habitat Zones* (DEC 2009a).

Informal reserves established in one forest management plan have no status beyond that plan unless carried forward into the next one. However, some informal reserves established under the *Forest Management Plan 1994-2003* were recognised as CAR informal reserves in the 1999 RFA, which committed the State to establish these as such under the current FMP, and this subsequent plan.

In this Draft plan, some management options for changes to certain informal reserve types are proposed, as outlined next, and summarised in Table 3. There are no changes proposed to the purpose, location or aggregate area of other informal reserve types, *other than* those listed below.

Old-growth forest

In December 2011, there was a total of 333,160 hectares of old-growth forest recognised in formal or informal reserves (up from 331,370 hectares at the commencement of the current FMP).

The current FMP included a number of actions to review/confirm the quality of data contributing to the original determination of old-growth forest status. A category referred to as ‗old-growth forest under review' was created, which the Conservation Commission has been progressively checking to confirm the status of patches of forest that during 1997-2001, were reclassified from old-growth forest to non old-growth forest because of updates to harvest history, forest ecosystem and *Phytophthora* dieback records. The Conservation Commission's review involves checking individual two hectare pixels of data for nearly 9,400 hectares of ‗old-growth forest under review', and results for each area are then published on the Conservation Commission website. About one quarter of the 9,400 hectares on State forest has been checked by the Conservation Commission to date. Over 94 per cent of the patches it reviewed have been confirmed as not old-growth forest, and the remainder are areas that would have been reclassified to old-growth forest under the routine field inspection processes now in place. This Draft plan proposes that the Conservation Commission accredit the Department's data, given that the work undertaken during the current FMP confirms the reclassifications were valid and unbiased, and the Department will continue its routine field inspection process.

In the current FMP, some small areas were designated as ‗Areas previously classified as old-growth forest' as a type of informal reserve. These are areas in the corporate database classified as old-growth forest at the start of the current FMP that were subsequently determined not to be old-growth forest or any other type of informal reserve. This category is a legacy, ‗default' category that does not provide protection to areas with any special conservation values that warrant protection as an informal reserve and accordingly, it is proposed that areas in this category would no longer be recognised as such. The gross area involved is about 480 hectares (or 230 hectares net – see Table 3). Additionally, when areas mapped as old-growth forest are found not to be old-growth forest or any other type of informal reserve, then they will no longer be recognised as an informal reserve, as described below. Of the 333,160 hectares of old-growth forest, over 93 per cent occurs in existing or proposed formal reserves and forest conservation areas (Appendix 9). The remaining seven per cent, or 21,910 hectares, occurs

in the various categories of informal reserves on State forest, including the 15,090 hectares that are in the old-growth forest informal reserve type. Categorisation of these 15,090 hectares may be progressively reviewed as part of the planning for disturbance operations.

The definition of old-growth forest under this Draft plan remains the same as for the current FMP. As noted in the end-of-term audit report (Conservation Commission 2012), the Department has been developing a procedure to refine the methods for identification and demarcation of old-growth forest, and intends to finalise this procedure in consultation with the Conservation Commission.

This Draft plan acknowledges that the total extent of old-growth forest can change over the long term as a consequence of events (for example, altered spread and extent of dieback in jarrah forests, stand changing bushfire in karri) and as datasets are refined or updated (for example, the incorporation of previously unmapped areas of old-growth forest or the exclusion of areas found not to be old-growth forest). It is essential to maintain corporate datasets that reflect the field reality as closely as possible. Continuous improvement in data, mapping techniques and field survey will generate relatively small changes. To record this, it is proposed that the Department publish a map on its website each year, depicting the status and extent of the old-growth forest at the end of the previous year, which identifies and explains any variations that have occurred during the previous year. Map 7 depicts the extent of old-growth forest as recorded in the Department's databases at March 2012.

Assessment of the old-growth forest status of areas subject to proposed timber harvesting is a routine requirement on State forest and timber reserves. However, the checking for old-growth forest as part of planning for other operations has not been as systematic and it is proposed those planning processes be reviewed to ensure a consistent approach to all disturbance operations on all land categories.

Management options for review of previously unmapped old-growth forest

During the current FMP, an additional 1,390 hectares of additional, previously unmapped old-growth forest has been set aside in informal reserves following review of areas by the FPC, the Department and the Conservation Commission. Management options to streamline this review process, while recognising the level of public interest in nominating areas as previously unmapped old-growth forest, include:

Management option 1 is no change – maintain the current system of public nominations received and assessed by the Conservation Commission.

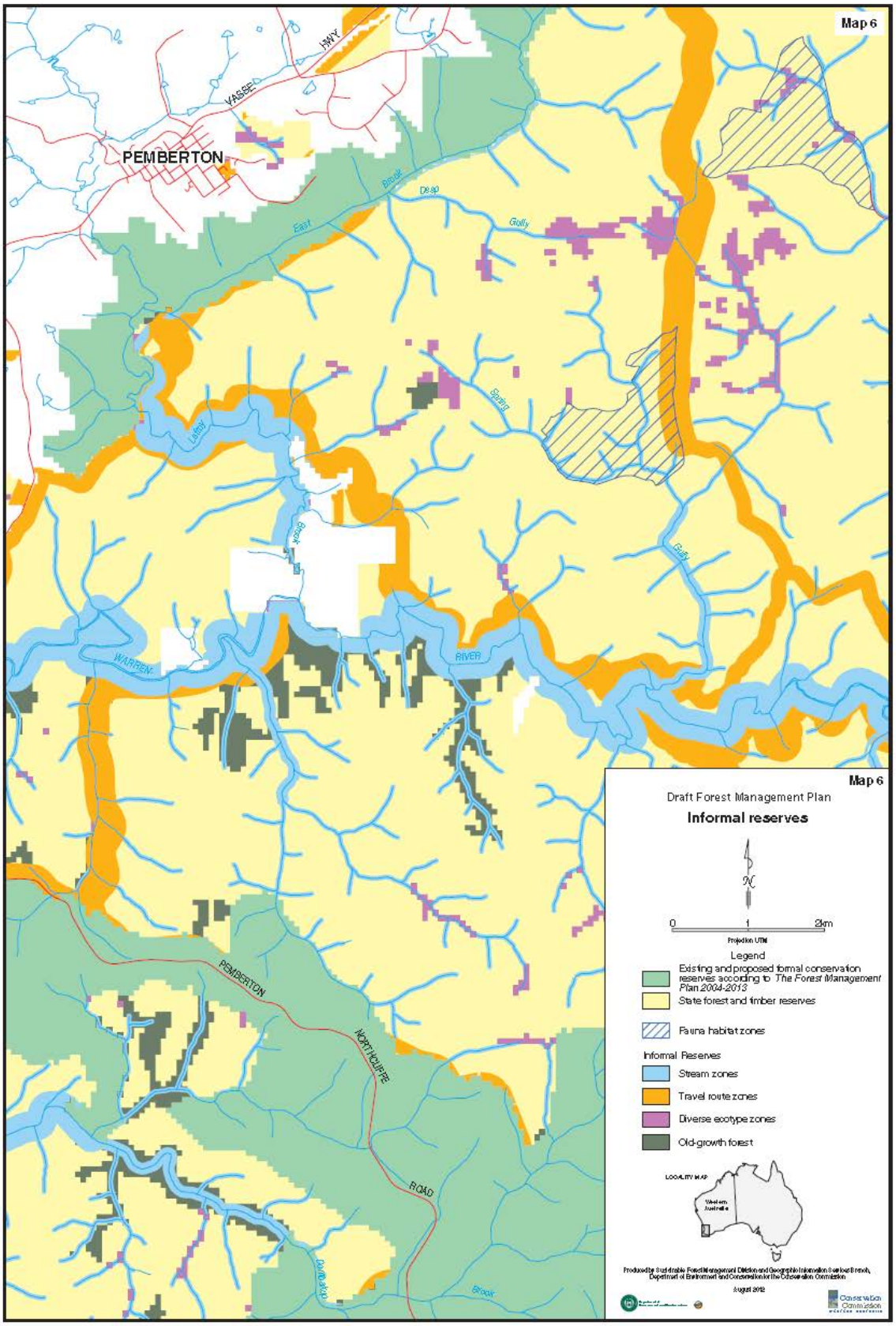
Management option 2 is to modify the public nomination process – maintain the process of public nominations, but transfer its administration to the Department.

Management option 3 is to discontinue the public nomination process – but have the Conservation Commission retain oversight on procedures used by the Department, FPC and other proponents, through the Conservation Commission's routine audit processes under the CALM Act.

Comment is sought on these management options and there are no corresponding proposed operations (management activities) – these will be included in the proposed FMP, as required.

Travel routes

These informal reserves provide linkages between other formal and informal reserves, thereby making an important contribution to conservation outcomes, while also providing socio-economic benefits (particularly for recreation and tourism). Level 1 and 2 travel routes along certain roads within the Department's Warren Region were established in the current FMP, along with a Level 1 travel route for the Bibbulmun Track where it occurs in State forest or timber reserve in areas covered by this Draft plan (for which there are *no* proposed changes in this Draft plan).


Map 6
PEMBERTON
HWY
VASSE
East
Brook
Deep
Gully
Spring
Lefroy
Brook
Gully
WARREN
RIVER
PEMBERTON
NORTHCLIFFE
ROAD
Donnelly
Brook
Map 6
Draft Forest Management Plan
Informal reserves
N
0
1
2km
Projection UTM
Legend
Existing and proposed formal conservation reserves according to The Forest Management Plan 2004-2013
State forest and timber reserves
Fauna habitat zones
Informal Reserves
Stream zones
Travel route zones
Diverse ecotype zones
Old-growth forest
LOCALITY MAP
Western Australia
Produced by Sustainable Forest Management Division and Geographic Information Services Branch, Department of Environment and Conservation for the Conservation Commission
August 2012
Conservation Commission

As a result of changing patterns of usage, the Department conducted a review of travel routes in the Warren Region. The review aimed to identify those travel routes that would provide most benefit in terms of managing scenic quality and considered among other things, changes in land category, the levels and nature of use of the road network, and the effect of application of silvicultural practice (for example, with respect to visual amenity). The proposed redistribution results in a net area of about 510 hectares no longer recognised as informal reserve. This area comprises 220 hectares of karri forest, 270 hectares of jarrah forest and 20 hectares of yellow stringybark, cleared or other exotic species. Appendix 12 lists the travel routes that it is proposed be recognised as informal reserves.

Management options for Munda Biddi Trail travel routes

The Department has also evaluated the use of the Munda Biddi Trail (see Map 12) by off-road cyclists and the management issues associated with user safety and enjoyment, given disturbance operations that may occur within State forest and timber reserves. Currently, there is no travel route associated with the trail, and two management options are presented for comment:

Management option 1 is no change – apply conditions to disturbance activities and utilise temporary trail diversions to manage temporary use conflicts.

Management option 2 is to apply a travel route to certain parts – in addition to conditions imposed on disturbance activities for the majority of the length of the trail. Conditions would be established on a case by case basis with the objective that the amenity and integrity of the trail be maintained as much as practicable. Activities such as establishment of landings and creation of gaps adjacent to the trail would be considered inappropriate in most cases. The travel route zone would include a:

- 200 metre zone around Munda Biddi Trail campsites
- 50 metre zone around bridges and crossings that form part of its designated route
- 50 metre zone around sections of constructed ‗single' trail.

In total, management option 2 would result in about 460 hectares being established and added as informal reserves. Combined, these changes (to travel routes in the Warren region and management option 2 for the Munda Biddi Trail) would result in a net decrease of 50 hectares of travel routes under this Draft plan.

Table 3: Area* of informal reserves within State forest and timber reserves

Variation	Composite area of informal reserves (ha)	Net change from the current FMP (ha)	Explanatory comments
Current FMP	195,510		
Exclude ‗previously classified' old-growth forest		- 230	The area results from the continuing refinement of source datasets and is in small patches (about 80 per cent of the area is in patches smaller than five hectares). The gross area is 480 hectares, which reduces to 230 hectares after taking into account intersections with other informal reserve categories.
Review travel routes in the Warren Region		- 510	
Apply travel routes to part of the Munda Biddi Trail		+ 460	
Implement **all** of the above variations	195,230	- 260	

* figures rounded to nearest 10 hectares

Integrating biodiversity management across the plan area

As explained by Lindenmayer *et al.* (2006), biodiversity conservation depends on maintaining habitat across the full range of spatial scales. Developing and sustaining diversity in the spatial distribution of different native vegetation types, structures and seral or ‗life-cycle' stages (landscape heterogeneity) promotes resilience and provides multiple opportunities to support the range of natural biodiversity that exists. In addition to the establishment of formal reserves, a network of informal reserves, and areas temporarily unavailable for timber harvesting (such as areas required to meet phased harvesting requirements in the moderate salt sensitivity zone – see the ‗Soil and water' chapter), the plan seeks to maintain connectivity at a landscape and whole of forest scale, and achieve stand structural complexity and understorey vegetation diversity at the local and landscape scale, through a range of other complementary measures, as outlined in this part.

Protecting threatened and priority species and communities

Populations of threatened and priority flora and fauna, and threatened and priority ecological communities occur within the plan area and need to be protected. Their continued survival and ability to recover is potentially affected by a range of processes, such as inappropriate fire regimes, predation by feral animals, salinity and introduced plant pathogens. In addition, activities associated with land use and management have the potential to impact them, including, for example, road construction and infrastructure development, mining, timber harvesting, wildflower picking (see ‗Other forest produce' in the ‗Productive capacity' chapter), prescribed burning, recreational facility development and public use and access.

Populations are identified in planning processes associated with proposed disturbance activities, and any particular measures necessary to protect them are determined and included in conditions, if approval is granted by the Department. Others require special management attention, which is described in a series of recovery plans that identify threats and planned remedial actions. Appendix 13 outlines recovery plans relevant to the plan area.

The management procedures and systems that address the protection of these populations include:

- Maintaining databases of the locations of threatened species and ecological communities, conducting searches where high impact disturbance such as road making is proposed, and maintaining licensing systems and compliance checking programs where any threatened flora is proposed to be ‗taken'.
- The development of the Forest Vertebrate Fauna Distribution Information System (Christensen *et al.* 2001), which is reviewed periodically. The system combines the vegetation complexes mapped for the RFA into fauna habitats and correlates those habitats with the likely presence in them of particular vertebrate fauna species. It can then be used to predict the likely occurrence of sensitive species, relative to planned management activities.

During the term of the current FMP, a number of species have moved to a higher category of threat, for a range of reasons (see the *end-of-term audit of the current FMP*, Conservation Commission 2012). This is not attributed to the consequences of management activities, but rather, is a reflection of a range of pressures impacting biodiversity in the broader region. Activities to conserve biodiversity have been and will continue to be reconsidered and be implemented as new knowledge is acquired and resources permit. Strategies for the maintenance of biodiversity continue to evolve as knowledge increases. The continuation of research and other processes to increase the knowledge base is an essential part of management. For example, recovery plans can be revised as required to take into account changing circumstances, such as the expected impacts of climate change. Recovery plans are in place for black cockatoo species and include actions to remove feral honeybees from nesting hollows, managing nest hollows to increase recruitment of cockatoos, and identification and management of feeding and breeding habitat critical to survival of important populations.

In addition, in some land management units (LMUs) covered by the plan, as identified in Appendix 1, there are relatively fewer ‗legacy' habitat elements (such as tree hollows and fallen, hollow logs), and accordingly, in those areas, additional management emphasis is applied to ensure this habitat is protected, wherever practicable. This is proposed to include greater retention of habitat trees in these LMUs for those areas subject to timber harvesting through inclusion of this requirement in silviculture guidelines, and reviewing fire management guidance documents to reflect the importance of legacy elements in these areas (see below).

Managing key disturbance activities

Different types of disturbance activities have different impacts, and the scale and longevity of these vary. Key disturbances with potential impacts on biodiversity are mining activities, infrastructure development and maintenance, work carried out on boundaries of prescribed burns and bushfires, and timber harvesting. Each is discussed in turn below (and measures to minimise the risk of introduction and spread of weeds, pests and diseases from disturbance activities are covered in the ‗Ecosystem health and vitality' chapter). Human-induced disturbance is sometimes required for regeneration of various plant species, and in addition, the resulting heterogeneity can provide and/or enhance opportunities to conserve biodiversity, by creating and/or maintaining further diversity in habitat and food sources. Wherever possible, these activities should be guided by natural disturbance regimes.

Mining

Mineral and petroleum operations in the plan area provide significant economic and social benefits to the State. However, mining for bauxite, mineral sands and open-cut mining for gold and coal, involves significant modification of the environment, including clearing of all above-ground vegetation and transformation of the soil profile to remove ore. While most mined areas are rehabilitated with native species, there are enduring impacts on habitat and biodiversity, soils, water, carbon, production of wood and other forest produce, and recreation values. Exploration, extraction and rehabilitation activities are approved and largely governed by processes managed by other government agencies under legislation such as the EP Act, Mining Act and State Agreements (see the ‗Background' chapter). However, there is still considerable input required from the Conservation Commission and the Department in relation to processes associated with approvals, oversight of current operations, development of rehabilitation requirements and post-hand back management of rehabilitated sites (see ‗Developing self-sustaining ecosystems' in the ‗Ecosystem health and vitality' chapter).

Within the plan area, there are about 1.2 million hectares of State forest and timber reserves. Each year about 1,000 hectares (or 0.08 per cent) are subject to mining operations that include clearing, principally for extraction of bauxite (Darling Scarp north and east from Collie), coal (east of Collie) and gold (near Boddington). Of this total area of State forest and timber reserves, around 45 per cent is covered by State Agreements or approved mining leases (95 per cent of which is within the Alcoa and Worsley Alumina lease areas). This encompasses about 47 per cent of the total area of forests in the plan area. Analysis by the Department indicates a further 34 per cent of State forest and timber reserves is covered by pending mining leases and granted and pending exploration licences, inclusive of exploration licences issued to Bauxite Resources Limited. The Department estimates that the combined bauxite mining operations of Alcoa and Worsley Alumina, and potential Bauxite Resources operations, could potentially, in the long term, have a cumulative impact from direct clearing on about 83,000 hectares (about seven per cent of the State forest area), with a total of around 337,000 ha (or about 28 per cent) being subject to ‗various levels of fragmentation'.

Given the potential cumulative, long-term impacts from mining, this Draft plan includes a number of proposed mitigating activities (see the ‗Operations proposed to be undertaken (management activities)', later in this chapter).

Infrastructure development and maintenance

There is a considerable network of roads, tracks and railways (some no longer in use), communications, water, power, gas and other utility structures and corridors throughout the plan area. These service and support metropolitan and rural communities and a wide range of industries and forest users, provide access for people for tourism and recreation, and are critical for routine functioning of the economy. However, many of these corridors are cleared and further fragment areas of native vegetation and habitat, and provide opportunities for spread of invasive species and disease-causing agents. Management of weeds, pests and diseases is addressed in the ‗Ecosystem health and vitality' chapter. The other potential impacts are addressed in the ‗Operations proposed to be undertaken (management activities)', later in this chapter.

Prescribed burning and bushfires

Prescribed burning has a range of potential impacts, particularly for understorey vegetation and fauna habitats, which are assessed as part of the planning and post-burn monitoring process, as described in the ‗Ecosystem health and vitality' chapter. Departmental guidelines address a range of issues, including work associated with preparation of prescribed burn boundaries. Related to this is work associated with ‗mop-up' of bushfire containment lines. In both cases, trees and logs that may pose a hazard to the safety of fire crews or the public, or that may increase the risk of fire escape, are sometimes felled or pushed in from the perimeter. In some places, where practicable, additional measures may be appropriate to protect remaining legacy habitat elements, particularly where there is a relative shortage (such as in the areas referred to above).

Timber harvesting

Native forest timber harvesting involves varying degrees of removal of overstorey trees and disturbance of understorey by machinery, and it can have some impacts on soil and water values (see the ‗Soil and water' chapter). Within the plan area, harvesting is carefully planned to be dispersed in space and time across the available area, and may affect up to 0.7 per cent (under Scenario 2) or up to 1.1 per cent (under Scenario 1) per annum of forests on all lands vested in the Conservation Commission (also see the ‗Productive capacity' chapter). The type of impacts it has depends largely on the area cutover and the extent of overstorey removed, harvest interval (cutting cycle), the way in which the extraction tracks, landings and roads are set out and the type of vehicles used, and the nature of any follow-up treatments, including prescribed burning. Follow-up treatments are matched to the type and condition of the forest and are designed to ensure successful regeneration.

In addition to detailing the required follow-up treatments, silviculture guidelines include measures designed to minimise the potential impacts of timber harvesting on other values, which focus on maintaining stand complexity and structural diversity, and defining the type and extent of habitat elements and future ‗crop' trees that must be retained. Habitat requirements (such as nesting, roosting and foraging needs) for a range of fauna are considered in determining the criteria for selection and retention of habitat trees and coarse woody debris (for example, hollow logs) on the ground.

As required by the current FMP, an expert panel has completed a review of silvicultural practices (in 2011). The expert panel found:

> *In summary, the Panel identified a number of relatively minor issues of potential concern (see below) regarding biodiversity conservation and silvicultural prescriptions that require attention, but overall, existing and proposed practices should sustain biodiversity and forest productivity at the local forest scale.*

Proposed modifications to silvicultural practice in jarrah forest to enhance biodiversity outcomes include:

- retaining dead standing trees (particularly in the northern or eastern jarrah forest) and large logs on the forest floor
- retaining additional habitat logs where there is a moderate to high probability of numbat populations
- retaining large marri trees (see below for further detail)
- giving greater preference to retention of habitat trees with nests of threatened species (see below)
- retaining the mid-storey shrubs and small tree species in jarrah forest except where it is deemed essential for the establishment and survival of regeneration of overstorey tree species
- identifying and retaining dieback-resistant trees in areas of high disease impact and individual trees or groups of trees that exhibit resistance to disease or the effects of insect outbreaks
- using temporary exclusion areas in areas where harvesting and follow-up treatments achieve target stand density, in areas around mine site rehabilitation, in areas where there is intensive removal of non-sawlog material, in forest blocks isolated in an agricultural landscape and to provide linkage with mature forest in informal reserves
- varying rotation lengths and introducing variable density thinning into extensive areas of even-aged or relatively even-aged regrowth so as to increase structural diversity and ensure marri is retained in regrowth karri stands
- silvicultural burning to provide a mosaic of burnt and unburnt patches.

For karri forest, proposed modifications to silvicultural practice to enhance biodiversity outcomes include:

- retaining a selection of mature trees where they exist in stands to be thinned
- retaining a selection of senescent trees in stands to be clearfelled
- retaining dead standing trees in areas to be salvage harvested
- retaining some large diameter logs
- using temporary exclusion areas in forest blocks isolated in an agricultural landscape.

Consideration will also be given to recording the location of habitat trees and logs marked for retention, to aid their protection during subsequent operations. However, the feasibility of this requires evaluation.

Notably, the conservation status of some black cockatoo species has declined in recent decades and the end-of-term audit of performance report (Conservation Commission 2012) noted the need to reconsider conservation strategies for such species. Significant threats to cockatoo populations include illegal culling and competition for nest sites with native and introduced species, most notably feral bees. Silviculture guidelines will continue to require the retention of mature trees to maintain the availability of shelter and nest sites for hollow dependent fauna including black cockatoos. As black cockatoos have shown a preference for nesting in marri and marri represents an important food source for cockatoos, it is proposed that, where practicable, large senescing marri trees (greater than 70 centimetres in diameter with a senescent crown) be retained in the jarrah forest, in addition to the existing requirement for habitat tree retention. In areas of the jarrah forest where large marri are relatively low in abundance (Darkin Towering, Eastern Blackwood, Eastern Dissection, Eastern Murray, Monadnocks Uplands Valleys, North Eastern Dissection, Northern Sandy Depression, Northern Upper Plateau, North Western Dissection, North Western Jarrah, Redmond Siltstone Plain),

all marri 50 to 70 centimetre diameter with a healthy crown and all marri greater than 70 centimetre diameter, will be retained where practicable.

Silviculture is discussed further in the ‗Productive capacity' chapter, and links to the silviculture guidelines and report from the 2011 *Review of Silviculture in Forests of South-west Western Australia* (Burrows *et al.*) can be found there. Appendix 14 also provides information on the history of silvicultural practices in Western Australia's native forests, the current silvicultural practices and proposed changes.

In addition to the requirements set by the silviculture, soil and water protection and other relevant guidelines, further conditions can be set for individual harvesting operations through the Department's approval processes, to minimise potential impacts on any specific site-level values. This might include, for example, additional fox baiting to augment the Department's *Western Shield* program.

Long-term monitoring of the effects of timber harvesting on biodiversity, including that conducted through the Department's major monitoring program, *FORESTCHECK*, shows that its impacts are relatively transient. Comparison of biodiversity on sites where timber harvesting has occurred in the jarrah forest at a range of intensities, and at reference sites, shows that ‗*few significant impacts were evident, and most species groups were resilient to the disturbance imposed*'. *'For all species groups studied,*' (vascular flora, macrofungi, lichens bryophytes, macroinvertebrates, birds and terrestrial vertebrates) ‗*the imprint of harvesting 40 or more years earlier on species composition had become indistinguishable from that on grids never harvested*' (Abbott and Williams 2011).

The results from *FORESTCHECK* show that the biodiversity of the jarrah forest is resilient to disturbance from silvicultural operations, and indicate that provided a forest management regime is maintained that embeds silvicultural operations in a mosaic of connected areas where no harvesting occurs, and specific measures are applied for particular species, biodiversity will be maintained. Further comprehensive reading on this can be found in the *FORESTCHECK information sheet series*.

Timber harvesting from native forests on private property is subject to the Environmental Protection (Clearing of Native Vegetation) Regulations under the EP Act, and the Department administers the approvals process. Such activity is outside the scope of the plan.

Conservation of flora

The current FMP includes actions to protect significant flora species. The end-of-term audit (Conservation Commission 2012) found that not all of these actions had been fully implemented to date, and it is intended that these be implemented progressively as resources permit.

Fauna habitat zones

Fauna habitat zones (FHZs) were introduced in the current FMP as a mechanism at the landscape scale to provide a rotating source of fauna to recolonise disturbed areas as they regenerate or recover from timber harvesting (as explained in the current FMP, areas identified as fauna habitat zones can be rotated over time as alternative areas of regenerating forest are able to replace the purpose of established fauna habitat zones). Indicative zones of about 200 hectares size were located systematically across State forest and timber reserves, to provide a separation distance of about three kilometres between FHZs and areas of mature forest located within formal reserves. This design provided for 283 FHZs which, in aggregate, resulted in a net area of 52,042 hectares of State forest and timber reserves being set aside from timber production. Since 2004, subsequent boundary amendments and updates to the contributing datasets (such as various categories of informal reserves) mean that the current area set aside under the original design is 52,673 hectares.

During the term of the current FMP, the location of indicative FHZs has been progressively reviewed prior to disturbance operations in the vicinity, and to April 2012, a total of 102 have been finalised in accordance with *Guidelines for the Selection of Fauna Habitat Zones* (DEC 2010a) (see Table 4).

Table 4: Progress with finalising fauna habitat zones in State forest and timber reserves (see *April 2012 FHZ maps*)

Description	Original design (beginning of the current FMP)	Current design (to April 2012)		
		Finalised	Remaining (to be finalised)	Total
Number of indicative FHZs	283	102	181	283
*Average gross[1] area of FHZs (ha)	203	218	203	209
*Average net[2] area of FHZs (ha)	172	173	172	172
Total gross area of State forest included in FHZs (ha)	61,404	26,708	36,780	63,488
Total net area of State forest set included in FHZs (ha)	52,042[3]	21,534	31,139	52,673

Notes:

1. The gross area of the FHZs is the sum of the area of informal reserves and the area outside the informal reserves that would otherwise be available for disturbance activities including wood production, wildflower picking and firewood collection.
2. The net area of the FHZs is the area outside of informal reserves that would otherwise be available for a range of disturbance activities as listed above. The increase in the total net area since 2004 is due to updates since then to the informal reserves and other datasets.
3. These figures are calculated for the current FMP settings and guidelines, and therefore do no incorporate minor changes that would arise from the proposed reservation of additional portions of the Whicher Scarp forest ecosystem and possible changes to informal reserves.

* the average does not include the Kingston consolidated FHZ.

FHZs have been noted as an important element in the forest matrix that contributes to the maintenance of biodiversity values in these landscapes (see *Burrows et al. 2011*). Among other things, the location of each FHZ considers landscape connectivity, anticipated climate change consequences, and the degree of fragmentation that may result from known, foreseeable disturbances (see the *Guidelines for the Selection of Fauna Habitat Zones* (DEC 2010a)).

The overall number, size and location of FHZs has remained an issue with some stakeholders, with preferences ranging from a perceived need for fewer, larger zones in some regions to their abolition altogether. Knowledge gained through the finalisation of FHZs to date, review of *FORESTCHECK* results, and the evolving nature of landscape fragmentation associated with mining and timber harvesting in some landscapes, suggests that some modification of settings could be explored.

Management options for fauna habitat zones

Management options to vary FHZs range from retaining the existing settings of number, spacing and size in the current FMP, through to redistributing (or removing) the FHZs by amending their size and location.

This Draft plan presents two management options for comment (from a spectrum of possibilities):

Management option 1 is no change – that is, to carry forward the existing settings for FHZs into the new plan (i.e. 283 zones now equivalent to 52,673 hectares).

Management option 2 is to refine the network of FHZs – using landscape connectivity considerations, together with knowledge of fauna hotspots, forest condition, and the likely extent of ongoing fragmentation from mining in some landscapes. It comprises the following refinement of FHZ settings:

- retain all FHZs finalised to April 2012
- maintain the number and systematic location of FHZs, but reduce their average gross size from 200 hectares to 100 hectares each, except in the area to the east of Manjimup and north of Muir Highway which is an important area for some threatened fauna species, where FHZs will be maintained at an average gross size of 200 hectares
- consolidate a gross area of 6,743 hectares of FHZs into Batalling forest block (a recognised fauna hotspot), portions of Topanup forest block (consolidate a poorly represented vegetation complex) and portions of Molloy and Rapids forest blocks adjacent to the upper reaches of the Margaret River (areas of highly prospective habitat for threatened fauna, including invertebrates and quokka)
- set aside from harvesting some smaller isolated areas of mature forest located among predominantly regrowth forests in the Warren region.

Management option 2 would result in 285 zones, comprising an equivalent net area of 44,244 hectares of State forest and timber reserves (see *option 2 FHZ maps*). If this management option is adopted, the *Guidelines for selection of fauna habitat zones* will be reviewed by the Department, in consultation with the Conservation Commission, to be consistent with the settings included in the next FMP.

Potential impacts on productive capacity

The potential impact of these proposals and management options – for possible changes to both the formal and informal reserve system, and to fauna habitat zones – on the productive capacity of the forest (sustained timber yield), is identified in the ‗Productive capacity' chapter (see Table 7).

Goals

The plan seeks to conserve biodiversity and self-sustaining populations of native species and communities, and seeks to allow for the recovery of biodiversity from disturbance operations. This overarching goal is supported by a number of subsidiary goals for which the plan proposes a range of corresponding activities, as set out under ‗Operations proposed to be undertaken (management activities)', below.

Identified values and threats[6]

The plan seeks to protect and maintain the following values:

- threatened species and ecological communities and the habitats on which they depend
- natural biodiversity and ecological integrity
- ecosystem services, structure and function.

Threats to these values include:

- further degradation, fragmentation and loss of habitat connectivity

[6] Note there are other values and threats that are relevant and these are dealt with in other chapters.

- disturbance activities including mineral extraction, inappropriate fire regimes, construction or maintenance of facilities and infrastructure, timber harvesting, inappropriate recreation use, and uncontrolled vehicular access
- climate change
- inadequate procedures or ineffective operational application of current procedures.

(note fire, pests, weeds and diseases are addressed in the ‗Ecosystem health and vitality' chapter).

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to:

Policy Statement 3: *Management of Phytophthora and disease caused by it*

Policy Statement 9: *Conservation of threatened flora in the wild*

Policy Statement 13: *Commercial flora harvesting*

Policy Statement 19: *Fire management*

Policy Statement 27: *CALM's role in the management of native vegetation in rural areas*

Policy Statement 29: *Translocation of threatened flora and fauna*

Policy Statement 31: *Management of reserves for the conservation of nature*

Policy Statement 33: *Conservation of endangered and specially protected fauna in the wild*

Policy Statement 44: *Wildlife management programs*

Policy Statement 50: *Setting priorities for the conservation of Western Australia's threatened flora and fauna*

Policy Statement 62: *Identification and management of wilderness and surrounding areas*

Code of Practice for Fire Management

Guidelines for Management of Phytophthora cinnamomi *and disease caused by it – Vol. 1*

Silvicultural Practice in the Jarrah Forest

Silvicultural Practice in Wandoo Forest and Woodland

Silvicultural Practice in the Karri Forest

Guidelines for Protection of the Values of Informal Reserves and Fauna Habitat Zones

Guidelines for the Selection of Fauna Habitat Zones

Management of Commercial Harvesting of Protected Flora in Western Australia 2008– 2013

Guidelines for Conservation Management Plans Relating to Mineral Exploration on Lands Managed by DEC

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

CAR formal reserve system

The plan proposes the following actions at the whole of forest scale for the purpose of seeking to conserve biodiversity and ecological integrity in all native forest ecosystems through the establishment and management of a system of reserves that is comprehensive, adequate and representative:

1 The Department will initiate the processes required for the land category changes proposed by this Draft plan by:

1.1 undertaking fine scale reserve design for the formal reserves proposed in this Draft plan

1.2 consulting with the Conservation Commission and then advising the Minister for Environment on final reserve boundaries.

Minor amendments to the boundaries of reserves shown on Map 3 and Map 4 may result from the fine scale reserve design and consultation processes required to establish these reserves.

2 The Department will manage the areas vested in the Conservation Commission and proposed by Appendix 5 for inclusion in a national park, nature reserve or conservation park consistent with their proposed land category and purpose and relevant Department policies until such time as they are formally created.

3 The Department will cooperate with relevant agencies in relation to the establishment of a comprehensive, adequate and representative reserve system outside the RFA area, through *Bush Forever* and other relevant programs.

Forest conservation areas and informal reserves
The plan proposes the following activities at the whole of forest scale for the purpose of seeking to complement the function of the formal reserve system in the conservation of biodiversity:

4 The Department will manage the areas vested in the Conservation Commission and proposed by Appendix 5 to be classified as forest conservation areas consistent with their proposed classification and purpose and relevant Department policies until such time as they are formally classified. Timber production in these areas will not be permitted, but other productive activities, such as firewood collection, may be allowed, on an area by area basis, unless an area management plan expressly precludes it.

The plan will establish informal reserves referred to in Appendix 12 and proposes the following activities at the local scale for the purpose of seeking to conserve biodiversity outside of formal reserves and forest conservation areas:

5 The Department, FPC and other proponents where required by the Department, will conduct their operations within the informal reserve types shown in Appendix 12, in accordance with the Department's *Guidelines for the Protection of Values of Informal Reserves and Fauna Habitat Zones*.

6 The Department will:

6.1 publish a map each year on its website depicting the extent and status of old-growth forest, that identifies and explains any changes arising during the previous year

6.2 review planning processes for disturbance processes on all land categories to ensure a uniform approach for assessment of old-growth forest status, consistent with that used in areas subject to proposed timber harvesting.

Integrating biodiversity management across the plan area
The plan proposes the following activities at the whole of forest, landscape and/or local scales, for the purpose of promoting resilient ecosystems, including by seeking to:

- maintain the net area and connectivity of native vegetation and reduce the impact of mineral and petroleum operations, State development and infrastructure projects on biodiversity and land to which the plan applies
- maintain habitat elements and vegetation diversity across spatial and temporal scales

- protect, and assist the recovery of, threatened and priority species of flora and fauna and ecological communities.

7 The Conservation Commission and the Department will make submissions in relation to development proposals (including, but not limited to, proposals for infrastructure development, extraction of minerals and petroleum resources, development of geothermal energy and, the geological storage of greenhouse gases) forwarded to them for comment or advice, with a view to:

7.1 seeking to minimise the permanent loss of native vegetation and/or impacts on its integrity as a result of development

7.2 seeking the replacement of native ecosystems permanently lost to development, in line with the 2011 *WA Environmental Offsets Policy*

7.3 promoting the construction of infrastructure such as roads, pipelines and other utilities at common locations, such as infrastructure corridors, while minimising construction in sensitive areas.

8 The Conservation Commission and the Department will:

8.1 liaise with the Departments of Mines and Petroleum and State Development and relevant mining, petroleum and other companies in relation to land management and encourage them to act in a manner that is consistent with the plan

8.2 seek to minimise the impact of mining and petroleum operations on important areas, such as key habitat for threatened species, and those with a high productive capacity for timber production, and key recreation sites

8.3 provide advice and, where appropriate, assistance to industry and government agencies in relation to the effects of mining and petroleum operations on native ecosystems, the means by which those effects may be reduced (including through retention of ecological linkages between unmined areas throughout mine envelopes, to link with adjacent native vegetation areas outside mine envelopes) and the appropriate rehabilitation of native vegetation as those operations are completed

8.4 explore with the relevant agency mechanisms to recover the costs of providing that advice and assistance, other costs incurred as a result of proponents' operations, and any additional costs that may be associated with post hand-back management.

9 The Department will maintain a list identifying threatened and priority species of flora and fauna, and threatened and priority ecological communities.

10 The Department will where practicable, develop, review and implement recovery plans for selected threatened species and ecological communities.

11 The Department, FPC and other proponents where required by the Department, will undertake prescribed burning and timber harvesting having regard to the Fauna Distribution Information System.

12 **(Plantations):** The FPC will advise the Department of its planned harvesting and management activities within plantations, and where those activities may impact on threatened species and threatened or priority ecological communities, the Department will establish the conditions for access (also see activity 66 in the _Productive capacity' chapter).

13 The Department will:

13.1 seek to maintain a broad range of forest ages, structures and compositional diversity at the landscape scale to provide resilience, flexibility to respond through adaptive management and a basis for the expression of variable and relative impacts of climate-related changes

13.2 conduct its operations having regard to *Goals for Understorey Structural Diversity*, which are to be prepared by the Department in consultation with the Conservation Commission

13.3 as required, identify and, following consultation with the Conservation Commission, implement at relevant scales, management strategies that are designed to promote the adaptation of forest ecosystems, processes and individual biota to climate-related changes, consistent with biodiversity conservation and the maintenance of other forest values

13.4 review the conservation reserve system, as necessary, to ensure ongoing comprehensiveness, adequacy and representativeness, depending on the extent of any further significant changes to, or fragmentation of, forest ecosystems.

14 The Department, FPC and other proponents where required by the Department, will:

14.1 revise standards for the protection of key habitat requirements for listed threatened species in relevant codes of practice and other guidelines

14.2 apply agency procedures so that the presence and type of biodiversity values is appropriately recorded, accessible to staff and considered prior to operations taking place

14.3 apply procedures and set appropriate conditions to ensure that biodiversity values are effectively protected during permitted disturbance activities

14.4 promote awareness and understanding of the importance of protection and appreciation of the value of biodiversity amongst staff, proponents, operators and visitors.

15 The Department will revise relevant documents pertaining to fire management to seek to ensure that where practicable, its prescribed burning and bushfire operations consider appropriate measures to minimise loss of legacy habitat elements.

16 The Department will:

16.1 finalise the location of fauna habitat zones according to the *Guidelines for Selection of Fauna Habitat Zones*

16.2 publish a map each year on its website depicting the status of all fauna habitat zones, which identifies and explains any changes arising during the previous year.

17 The Department, and other proponents where required by the Department, will conduct their operations in indicative fauna habitat zones, and in fauna habitat zones, in accordance with the *Guidelines for Protection of the Values of Informal Reserves and Fauna Habitat Zones*.

Increasing knowledge

The plan proposes the following activities at the whole of forest scale for the purpose of seeking to develop an improved understanding of the biodiversity of forest regions and the response of forest ecosystems to natural and human induced disturbance, with a view to improving forest management practices:

18 The Department will undertake biological surveys, which will be:

18.1 of priority areas

18.2 used, where appropriate, to assist in evaluating the extent to which biodiversity is being conserved and the need for any review of the reserve system.

19 The Department will seek to:

19.1 maintain the species, community and process monitoring program, *FORESTCHECK*, and seek to extend it

19.2 maintain a research program on ESFM.

Key performance indicators

Key performance indicators will be used to track the implementation of the next FMP. Three indicators have been selected to provide a broad cross-section of achievement of the activities related to conserving biodiversity.

Key performance indicator 1	The status of (critically endangered, endangered and vulnerable) forest-dwelling species and ecological communities as determined by listing.
Performance measure	Lists of species and ecological communities and their status that tracks movement of species between threat categories.
Performance target(s)	No species or ecological community will move to a higher category of threat as a result of management activities.

Key performance indicator 2	The representation of forest ecosystems in formal reserves.
Performance measure	Area of each forest ecosystem by land category (existing and proposed separately).
Performance target(s)	The Department and the Conservation Commission to complete all actions for which they are responsible in order to formally change the land category of areas proposed for the reserve system within 10 years after the commencement of the plan.

Key performance indicator 3	The conservation of selected biodiversity groups in areas subject to timber harvesting.
Performance measure	Species richness and abundance of selected biodiversity groups.
Performance target(s)	Species richness and abundance of selected biodiversity groups in the matrix within which timber harvesting is undertaken not to be negatively impacted by management activities.

Ecosystem health and vitality

Background

A healthy ecosystem is a more resilient[7] and productive one, and resilience of natural areas and ecosystems is related to their ‗naturalness', which stems from their biological and structural diversity, size, connectivity and the nature of disturbances within and around them. Maintaining biodiversity promotes resilience to various environmental pressures and further statements to address this are included in the preceding ‗Biological diversity' chapter. Maintenance of ecosystem health and vitality has become increasingly complex given the combined influences of climate change, the global mobility of people, plants, animals and materials, and the demands placed on natural areas by a growing local population and other visitors. Management approaches and responses are knowledge, funding and resource dependent.

For example, within the plan area, an extensive network of electricity, water, transport, communication and other infrastructure corridors traverse the forest to support communities, mining activity, timber harvesting, recreation and water supply, with resultant consequences for habitat connectivity and the potential for introducing and spreading pests, weeds and diseases. Intensive landscape modification results from mining operations for bauxite and other minerals, leading to further impacts on connectivity of remaining forests and other native vegetation. Resulting rehabilitation is structurally less complex than unmined forest. Accordingly, there is inter-connectedness with other sections of this plan addressing other ESFM criteria, and hence, the requirements of the plan and the provisions of key subsidiary documents need to be considered in their entirety.

Issues that can affect ecosystem health and vitality can be divided broadly into abiotic factors (such as bushfires, storms and climate change), biotic factors (such as weeds, pests and disease-causing pathogens) and anthropogenic factors (disturbance such as prescribed fire, timber harvesting, and land clearing for mining and infrastructure projects). It is important to note that impacts from these factors can be cumulative and/or may interact in ways that are not always well understood. For example, a combination of more frequent hot days and severe drought stress may cause higher rates of mortality and/or facilitate insect attack on jarrah, and conversely, may disfavour *Phytophthora* introduction and/or spread of dieback disease (see the ‗Climate change and carbon cycles' chapter for further discussion relating to climate change and its possible impacts). The scale of impact can range from small, periodic events (for example, isolated tree falls and mortality; infrequent tornadoes) to broader-scale events that may have longer-term impacts (for example, insect infestations; large, high intensity bushfire). Some of these events can assist the recovery and maintenance of ecosystems, while others can have adverse impacts and impede recovery. Others may induce enduring changes (for example, infection by *Phytophthora cinnamomi*, persistent drought) that may not become fully evident for some time and which are difficult, if not impossible, to reverse. For example, the reduction in rainfall across the south-west over recent decades presents particular issues for water values, which is covered in the ‗Soil and water' chapter.

The Department has certain statutory obligations under the BAM Act concerning biosecurity matters generally, and particularly with respect to the management of pathogens that cause forest diseases, through the CALM Act. However, organisms and natural processes transcend land tenure boundaries

[7] *Resilience* is the capacity of an ecosystem to withstand external pressures and, over time, return to its prior condition, including its ability to maintain its essential characteristics such as taxonomic composition, structural forms, ecosystem functions and processes. *Resistance* is the capacity of the ecosystem to absorb disturbances and remain largely unchanged. (adapted from Thompson *et al.* 2009, who cite Holling 1973).

and ultimately, success is more likely where there is a holistic and coordinated approach by all land managers, including government agencies, local governments, private landholders, and all land users, including the mining and timber industries and the broader community who use and visit the forest.

In addition to coordinated action, a successful management strategy must include the elements of forecasting, planning, implementing and monitoring of mitigating strategies. The creation of new knowledge to inform adaptive management and its incorporation into controls through continuous improvement must be supported by targeted research, knowledge sharing and capacity building. New technology can also assist – such as the use of remote sensing, combined with ground-truthing, to monitor the condition of native vegetation and the health of tree canopies and potentially, regeneration, over broad areas. A flexible approach to management is important – in order to be able to respond to any new threats and outbreaks in the most appropriate and timely way. It is also important to recognise that available funds and resources are limited, and that weeds, pests and diseases are spread in ways over which land managers may have limited control – for example, by wind and animals.

Given limited funds and resources, there is a need to prioritise research and management efforts. For example, in 2008 the Department's approach to weed management was reorganised through its *Invasive Plant Prioritisation Process*. The aims of this were to refocus and better integrate efforts within the agency and with its partners, by establishing an approach with both 'species-led' and 'asset-based protection' components. The 'species-led' approach focuses on infestations of weeds which are considered to be high impact, rapidly invasive and still at a population size that might be possible to eradicate, or feasible to contain to a defined control area. The 'asset-based protection' approach focuses on identifying high-value biodiversity assets, the particular weeds that pose a threat to these assets and the sites where control will most likely have the greatest benefit. These two processes can be used to inform regional priorities and hence target the allocation of resources and funds for the best return on investment and improved outcomes in the long term. Similar principles underpin a contemporary approach to managing other pest and diseases.

The end-of-term audit of the current FMP (Conservation Commission 2012) noted the potential for increased impacts from weeds, pests and disease associated with climate change. As healthy ecosystems are more resilient to climate change, it will become increasingly important to manage the effects of pests, weeds and disease through the refocused approach outlined in this Draft plan and described in the sections below.

Goal

An overall goal of the plan is to seek to maintain ecosystem health and vitality.

Identified values and threats[8]

Values and threats relevant to fire are identified in the following section.

In other sections of this chapter, the plan seeks to protect and maintain the following values:

- 'naturalness' of areas
- ecosystem functions and processes.

Threats to these values include**:**

- uncontrolled weeds, pests and diseases
- rehabilitation that is not self-sustaining.

[8] Note there are other values and threats that are relevant and these are dealt with in other chapters.

Fire

Background

Fire is a naturally occurring disturbance in the forest ecosystems of the south-west. Fire regimes that are sympathetic to the ecological requirements of these ecosystems are essential for their effective functioning. For example, fire can assist in the regeneration of native vegetation and promote the germination of seed, the maintenance or modification of habitats, and release and cycling of nutrients required for plant growth. Fire has a role in a range of other ecosystem processes, including hydrology, and can in some cases be used to manage certain weeds, pests and diseases. Fire regimes that are characterised by an appropriate range and diversity of fire intensities, seasonality, frequency (return intervals) and spatial heterogeneity will facilitate biodiversity and therefore promote ecosystem health and vitality, thereby providing greater resilience to climate change. Fire regimes must also accommodate requirements for bushfire risk mitigation and facilitate the provision of water and forest products, such as wood. Through research, training, careful planning and judicious implementation, it is possible to achieve biodiversity conservation, mitigate bushfire risk, and accommodate various other forest values and uses.

In most vegetated ecosystems, and particularly in Western Australia's fire-prone south-west, it is difficult to prevent fire for long periods over large areas. Attempts to exclude fire over large areas can result in the gradual build-up of a flammable layer of litter, twigs, bark and understorey vegetation, leading to high fuel loads. This will increase the probability of large-scale, high-intensity bushfires, which are costly and dangerous to suppress, pose a great risk to life and property and which may result in significant loss of economic and biological assets. Landscape-scale analysis of fire history in the south-west shows that the extent of planned fire has a strong inverse relationship to the extent of bushfire (for example, see Boer *et al*. 2009), and a separate landscape-scale study of fire regimes over 40 years shows that the biota of south-west forest and shrubland ecosystems is resilient to a wide range of fire frequency (Wittkuhn *et al*. 2011). However, longer fire return intervals may be required in some situations for certain plants and animals with specific fire regime requirements. The EPA (2012) shares the view of the Conservation Commission that further studies into the ecological effects of fire should be undertaken.

The Department's fire management approach is underpinned by legislation and guided by Policy Statement No. 19: *Fire management* and the associated *Code of Practice for Fire Management*. Sections 33(1)(a) and 33(3) of the CALM Act provide for the Department to manage lands to which the Act applies, according to management plans or, in the absence of a management plan, in accordance with the necessary or compatible operations provisions of the Act, depending on the land tenure category. Fire management activities are subject to these provisions. The WC Act and the Commonwealth EPBC Act provide special protection to threatened species. The latter Act includes provisions relating to recognised threatened ecological communities. These Acts impose an obligation to conduct fire management activities accordingly.

The Department has responsibilities to prepare for and respond to bushfires under the Bush Fires Act and CALM Act. Also, under common law, and as an 'occupier' of land, the Department needs to take 'all reasonable care to eliminate or minimise foreseeable risks of harm', which includes bushfires and the risks these pose to people who use and visit land managed by the Department, and its neighbours. Additionally, the Emergency Management Act sets out the emergency management arrangements for the State, requiring that a number of emergency response plans be maintained. The response plan for bushfire is *Westplan Bushfire*, which sets out the Department's role and obligations as a 'Controlling Agency', along with that of other relevant agencies, in contributing to bushfire suppression planning and response operations. The Department also has been allocated the role of managing fire prevention and preparedness on non-metropolitan, non-townsite 'unallocated Crown land' and 'unmanaged reserves'. However, the responsibility for fire suppression on these lands lies with local government.

One of the most effective tools available to achieve land management outcomes, including biodiversity conservation and bushfire risk mitigation, is the application of fire under prescribed conditions. For example, prescribed fire is used to:

i) conserve biodiversity by providing a spatial and temporal diversity in vegetation structure and therefore habitat opportunities

ii) promote ecosystem resilience to perturbation such as climate change and bushfire by providing a spatial and temporal diversity of vegetation structure, and therefore habitat opportunities

iii) maintain forest productivity associated with silviculture operations and the provision of potable water from drinking water catchments

iv) mitigate the risk of damage to life and property from bushfires by managing the quantity and spatial distribution of fuel loads across the land it manages.

Typically, prescribed fire will be applied to land to which the plan applies for purposes including:

- biodiversity conservation (on all land categories)
- life and asset protection (on all land categories)
- silvicultural management (on State forest and timber reserve land categories only).

In many cases a single application of fire will be for more than one of the above purposes.

The Department has a well established framework and process for planning, implementing and reviewing its prescribed burning program. This ‗fire management plan' approach considers biogeography, land use, community protection and other factors, such as the available workforce, plant and equipment, and establishes management objectives, burn strategies and success criteria. When fully implemented, it is intended to operate at five levels, as follows:

i) Preparation of ‗Regional Fire Management Plans' that consider these matters, covering a five-year period, which are updated as required (for example, to accommodate new knowledge from research, experience and adaptive management processes).

ii) The ‗Master Burn Planning process' that transforms the settings from the ‗Regional Fire Management Plan' into a three-year (six season) indicative plan and an annual (two season) prescribed burn program. The ‗Master Burn Planning' process incorporates a twice-annual cycle of planning and review meetings, considering a range of conservation and land management expertise and scientific, spatial and other inputs, together with processes for establishing priorities, resolving issues and engaging with the community.

iii) The ‗Three-year (six season) indicative burn plan', which utilises GIS technology in an interactive environment to develop ‗best fit' options for achieving biodiversity outcomes, and any burning that is required to achieve particular land management objectives, such as those for silviculture and catchment protection. This potential prescribed burn program is then assessed for its effectiveness in mitigating bushfire risk. If necessary, modifications are made to ensure that strategic protection outcomes are satisfied. The three-year (six season) indicative burn planning horizon allows sufficient time for public consultation, and to put in place any arrangements and/or undertake preparation operations which take some time to plan and implement, prior to burning commencing.

iv) The ‗Annual burn program' that is derived from the first two seasons of the three-year (six season) indicative burn plan, and which constitutes the planned works program for the year. It is also the basis for burn program approval for the forthcoming season (autumn or spring) and the preparation of ‗Prescribed Fire Plans'. Three-year (six season) indicative burn plans, together

with forthcoming season burn programs for each region, are integrated into a statewide program, which is submitted to the Department's Corporate Executive group twice each year for approval. The Office of Bushfire Risk Management attached to the Fire and Emergency Services Authority now has oversight of the process.

v) ‗Prescribed Fire Plans', which are then developed for each planned burn. These include key requirements such as fire and land management objectives, fuel assessments, acceptable weather and fuel moisture conditions for ignition, and pre-burn checklists. ‗Prescribed Fire Plans' identify remaining activities required to prepare the burn area and address any related environmental issues (such as boundary track maintenance and burn security treatments, such as boundary fuel modification and dangerous tree treatment, and dieback hygiene). They also identify any particular values that need special consideration, including granite outcrops, wetlands and organic-rich soils (for example, peat swamps), and recreation sites. Adjoining land uses, neighbours and values at risk beyond the burn are also identified for any required management action. Each burn is then scheduled, approved and implemented as suitable weather and fuel moisture conditions occur for safe and effective burning. Models are used to predict smoke plume trajectories from burns to assess potential community impacts, and inform decisions on timing of burn ignitions. Post-burn assessments are subsequently carried out against the success criteria established in each ‗Prescribed Fire Plan' and reports are prepared at a regional and state level after each season.

Appendix 1 provides some indication of particular current emphases for fire management across the plan area – however, as indicated above, values, threats and objectives vary and are specific to each ‗Prescribed Fire Plan'.

The frequency distribution of fuel age (i.e. time since fire, which is also a proxy for fuel load) gives a broad indication of the diversity of fuel ages and in turn, the structural diversity of understorey and thus, habitat diversity. The target distribution is a theoretical negative exponential function that is based on inputs relating to the life history attributes and ecological requirements of native vegetation (McArthy *et al.* 2001). The degree to which the fuel age distribution conforms to the theoretical negative exponential curve gives an indication as to how well the Department's fire management program is achieving biodiversity goals of the plan. This was identified in the end-of-term audit of the current FMP (Conservation Commission 2012) and the Department will continue to endeavour to achieve the target distribution during the life of this plan. However, variations are inevitable due to the random occurrence of bushfire and/or arise from the need to manage fuels to mitigate the risk of bushfire to protect communities and high value community assets. The Department will also continue to improve the data on which fuel age distribution is based. Further review and analysis of key performance indicators will occur in the period between this Draft plan and the final plan and will include consideration of more direct monitoring of biodiversity outcomes.

Additional information is available on the Department's *approach to planning for prescribed burning* in supplementary reading.

To maintain its prescribed fire program and an effective fire suppression capability, the Department invests in and maintains a network of access roads, bridges, culverts, firebreaks and water points, along with plant, vehicles, specialised equipment, information management systems, and staff training and development programs. The Department deploys resources used for its prescribed fire operations to provide its bushfire suppression capability, which it augments as necessary through seasonal contracting arrangements. It maintains a fire detection and surveillance network of fire towers and spotter aircraft, and in collaboration with the Fire and Emergency Services Authority, a number of specialised aerial suppression aircraft and crews are hired each summer. Also in collaboration with the Fire and Emergency Services Authority and local governments, the Department maintains an organisational structure capable of mobilising an effective response to manage bushfire incidents.

In determining its approach to suppressing bushfires, the Department considers environmentally sensitive areas and may modify its approach accordingly, where practicable. A range of fire operations guidelines exists to assist decision-makers and the incident management structure is modified, as required, to include a group that provides specialist advice regarding the conduct of both suppression and post-fire rehabilitation operations.

Goal

The plan proposes the following activities at the whole of forest, landscape and/or local scales, for the purpose of seeking to use and respond to fire in a manner that promotes the maintenance of ecosystem health and vitality, the conservation of biodiversity, and mitigates the risk of adverse impacts of bushfire.

Identified values and threats

The plan seeks to protect and maintain the following values:

- ecosystem health and vitality, through maintaining biodiversity, including structural complexity and heterogeneity
- places and objects of spiritual and cultural significance to Aboriginal people
- life and property, including community and neighbour assets, which includes built infrastructure, and native and plantation timber resources
- places of historic and cultural significance to non-indigenous people
- soil, water, wood and carbon.

Threats to these values include**:**

- fire regimes inappropriate for the maintenance of ecosystem health and vitality, and biodiversity
- areas with high fuel loads that present a high risk to life, biodiversity, property, heritage and other values in the event of a bushfire.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to:

Policy Statement 19: *Fire management*

Policy Statement 65: *Good neighbour policy*

Code of Practice for Fire Management

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

20 The Department will:

20.1 maintain a competent capability in fire management, prescribed fire, bushfire risk mitigation, detection and suppression

20.2 seek to maintain a fire science capability and work collaboratively with other agencies and institutions on matters of mutual interest

20.3 consult with stakeholders and interested community members on the planning and implementation of prescribed burning and other fire management programs to:

- develop community understanding of, support for and collaboration in, fire management
- enable constructive discussions and deliberations on fire management approaches

20.4 undertake an annual prescribed burning program in a manner that:

- seeks to address the risk presented by bushfire to the ecological, social, cultural and economic values occurring on lands managed by the Department, and the risk presented by bushfire emanating from land it manages moving into surrounding land
- considers any specific ecological, silvicultural, social, cultural and other identified management objectives in areas subject to planned burning
- seeks to minimise emissions of greenhouse gases while achieving fuel reduction objectives so as to avoid major emissions arising from periodic catastrophic bushfires
- maintains or enhances the conservation of biodiversity by maintaining or enhancing the diversity of understorey vegetation structure and composition that facilitates a diversity of habitat opportunities
- creates and utilises new knowledge in an adaptive management framework
- is assessed against stated objectives for the program and stated objective(s) and success criteria for individual burns

20.5 undertake bushfire suppression and recovery operations in a manner that has regard to fire operations guidelines, that are periodically revised

20.6 ensure staff and contractors are competent to assist with management of environmental issues associated with bushfire suppression and recovery operations, including through training programs, where appropriate.

21 The FPC will:

21.1 collaborate with the Department in determining appropriate risk mitigation strategies to be applied to land managed by the Department, and in particular, the State's native and plantation timber resources

21.2 as agreed between the agencies, provide to the Department funding to enable the Department to control the risk to acceptable levels, so far as is reasonable and practicable.

Key performance indicators

Key performance indicators will be used to track the implementation of the next FMP. Two indicators have been selected related to fire management.

Key performance indicator 4	The risk to ecosystem health and vitality and biodiversity posed by bushfire and planned fire management.
Performance measure	The area of forest by fuel age classification.
Performance target(s)	General conformance with the theoretical distribution of time since fire for the whole of forest and major LMUs.

Key performance indicator 5	The effectiveness of fire planning and management in meeting objectives for prescribed burning.
Performance measure	The percentage of completed prescribed burns that meet their stated objectives.
Performance target(s)	90 per cent.

Weeds

Background

The management and control of weeds in Western Australia is guided by the BAM Act and the Agriculture and Related Resources Protection Act, which is administered by the Department of Agriculture and Food (and note the BAM Act will replace the Agriculture and Related Resources Protection Act and some other Acts in the near future).

In addition to those declared noxious, there are certain weeds which may have little impact on agricultural production, or may be relatively easily controlled in those situations, but which may present major threats to ecosystem health and vitality, and the Department seeks to identify, monitor and manage these species where possible. Many of these environmental weeds are successfully invading natural areas, where they can modify natural processes. Many of these weeds are adversely impacting biological diversity and ecosystem health and vitality at genetic, species and community levels. Competition from weeds is a threatening process affecting many threatened flora and ecological communities, particularly those restricted to small, disturbed areas highly vulnerable to invasion. The Department considers various factors in determining its weed management priorities, including its legislative obligations (for further information see the Department's *Invasive Plant Prioritisation Process*).

Goals

The plan proposes the following activities at the whole of forest, landscape and/or local scales, for the purpose of seeking, as far as is reasonable and practicable, to:

- minimise the impact of weeds on ecosystem health and vitality, including plantations
- minimise the risk of introduction or naturalisation of weeds and protect those areas currently free of infestation.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to:

Policy Statement 14: *Weeds on CALM lands*

Policy Statement 45: *Environmental monitoring of pesticides used by CALM*

Policy Statement 65: *Good neighbour policy*

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

22 The Department, and other proponents where required by the Department, will:

22.1 maintain surveillance and recording systems for weeds that are known to have a significant impact on ecosystem health and vitality

22.2 work collaboratively with other agencies and land managers, as appropriate, to identify priority weeds using risk-based procedures for determining their relative importance

22.3 work collaboratively with other agencies and land managers, as appropriate, to prepare incursion management plans for priority weeds which are not yet present

22.4 use planning procedures and operational controls to identify the relative importance of areas for protection, and to minimise the risk of spread and impacts from priority weeds already present

22.5 where reasonable and practicable, implement control programs for priority weeds, and encourage the coordinated involvement of Government, industry, the community and other land managers in addressing these, including through facilitating knowledge transfer, awareness raising and capacity building.

23 The Department will seek to maintain a weed science capability and work collaboratively with other agencies and institutions on matters of mutual interest.

24 **(Plantations):** The FPC will:

24.1 maintain surveillance and recording systems for priority weeds, compatible with those of the Department

24.2 use planning procedures and operational controls to minimise the risk of introduction, spread and impacts from priority weeds, and where reasonable and practicable, implement control programs for priority weeds

24.3 take appropriate steps to control the spread of plantation species beyond plantation boundaries into adjacent native vegetation

24.4 take appropriate steps to ensure that the seedlings it obtains from its own and other nurseries are free from weeds that could be transported into the forest with planting stock.

Pests

Background

Certain animal and invertebrate species can become pests and present major threats to ecosystem health and vitality, biological diversity or productive capacity. These pest species are often exotic species (such as foxes, cats, pigs, starlings, cane toads, *Sirex* wood wasp, European house borer), but may also be introduced native Australian animals (such as kookaburras, rainbow lorikeets or corellas) or endemic species that can have an undesirable impact on the ecosystem or particular forest values (for example, locusts, gum leaf skeletoniser, leaf miner and grazing marsupials). Each of these types of pest species needs to be considered separately and the management and control activities varied to address the extent and severity of the impact.

Western Shield is the biggest wildlife conservation program ever undertaken in Australia, focused on introduced predators impacting ‗critical weight range' native fauna, with most emphasis being on the fox, and increasingly, cats. While it is undertaken across lands covered by the plan, it is a statewide project. The main tool in the program is the use of baits containing the naturally occurring poison 1080, found in native plants called *Gastrolobiums* or ‗poison peas'. While native animals have evolved with these plants and have a high tolerance to the poison, introduced animals do not. *Western Shield* makes use of this natural advantage.

Sometimes, populations of native fauna, plants and plantation trees may display resistance to pests (and diseases). Where identified and practicable, various measures are used in an effort to protect these resistant individuals and populations from disturbance, and they may be used as breeding stock for re-population of affected areas. For example, the *proposed revised silviculture guideline for jarrah* will require greater protection, during timber harvesting operations, of trees or groups of trees that exhibit resistance to pests (or disease). Where required, planning procedures for other disturbance operations will be reviewed to address this issue (for example, see activity 25.5 below).

Goals

The plan proposes the following activities at the whole of forest, landscape and/or local scales, for the purpose of seeking, as far as is reasonable and practicable, to:

- minimise the impact of pests on ecosystem health and vitality, including plantations
- minimise the risk of introduction or naturalisation of exotic pest species and protect those areas currently free of infestation.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to:

Policy Statement 45: *Environmental monitoring of pesticides used by CALM*

Policy Statement 47: *Control of Sirex wood wasp in plantations*

Policy Statement 65: *Good neighbour policy*

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

25 The Department, and other proponents where required by the Department, will:

25.1 maintain surveillance and recording systems for pests that are known to have a significant impact on ecosystem health and vitality

25.2 work collaboratively with other agencies and land managers, as appropriate, to identify priority pests using risk-based procedures for determining their relative importance

25.3 work collaboratively with other agencies and land managers, as appropriate, to prepare incursion management plans for priority pests which are not yet present

25.4 use planning procedures and operational controls to identify the relative importance of areas for protection, and to minimise the risk of spread and impacts from priority pests already present;

25.5 seek to identify and protect, including through use of planning procedures and operational controls, individuals and populations of native flora and fauna that show resistance to pests

25.6 where reasonable and practicable, implement control programs for priority pests, and encourage the coordinated involvement of Government, industry, the community and other land managers in addressing these pest species, including through facilitating knowledge transfer, awareness raising and capacity building.

26 The Department will seek to maintain the *Western Shield* program so as to reduce predation pressure on threatened and priority species of fauna.

27 The Department will seek to maintain a pest science capability and work collaboratively with other agencies and institutions on matters of mutual interest.

28 (**Plantations**): The FPC will:

28.1 maintain surveillance and recording systems for the presence of *Sirex noctillio*, European house borer and other priority pests, compatible with those of the Department

28.2 use planning procedures and operational controls to minimise the risk of introduction, spread and impacts from priority pests, and where reasonable and practicable, implement control programs for priority pests

28.3 seek to identify and protect, including through use of planning procedures and operational controls, individuals and populations that show resistance to pests

28.4 take appropriate steps to ensure that the seedlings it obtains from its own and other nurseries are free from pests that could be transported into the forest with planting stock.

Diseases

Background

A number of forest diseases and ‗syndromes' (sometimes referred to as ‗tree declines') present a major threat to the health and vitality of forest ecosystems. Often these are recognised by the causal agent (for example, the pathogen *Phytophthora cinnamomi*), but in some other cases, where the cause is less clear or the result of a combination of factors, they are recognised by their outcome, which is referred to as a particular syndrome (such as Mundulla Yellows), or ‗tree decline' (such as ‗tuart decline').

Dieback disease caused by *Phytophthora cinnamomi* continues to spread and affect the distribution and abundance of many native south-west plant species and their associated fauna (for further information, see *management of Phytophthora dieback*). This plant pathogen and a number of related *Phytophthora* species present a significant threat to the health and vitality of many ecosystems in and outside of the plan area and as such, it remains a high priority to minimise the risk of new infections in areas that are not yet infected. *Phytophthora cinnamomi* can alter species composition and ecosystem functioning, by impacting susceptible species and vegetation types, some of which may be rare or threatened, and by increasing the vulnerability of impacted areas to invasion by weeds. It can adversely affect a range of other forest values, including productive capacity and the value of areas for recreation.

Subsidiary documents, which are periodically reviewed, detail the planning and approval process used by the Department and other proponents to minimise the risk of introduction and spread of *Phytophthora cinnamomi* (and other damaging agents, including weeds and pests). Key tools in this approach include field demarcation of known infected areas and the preparation of hygiene management plans. Additional requirements are imposed for winter harvesting, given the elevated risk of spreading *Phytophthora* under moist soil conditions. Monitoring and audit through the period of the current FMP have indicated shortcomings in some aspects of dieback planning and management (Conservation Commission 2010), as noted in the end-of-term audit of the current FMP (Conservation Commission 2012; EPA 2012). In order to address this, the Department continues to review the approach to management of dieback disease, including mapping standards, the efficacy of planning, risk assessment and approval processes, the operational controls and supervision applied, and the training provided.

Analysis has been conducted by the Department (in conjunction with South Coast Natural Resource Management. Inc.[9]) to identify areas of relative importance (at a landscape level), which helps inform

[9] Further information is provided on the *Project Dieback* website.

decisions about where to focus efforts for management of *Phytophthora cinnamomi*. This analysis identified those LMUs within the plan area with the higher proportions (percentage of total LMU area) and/or area, of ‗high threat' and ‗high asset' values. ‗Threat' is based on the current extent of dieback and its predicted spread (including the threat of ‗vectored spread' based on access networks and use patterns), and ‗asset' is based on such things as biodiversity values (for example, threatened flora, threatened ecological communities, listed wetlands), the amount of disease free vegetation and the susceptibility of those natural assets to dieback. The relevant LMUs are identified in Appendix 1. This analysis will be revisited from time to time, and as circumstances change, the relative importance of different areas may change.

The impact of other *Phytophthora* species is not as well understood, however they have been associated with deaths of a number of important native plant species (such as *Phytophthora multivora* in tuart woodlands). Further research is required to ascertain the importance of these and to develop appropriate management responses.

There are also other fungal or microbial agents that cause damage or have potential forest health impacts on native forests, as well as plantations. For example, *Mycosphaerella* leaf blight is known to affect bluegum plantations and has also been recorded in native forests. Some pathogens are endemic to south-west Western Australia, such as *Quambalaria coyrecup* which is having an impact on the health of marri trees throughout its range, and *Armillaria luteobubalina* root disease has some impact on karri regrowth. Others are not yet present in Western Australia, but could have major consequences for the environment if introduced (for example, Myrtle Rust is not native to Australia but was recently introduced and is now extant on the east coast). Activities to manage these and other species will require a coordinated focus on biosecurity measures to slow or prevent their introduction and/or spread.

Goals

The plan proposes the following activities at the whole of forest, landscape and/or local scales, for the purpose of seeking, as far as is reasonable and practicable, to:

- minimise the impact of forest pathogens, and syndromes, on the health and vitality of forest ecosystems, including plantations
- minimise the risk of introduction or naturalisation of exotic pathogens and protect from infection those areas currently free from disease symptoms.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to:

Policy Statement 3: *Management of* Phytophthora *and disease caused by it*

Guidelines for Management of Phytophthora cinnamomi *and disease caused by it – Vol. 1*

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

29 The Department, and other proponents where required by the Department, will:

29.1 maintain surveillance and recording systems for forest diseases and syndromes that are known to have a significant impact on ecosystem health and vitality

29.2 work collaboratively with other agencies and land managers, as appropriate, to identify priority forest diseases and syndromes using risk-based procedures for determining their relative importance

29.3 work collaboratively with other agencies and land managers, as appropriate, to prepare incursion management plans for identified causal agents which are not yet present

29.4 use planning procedures and operational controls to identify the relative importance of areas for protection, and to minimise the risk of spread and impacts from priority forest diseases and syndromes already present

29.5 seek to identify and protect, including through use of planning procedures and operational controls, individuals and populations of native flora and fauna that show resistance to disease

29.6 where reasonable and practicable, implement control programs for priority diseases, and encourage the coordinated involvement of Government, industry, the community and other land managers in addressing these, including through facilitating knowledge transfer, awareness raising and capacity building

29.7 undertake targeted training programs and implement an accreditation process for staff, contractors and operators involved in disturbance activities, to support consistent and effective implementation of guidelines, standards and procedures for mapping, planning, supervision and operational controls for management of *Phytophthora* dieback disease.

30 The Department will seek to maintain a diseases and syndromes science capability and work collaboratively with other agencies and institutions on matters of mutual interest.

31 (**Plantations**): The FPC will:

31.1 maintain surveillance and recording systems for priority forest diseases and syndromes, compatible with those of the Department

31.2 use planning procedures and operational controls to minimise the risk of priority disease introduction, spread and impacts, and where reasonable and practicable, implement control programs for priority diseases

31.3 seek to identify and protect, including through use of planning procedures and operational controls, individuals and populations that show resistance to disease

31.4 take appropriate steps to ensure that the seedlings it obtains from its own and other nurseries are free from pathogens that could be transported into the forest with planting stock.

Key performance indicators

Key performance indicators will be used to track the implementation of the next FMP. Three indicators have been selected to provide a broad cross-section of achievement of the activities related to the management of pests, weeds and diseases.

Key performance indicator 6	The status of weeds, pests and diseases and severity of their impact as determined by subjective survey.
Performance measure	List of priority weeds, pests and disease pathogens and their severity status, that tracks changes between severity categories.
Performance target(s)	No weed, pest or disease to increase in severity status as a result of management activities.

Key performance indicator 7	The effectiveness of *Phytophthora* dieback hygiene.
Performance measure	The number of sampled areas uninfested with *Phytophthora cinnamomi* that remain uninfested following an operation and the proportion of operations undertaken with an approved hygiene management plan.
Performance target(s)	No planned operations undertaken without an approved hygiene management plan, and less than five per cent of uninfested protectable area to become infested as a result of management activities.

Key performance indicator 8	The presence of *Sirex* and other priority pests in softwood plantations.
Performance measure	Evidence of Sirex in trap trees; evidence of other priority pests from monitoring.
Performance target(s)	No evidence of *Sirex* in trap trees or of other priority pests in monitoring sites.

Developing self-sustaining ecosystems

Background

In order to maintain a wide range of forest values, including ecosystem health and vitality, regeneration is required in areas of native forest subject to timber harvesting and statements relating to regeneration are included in the ‗Productive capacity' chapter. This section is focused on rehabilitation of areas of native vegetation that are cleared during other planned disturbance operations.

Where other planned disturbance occurs, such as mining or extraction of basic raw materials, the impacts are minimised when there is capacity for the area to be self-sustaining and, after time, provide for as many of the former values as possible. This can be achieved where propagules of local native species are sourced from within an area surrounding the target site for rehabilitation, which has been conservatively determined here as the same LMU. However, flexibility may be required in some cases in order to achieve successful rehabilitation that is self-sustaining. For example, where disease is present, or rainfall has become limiting, it may be appropriate to consider the use of disease- and/or drought-resistant varieties of those same species. In this case, the best source of seed or seedlings of some species may be from another area. Alternatively, if disease or drought resistant varieties are unavailable or unknown, then using mixed seed sources to maximise genetic diversity might be an appropriate alternative strategy. This would provide a broader source of variation which would allow greater potential to adapt to new perturbations such as disease or environmental change. Accordingly, the plan proposes a mechanism to accommodate this (see activity 33.4 below).

While it remains the aim, rehabilitation to achieve the former ‗natural state' and provide the same suite of values is difficult to achieve. In comparison to the native vegetation rehabilitated areas have replaced, the utility of these areas is somewhat limited, with lower value (in relative terms) for nature conservation and recreation. However, with appropriate design and management intervention, their capacity to provide wood products and contribute more effectively to water supply for the environment and human use can be restored. The Department actively contributes to discussions with other agencies and the companies involved to determine appropriate standards for rehabilitation, which are incorporated into criteria for hand-back to the State and are reviewed from time to time. As part of an adaptive management approach, this process takes into account results from ongoing research into various issues, including biodiversity and hydrology.

Within the area covered by the plan, there are about 3,200 hectares of mine site rehabilitation planted with a range of exotic species, which is covered in the section ‗Exotic species on State forest and timber reserves' of the ‗Productive capacity' chapter. Since 1998, the majority of bauxite mine rehabilitation has been undertaken with a mix of native species, with much of this having a jarrah-dominant overstorey. Some of this jarrah was planted, but contemporary practice involves direct seeding. Appropriate guidelines for the ongoing management of these areas of native-species rehabilitation are required.

Goals

The plan proposes the following activities at the whole of forest, landscape and/or local scales, for the purpose of seeking to develop and maintain self-sustaining ecosystems of native species from rehabilitation operations in areas of native vegetation, and ameliorating the impacts of other threats including the impacts of climate change.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to:

Policy Statement 10: *Rehabilitation of disturbed land*

Guidelines for management and rehabilitation of basic raw material pits

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

32 The Department will work with industry and relevant government agencies regarding the rehabilitation of areas subject to petroleum and mining activities, including extraction of basic raw materials, by:

- 32.1 recommending, where practicable and economically feasible, the inclusion of a formal requirement for the rehabilitation of areas subject to those activities, based on agreed rehabilitation standards and completion criteria that are subject to review and reflect the intended future management emphasis
- 32.2 seeking confirmation from the relevant agency, either directly or through independent verification by suitable parties, that rehabilitated areas meet agreed completion criteria
- 32.3 exploring mechanisms for payment by proponents of appropriate environmental performance bonds that would be refundable on satisfactory ‗hand-back', on a pro-rata basis.

33 The Department, and other proponents where required by the relevant agency, as appropriate, will undertake their rehabilitation operations by:

- 33.1 using natural regeneration where reasonable and practicable, or
- 33.2 where natural regeneration is not reasonable and practicable, and where data are available on the underlying genetic diversity within rehabilitation species through genetic analysis and an understanding of life history traits, use this information to inform choice of areas from which seed is sourced, or
- 33.3 where natural regeneration is not reasonable and practicable, and where the information referred to in 33.2 is not available, using as the first preference seed or plants propagated from seed collected from the same LMU as the area to be

rehabilitated, or where seed is not readily available from this LMU, then using seed from adjacent LMUs, or

33.4 otherwise, subject to a process of approval by the Department, based on assessment criteria agreed between the Department and the Conservation Commission, using other seed sources, including mixed seed sources, where climate change, impact from damaging agents or some other identified management need requires it.

34 The Department, and other proponents via the Department, will report to the Conservation Commission annually as to the circumstances where seed sources other than those referred to in 33.2 and 33.3 have been used in their rehabilitation operations.

35 Consistent with the intended management emphasis, rehabilitation standards and completion criteria for areas subject to mining and petroleum activities, including extraction of basic raw materials, will, among other things:

- be revised from time to time to be consistent with contemporary ‗good practice'
- specify species composition, with the aim of ensuring ‗representativeness', and state overstorey stocking and stand density levels to be achieved prior to ‗hand-back'
- specify where necessary, after giving due regard to the habitat values in adjoining unmined areas, that important (missing) habitat elements are returned to the site (appropriately defined in terms of characteristics and spacing/numbers per unit area)
- include, in addition to current flora and fauna surveys and other routine measurements carried out by proponents, a requirement for forest inventory and data provision that meets the Department's standards
- define agreed access conditions, including any road closures, taking into account future management requirements, including ongoing fire management.

36 The Department will:

36.1 develop guidelines for the appropriate ongoing management of mine site rehabilitation

36.2 in the interim, consider and, as appropriate, approve the use of management intervention within mine site rehabilitation, to ameliorate the impacts of a changing climate on a range of forest values

36.3 encourage an active adaptive management approach to the management of mine site rehabilitation.

Key performance indicator

Key performance indicators will be used to track the implementation of the next FMP. One indicator has been selected related to the management of rehabilitation of basic raw material pits.

Key performance indicator 9	Time to rehabilitate basic raw material extraction sites.
Performance measure	The time between completion of extraction of basic raw materials and the successful establishment of vegetation.
Performance target(s)	More than 75 per cent of basic raw material extraction sites to be successfully rehabilitated within 18 months and 100 per cent of basic raw material extraction sites to be successfully rehabilitated within 30 months.

Soil and water

Background

This chapter encompasses the conservation of soil and water resources, and measures to protect the values associated with these resources. The conservation of soil and water is intimately linked to the conservation of biological diversity and to sustaining the productive capacity and health and vitality of ecosystems. Water is also an essential commodity for people, communities and various industries, and the quality of water determines its utility for various end-uses.

The chemical, physical, and biological characteristics of aquatic systems are a good indicator of the condition of the forests around them, although they can be difficult to measure. Streams within the forest estate are the least disturbed in the south-west and the water quality of streams wholly contained within the forest remains largely undiminished. This is essentially due to the fact that forest management for wood and other uses, when properly undertaken, is a benign land use in terms of its effect on streams compared to alternative land uses such as agriculture, mining, horticulture or urbanisation.

Nevertheless, forest disturbance activities such as mining, prescribed burning, timber harvesting and access construction and maintenance can be detrimental to soil and water resources if not properly managed. For example, mining strips soil completely, timber harvesting may compact soils in places, and road construction and maintenance can increase the sediment load in streams and thus alter in-stream habitats and water quality. The extent of impact from these operations can be controlled using appropriate management techniques, such as the establishment of riparian zones to protect streams, minimising the extent of compaction and the use of techniques to remedy the consequences of compaction. On the other hand, certain types of soil disturbance assist the regeneration of some plant species.

Goal

An overall goal of the plan is to seek to protect soil and water resources on land to which the plan applies.

Soil

Background

Soils, and the organic matter they contain, provide the physical, chemical and biological foundation necessary to support plant and animal life and sustain ecological processes. Soils provide the basis for the growth potential of native plants and consequently the habitats necessary for native fauna. For example, soils store and regulate the supply of nutrients and water essential for plant growth and development. Soils contain micro-organisms which regulate the supply of nutrients essential for the maintenance of healthy ecosystems, and uncultivated soils make positive contributions to global carbon cycles.

Erosion, compaction and salinity impact adversely on soil fertility, and ecosystem and hydrologic processes. Disturbance to vegetation from mining, prescribed burning, roading, timber harvesting, pest animals and grazing can cause soil erosion and may result in lower soil fertility and increased sediment delivery to streams and rivers. Even incremental losses of soil are important and the risk should be minimised by the application of contemporary operating standards in codes of practice and guidelines. Soil erosion may be more pronounced where loss of vegetation and ground cover is

extensive, as can occur following intense bushfires. Prescribed fires help reduce the risk and scale of such bushfires and the associated impacts on a range of values (see the ‗Ecosystem health and vitality' chapter), including soils, but where they do occur, measures to minimise erosion from fire containment lines and exposed burnt, steep ground are an important consideration in post-bushfire recovery planning. Such measures help conserve soil and protect water quality.

Soil bulk density is a measure of the soil's physical properties that is important for fertility and hydrological processes. Soil-bound organic matter and above-ground organic debris are important to soil fertility in that they contribute to the physical, chemical and biological properties of soil.

The impact of vehicles on the physical characteristics of soils is immediate and generally obvious. The impact is a function of the soil type, its moisture content and the loading pressure, duration and frequency. Timber harvesting is the most extensive operation that has the potential to affect the physical structure of soils, although extraction of minerals and basic raw materials through surface and open-cut mining has a much greater impact on soil but over a lesser area. As compaction takes many decades to return to its pre-disturbance level (Whitford and Mellican 2011), a key to managing this impact is to focus vehicle movements associated with timber harvesting on to the minimum amount of a well structured set of extraction tracks which are only accessed under appropriate soil moisture conditions. In bauxite mining, the topsoil is stripped first and, where feasible, directly respread onto a nearby rehabilitated pit so that the biologically active components, especially seed, remain viable. The overburden (between the topsoil and the bauxite layer) is then removed and generally stockpiled for respreading after completion of mining. Following mining, rehabilitation includes reshaping the mined area, establishment of drainage systems, replacement of overburden and topsoil, deep ripping to relieve pit floor compaction, seeding, planting and fertiliser application. Similar rehabilitation work is carried out on retired basic raw material pits associated with road works.

Unlike the physical effects on soil from disturbance, the effect on some chemical properties is subtle, long term and poorly understood. For example, fire regimes can affect nitrogen balance and nitrogen availability (Raison *et al*. 1993). However, Adams *et al*. (2003) could find no evidence that prescribed fire regimes caused significant sustained losses of nutrients or a decline in nutrient availability in jarrah or karri forests. While adverse impacts on the physical properties of soils can be addressed in day-to-day management, the impact on chemical properties requires long-term research and monitoring to detect changes and identify causes. In certain soil types, activities that alter groundwater levels have the potential to cause soil acidification.

Acid sulfate soils are soils and sediments that contain iron sulfides. They occur naturally in Western Australia and are harmless when left undisturbed. However, when exposed to air, through drainage or excavation, the iron sulfides in the soil react with oxygen and water to produce iron compounds and sulfuric acid. This acid can release other substances, including heavy metals, from the soil and into the surrounding environment and waterways. Activities within this Draft plan that may activate acid sulfate soils include road construction, and excavation to create water points for fire management or extract basic raw materials.

The contamination of soil can have negative impacts on terrestrial and aquatic ecosystems. The types of contamination with the highest potential impacts are hydrocarbons such as diesel, oil and lubricants as well as pesticides. Effective measures to control the risk of contamination are to ensure that operators are trained and equipped for the appropriate use of materials, and to have predefined strategies for the cleanup of spills.

Controlling disturbance

The physical impact on soils from timber harvesting can be managed through use of appropriate, modern vehicles, extraction track layout, timing operations to avoid high soil moisture and physically protecting soils with vegetative matting (Rab *et al*. 2005). Of these, the most useful soil conservation strategies are to avoid timber harvesting during periods when soils are wet and susceptible to damage and to plan operations to minimise vehicle passes (Whitford *et al*. in press). To avoid timber harvesting during periods when soils are wet it is necessary to establish stockpiles of logs, preferably at the mill but sometimes in the forest, so that wood processing mills can continue to operate during periods when harvesting operations have ceased.

Where soil values are threatened, through mining and basic raw material extraction, the Mining Act requires the removal of topsoil and overburden prior to the mining operation, followed by its replacement when rehabilitation commences. Mining companies have their own codes of practice for soil conservation.

Where compaction is significant (for example, major extraction tracks and landings, basic raw material pits, roads and tracks no longer required), guidelines are in place or under review to require (among other things) rehabilitation by ripping to decrease bulk density. Rehabilitation is more effective when undertaken as soon as possible after the damage, under dry soil conditions and using appropriate ripping technology. While these techniques do not immediately repair the compaction damage, they facilitate natural methods of repair by biological activity (roots, soil flora and fauna). Rehabilitation requirements for basic raw material pits are covered in the section ‗Developing self-sustaining ecosystems' in the ‗Ecosystem health and vitality' chapter (with some complementary statements in the ‗Socio-economic benefits' chapter).

The management of soils aims to reduce the impact from physical, chemical and biological degradation, and therefore sustain biological diversity, productivity, hydrologic systems and ecosystem function. Where soils are damaged, rehabilitation will be undertaken.

Modern harvesting vehicles greatly improve the safety of harvest operations and ground pressures are typically lower than older models, however the potential to compact soils and cause rutting remains. The protection of soil during timber harvesting and other disturbance operations has been an area of considerable development during the current FMP as noted in the mid-term audit of performance (Conservation Commission 2008b; EPA 2010a) and end-of-term audit of performance reports (Conservation Commission 2012). While the performance target for KPI 21 (level of soil damage resulting from timber harvesting) of the current FMP was not achieved for all harvest areas sampled, it is considered that management of this impact is adequate and the target was not achieved largely because the target does not allow for a range of practical constraints that influence the portion of a harvest area subject to disturbance (Conservation Commission 2012). The key to minimising the level of soil disturbance is to have harvest vehicles that are appropriate to the characteristics of the area being harvested, continue to have a management emphasis on planning and supervision of operations, and the training of staff and contractors to aid consistency of understanding and achievement of desired outcomes.

The *Soil and Water Conservation Guideline* (DEC 2009b) includes the following guiding principles, supported by a number of strategies for each principle, to provide for the conservation of soil values:

- the extent of soil disturbance caused during timber harvesting will be minimised by planning and managing the location of the landing and the minimum extraction track network required for efficient operation
- the severity of soil disturbance will be controlled using a risk management approach coupled with restrictions on access to the forest

- landings will be planned and managed to minimise the area affected, to minimise the severity of disturbance and to provide for successful rehabilitation
- where protective treatments are applied to minimise the severity of soil disturbance, they will be planned and applied prior to the commencement of disturbance operations
- surface water management structures will be installed and maintained to reduce the likelihood and severity of soil erosion, waterlogging and the contamination of rivers, streams and wetlands
- monitoring of soil disturbance will be conducted to ensure allowable limits are not exceeded and to facilitate progressive improvement in practices – harvesting will cease if limits are exceeded or likely to be exceeded
- visual triggers will be used to identify localised risk to soil values and to change or cease operations if values are threatened
- where severe or very severe soil disturbance occurs, it will be identified, mapped and rehabilitated as soon as possible after the completion of timber harvesting
- silvicultural treatments will be conducted in a manner that maximises the effectiveness of treatment and minimises the risk of unnecessary soil disturbance or soil damage
- soil will be protected from contamination.

The *Manual of Procedures for the Management of Soils Associated with Timber Harvesting in Native Forests* (DEC 2010b) includes a trafficability index that defines soil management risk periods and permissible activities in relation to soil moisture. The Department maintains a webpage for its staff and FPC staff, which is updated daily, and which displays the trafficability index for each harvest coupe on the annual indicative timber harvest plan. The manual also specifies the additional planning and approval requirements for operations during the wetter part of the year, definitions of soil disturbance categories and procedures for assessing and monitoring soil disturbance.

The *Manual for the Management of Surface Water* (DEC 2009c) provides operational guidance for use in the establishment and maintenance of structures to manage surface water so as to prevent erosion associated with extraction tracks, landings, gravel pits and in-forest access tracks carrying relatively low volumes of traffic.

Goal

The plan proposes the following activities at the whole of forest, landscape and/or local scales, for the purpose of seeking to minimise unnecessary soil disturbance.

Identified values and threats

The plan seeks to protect and maintain the following values:

- soil physical properties
- soil chemical properties, including soil organic matter
- soil biological properties.

Threats to these values include**:**

- compaction and rutting of soils as a result of use of heavy vehicles
- erosion associated with disturbance to soils and vegetation
- acidification as a result of exposure, drainage or excavation of acid sulfate soils
- loss of soil nutrients as a result of management activities

- soil contamination as a result of use of pesticides or hydrocarbon spills
- inadequate rehabilitation of damaged soil.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department and FPC will have regard to:

Policy Statement 19: *Fire management*

Code of Practice for Fire Management

Soil and Water Conservation Guideline

Silvicultural Practice in the Jarrah Forest

Silvicultural Practice in Wandoo Forest and Woodland

Silvicultural Practice in the Karri Forest

Manual of Procedures for the Management of Soils Associated with Timber Harvesting in Native Forests

Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes

Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes

Manual for the Management of Surface Water

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

37 The Department, FPC and other proponents where required by the Department, will conduct their operations involving the use of heavy vehicles in a manner that is in accordance with the *Soil and Water Conservation Guideline*, the *Manual of Procedures for the Management of Soils Associated with Timber Harvesting in Native Forests* and the *Manual for the Management of Surface Water*.

38 The Department will revise relevant subsidiary documents pertaining to rehabilitation requirements for major extraction tracks and landings, and roads and tracks no longer required, to ensure these issues are adequately addressed.

39 The Department will revise relevant documents pertaining to fire management to seek to ensure that its bushfire recovery planning considers appropriate measures to minimise erosion from fire containment lines and exposed burnt, steep ground.

40 The Department, FPC and other proponents where required by the Department, will review subsidiary documents and training programs to ensure that procedures for containment of spills are adequately addressed.

41 **(Plantations):** The FPC will:

41.1 conduct its operations:

41.1.1 in a manner having regard to the guidelines for soil protection in the *Code of Practice for Timber Plantations* (2006)

41.1.2 in accordance with Department requirements where the Department establishes these, and which are to prevail over those referred to in activity 41.1.1

41.2 rehabilitate damaged soil resulting from plantation operations:

41.2.1 in a manner having regard to the *Code of Practice for Timber Plantations* (2006)

41.2.2 in accordance with new requirements where the Department establishes these, and which are to prevail over those referred to in activity 41.2.1.

Key performance indicator

Key performance indicators will be used to track the implementation of the next FMP. One indicator has been selected related to protecting soil values.

Key performance indicator 10	The level of soil damage resulting from timber harvesting.
Performance measure	Soil damage as measured by survey, which is to be based on a stratified random sample of harvest cells each year.
Performance target(s)	Soil damage not to exceed prescribed maximum levels for 95 per cent of harvest cells surveyed, except in circumstances accepted by the Department.

Water

Background

Within the plan area, there are important surface water and groundwater resources that the majority of Western Australia's population depends on for water supply. Traditionally, harnessed surface water catchments (see Map 2) and groundwater source areas (such as the Gnangara and Jandakot mounds) have supplied the majority of drinking water supplies for the metropolitan area, Great Southern and Goldfields regions. In more recent times, desalination plants have come on line and other groundwater areas have been explored as potential future sources of supply. Much of the catchment area for these surface and groundwater resources occurs within land covered by the plan. Accordingly, the way in which the land is managed and permitted disturbance activities are undertaken has important consequences for both the quantity and quality of these water supplies.

Water supply in some towns in the lower south-west has been low to the point that supplementary supplies have needed to be used in recent summers and proposals for improvement in water supply to these towns may involve water sourcing activity on land that is subject to this plan (Water Corporation 2010). This applies to several LMUs in the south-west, as identified in Appendix 1 (Central Blackwood, Central Karri, Margaret Plateau, Northern Karri, Redmond Siltstone Plain and Southern Hilly Terrain).

Desalination plants have been built partly because of population growth but also in response to concerns about the reliability of traditional sources. Both the mid-term audit of performance and end-of-term audit of performance reports (Conservation Commission 2008b and 2012) and the EPA reports in response to these (EPA 2010a and 2012) identified implications of climate change as an important issue. The end-of-term audit report found that annual streamflow in forests over the period 2004-2009 declined by 12 to 50 per cent, compared to the 1975-2003 average, and the decline was greatest in the northern jarrah forest (Conservation Commission 2012). The report also found that aquatic biodiversity at many sample sites was in poorer condition than the reference standard, and concluded this was due to the lower than average rainfall experienced during the current FMP (Conservation Commission 2012).

Ecological impacts from changing forest hydrology

A decline in rainfall in the south-west of Western Australia has been widely reported since the early 1970s (Bates *et al*. 2008). In recent decades, the cumulative effect over time from this change has been reported in terms of reduced streamflow, reduced flow into harnessed catchments and impacts on water dependent ecosystems in the south-west of Western Australia. CSIRO (2009) indicated that under the median future climate, runoff is expected to decrease by a further 20 to 30 per cent relative to the period from 1975 to 2007, which would especially affect surface water dependent ecosystems and particularly those that depend on high flows. In addition, a number of groundwater dependent ecosystems including Ramsar Convention wetlands, river base flow systems and cave systems and their associated flora and fauna are also potentially at risk. There are still many knowledge gaps and uncertainties in determination of ecological water requirements for groundwater dependent ecosystems. In addition to the potential impacts of a decline in rainfall on streams and wetlands, there is potentially a more broadscale impact on ecosystem health. The *Review of Silviculture in Forests of South-west Western Australia* (Burrows *et al.* 2011) made the following comments.

> *It is the Panel's view that forest management to achieve a better water balance in a drying climate is a most critical issue facing forest managers now and in the future. As a consequence of a drying and warming trend since the 1970s, and a legacy of predominantly heavily stocked regrowth forests, these ecosystems are experiencing acute water stress.*
>
> *If this issue is not addressed as a matter of priority, then the consequences will be undesirable, probably irreversible, and will likely compromise efforts to achieve ESFM. Silviculture has a pivotal role in addressing this issue. As far as is feasible given capacity constraints, the focus of timber production from jarrah forests in particular should be to increase environmental water availability through reduction of standing basal area and leaf area index. While all jarrah forest ecosystems will probably benefit from silvicultural measures that reduce water stress, management should focus in the higher rainfall zones, as achieving significant improvement in water yield is most likely in these areas.*

A management response that is available and potentially effective for the maintenance of water to ecosystems is the development and application of silvicultural practices to provide for ecosystem health, hereafter called ‗silviculture for ecosystem health'. This involves the use of silvicultural treatments to enhance water availability to identified areas, such as surface water dependent ecosystems, groundwater dependent ecosystems or over-stocked regrowth forest, in order to improve the resilience of these ecosystems (also see Appendix 14). The practice of managing vegetation density to enhance ecosystem health is only expected to be operationally or economically feasible over a very small proportion of the area covered by the plan.

Increased demand for extraction of water

Over the period of the next FMP, population growth, mining, agriculture and horticulture are expected to drive increased demand for water. The CSIRO sustainable water yield project study (CSIRO, 2009) investigated an area covering south-west Western Australia from Gingin Brook, north of Perth, to Albany, and groundwater resources between the Perth Basin, north-east of Geraldton, down the west coast and across to Albany in the south-east. This area covers all current and anticipated future water resources in south-west Western Australia suitable for irrigation, domestic water supplies and industries that require low salinity water.

The study indicated that:

- When both future surface water and groundwater demands are combined, the median increase to 2030 from 2008 is expected to be about 35 per cent, but this may be up to 57 per cent, depending on population and economic growth.

- Under the influence of climate change, the available surface water supply is expected to drop by around a quarter, and groundwater supply is expected to drop by around three per cent.
- Noting that demand management and desalination plants will also play a role, gaps are likely to develop between future ground and surface water yields and demands. The greatest deficits are expected to develop in the Harvey and Warren surface water basins and in the groundwater areas around Perth and Albany.
- Groundwater (and desalination plant water) will progressively substitute for surface water as a water source where both types are available.
- Falling groundwater levels in the sandy soils of the Perth Basin will result in groundwater dependent ecosystems such as wetlands being impacted and current abstractions may need to be adjusted downward accordingly.

The main State legislation that governs water resource management is the Rights in Water and Irrigation Act, which is administered by the Department of Water. A licence issued by the Department of Water is the key regulatory instrument governing the extraction of both surface and groundwater. Each licence defines an annual right to take water (an individual annual entitlement or allocation) and sets conditions that apply to the allocation. This Act also requires that water be set aside to sustain the environment. The Department of Water undertakes allocation planning to decide what water can be taken for consumptive use, while leaving sufficient in the environment to meet *in situ* ecological and recreational or cultural needs.

The Department's primary role in this aspect of water resource management is to provide input and advice into the licensing process regarding potential environmental risks associated with the taking of water from land vested in the Conservation Commission. This occurs through the environmental impact assessment process via advice to the Conservation Commission and EPA. On lands vested in the Conservation Commission, the Department-issued CALM Act section 101 permit is considered a precursor to a Rights in Water and Irrigation Act process and the Department is required to consult the Conservation Commission.

The use of silvicultural treatments to increase the flow of water to surface and groundwater reservoirs was foreshadowed in the current FMP through its action 21.3 and the Wungong Catchment Trial, commenced during the term of that plan. The development and application of silvicultural practices to provide for water production is hereafter called ‗silviculture for water production'. This may include a mix of silvicultural treatments such as thinning, shelterwood, gaps, selective and selection cuts, each of which may be adapted from standard silvicultural settings so as to achieve the desired outcome. Silviculture has historically been used as a mechanism for increasing the flow of water into streams and surface reservoirs and groundwater systems. Intensive vegetation reduction treatments were applied in the Perth hills region following construction of some of the early integrated water supply system reservoirs (dams). Management of stand density has historically been an important part of plantation management on the Gnangara Mound. More recently, more targeted treatments have been applied in the Warren Region, and in the Swan Region through the Wungong Catchment Trial.

Since the early 1970s, the Department, other government agencies and research partners have built a substantial body of knowledge about forest hydrology that can be used to inform discussion about the effects of ‗silviculture for water production'. In the 1970s and 1980s the work was focused on understanding the hydrology of the jarrah forest and determining the amount and duration of additional streamflow that could be generated while managing the threats to water quality including stream salinity and turbidity. The most recent work in this area indicates that to be effective under a drying climate, a reduction in stand basal area from the current standing 24 to 30 square metres per hectare, down to around eight to 10 square metres per hectare, will be required to generate increased streamflow in the western part of the northern jarrah forest, where groundwater is still close to, or connected to, the surface water system. This level of treatment is at or in excess of the levels currently prescribed in silviculture guidelines. Some of the more recent work in this area, such as that carried

out in the Water Corporation's Wungong trial, has expanded the discussion on potential benefits beyond water production to include biodiversity benefits for the forest understorey, streams and wetlands, as the additional water is first made available to meet environmental needs, with any surplus then being available for consumptive use. The EPA (2012) considers that protection of biodiversity values should be one of the objectives of the trial. For further information, including publications of results, see *Wungong catchment trial*.

Management options for 'silviculture for water production'

This Draft plan puts forward two management options for public comment.

Management option 1 is no change – no silvicultural treatment outside current levels. Under this option the main silvicultural methods will be shelterwood cuts, selection cut in dieback-affected areas, a 'selective cut outcome', and thinning, particularly in karri forest. For other parts of the south-west, option 1 means the forest and associated streams, wetlands and other water dependent ecosystems will self-adjust to a drying climate, without management intervention, except where action might be taken in relation to 'silviculture for ecosystem health'. However, the rate of climate change is expected to be faster than the ability of the forest to self-thin and it is considered unlikely that the existing structure, density and composition of ecosystems will persist in their current form. The nature of and consequences of this adjustment are uncertain but the most heavily impacted areas, at least in the short to medium term, are likely to be surface and groundwater dependent ecosystems, areas with shallow soils and areas where the future rainfall is outside the historic threshold annual rainfall for the species.

Management option 2 is 'silviculture for water production' applied to particular catchments.
Option 2 potentially involves treating selected higher rainfall portions of the Wungong, Serpentine, North Dandalup, South Dandalup, Harris, Canning, Stirling and Samson dam catchments (see the map of the *potential treatment envelope - 'silviculture for water production'*). Option 2 could potentially apply, over time, within an area available for timber harvesting of about 77,500 hectares as nominated by the Water Corporation, within which the maximum area that might be treated is about 65,500 hectares. Not all of this area would be treated during the term of the next FMP. However, for modelling purposes (see the 'Productive capacity' chapter), it has been assumed that up to 65,500 hectares could potentially be treated during the term of the next FMP, if this management option was adopted. The actual area treated during the term of the next FMP would be subject to consideration and approval of silviculture guidelines and catchment management plans (see below).

The 65,500 hectares represent about 24 per cent of the total area of these catchments, which is around 268,400 hectares, and about three per cent of the area covered by the plan. The envelope identified for treatment overlaps two LMUs. The majority (about 78 per cent) occurs within the Central Jarrah LMU and the remainder (about 22 per cent) within the North Western Jarrah LMU, representing about 10 per cent of the total area of each LMU, or 15 per cent of the area of each LMU on lands vested in the Conservation Commission. This potential treatment envelope has a substantial degree of overlap with areas already mined and rehabilitated and other areas within the envelope proposed for bauxite mining.

If all 65,500 hectares of forest within the envelope were treated, modelling indicates that streamflow from the targeted catchments would recover to provide an additional 22 gigalitres per year on average for the first 10 years, and an additional 45 gigalitres per year thereafter with ongoing forest management (see *Future streamflows from the Northern Jarrah Forest – Learnings from the Wungong Catchment Trial*).

The primary driver for achieving management option 2 is the commercial benefit of increased water yield, although the treatments will first provide an increase in the availability of water to the environment, with benefits for ecosystem health and vitality. However, if suitable markets emerge for the use of non-sawlog material, then the wood products made available could be utilised.

To achieve this, it is likely that the initial treatment would involve reducing stand density to a leaf area index (LAI) of not less than 0.6 (about eight to 10 square metres per hectare of basal area - see *Treatment Area 4*). Coppice control would be applied when required after the treatment to reduce stand density, to ensure that regeneration contributes an average of no more than 0.05 LAI (about one square metre per hectare of basal area). A subsequent silvicultural treatment would most likely occur when the stand density exceeds an average LAI of about 1.2 (about 13 square metres per hectare of basal area), which is likely to be around 10 years after the initial reduction in stand density, which would not be in the period 2014-2023. Any subsequent treatments would be subject to review of the project's success as a part of the end-of-term review for the next FMP, and any future proposals would need to be included in the subsequent plan (from 2024).

A variant of management option 2 is to limit the proposed silvicultural treatment so that the upper slopes are not treated. The rationale for this variant is that many upper slopes do not have groundwater beneath them and treatment of them may provide little increase in streamflow while adding significant cost to the proposal. It is likely that this variant would reduce the area that would be treated by between one quarter and one third.

If management option 2 (or a variant thereof) is adopted, a corresponding key performance indicator will be included in the proposed FMP.

The *Soil and Water Conservation Guideline* (DEC 2009b) includes a guiding principle that silvicultural treatments and fire regimes may be used to enhance the quantity of water for surface and groundwater reservoirs. This option can be considered as an expansion of the Water Corporation's Wungong trial and as such depends on public reporting on this trial by the Water Corporation, and evaluation of its effectiveness and impacts. Subject to this evaluation, the mechanism proposed for implementing this option is the development of silviculture guidelines and catchment management plans. Catchment management plans will be required where any proposal seeks to reduce stand density below that provided for in the relevant silviculture guideline, or where it is considered that a proposal will result in an excessive proportion of the forest in the catchment being in the juvenile and immature stages of development, which may have greater water use than older stages of development. A draft outline of the required content for a catchment management plan is at Appendix 15. Approved catchment management plans will specify any additional operational controls that might be required to address other forest values, and monitoring and reporting. In the case of management option 2, above, it is envisaged that separate catchment management plans will be prepared for the individual catchments identified, with progressive implementation upon approval and as proponent funding permits.

Management of vegetation density to enhance water availability might also be applied to mine rehabilitation (see _Developing self-sustaining ecosystems' in the _Ecosystem health and vitality' chapter).

Management of water quality

Historically, the main risk to water quality has been from groundwater rise dissolving and transporting salt stored in the unsaturated zone of the soil profile. The two primary controls over the risk of causing salinity in forested areas are the phased harvesting requirement for _salt sensitive' areas (carried over from Ministerial Condition 12 on the FMP 1994-2003) and the _high salt risk' requirement (carried over from Ministerial Condition 16 on the FMP 1994-2003).

The meaning of _salt sensitive' and _high salt risk' areas of the forest is clarified in the following text. Mean annual rainfall (MAR) zones (based on data up to 1978) have been used to broadly differentiate geographic divisions within the plan area that have different attributes related to the risk of developing secondary salinity. These attributes are the amount of salt stored in the soil profile and the proximity of groundwater to the valley invert. The general relationship has been:

- *High Rainfall Zone* (greater than1100 millimetres MAR) – groundwater close to the valley invert but soil profile does not contain high levels of accumulated salt
- *Intermediate Rainfall Zone* (900 to 1100 millimetres MAR) – groundwater was close to the valley invert with moderate levels of salt accumulation
- *Low Rainfall Zone* (less than 900 millimetres MAR) – groundwater generally well below the valley invert with high levels of salt accumulation.

In the current FMP, ‗salt sensitive' areas are those falling within the intermediate and low rainfall zones as previously defined. The phased harvesting requirement for these areas meant that 30 per cent of each second-order catchment needed to be retained unharvested or with a basal area of 15 square metres per hectare for a period of at least 15 years after harvesting the remainder. This requirement is embedded in the current jarrah silviculture guideline.

The MAR bands used to define Low, Intermediate and High rainfall zones for salt sensitivity purposes are carried forward in this Draft plan as geographic boundaries (using the isohyets from which they were originally derived). These zones will be referred to as ‗salt sensitivity zones' to avoid confusion with shifts in rainfall isohyets associated with drying of the south-west climate.

However, as a result of reduced rainfall and declining groundwater levels (see Figure 2), salt sensitivity is now considered to be significantly reduced in the Department's Swan and South West regions and parts of the Warren Region. Accordingly, the measures that were introduced for the protection of water quality under the previous hydrological regime (mainly higher groundwater levels), are now considered to be less relevant.

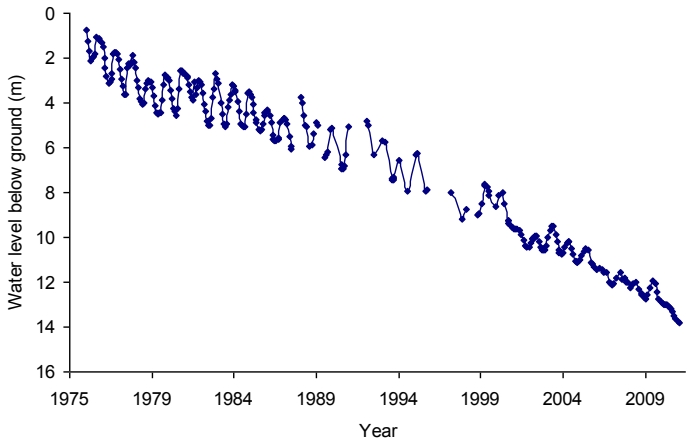


Figure 2: Groundwater level in a valley borehole located in the Department's Swan Region

In this Draft plan, it is proposed that the Swan and South West regions and parts of the Warren Region be classified as low salt sensitivity and other parts of the Warren Region be classified as moderate salt sensitivity (see Map 8). Consequently, it is proposed to remove the phased harvesting requirement in the Department's Swan and South West regions and parts of the Warren Region. The phased harvesting requirement for the moderate salt sensitivity part of the Warren Region will be retained as groundwater levels have not fallen to the same extent in this area.

This proposal is informed by the following:

- groundwater levels that were near the surface in the 1970s and 1980s are now deeper than five metres in the Swan and South-West regions as a result of a several decades of below average rainfall
- annual rainfall and groundwater levels are projected to decline further for several decades
- changes in timber harvest and silvicultural practices have augmented the precautionary measures applied earlier so that the disturbance is now less intense than examined in previous hydrological studies.

As in the current FMP, ‗high salt risk' refers to certain river systems within the historic intermediate rainfall zone (as described above, based on data up to 1978) that are least disturbed and as such, are presumed to have the most intact aquatic ecosystems and consequently, are the most environmentally sensitive to rises in saline groundwater. Accordingly, there is a range of additional precautionary measures applied, including additional stream buffers, limits to the intensity of timber harvest and on the extent of harvest in any of the identified catchments within a 15-year period.

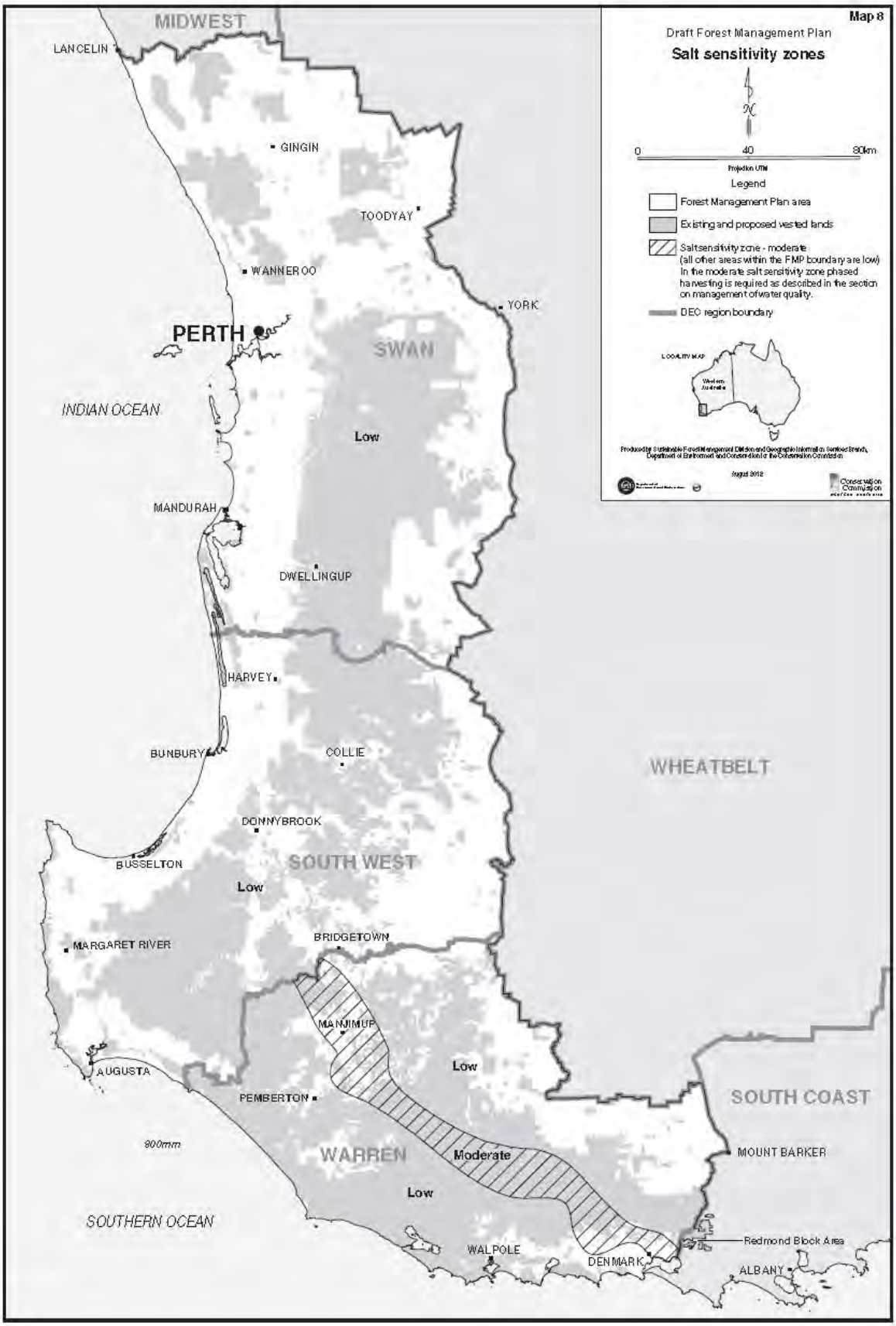
The ‗high salt risk' river areas are: Canning River east branch (second order catchments 1 to 4); unnamed tributary of the Murray River (second order catchment 1); unnamed tributary of the Harris River (second order catchment 1); Thomson Brook tributary (second order catchments 1 to 5); Donnelly River tributary (second order catchments 1 to 9); Little Quinninup Brook and Tinkers Brook tributaries (second order catchments 1 and 2); and Deep River tributary (second order catchments 1 to 4). Also see the *'high salt risk' areas map*.

The proposed changes have been subject to review by an expert panel (see *Burrows et al. 2011*), which has supported the proposed changes and recommended that ongoing monitoring of groundwater should continue, so that management can respond should there be a return to a wetter climate. The Department and Conservation Commission support the continuation of this monitoring.

In addition to controls over the intensity and proportion of a catchment that is harvested, the use of stream reserves is a measure prescribed by the current FMP and the *Guidelines for Protection of the Values of Informal Reserves and Fauna Habitat Zones* (DEC 2009a) for the protection of water quality (salinity, turbidity and contamination), and this measure is carried forward into this Draft plan (see Appendix 12). Stream zones also play an important role in the conservation of biodiversity and other values. In addition to salt risk, poor drainage or surface water management can also potentially increase risks to water values through erosion, sedimentation and contamination. These aspects are dealt with in the *Soil and Water Conservation Guideline* (DEC 2009b) and its subsidiary documents.

The *Manual for the Management of Surface Water* (DEC 2009c) provides operational guidance for use in the establishment and maintenance of structures to manage surface water. The main activities are prevention of erosion, waterlogging, turbidity and contamination associated with extraction tracks, landings, gravel pits and in-forest access tracks carrying relatively low volumes of traffic. The design, construction and maintenance of unsealed roads on lands to which the plan applies is currently guided by the *Unsealed Roads Manual – Guidelines to Good Practice*, issued by the Australian Roads Research Board (2009), while the Department works to finalise its own policies and guidelines. Other comments relating to access infrastructure are included in the ‗Socio-economic benefits' chapter.

Also to help protect water quality, the use of certain products or practices may be limited or controlled in some areas like Reservoir Protection Zones established by the Department of Water, where additional safeguards are applied to timber harvesting to further minimise the risk of sediment movement. Similarly, the type of recreational activities that are permitted in drinking water supply catchments may be restricted, and Health Department regulations control pesticide use in these areas.


Map 8
Draft Forest Management Plan
Salt sensitivity zones
N
0
40
80km
Projection UTM
Legend
Forest Management Plan area
Existing and proposed vested lands
Salt sensitivity zone - moderate
(all other areas within the FMP boundary are low)
In the moderate salt sensitivity zone phased harvesting is required as described in the section on management of water quality.
DEC region boundary
LOCALITY MAP
Western Australia
Produced by Sustainable Forest Management Division and Geographic Information Services Branch, Department of Environment and Conservation for the Conservation Commission
August 2012
Conservation Commission
MIDWEST
LANCELIN
GINGIN
TOODYAY
WANNEROO
YORK
PERTH
SWAN
INDIAN OCEAN
Low
MANDURAH
DWELLINGUP
HARVEY
BUNBURY
COLLIE
WHEATBELT
DONNYBROOK
BUSSELTON
SOUTH WEST
Low
MARGARET RIVER
BRIDGETOWN
MANJIMUP
Low
AUGUSTA
PEMBERTON
SOUTH COAST
900mm
WARREN
Moderate
MOUNT BARKER
Low
SOUTHERN OCEAN
Redmond Block Area
WALPOLE
DENMARK
ALBANY

Various registered pesticides are used by landholders and various government agencies, including the Department and FPC, within drinking water supply catchments and elsewhere in the plan area. They are used to manage pests, weeds, diseases and other vegetation to meet legal obligations, protect biodiversity and to help achieve a range of management objectives, and are applied by trained people using modern equipment, under controlled conditions that minimise off-target impacts. The *Code of Practice for the use of Agricultural and Veterinary Chemicals in Western Australia* (DAFWA 2007, Bulletin 4648) provides guidance on the safe storage, handling and responsible use of these products.

Recreation and water

Water bodies are also important places for a range of recreational activities and this aspect is covered in the ‗Socio-economic benefits' chapter.

Goals

The plan proposes the following activities at the whole of forest, landscape and/or local scales, for the purpose of seeking, as far as is reasonable and practicable, to protect:

- the ecological integrity and water quality of groundwater, streams and wetlands and their associated vegetation
- the water quality and flow of water to surface and groundwater reservoirs.

Identified values and threats

The plan seeks to protect and maintain the following values:

- water quality, water quantity and ecological integrity of groundwater, streams and wetlands and their associated flora and fauna.

Threats to these values include**:**

- stream salinity as a result of rising groundwater tables
- turbidity of surface water as a result of erosion
- bacterial contamination (for example, as a result of waste and faecal matter)
- contamination from hydrocarbons and pesticides
- excessive extraction of water for human use
- declining rainfall and consequent reductions in groundwater levels and streamflows
- excessive use of water by native vegetation and plantations
- damage to stream beds and banks
- changes to flow regimes
- changes in composition, structure and density of riparian vegetation.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department and FPC will have regard to:

Policy Statement 9: *Conservation of threatened flora in the wild*

Policy Statement 18: *Recreation, tourism and visitor services*

Policy Statement 19: *Fire management*

Policy Statement 33: *Conservation of endangered and specially protected fauna in the wild*

Policy Statement 44: *Wildlife management programs*

Policy Statement 50: *Setting priorities for the conservation of Western Australia's threatened flora and fauna*

Code of Practice for Fire Management

Soil and Water Conservation Guideline

Silvicultural Practice in the Jarrah Forest

Silvicultural Practice in Wandoo Forest and Woodland

Silvicultural Practice in the Karri Forest

Guidelines for Protection of the Values of Informal Reserves and Fauna Habitat Zones

Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes

Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes

Manual for the Management of Surface Water

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

42 The Department, the FPC and other proponents where required by the Department, will conduct their operations in accordance with silviculture guidelines, the *Guidelines for the Protection of the Values of Informal Reserves and Fauna Habitat Zones*, and the *Soil and Water Conservation Guideline*.

43 The Department may undertake or approve ‗silviculture for ecosystem health' to enhance water availability to identified areas, such as surface water dependent ecosystems, groundwater dependent ecosystems or over-stocked regrowth native forest, in order to improve the resilience of these areas.

44 The Conservation Commission, in consultation with the Department, will develop a position statement to provide guidance when proposals to take water from land to which the plan applies are considered.

45 The Department:

- 45.1 will provide advice and assistance to organisations seeking access to the potential sub-surface aquifers and surface reservoirs located on land to which the plan applies
- 45.2 will facilitate access to land to which the plan applies for the purposes of water extraction and the development of associated infrastructure for public water supply purposes where this is consistent with the CALM Act
- 45.3 will take and use water sustainably from land to which the plan applies
- 45.4 may issue permits, after consultation with the Conservation Commission, for the sustainable taking of water from land to which the plan applies.

46 The Department, the FPC and other proponents where required by the Department, will undertake design, construction and maintenance operations for unsealed roads in a manner that:

46.1 has regard to the 2009 *Unsealed Roads Manual – Guidelines to Good Practice*, issued by the Australian Roads Research Board, prior to the approval of the policy and guidelines referred to in 46.2

46.2 is in accordance with Departmental policy and guidelines which are to be prepared by the Department.

47 **(Plantations):** The FPC will conduct its plantation operations in a manner having regard to the guidelines for water protection in the *Code of Practice for Timber Plantations* (2006).

48 **(Plantations):** The Department may require the preparation of catchment management plans where proponents seek to apply silvicultural or other practices that, in the view of the Department, could result over time, in a reduction in flow to surface or groundwater reservoirs. Catchment management plans require approval by the Department, which will consult with the Conservation Commission and Department of Water, and where applicable, the Water Corporation. Approved catchment management plans will be made publicly available.

Key performance indicators

Key performance indicators will be used to track the implementation of the next FMP. Three indicators have been selected to provide a broad cross-section of achievement of the activities related to protecting water values.

Key performance indicator 11	The trend in annual flow weighted mean salinity for fully forested catchments.
Performance measure	The annual flow weighted mean salinity and the trend for selected gauging stations.
Performance target(s)	No gauging stations with annual flow weighted mean salinity that is not fresh as a result of management activities.

Key performance indicator 12	The trend in annual streamflow for forested catchments.
Performance measure	Annual streamflow and the trend for selected gauging stations.
Performance target(s)	No sites with a decline in streamflow as a result of management activities.

Key performance indicator 13	The trend in groundwater level for forested catchments.
Performance measure	Depth to groundwater and the trend for selected groundwater monitoring boreholes.
Performance target(s)	No sites with a decline in groundwater level as a result of management activities. No sites with a rise in groundwater level to the extent that it could lead to annual stream salinity not remaining fresh, as a result of management activities.

Climate change and carbon cycles

Background

Carbon dioxide is one of the gases naturally found in the Earth‘s atmosphere. It is widely accepted and well documented that atmospheric levels of carbon dioxide have increased dramatically over the past 100 years. Many scientists believe the greenhouse effect from increased levels of atmospheric carbon dioxide, methane and other greenhouse gases (GHG) is increasing the Earth‘s temperatures to the point of undesirably changing the Earth‘s climate – a phenomenon referred to as global warming and climate change. South-west Western Australia is considered to be particularly vulnerable to climate change (Climate Commission 2011a).

Predicted climate change in south-west Western Australia

In Western Australia‘s south-west, the impact of climate change has been most apparent in a substantial drying trend, with significant decreases in rainfall, streamflow and groundwater levels recorded in the last 40 years. The latter has been particularly evident in the northern jarrah forest (see Figure 2, in the ‗Soil and water‘ chapter) and has been associated with a 15 per cent reduction in rainfall since the mid 1970s (Climate Commission 2011a).

Bates *et al.* (2008) report on work conducted by the Indian Ocean Climate Initiative (IOCI), which has been studying the climate of the region since 1998. They note significant features of the rainfall decline are the reduction in early winter rain and the absence of very high rainfall years which were once more common. Warming has also been observed over the same period. They also explain that the expected level of climate change in the south-west remains imprecise, reflecting in part different expectations about future GHG emissions. However, all the emission projections and climate models used by IOCI point to drier conditions across the south-west in the future. These projections indicate that, relative to the period 1960-1990:

- rainfall may decrease by between two to 20 per cent by 2030, and by between five to 60 per cent by 2070
- summer temperatures may increase by between 0.5 to 2.1 degrees Celcius (C) by 2030, and by between 1.0 to 6.5 degrees C by 2070
- winter temperatures may increase by between 0.5 to 2.0 degrees C by 2030, and by between 1.0 to 5.5 degrees C by 2070.

The predicted changes to 2030 provide an indication of the magnitude of change that may be experienced by the end of the period of the next plan (i.e. at the end of 2023).

There are two future climate change severity projections used in this Draft plan in modelling the potential impacts of climate change on sustained timber yields (see the ‗Productive capacity‘ chapter) and carbon stocks. These are described in the vulnerability study (see page 21 in *Maher et al. 2010*), as the ‗medium severity‘ and ‗high severity‘, comprising a combination of GHG emission projections and the sensitivity of climate to modelled impacts of these emissions. A ‗low severity‘ category was not developed, as it was considered least likely given the rate at which global emissions of GHGs have since exceeded the original forecasts by the Intergovernmental Panel on Climate Change (Steffen *et al.* 2009).

The projections of future climate for the south-west referred to here as ‗medium‘ and ‗high severity‘ were derived from the datasets developed by CSIRO (2007) for the regional analysis of climate

change in Australia. These data have been used in other studies assessing the impacts of climate change on the distribution of key flora and fauna species (Yates *et al.* 2010; Gibson *et al.* 2010) and forests in the south-west (see the study on the vulnerability of south-west forests at *Maher et al. 2010*). Projections of future mean monthly temperature, rainfall and evapotranspiration to the years 2030, 2050 and 2070 were used to predict the variation in tree and stand growth likely to arise under each projection, which encompass the range of projected changes in rainfall and temperature to 2070 described above.

Given current knowledge and uncertainties of the likely magnitude and result of changes to climate from increases in atmospheric levels of GHGs, it is considered the management activities proposed throughout this Draft plan encompass an appropriate range of broad precautionary actions. While the impact of climate change may not be obvious in the 10-year life of the plan, it is important that it be monitored and its impact on productive capacity, biological diversity, hydrology and ecosystem health, in particular, be considered in ongoing strategic planning and operational practices. Adaptive management to enhance resilience will likely be of increasing importance and there needs to be flexibility to respond as new information becomes available.

Potential consequences of climate change

The extent of possible impacts on native vegetation ecosystems is not well understood, but climate change is expected to have important but variable consequences for a range of ESFM values, as noted in the mid-term audit of performance (Conservation Commission 2008b; EPA 2010a) and end-of-term audit of performance reports (Conservation Commission 2012; EPA 2012). These issues have been given particular emphasis in the 2011 review of silviculture guidelines and are discussed further in several chapters in this Draft plan (see the chapters ‗Biological diversity', ‗Ecosystem health and vitality' and ‗Productive capacity', in particular). Some summary comments in relation to each ESFM criterion follow.

Biological diversity – it is possible that changes in flowering cycles, seed production and species distribution will result from the change in environmental conditions induced by a change in climate. Because some indigenous biota is restricted to narrow ranges, climate change is an important threatening process affecting their survival. A comprehensive, adequate and representative (CAR) conservation reserve system provides an important base from which to manage any adverse impacts on the biota that may arise from climate change. Sustaining connectivity in fragmented landscapes is an important strategy that provides for stepping stones or contiguous habitat that facilitates the maintenance of ecological processes and movement of organisms across landscapes. In a relatively intact landscape like the south-west forests, consideration of habitat connectivity is nevertheless still important and is contributed to through the network of informal reserves, fauna habitat zones and other protected areas, the retention of key habitat elements in areas subject to timber harvesting, and the dispersion in space and time of areas subject to disturbance (see ‗Integrating biodiversity management across the plan area', in the ‗Biological diversity' chapter). These measures serve to provide connectivity across areas of State forest and also connectivity between formal conservation reserves. In future, additional corridors may be required on other lands not covered by this Draft plan. The importance of retaining ecological linkages between remaining remnants of native vegetation in cleared landscapes is well recognised (for example, see the EPA 2009a – Environment Protection Bulletin No 8).

Ecosystem health and vitality – climate change presents a very complex situation for ecosystem health and vitality, potentially favouring some and disfavouring other weeds, pests and diseases. Rainfall decline and associated water stress is an important factor in the health of native forests (for example, see *CoE Forest Health Bulletin No. 11* and *CoE Forest Health Bulletin No. 13*) and plantations. Further information on climate change and its potential effects on south-west native forest types can be found at (see *Maher et al. 2010*).

To sustain the ability of vegetation to sequester (absorb) carbon and to minimise the impact on biodiversity, it is important to seek to control priority pests and diseases to maintain healthy leaf area. In the south-west forests, pests such as the jarrah leaf miner, gum leaf skeletoniser and the tuart borer have caused infestations at a scale that have sometimes impacted biodiversity and reduced growth and carbon sequestration. The greenhouse implications of these outbreaks have not been quantified and no broadscale affordable, environmentally-acceptable control has been found to be effective. Dieback disease caused by *Phytophthora cinnamomi* is recognised as a significant threat to biodiversity and has resulted in places in some losses from the carbon pool, and various measures are used to limit its spread (see the ‗Ecosystem health and vitality' chapter).

Climate change will affect fire regimes through the effects of changes to temperature, rainfall, humidity, wind and other components of fire weather, including possible extreme events such as ex-tropical cyclones impacting the south-west. Changes are also anticipated as a result of increases in atmospheric carbon dioxide and the effect of changed moisture regimes on vegetation and fuels. Future fire regimes may also be affected by other agents of change, such as invasive species that may affect the amount and continuity of fuels. With continued drying and warmer conditions predicted in the area covered by the plan, it can be expected that a higher proportion of the landscape and fuels will remain drier for longer, extending the bushfire season and increasing the likelihood of more frequent, extensive, high-intensity bushfires. GHGs, including carbon dioxide, methane and nitrous oxide are released by prescribed burning and in bushfires. Emissions levels depend on the frequency and scale of fires, and on the amount of fuel consumed, and in some forest types, emissions of GHGs from intense bushfires may be up to three times as high as those from fires of low to moderate intensity (Irvine *et al.* 2007). It has also been proposed that low intensity fires may result in a significant increase in the amount of soil carbon over time, as a result of storage in inert forms such as charcoal (see Adams and Attiwill 2011). Scientific opinion is divided as the extent to which planned burning may contribute to minimising the net emission of GHGs from fire. Some studies suggest that replacing high intensity bushfire with planned fire may reduce overall emissions (Wiedinmayer and Hurteau 2010), but others argue that planned burning is unlikely to yield a net reduction in carbon emissions in temperate forests, because of the extent and frequency of burning necessary to significantly reduce the scale of high intensity bushfires (Bradstock *et al.* in press). Resolution of this issue will require a better understanding of the dynamics of combustible forms of carbon, particularly carbon stored in coarse woody debris and soil.

Fire is a natural part of south-west forest ecosystems and is intimately connected to regeneration and forest health, both of which promote the sequestration of carbon from carbon dioxide released by fire. Climate change has implications for biodiversity and ecosystem processes, with direct impacts through changed levels of moisture, temperature and carbon dioxide potentially affecting the biota through possible changes in regeneration, growth and reproduction, and indirectly through the interaction with changing fire frequency, fire scale, fire intensity and fuel dynamics (as noted above). A preliminary assessment of interactions between climate change, fire regimes and biodiversity was undertaken by Williams *et al.* (2009), with an overview published by the Department of Climate Change and Energy Efficiency (2011). Management of prescribed fire regimes includes monitoring the effects on biodiversity, which will continue, to provide a system that facilitates adaptation to the effects of climate change. A well-planned, proactive prescribed burning program will play a vital role in protecting a range of forest values, including biodiversity, communities, and managing greenhouse emissions (fire management is discussed in the ‗Ecosystem health and vitality' chapter).

Soil and water – groundwater levels and streamflow from forested catchments will continue to decline if rainfall declines further, and this could threaten flora and fauna, particularly that associated with streams and wetlands. The protection of water dependent ecosystems as centres of biological activity will become increasingly important. Any effects on soil will largely be on its chemical and biological features. Soil carbon and nutrient cycling may be affected by changes in vegetation associations, fire regimes (see above) and soil disturbance. Measures to protect soils, including organic rich soils, from unnecessary disturbance and inappropriate fire regimes, are outlined in the ‗Soil and water' and

_Ecosystem health and vitality‘ chapters, respectively. Additional comments in relation to soil carbon pools are included below under _Global carbon cycles and carbon stocks‘.

Productive capacity – impacts on plant growth and biomass accumulation will vary depending on the species. Increasing atmospheric carbon dioxide concentrations and increasing winter temperatures may assist plant growth, as will any increase in summer rain. However, a decrease in overall rainfall, higher summer temperatures and increased occurrence of droughts will shorten the growing season for many plants and may impact survival in some places, leading to reduced biomass production and thus reduced sequestration potential in affected areas. Consequently, the carbon carrying capacity of both native forests and plantations is likely to reduce as a result of predicted climate change. These changes may also negatively impact productive capacity of native forests and plantations (see further comments in relation to work by Allen *et al.* 2010, below). This has been factored into the calculations of sustained yield, as explained in the _Productive capacity‘ chapter.

Heritage – since natural heritage is based on the same values as those important for the conservation of biological diversity, it has the potential to be similarly affected. Measures to ameliorate the impact on biodiversity therefore also apply to natural heritage and contribute to maintaining the connection of Aboriginal people to country.

In many places the variability of the landscape and its key elements is important to heritage values. The potential for increased bushfire size and intensity may result in an increased rate of loss of historic structures and buildings, particularly where timber is a key structural component (for example, bridges, stock yards, wells). The possible decrease in water levels in streams and swamps could mean some indigenous artefacts, such as fish traps, are at greater risk of damage or loss. The impact of rising sea levels may result in brackish or fresh areas becoming true estuarine environments, and also in the inundation of heritage sites in estuarine systems. It is also possible that climate change may lead to extremes of weather which may accelerate weathering processes impacting important objects, places and buildings.

Socio-economic benefits – social benefits based on the use of biomass will be affected to the extent that biomass production and condition are affected. As mentioned above, for timber harvesting, the expected impacts have been explicitly factored into the calculations of sustained timber yield. Climate change may impact other socio-economic values in unexpected ways – for example, if flowering cycles or relative abundance are affected, there may be impacts on wildflower and honey production; and adverse impacts on water bodies will affect their appeal and utility for recreational activities.

Adaptation and mitigation

The vulnerability of systems to a changing climate is a function of the likelihood and magnitude of change, the sensitivity of the system to that change, and the capacity to adapt to the change being experienced. A system that will be exposed to a large change, is sensitive to change, and has a limited capacity to adapt, is most vulnerable. The environmental, economic and social risks associated with change to systems vulnerable to the effects of climate change can be managed by seeking to reduce the likelihood and magnitude of change through a reduction in greenhouse gas emissions (mitigation), or by reducing the consequences of a change by increasing the ability of a system to cope with that change (adaptation).

In line with broader government policies, the Department has introduced a number of initiatives to reduce GHG emissions, including considering emissions levels in determining its fleet, and construction methods and materials used for recreation facilities, and targeted reductions in stationary emissions (for example, through electricity savings). However, mitigation requires broader efforts and global cooperation to be achieved effectively (Pittock 2009). In terms of this Draft plan, mitigation actions are therefore most relevant at a whole of forest (or greater) scale, and these are discussed further in the section _Global carbon cycles and forest carbon stocks‘, below.

In contrast, adaptation strategies may be relevant at all scales, although Pittock (2009) considers it as essentially a local challenge. Allen *et al*. (2010) have conducted analysis of recent tree deaths observed in many forest types across the globe. The study included parts of eastern Australia but did not include Australia's south-west. However, during 2011 drought deaths were observed in places across the south-west, particularly in parts of the northern jarrah forest and the Swan Coastal Plain, with most impacts in the northern jarrah forest being associated with rocky outcrops, areas of shallow soils and/or dense regrowth (including some areas of dense mine site rehabilitation). Allen *et al*. (2010) suggest that the increase in the frequency, duration and/or severity of drought, combined with more heat stress associated with climate change, could fundamentally alter composition, structure and composition of forests in many regions, and note that mortality functions used in forest modelling may need to be revised (for more discussion of the latter, see the 'Productive capacity' chapter). The authors state:

> *…given the potential risks of climate-induced die-off, forest managers need to develop adaptation strategies to improve the resistance and resilience of forests to projected increases in climate stress. Options might include thinning stands to reduce competition, selection of appropriate genotypes (e.g. improved drought resistance), and even translocation of species to match expected climate changes*.

Accordingly, an option to conduct 'silviculture for water production' within parts of particular catchments is outlined in the 'Soil and water' chapter. Statements related to selection of appropriate genotypes are included in the section 'Developing self-sustaining ecosystems' of the 'Ecosystem health and vitality' chapter, and the 'Regeneration and management of harvested native forest' section of the 'Productive capacity' chapter.

Global carbon cycles and forest carbon stocks

Figure 3 provides an overview of the global carbon cycle and a good written description can be found at *The critical decade: Tasmanian impacts and opportunities report* (Climate Commission 2011b).

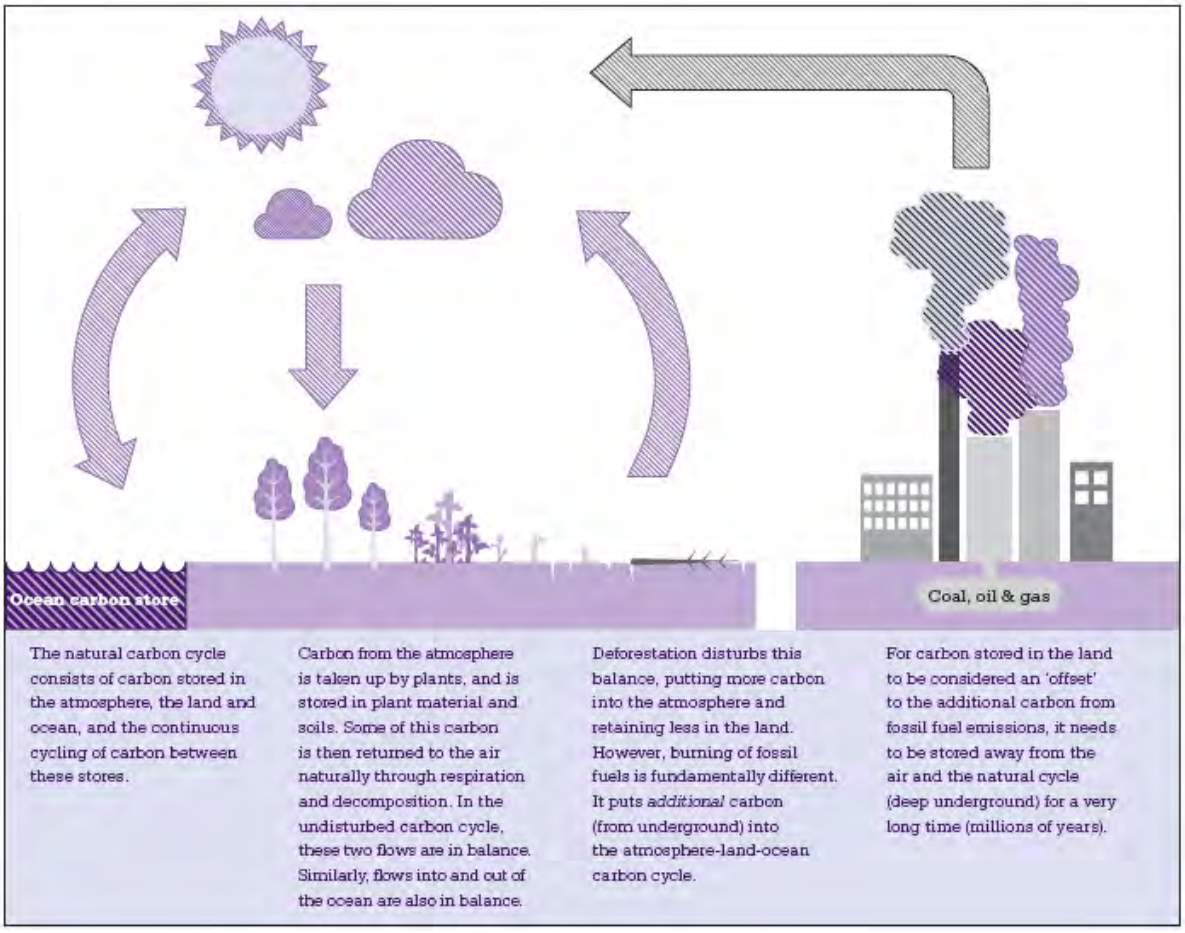


Figure 3: Carbon cycle schematic (source: Fig. 14 in Climate Commission 2011b)

Native vegetation – in particular forests – plays a major role in the functioning of the Earth's biosphere and contributes to and regulates the global carbon cycle. Forests and tree plantations can be both a ‗source' (of emissions) and ‗sink' (i.e. lead to removals through biosequestration), and the change in forest carbon stocks is a key indicator of sustainable forest management (Montreal Process Implementation Group for Australia 2008). Sources of carbon within native forests and plantations include those associated with biomass (above ground in living and dead trees, understorey plants, surface litter and woody debris, and below-ground in roots) and that found in the soil. The quantities (or stocks) within these pools are not static, and are dynamic even in the absence of disturbance (Moroni 2011).

The total amount of carbon stored in forests and plantations within the plan area may change over time for various reasons, with the key ones being:

- Variation in climate, affecting growth and mortality rates in the short term, and potentially over the longer term, the native vegetation and forest types that occur, and plantations that can be grown.
- Increases and decreases in the area of native vegetation, particularly forests – for example, the establishment of new plantations resulting in new carbon stores, or clearing resulting in a permanent loss of native forests or plantations and stored carbon.

- Disturbance-induced dynamics, particularly in forests. These disturbances can be natural and human-induced – for example, timber harvesting affects age and size class distribution of native forests and plantation stands and thus local carbon stocks at a point in time. Natural disturbances include events such as storms and outbreaks and spread of pests and disease. Fire can be both natural and human-induced.

Carbon management objectives can be incorporated into policies and management guidelines to increase carbon accumulation or conserve existing carbon pools. Existing carbon pools can be conserved by avoiding their permanent loss through conversion of native vegetation and plantations to other land uses, and by sustaining the total biomass over time. Clearing without reforestation causes the major loss of carbon from forest carbon pools, so seeking to prevent further conversion of areas of native vegetation and tree plantations to other land uses will minimise this impact. This is also important to sustaining a range of other ESFM values and in particular, biological diversity and productive capacity. The end-of-term audit of the current FMP (Conservation Commission 2012) identified losses of forest area resulting from fire, drought, land use change and infrastructure development, and it is likely this will continue in the period of the next FMP, resulting in consequent reductions in carbon storage. Statements that seek to address this are included elsewhere in this Draft plan (see the ‗Biological diversity' and ‗Productive capacity' chapters).

Some authors argue that maintaining or increasing the carbon density of forests at both stand and landscape scales is a key strategy that should be adopted to ensure the contribution of forests to the global carbon cycle (for example, Mackey *et al*. 2008). However, as explained by Canadell and Raupach (2008), there are four strategies available to mitigate carbon emissions that are related to forest management, being to:

i) increase forested land through revegetation

ii) reduce emissions from deforestation and degradation

iii) increase the carbon density of forests at both stand and landscape scales

iv) expand the use of wood products that sustainably replace fossil-fuel emissions.

In other words, carbon storage can be *increased* by revegetating cleared land, rehabilitating deforested and degraded vegetation, managing the density and improving the growth rates of standing vegetation, and encouraging the use of wood products that are produced sustainably. Some comments on each follow.

i) Revegetation within the area of the Draft plan will be limited, as there is little cleared land vested in the Conservation Commission. Various organisations are involved in seeking to increase tree cover and integrate it with other land uses on cleared private land, mainly in the wheatbelt region of Western Australia, outside the area covered by this Draft plan.

ii) Rehabilitation following disturbance of native vegetation through mining or other activities is actively pursued to return habitat, biodiversity, carbon and other forest values (see ‗Developing self-sustaining ecosystems' in the ‗Ecosystem health and vitality' chapter). The rehabilitation of land degraded by *Phytophthora cinnamomi* presents an opportunity to increase carbon storage, however, this remains a challenge for biological and financial reasons. Rehabilitation of unwanted roads is also carried out by other proponents where required, and by the Department as funds permit. This also applies to ex-plantation sites that are being replanted to native vegetation.

iii) Fully stocked forest in the mature and senescent stages of growth is generally at its maximum carbon storage potential and is no longer accumulating carbon. Silvicultural management of forests in younger stages of growth, such as thinning, generally redistributes carbon accumulation onto fewer trees (per unit area) rather than increasing overall carbon accumulation. If other factors (for example, water availability) are not limiting, fertilisation can increase the rate of carbon gain and is often used to establish seedlings and after thinning to

boost productivity in tree plantations, but is not widely used in native forests, except in replanting of karri following harvest. Some fertiliser is also used to help seedlings establish in rehabilitated sites (for example, closed mine sites and basic raw material pits).

iv) Promotion of the use of wood products, particularly in end-uses with a long ‗service life' (for example, construction, flooring and furniture products), and as a substitute for high embodied-energy, greenhouse-intensive products (with higher life cycle GHG emissions), has long been recognised as a way to sustain the contribution of forests to global carbon cycles (Kirschbaum 2001; Moroni 2011). This is acknowledged by the Intergovernmental Panel on Climate Change, which states: *In the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit.* (Nabuurs *et al.* 2007). While the end use of forest products is outside the scope of this Draft plan, efforts by the FPC that promote the use of available wood resources for end products which have a long life in service, and can substitute for high-embodied energy building alternatives, and reduce fossil fuel use, will contribute to mitigation.

For lands vested in the Conservation Commission covered by this Draft plan, about 62 per cent of native forest ecosystems within the RFA area is protected by formal or informal reserves and other protected areas. This includes all old-growth forest, thus protecting the parts of the forest assumed to have the highest carbon density. The remaining 38 per cent is available for a range of disturbance activities that are not allowed elsewhere, including timber harvesting. In native forests subject to cycles of harvest and subsequent regrowth, and plantations similarly subject to harvest and subsequent replanting, the cumulative impact of practices implemented at a stand scale contributes to both the rate of accumulation of carbon and the quantity of carbon emitted. These include (also see Sampson and Scholes 2000):

- *Quantity and timing of timber harvests:* the extent to which carbon stocks are modified at a point in time through harvesting practices is related to the proportion of area harvested, proportion of trees removed and the harvest interval (or rotation length, in plantations). Regeneration and replanting ensure that the area of forest available to store carbon is not reduced, and the preferential use of low impact forest harvesting practices can reduce the quantity of carbon emitted (see next dot point). There are however situations where silvicultural practices are undertaken at the local scale (for example, gap creation) that substantially reduce the site carbon store for a period of time, but this Draft plan seeks to limit these practices to where they are necessary to achieve particular forest management objectives. All areas of native forest that are harvested are regenerated (see the ‗Productive capacity' chapter).
- *Low-impact practices:* reducing the disturbance of soil and remaining vegetation during harvesting will help conserve soil carbon and the productive capacity and sequestration potential of the site. Soil carbon is mostly held in organic matter and measures to protect soils from disturbance are covered in the ‗Soil and water' chapter. However in terms of carbon stocks, as noted in Australia's *State of the Forests Report 2008* (Montreal Process Implementation Group for Australia 2008), in native forests subject to cycles of harvest and subsequent regrowth, change in soil carbon is believed to be insignificant since emissions caused by harvesting disturbance of soils: *are balanced in a given inventory period by re-accumulation through regrowth. This reasoning is also used in accounting rules set out by the UNFCCC*. The report goes on to note that for plantations*: there is typically a long-term increase in soil carbon after some possible (initial) losses.* (The) *effects are dependent upon the pre-establishment condition and establishment technique (Polglase et al. 2000)*.

Also relevant are other key findings from Australia's *State of the Forests Report 2008* (Montreal Process Implementation Group for Australia 2008), which include that:

- Australia's forests sequester (absorb) more GHG from the atmosphere than they emit, helping to offset Australia's contribution to global GHG emissions
- the main historical source of emissions associated with forests is permanent clearing of land for agriculture, and development of urban areas and associated infrastructure (i.e. emissions associated with land use change)
- large releases of GHG are associated with extensive bushfires, although over time, those emissions are expected to be offset by new growth as those areas recover
- a net amount of GHG is sequestered in sustainably harvested native forests – for example, country-level calculations for 2005 show about three times more carbon was sequestered than was removed or emitted in native forests subject to harvest and subsequent regrowth.

Effect on native forest carbon stocks associated with this Draft plan

The estimates of carbon stocks presented in this Draft plan relate to native vegetation within the forest ecosystems summarised in Appendix 6 and do not include estimated changes in carbon stocks for plantations, where there could be significant losses as a result of land use change, drought and bushfire. The calculations do, however, include assumed rates of mine site clearing and associated rehabilitation. Less clear are the potential future rates of clearing that may be associated with infrastructure and development for other land uses, which are therefore not included. However, there are various management activities proposed elsewhere in this Draft plan that seek to minimise these losses (of area).

It is important that the change in carbon stocks be considered at a whole of forest level, and for a relevant timeframe. Some whole of forest studies have been conducted elsewhere which provide a basis for similar work undertaken as part of preparing this Draft plan. Historical analysis and modelling conducted for Victoria's publicly managed lands by Norris *et al*. (2010) showed that carbon stocks were most heavily impacted by bushfire events, harvesting and prescribed burning, although the effects were found to be largely transient as they were offset over time by sequestration from regrowth over the affected area. Of these events, the direct effect of timber harvesting was greater at particular locations than either bushfire or prescribed burning, but the relative effect of bushfires was greatest due to their spatial extent. Prescribed burning was shown to have the least effect, due to the ‗patchy nature' and low intensity (and the proportion of total area treated). Carbon stocks were found to return to pre-disturbance levels over time, with the soil carbon pool being relatively stable and the biomass pool being the most dynamic and most influenced by events. The study found that the carbon stock across Victoria's publicly managed lands is essentially stable over time, in the absence of permanent land-use change.

Native forests are recognised as a major store of carbon, and knowledge of the stock and how it changes over time is essential to inform strategies to maintain or enhance carbon stores. Obtaining precise estimates of the total carbon stocks is a challenging task, as the quantity of carbon stored varies across vegetation types and is directly influenced by the management history and growth stage of the forest. Recent studies conducted in Victoria (Norris *et al.* 2010), Tasmania (Moroni *et al*. 2010) and the Great Western Woodlands (Berry *et al.* 2010) highlight the sampling and technical complexity of this task.

Prior to this Draft plan, estimates of carbon stocks within the south-west forests on the lands vested in the Conservation Commission had not been developed. The National Carbon Accounting System (NCAS) (Richards 2001) provides a comprehensive framework and modelling toolkit to generate broad regional level estimates, but does require substantial calibration of components and refinement of input datasets for the south-west native forests. A recent review by the Department of relevant

research and historic data that could directly or indirectly contribute to the estimation of the total carbon stock or components (above and below ground biomass, soil carbon) within south-west vegetation types found very few comprehensive studies and limited available suitable information. While most forest research projects had collected data on forest condition, structure, silvicultural or other characteristics, only a limited number of studies at specific sites in the jarrah and karri forests had quantified the relative contribution to the total carbon pool of the components. In contrast, the timber inventories undertaken within the south-west forests have measured the standing tree volume to a consistent measurement standard, and generally sampled the range of vegetation types present in State forests and timber reserves, and formal reserves which were previously State forest or timber reserve. These tree volume inventories can be used to provide an indirect measure of the above-ground forest biomass, from which broad regional estimates of the above- and below-ground carbon stocks can be calculated (Snowdon *et al.* 2000; Moroni *et al*. 2010). Importantly, these inventories are applied in the whole of forest woodflow modelling used to calculate the sustained yields (see 'Productive capacity' chapter). Consequently, estimates of the standing carbon stocks derived from the inventories can be directly applied in the modelling systems to forecast changes to those stocks arising from timber harvesting, natural growth and climate change at the whole of forest level.

For this Draft plan, an indicative estimate of the above- and below-ground carbon stocks in live standing trees within the major forest types has been developed by combining data from the Department's timber inventory (using 23,470 aerial photo plots and over 2,000 ground plots), vegetation and forest disturbance datasets. Within similar forest strata (i.e. areas of the same geographic, forest type and disturbance history class), the tree volume estimates were converted to biomass using the basic density for the dominant tree species. The total above-ground biomass in live trees (i.e. the bole, bark, branches and leaves) was then computed using a default _expansion' factor of 1.46 as recommended for eucalypt native forests and applied in the NCAS (Snowdon *et al*. 2000). Similarly, to derive below-ground (root) biomass, a default factor of 0.25 (NCAS) was applied to all forest types and development stages. The dry tree and root biomass was assumed to be 50 per cent carbon (i.e. 0.5, after Snowdon *et al.* 2000).The use of these _expansion' factors across all forest types and development stages is clearly a first approximation, pending future refinement through detailed site studies. For further information see *estimating native forest carbon stocks*. The estimation of soil carbon stocks was not attempted at this time, given the lack of data available for the forest soils.

The indicative estimate of the total above- and below-ground carbon in the live standing trees in the south-west forests projected to 2014 is 164.1 million tonnes, of which some 44 per cent (or 72.8 million tonnes) occurs on formal reserves and forest conservation areas (Table 5).

Table 5: Indicative estimates of the above- and below-ground live tree carbon stocks to 2014 in major native forest types

Major forest type	**Biomass carbon Mt C**	
	Formal reserves and forest conservation areas	**State forest and timber reserves**
Jarrah	47.8	74.0
Karri	15.5	14.3
Wandoo /other	9.5	3.0
Total	**72.8**	**91.3**

Notes:

1. These estimates are for the 2.25 million hectares of south-west forests within the RFA boundary on lands vested in the Conservation Commission.
2. These estimates have been compiled from inventories that vary in sample intensity and geographic coverage, and the relative precision of the estimates therefore varies markedly between vegetation types and tenure categories.
3. These estimates do not include litter, coarse woody debri and shrub components.
4. _Other' forest types are bullich, peppermint and coastal heath, shrub, herb and sedgelands, ecosystems.

The lower total carbon stock in the formal reserves and forest conservation areas (Table 5) arises from several factors. Over 28 per cent of the total area in these reserves comprises ecosystems with very low standing woody biomass such as shrub, herb and sedgelands, peppermint and coastal heath, rocky outcrops and sand dune systems. Also, within most of the jarrah forest ecosystems, the average standing volumes within the two-tiered and regrowth forests were estimated to be higher in the State forest areas than in reserves, which reflects both the past silvicultural history of these forests and some bias in location of plots on which the estimates are derived, since the plots were established during the late 1980s only in areas that were (then) State forest or timber reserve.

The above-ground average carbon density of live trees within the jarrah forests ranged from 30 to 143 tonnes per hectare. These figures are comparable to the mean carbon densities reported by Moroni *et al.* (2010) of 118 tonnes per hectare for dry eucalypt forests in Tasmania. Hingston *et al.* (1981) reported the total above-ground live tree biomass in a jarrah forest near Dwellingup was 263 tonnes per hectare, equivalent to 131 tonnes of carbon per hectare. In the karri forests, the above-ground average carbon density of live trees ranged from 80 to 183 tonnes per hectare.

Additions and losses to the total biomass carbon stocks will occur during the 10-year period of the plan. As indicated above, assuming a stable land base, additions will arise from net growth (i.e. growth in excess of mortality) across the forest, while localised losses will accrue from clearing for mining and infrastructure, prescribed fire and bushfire events, timber harvest events, and significant pest or disease events. Further, the rate of recovery of carbon following disturbance will vary with the intensity and scale of vegetation changes. The changes in the standing live biomass carbon arising from forest growth, mining and timber harvesting were projected using the combination of settings for Scenario 1 and Scenario 2 described in the _Productive capacity' chapter. The results are presented in Table 6.

Table 6: Projected changes in the indicative above and below ground live tree carbon within major forest types under the Draft plan scenarios for sustained yield

Major forest type	**Biomass carbon Mt C**		
		Scenario 1	**Scenario 2**
	2014	2023	2023
Jarrah	121.8	123.2	126.0
Karri	29.8	32.8	33.5
Wandoo/Other	12.5	13.0	13.0
Total	**164.1**	**169.0**	**172.5**

Notes:

1. These estimates are for the 2.25 million hectares of south-west forests within the RFA boundary on lands vested in the Conservation Commission.
2. The precision of these estimates differs between forest types due to variations in the quality and quantity of data contributing to projections of growth and change (e.g. limited samples within the _other' forest types).

These projections suggest that at the whole of forest scale, during the period of the Draft plan under both scenarios there would be a net increase in the total carbon stored above and below ground in the live standing trees. The net increase is likely to be higher under Scenario 2 due to less wood being removed from the both the jarrah and karri forests. Overall, however, this component of the carbon stock is comparatively stable at the whole of forest scale given the large area of forest set aside from disturbance in reserves, and the comparatively small area subject to timber harvesting each year in the various forest types.

In terms of the total carbon cycle, the figures in Table 6 are only a partial analysis: over the period of the plan, the soil carbon pool has been assumed not to change, the effect of fire events has not been directly modelled, but rather assumed to be consistent between the scenarios and balanced over the longer term at the whole of forest scale, and both the above-ground dead biomass component and the carbon removed from the forest but stored in wood products have not been considered. Work is

therefore ongoing to refine the estimates of above- and below-ground carbon, and to expand the scope of analysis to incorporate these components.

Notwithstanding the imprecision in the estimates of above-ground biomass and the carbon pool, management activities proposed through this Draft plan seek to minimise unnecessary emissions and maximise biosequestration (subject to the other goals identified in this Draft plan).

Goal

Within the constraints of a changing climate, the plan proposes the following activities at the whole of forest scale, for the purpose of seeking to sustain the contribution of the areas covered by the plan to global carbon cycles consistent with relevant legislation and the achievement of other goals.

Identified values and threats

The plan seeks to protect and maintain the following values:

- the land base and extent of native vegetation and forest cover
- the land base, extent and type of plantations
- site attributes that determine the carbon density and capacity of areas to sequester carbon.

Threats to these values include:

- conversion of native vegetation and plantations to other land uses
- degradation of areas from damaging agents (including weeds, pests and diseases), droughts and inappropriate fire regimes
- climate change impacts on survival and growth
- excessive soil disturbance and compaction and loss of soil organic matter
- harvest and removal of wood products in excess of sustainable limits
- unsuccessful regeneration, replanting or rehabilitation.

Note that the capacity of areas covered by the plan to contribute to global carbon cycles is strongly linked to productive capacity, hence there is considerable similarity between the values and threats identified here, and those in the ‗Productive capacity' chapter.

Operations proposed to be undertaken (management activities)

(note there are a number of other management activities proposed in other chapters that will also contribute to achieving the goal identified in this chapter)

49 The Department will:

- 49.1 remain abreast of current knowledge and contemporary management approaches in relation to climate change and its possible impacts on native ecosystems and sustained yield
- 49.2 seek to maintain a forest carbon science capability and understanding of climate change and its impact on ESFM and work collaboratively with other agencies and institutions on matters of mutual interest
- 49.3 report on carbon stores in the next draft FMP
- 49.4 incorporate climate change prediction into future planning for the management of land to which the plan applies, where reasonable and practicable

49.5 contribute to State and national policy development on climate change adaptation and mitigation

49.6 investigate opportunities that may arise from an emerging carbon economy

49.7 periodically review guidelines for silviculture and fire management with a view to incorporating techniques that recognise the contribution of the areas covered by the plan to global carbon cycles, consistent with other mitigation and adaptation strategies and achievement of other silvicultural objectives and goals for forest management.

50 The FPC will:

50.1 **(Plantations):** remain abreast of current knowledge and contemporary management approaches in relation to climate change and its possible impacts on plantations

50.2 seek to encourage the use of wood harvested from native forests and plantations to maximise greenhouse mitigation benefits.

Key performance indicator

Key performance indicators will be used to track the implementation of the next FMP. One indicator has been selected related to global carbon cycles.

Key performance indicator 14	The establishment and measurement of representative plots for monitoring carbon stocks and change on lands covered by the plan.
Performance measure	Number of plots established and measured.
Performance target(s)	Twenty plots by mid-term and 40 plots by end-of-term.

Productive capacity

Background

Productive capacity refers to: *the relative capacity of an area to sustain a supply of goods and services in the long run* (Helms 1998). Broadly it is the capacity of natural areas to sustain ecosystem processes and provide a range of goods and services, whereas the productive capacity of a particular site refers to the total biomass that can be produced over time at that location, given the inherent resources available (such as soil, water and sunlight). Inappropriate fire regimes, and some weeds, pests and diseases can also have an impact on productive capacity. Statements to address these factors are included in the _Ecosystem health and vitality' chapter.

Productive capacity is also one way to measure the sustainability of the flow of some of the benefits from forests to society. It is a measure that can be applied to both wood and non-wood resources and is a key factor in assessing the sustainability of management. Maintaining productive capacity of forests involves maintaining the land base, and from areas of State forest and timber reserves where harvest is permitted, providing for harvesting rates for timber production on a sustained yield basis.

Maintaining the productive capacity on other tenure categories is also important to a range of other values, including ecosystem health and vitality and the contribution of those areas to global carbon cycles, and these issues are addressed in other chapters. This chapter is focused on the productive capacity of State forests and timber reserves within the plan area – including both native forests and plantations. Note that some freehold land held in the name of the Conservation and Land Management Executive Body (formerly the Department's Executive Director) contains some plantations and indigenous vegetation. While this land is not vested in the Conservation Commission, the area occupied by native forests (a component of indigenous vegetation) is taken into account in this Draft plan, because its productive capacity contributes to the sustained yield from native forests.

In the context of this chapter, the key native forest products include wood, and other forest produce such as public firewood, burls, craftwood, wildflowers and seeds and honey. The management of this other forest produce is discussed later in this chapter.

Wood products are harvested from native forests and plantations (predominantly of pine, with some areas of hardwood species) by the FPC under planning and approval processes established by the Department. For native forests, this begins with the Department preparing rolling, three-year indicative harvest plans in consultation with the FPC, and making these available for public comment. The FPC then prepares annual timber harvesting plans and also makes these publicly available. Removal of wood products from areas of clearing associated with operations on mining leases, the construction of roads or other infrastructure on State forests and timber reserves is also incorporated into these harvest plans as necessary. Subsequently, for each harvesting area (a coupe or compartment), detailed plans are prepared by the FPC and submitted to the Department for assessment. Harvesting operations are then conducted in accordance with a range of subsidiary documents and any specific site-level approval conditions imposed by the Department. Current processes for plantations are similar, although are not consistently applied in all areas. However, it is intended that where required by the Department, relevant elements of the process applied to native forests will also apply to plantation harvesting operations.

In addition to areas of pine plantations, native forests in some LMUs will be relatively more important for wood production during the term of this Draft plan, as identified in Appendix 1. This considers

when previous harvesting occurred across the forest, the percentage of the LMU area that is available for wood production and current stand condition.

There are several issues that have become more prominent during the term of the current FMP that have a bearing on wood production from forests, including:

i) *Climate change*: it is expected that the long-term productive capacity of south-west forest ecosystems (and plantations) will be affected by the predicted higher atmospheric carbon dioxide concentrations and associated drier and warmer conditions. The precautionary approach taken in the current FMP needs to be reviewed in light of further observations and modelling of climate change. Accordingly, CSIRO (2007) projections of climate change to 2070 have been applied when modelling changes in forest productive capacity for this Draft plan (see the ‗Global carbon cycles' chapter). Site productive capacity is fundamentally linked to available water (rainfall, soil moisture and groundwater) and temperature changes, hence the need to:
   - explicitly account for these trends in calculations of sustained yield
   - provide for adaptive measures that can be undertaken to mitigate adverse effects
   - maintain monitoring and review processes.

   The other key site attribute that contributes to productive potential is its inherent soil type. Measures to protect soils are discussed in the ‗Soil and water' chapter.

ii) *Degradation of forest*: with a projected increase in bushfire frequency, intensity and scale, and prolonged droughts, it is possible that more areas of native forest and plantations will be affected. Native forests may recover but plantations will often not. Infestation by *Phytophthora* dieback can have dramatic long-term impacts on the productive capacity of areas of native vegetation, including forests. A range of management activities are proposed to mitigate these risks (see the ‗Ecosystem health and vitality' chapter). Further comments in relation to salvage of wood products from native forests following major disturbance are included in the section ‗Sustained yield from native forests', later in this chapter.

iii) *Log product mix*: the species composition, structure and condition of the forests available for wood production influence the capacity to produce various wood products. The size and quality of wood products harvested have altered somewhat during the current FMP, relative to the period prior to that. For example, there was a shift during the current FMP toward greater reliance on regrowth forests[10] with a higher proportion of generally smaller, lower quality stems. The rate of adaptation by industry to use the available mix of log size and quality is a consideration in the settings adopted when calculating the sustained yields in this Draft plan. The mid-term audit of the current FMP (Conservation Commission 2008b) reported variation between predicted and realised jarrah sawlog yields under the current FMP, and corresponding adjustments have been made as necessary as part of the calculation of sustained yields for this Draft plan.

Several related issues were identified in the mid- and end-of-term audits of the current FMP (Conservation Commission 2008b and 2012), including:

- Issues associated with timely completion of processes for harvest planning, completion of harvesting and regeneration burning associated with harvesting operations. In 2009, the Department, in liaison with the FPC, undertook a review of performance and management practices associated with conducting timely regeneration burns. Changes to management practices

[10] In native forests, there are three broad stand structural types, being: *old-growth forest*, which is not available for timber harvesting; *two-tiered forest*, a general term used to describe stands of mixed age and structure, comprising mature trees intermixed with younger regrowth trees that have arisen from regeneration following the death or removal of mature trees by previous harvests or other disturbances (sometimes also referred to as ‗mixed species, mixed age forest' or ‗mixed species, uneven-aged forest'); and *regrowth forest*, which is dominated by similar aged stems originating from previous harvest events, such as gap creation, or other disturbances, such as bushfire.

were recommended in two key areas: revised requirements for approval of log stockpile locations and improved integrated planning practices.

- Changes that were proposed to log grading, which did not eventuate.
- The decline in the area of native forest as a result of infrastructure developments, and the decline in the area of plantations due to drought, fire and land use change (see ‗Maintaining forest area', below).
- The dominance of regeneration establishment and selective cut outcomes, and the low proportion of thinning in jarrah forest (however, it was noted that the delay in thinning of jarrah stands and the relative dominance of selective cut silvicultural outcomes were a result of lack of markets for non-sawlog quality wood. Accordingly, the mid- and end-of-term reports of the current FMP (Conservation Commission 2008b and 2012) noted that the FPC should pursue markets for this material).
- That sustained yield projections would need to be updated to reflect projections for the delay in early thinning of regrowth jarrah stands, and further work on stratification of the structure, condition and tree size of regrowth stands was required to improve scheduling of thinning and yield projections.

The lack of markets for smaller, lower quality logs has been a limitation to the implementation of some actions under the current FMP. Work by the FPC continues to explore potential new industries capable of using such resources, which may assist in achieving silvicultural objectives.

The stratification work referred to above is ongoing. The other issues and trends have been considered in proposed changes to silviculture guidelines and in formulating the range of settings to apply in determining the sustained yield of timber, and the amount of other wood products that may be provided for under this Draft plan, as discussed further in the sections which follow.

The end-of-term audit of performance report of the current FMP (Conservation Commission 2012) also noted the ‗incomplete compliance' by the public with the requirements for taking firewood. Public firewood collection is discussed further in the section ‗Other forest produce', later in this chapter.

Goal

An overall goal of the plan is to seek to sustain the productive capacity of native forest ecosystems and plantations as they progressively adapt to changing climate conditions. This overarching goal is supported by a number of subsidiary goals for which the plan proposes a range of corresponding activities, as set out in the sections which follow.

Identified values and threats

The plan seeks to protect and maintain the following values:

- the land base, extent and composition of native vegetation and forest cover
- the land base, extent and type of plantations
- site attributes that determine the capacity of areas to produce products valued by society
- a log product and wood quality mix that supports a viable industry
- the range of stand structures and age classes that contribute to a sustained yield and provide for resilient ecosystems.

Threats to these values include:

- conversion of native vegetation and plantations to other land uses
- other values taking precedence over productive activities within the land base available for productive activities
- degradation of areas from damaging agents (including weeds, pests and diseases), droughts and inappropriate fire regimes
- climate change impacts on survival, growth, flowering and seeding cycles
- excessive soil disturbance and compaction
- unsuccessful regeneration, replanting or rehabilitation
- lack of wood product markets and/or funds required to achieve silvicultural objectives
- values being impacted because of inadequate procedures or ineffective operational application of current procedures
- harvest and removal of forest produce in excess of sustainable limits.

Maintaining forest area

Background

As indicated above, maintaining the land base or area of forested land is a fundamental first step toward maintaining its productive capacity, but there is a range of pressures on the remaining areas of native forest and plantations that are available for productive activities. Within the areas covered by the plan, there are a number of redundant roads and legacy basic raw material pits that are being progressively rehabilitated as funds permit. The mid-term audit report on the current FMP (Conservation Commission 2008b) noted that additional funding would assist in addressing legacy rehabilitation work. Further statements in relation to roads are included in the ‗Socio-economic' chapter, and in relation to basic raw material pits, also in that chapter, and in the ‗Developing self-sustaining ecosystems' section of the ‗Ecosystem health and vitality' chapter. The latter is also relevant to the rehabilitation of mine sites.

Native forests

Increasing population growth and mining activity within the State's south-west continue to result in further alienation of native forests for utilities and infrastructure corridors. The end-of-term audit of the current FMP (Conservation Commission 2012) identified an additional 940 hectares of native vegetation cleared for these purposes during the term of the current FMP. Statements on measures that will seek to maintain the overall area of indigenous vegetation are included in the ‗Biological diversity' chapter, and those statements also serve to maintain the area of native forest with respect to productive capacity.

However, in order to provide stability for the dependent processing industry, it is important to seek to maintain the net area of native forest available for wood production, and to seek to ensure that productive capacity is restored through rehabilitation of cleared areas, such as mine sites and basic raw material pits. Activities that seek to achieve the latter are included in the section ‗Developing self-sustaining ecosystems' of the ‗Ecosystem health and vitality' chapter. Basic raw materials are also covered in the ‗Socio-economic benefits' chapter.

Plantations

Plantations of pines and eucalypt species have been established within the area covered by the plan for the purpose of supplying wood products to industry. To attract large-scale investment in processing, previous Governments offered long-term security of pine log supply for particleboard and medium-density fibreboard manufacture (1976), sawmilling (1992) and laminated veneer lumber manufacture (2002). These obligations are embodied in State Agreement Acts, all of which operate for the full 10-year period of the next FMP. These obligations include requirements to supply specified quantities of pine logs, and to maintain the area of plantation to ensure that supply obligations can be met.

Over the period of the current FMP, the area of pine plantations has reduced significantly, from 59,000 hectares to 52,000 hectares, mainly due to land use change, drought and bushfire. Due to ongoing reductions in area of plantations, the capacity to maintain the scale of the plantation industry and meet contractual obligations is becoming increasingly difficult. Historically, most reductions in the plantation land base have occurred as a result of urban and infrastructure developments. Also, in the 1990s, some areas of pine plantation were converted to hardwood plantation to assist in meeting the then Department of Conservation and Land Management's agency arrangements with Hansol and Bunbury Treefarms. These agreements expire during the term of the current FMP, and to help ensure there is sufficient supply for a viable pine processing industry, these areas may be replanted with pine. In more recent times, there have been further losses of plantation to drought and bushfire. In future years, it is possible that none of the pine plantations to the north of the Perth metropolitan area will be replanted. This proposed removal of pine plantations over the Gnangara water mound is intended to assist in boosting recharge of the groundwater resource and in particular, its continuing contribution to Perth's water supply.

Some plantation areas are also important for public recreation and provide an important food source for some native fauna (for example, for Carnaby's black cockatoo). The use of plantations for recreation is generally promoted, although public access may need to be temporarily suspended during harvesting operations or for other reasons (for example, to help in management of disease or pests).

Goal

The plan proposes the following activities at the whole of forest and local scales for the purpose of seeking to maintain the net area of native forests and plantations available for wood production.

Operations proposed to be undertaken (management activities)

(as noted above, statements relevant to maintaining the overall area of indigenous vegetation, including native forests, are included in the ‗Biological diversity' chapter)

51 The Conservation Commission, the Department and the FPC will make submissions in relation to development proposals (including, but not limited to, proposals for infrastructure development, extraction of minerals and petroleum resources, development of geothermal energy and, the geological storage of greenhouse gases) forwarded to them for comment or advice, with a view to:

- 51.1 seeking to minimise the permanent loss of native forests and plantations available for wood production and/or impacts on their integrity as a result of development
- 51.2 seeking the replacement of native forests and plantations not replanted or permanently lost to development, consistent with relevant legislation and government policies
- 51.3 promoting the construction of infrastructure such as roads, pipelines and other utilities at common locations, such as infrastructure corridors, while minimising construction in sensitive areas.

52 **(Plantations):** The FPC will seek to maintain the area of plantation estate required to meet State Agreement Act supply requirements by replanting pines in all suitable areas of State forest and timber reserve that have previously been planted with pines and have been clearfelled, except at Gnangara, Pinjar, Yanchep and other areas determined consistent with the agreement ratified under the *Wood Processing (Wesfi) Agreement Act 2000*.

53 **(Plantations)**: The FPC will replant areas of clearfelled hardwood plantation to softwood plantations.

Sustained yield from native forests

Background

Sustaining the flow of goods and services from the forest is an important element in ensuring forests are managed in an ecologically sustainable manner. Section 19(1)(i) of the CALM Act specifies that the Conservation Commission is to advise the Minister on the production and harvesting, on a *sustained yield basis*, of forest produce throughout the State. This includes the production of timber from native forests, and section 55 (1a) of the CALM Act explicitly requires that *timber production* from State forests and timber reserves be managed on a *sustained yield basis*. _*Timber*‘ is defined as *including trees when they have fallen or have been felled and whether sawn, hewn, split or otherwise fashioned,* while _*Tree*‘ includes *shrubs, bushes, seedlings, saplings, and reshoots of all kinds and of all ages.* Since hewing and splitting are not common contemporary practices, for the purposes of this Draft plan, _timber‘ refers to jarrah and karri first and second grade sawlog material.

The sustained yield of jarrah and karri sawlogs set in the next FMP informs the determination of _allowable cut‘ for those products. An _allowable cut‘ will also be set for other jarrah and karri log categories, and for sawlogs and where relevant, other log categories of other species.

The woodflow from each forest region may vary between years depending on the mix of forest made available in annual harvest plans. In the course of harvesting jarrah and karri sawlogs, lower grade logs are obtained from the boles of trees felled to obtain the first and second grade jarrah and karri sawlogs. Lower grade logs are also obtained from trees, including marri, that are removed in order to facilitate regeneration, or growth of retained crop trees. Lower grade logs are also available from some thinnings that do not produce sawlogs. Expanded programs of first thinning in regrowth karri and jarrah forest could be undertaken that would not affect the sustained sawlog yields but would make available additional bole volume. Such expanded activities would promote future sawlog growth and stand management, and may occur during the life of the plan in mining rehabilitation, water catchment areas, or regrowth karri forest.

Following the adoption of a forest management plan, the FPC is required (under section 58(1) of the *Forest Products Act 2000*) to ensure that the quantity, kind and location of forest products (the wood and related subset of forest produce) in its production contracts are in accordance with that plan. The period of production contracts also has to be aligned with the period of the plan (section 58(2) of the Forest Products Act), which means the production contracts issued by the FPC are limited to a maximum 10-year period.

The key agency roles in the process of regulating the level of yield from the forest are as follows:

- the Department undertakes the calculation of sustained yield, monitors and reports on the actual removals and related performance indicators (for example, KPI 16) during the term of the plan, and maintains datasets and information to perform these tasks
- the Conservation Commission prepares the Draft plan through the agency of the Department‘s CEO and proposes a level of sustained yield that is consistent with ESFM principles

- the Minister for Environment makes a determination on the limits to harvest levels allowed during the period of the (final) plan, following receipt of advice from the EPA
- the FPC informs the calculation of sustained yield through the specification of industry objectives, product requirements, economic and operational constraints, and subsequently issues and manages contracts for forest products up to the ‗allowable cut', and monitors actual removals and provides these data to the Department.

The process for estimation of sustained yield from native forest and the basis of the figures in the current FMP is described in supplementary reading (see the *sustained yield information sheets*).

Given the principles for ESFM and the various goals of management in this Draft plan, within a defined area, the main factors which affect the sustained yield of forests include:

- the net area available for the activity
- attributes of the forests – including species, age and size classes, growth and mortality rates, which in turn are affected by soils, climate, natural disturbance, pests, diseases and management history
- the silviculture applied.

Further comments on each of these factors follow.

Net area available

Calculations of sustained yield have been modified as required to reflect the net area of forest available for timber harvesting, within State forest and timber reserves. This excludes areas such as the network of informal reserves where timber harvesting is not permitted, and other areas, such as fauna habitat zones, where it is temporarily excluded (see the ‗Biological diversity' chapter). Further adjustments to the net area are made during the calculation of sustained yield, to exclude unproductive or degraded forest, such as those areas mapped as drought impacted to the end of 2010, areas that are too steep to harvest safely or are used as minor roads or landings. Included in the net area are areas of jarrah-dominant mine site rehabilitation.

Attributes of native forests

The Department maintains inventory information about native forest species and age class distribution for State forest and timber reserves, along with information about the extent and impacts of key tree pests and diseases. In this Draft plan, the sensitivity of sustained yield to the influence of a drying climate on forest growth has been explicitly incorporated into modelling, using the climate projections of CSIRO (CSIRO 2007; further information on this is included in the ‗Global carbon cycles' chapter). Specifically, the Department has incorporated elements of the following work into its modelling for this Draft plan, and will continue to refine these for the proposed FMP:

- *Standing wood inventory* – the standing inventories of the two-tiered/mature jarrah forest, regrowth karri forest and two-tiered karri forest are being progressively updated to 2010. These provide the basis for projecting future yields and for generating preliminary estimates of the standing above-ground biomass. In the two-tiered jarrah forest, the current FMP applied inventory data collected to 1990, so this update (based on a combination of re-measurements and modelling) accounts for growth and changes since 1990.
- *Forest stratification and extent* – the stratification of the regrowth jarrah and karri forests into areas of similar site quality or structural condition (for application of appropriate silviculture guidelines in modelling) is being enhanced for major portions of the forest. This work has involved interpretation of high resolution, digital aerial photography and field surveys to refine height, species mix and density classes.

- *Future growth* – adjustments for the potential impact of climate change on the growth rates of jarrah and karri trees and stands have been applied when projecting future yields. The approach varied according to whether two-tiered or regrowth forests were being projected.
    - *For regrowth jarrah and karri forests*, historical tree measurements to 2010 were used in the current empirical growth models to predict future stand growth and consequent yield. Reduced future growth rates were then applied as determined from a physiological growth model for the same site qualities, using the 3PG physiological growth model developed by CSIRO (Landsberg and Waring 1997; Landsberg and Sands 2010), which was calibrated for jarrah and karri by the Department. This model was then run on a monthly time step using the CSIRO (2007) climate projection datasets to 2070, for high and moderate GHG emission projections. The overall effect of this approach is a progressive reduction over the long term of the maximum productivity of the regrowth forest sites as the projected rainfall reduces. This trend is consistent with other analysis (for example, ABARES 2011).
    - *For the two-tiered jarrah and karri forests*, the projected yields are much less sensitive to variations in growth rates over the next few decades, because most of the available yield is already standing in larger trees of sawlog size. In these forests, the growth rates recorded in the inventory re-measurements for the period 1990 to 2010 (jarrah) and 2002 to 2012 (karri) were applied for the period of this Draft plan, that is to the end of 2023, and from 2024, no growth on the mature trees was applied in subsequent decades (this is very conservative and allows for the potential impacts of a drying climate on future growth).
    - The tree growth and consequent yields for forest areas identified as vulnerable to climate change in the vulnerability assessment report (see *Maher et al. 2010*) were included in the adjustments described above.
    - In the eastern jarrah forest, projections included extended time for recruitment and stocking levels adjusted to reflect expected drier conditions. These provisions are specified in the proposed revised silviculture guidelines for jarrah and its subsidiary guidance documents.

- *Past and future disease and insect impacts* – the current and future impact on yields from some forest diseases and insect outbreaks has been incorporated in yield projections, including:
    - Forest mapped (to 2010) as infested with *Phytophthora* dieback has had reduced growth rates applied, depending on the likely level of impact of the disease on the vegetation. The future autonomous spread of *Phytophthora* dieback (to the year 2160) was simulated and adjustments to the yields from areas following assumed ‗infestation' were applied in the woodflow modelling.
    - Reduced sawlog yields were projected for regrowth karri stands recorded (to 2010) as having a high incidence of *Armillaria*.
    - Adjustments to current and future yields were applied in the woodflow modelling for areas recorded (to 2010) as having high incidence of *Phoracantha* borer (karri regrowth). These adjustments typically took the form of higher rates of log product degrade for areas with recorded outbreaks.

- *Past and future bushfire impacts* – the impact of previous bushfire events on standing volume is incorporated in the standing wood inventories and forest stratification used in the woodflow modelling. The historical frequency and extent of catastrophic bushfires which initiated stand regeneration was factored into the projections of karri woodflows in a similar manner to the current FMP. The likelihood of an increase in the frequency and severity of bushfires under a drying climate was not directly modelled for this Draft plan, but further work is underway to develop this component.

- Related effects on *tree mortality* have been incorporated through adjustments to wood yields.

Further information on these aspects of yield modelling is available in supplementary reading (see the *sustained yield information sheets*).

Silviculture

Silviculture is _*the theory and practice of managing the establishment, composition, health, quality and growth of forests and woodlands to achieve specified management objectives*‘. The Department uses a series of silviculture guidelines to outline the management principles for the various forest types, and the silvicultural treatments that can be applied to them. The guidelines also inform decisions about the timing and duration of cutting cycles in the various forest types, and this information is used in conjunction with the outputs of forest and stand level inventories to determine sustained yield. The Department uses a range of subsidiary guidance documents (see Appendix 4) to define the parameters for the various components of the timber harvesting process, either in terms of recommended methods or required outcomes (or both).

Silvicultural practices are carried out in accordance with silviculture guidelines, which seek to ensure that a wide range of forest values are catered for at a local scale, and complement a range of other measures described by the Draft plan. As required by the current FMP, a review of silvicultural practices has been completed (*Burrows et al. 2011*) (see also the existing silviculture guidelines for *jarrah forest*, *karri forest* and *wandoo forest*, and the *proposed revised silviculture guideline for jarrah forest*). Appendix 14 also provides information on the history of silvicultural practices in Western Australia‘s native forests, the current silvicultural practices and proposed changes. It is intended that the revised silviculture guidelines for jarrah, karri and wandoo will be finalised in consultation with the Conservation Commission, in parallel with the finalisation of the next FMP and will be consistent with the settings adopted for that plan.

The *Review of Silviculture in Forests of South-west Western Australia* (Burrows *et al.* 2011) made the following comments.

> *There exists a comprehensive documentation of silvicultural policies, principles, guidelines and manuals prepared by DEC, which, based on the evidence available to the Panel, and given appropriate staff training and compliance, appears to adequately accommodate the conservation of biodiversity and other environmental values at the local forest scale.*
>
> *In summary, the Panel identified a number of relatively minor issues of potential concern (see below) regarding biodiversity conservation and silvicultural prescriptions that require attention, but overall, existing and proposed practices should sustain biodiversity and forest productivity at the local forest scale.*
>
> *It is the Panel’s view that forest management to achieve a better water balance in a drying climate is a most critical issue facing forest managers now and in the future. As a consequence of a drying and warming trend since the 1970s, and a legacy of predominantly heavily stocked regrowth forests, these ecosystems are experiencing acute water stress.*
>
> *If this issue is not addressed as a matter of priority, then the consequences will be undesirable, probably irreversible, and will likely compromise efforts to achieve ESFM. Silviculture has a pivotal role in addressing this issue. As far as is feasible given capacity constraints, the focus of timber production from jarrah forests in particular should be to increase environmental water availability through reduction of standing basal area and leaf area index. While all jarrah forest ecosystems will probably benefit from silvicultural measures that reduce water stress, management should focus in the higher rainfall zones, as achieving significant improvement in water yield is most likely in these areas.*

This issue is discussed further in the _Water‘ section of the _Soil and water‘ chapter.

The current silviculture guidelines include timber production objectives which aim to maximise site productivity and the volume of sawlogs over time. This involves managing the density, composition and structure of stands at all stages of stand development, from regeneration establishment to senescence.

The proposed revised silviculture guidelines for jarrah include a number of proposed changes which are intended to enhance productive capacity, including the use of ‗variable density thinning' (see glossary), the identification and retention of dieback-resistant trees in areas of high disease impact and individual trees or groups of trees that exhibit resistance to disease or the effects of insect outbreaks (jarrah leaf miner or gum leaf skeletoniser). The guidelines also recognise that disease resistant seed or propagules may be used for rehabilitation and regeneration activities where this material is available, and is considered likely to result in better long-term regeneration or growth.

The changes to the retention of larger marri trees outlined in ‗Integrating forest management across the plan area' in the ‗Biological diversity' chapter are expected to have little impact on the achievement of silvicultural outcomes and sustained yield, because these trees are a small component of the stand and often have poor crowns, hence at the landscape scale they are not thought to have a significant adverse impact on the overall productive capacity of regrowth forest.

In addition, the proposed revised guidelines have a number of changes that may impact on sustained yield including:

- the use of trees with mature spreading crowns as seed trees to improve regeneration success
- salvage of sawlogs in stands impacted by fire and other damaging agents
- use of temporary exclusion areas in areas where harvesting and follow-up treatments achieve target stand density, in areas around mine site rehabilitation, in areas where there is intensive removal of non-sawlog material, in forest blocks isolated in an agricultural landscape and to provide linkage with mature forest in informal reserves
- more timely completion of harvest operations in areas of regeneration release or establishment
- revised target stand density in jarrah forest subject to thinning.

The Conservation Commission raised concerns about regeneration in the eastern jarrah forest in its mid-term audit of the current FMP (Conservation Commission 2008b). In its corresponding report, the EPA questioned the capacity of the jarrah forest 'in the low and adjacent medium rainfall areas, particularly in the northern forest' to ‗contribute to the jarrah sustained yield and also be consistent with ESFM' (EPA 2010a). Subsequently, a review of the vulnerability of native forest areas to climate change (see *Maher et al. 2010*) and an expert panel review of silviculture (*Burrows et al. 2011*) were undertaken. Burrows *et al.* (2011) investigated this matter and reported it was ‗not aware of any evidence to support' this suggestion. The expert panel stated:

> *While growth rates in the northern and eastern jarrah forests are slow, the decline in the timber production from these forests is a consequence of a history of harvesting, and thus a reduction in the availability of sawlog, and the location of customers, who are predominantly located in the southern and western regions of the jarrah forest. Net productive capacity relies on production from the entire forest estate, and the current models accommodate low levels of production in some areas and higher levels of production in other areas. The Panel is of the view that jarrah forests in all rainfall zones have the potential to contribute to the jarrah sustained yield provided ecologically appropriate silvicultural and other management systems that support sustainable forest management are in place.*

As noted in the end-of-term audit of the current FMP (Conservation Commission 2012), this Draft plan addresses the issue of climate change and its potential implications for a range of forest values in this and other chapters. This will be considered further in preparing the proposed FMP.

In the karri forest, a nominal rotation length of around 100 years has generally been assumed in the management of regrowth stands. The current FMP also includes provision for the limited clearfell of regrowth karri stands older than 75 years. This Draft plan continues this setting and this is included in Scenario 1 in Table 7. Scenario 2 in Table 7 includes a setting which increases the rotation length to 90 to 100 years for a portion of those regrowth karri stands that would otherwise be subject to clearfell when older than 75 years. Under the settings for the current FMP, stands regenerated in the 1930s would be scheduled for clearfell in patch sizes of less than 20 hectares at a minimum age of 80 years. This provides for a higher proportion of larger log sizes to be made available to the timber industry over the period of the plan while also introducing structural diversity into areas of even-aged forest. The deferral of clearfelling of these stands in Scenario 2, results in a variation in the sustained yield of karri sawlogs and the mix of log sizes that would be made available over time.

Scenarios for sustained yields from native forests

Several management options are presented for comment in other chapters that will potentially impact productive capacity and the level of timber yield that can be sustained from State forest and timber reserves. Given various possible combinations of these management options, there are two scenarios for the determination of the sustained yields put forward for public comment in this Draft plan. This feedback will be considered in determining the settings adopted for the proposed FMP. This process will integrate long- and short-term economic, environmental, social and equitable considerations.

In summary, Scenario 1 includes settings that overall, provide for a higher sustained yield, while Scenario 2 includes settings that overall provide a lower sustained yield. Both scenarios are based on updates to a number of forest inventory datasets, growth rates that take into account expected climate change and related impacts as described above, most elements of the proposed revised silviculture guidelines, and an updated allowance for further areas of unmapped old-growth forest yet to be identified. Together, Scenario 1 and 2 encompass a range for the sustained yields which encapsulate ESFM values, from which a final balance is sought for inclusion in the next FMP. Those settings that differ between each scenario are listed in Table 7.

Table 7: Native forest sustained yield – scenarios and key settings

Setting influencing sustained yield	Component	Scenario 1	Scenario 2
ESFM/management objectives	**Silviculture**		
	_Silviculture for water production' within selected water catchments	✓	x
	Expanded thinning program within older jarrah dominant stands rehabilitated following mining	✓	x
	Increase the rotation length for some regrowth karri stands regenerated in the 1930s	x	✓
Area available for wood production	**Formal reserves**		
	Establish additional reserves within the Whicher Scarp ecosystem	x	✓
	Informal reserves		
	Not classify as informal reserve those areas previously classified as old-growth forest that are confirmed as not old-growth forest	✓	x
	Incorporate revised travel route locations in Warren Region	✓	x
	Incorporate a partial buffer on the Munda Biddi trail	x	✓
	Fauna habitat zones		
	Redistribute and reduce the size of some zones	✓	x
Effects of climate change	Medium climate change severity	✓	x
	High climate change severity	x	✓

In each scenario, the other major factors that will influence the sustained yields of sawlogs (and the volume of other log products arising) are the assumptions concerning the level of utilisation and silvicultural treatments undertaken. These factors are influenced by the availability of markets for all log products. This is because in the absence of markets for low grade and small logs, there is limited capacity to undertake thinning in regrowth jarrah forest and mine site rehabilitation. The presence of markets for low grade and small log material also facilitates the removal of cull trees according to silviculture guidelines in the jarrah two tiered forests, and increases the economic viability of accessing areas with a low yield of sawlogs, by providing an economic return from the lower quality logs. In Scenario 1, the level at which ‗silviculture for water production' is undertaken also has a significant effect, with a more limited program being required to achieve a higher sustained yield. The ranges presented in Tables 8, 9 and 10 indicate the variability that might arise as a result of different levels of utilisation, silviculture and access to lower yielding areas.

The projected impacts of the various settings in Table 7 on the sustained yields include the following:

- The relative impact of ‗silviculture for water production' in Scenario 1 on the sustained yield of jarrah sawlogs will vary from being neutral to potentially a significant reduction, depending on the area treated per year during the period of plan. If, for example, management option 2 as described in the ‗Water' section of the ‗Soil and water' chapter was implemented in full, 65,500 hectares within the target catchments could be treated during the period of the plan. This would generate a much higher volume of sawlogs from this area during the plan period than would be the case under ‗routine' harvesting. This would propagate a drop in supply in later decades, which could not be fully recovered through subsequent growth if the catchment areas were to be maintained at the nominated basal areas in the long term. Alternatively, a variant of the proposal which involved reducing the size and location of the treated areas would ameliorate the impact on the jarrah sustained yield.

- The proposal to establish a formal reserve within the Whicher Scarp ecosystem results in a relatively minor reduction in the jarrah sustained yield.

- The net effect on the sustained yield of the potential variations to informal reserves is limited under both scenarios, and the various components (see Table 7 and the ‗Biological diversity' chapter) largely counterbalance one another. However, the operational feasibility during the period of the next FMP is significantly enhanced by the proposal not to classify as informal reserve those areas previously classified as old-growth forest, which are confirmed not to be old-growth forest.

- There was limited effect on the karri sustained yield of the proposal to redistribute the fauna habitat zones (Management option 2), but a marked significant increase in jarrah sawlog availability under this redistribution proposal.

- The effect of climate change on the woodflows was most pronounced in the level of karri other bole volume generated under the high climate change severity included in Scenario 2. Although this is partly an artefact of the modelling approach, the limited impact on the sustained yield reflects the large increase in projected karri sawlog arising in future decades from the older regrowth forest. Neither the jarrah nor the karri sustained yields were substantially affected under the medium climate change severity included in Scenario 1, because although tree growth rates were projected to slow, the impact on the standing volume and the cumulative future yield is relatively limited.

Calculating sustained yields for this Draft plan

For this Draft plan, the calculation of woodflows to compute the sustained yields for each scenario was undertaken using a combination of the scheduling systems used for the current FMP (see Ferguson *et al.* 2003) and components of a new forest estate-level computer modelling system called Woodstock™. The modelling for the proposed FMP will be finalised using the Woodstock™ modelling system, which is used by forest planners around the world to address the complexity of scheduling timber harvesting over time and space to meet ESFM objectives. For jarrah and karri sawlog production, the objective was to calculate a sustained yield from woodflows averaged to the year 2070. Beyond this period the absence of climate change projection datasets, together with the increasing uncertainty about such settings as land use, product requirements, inventory projections and wood processing technologies, makes detailed scheduling unrealistic (Ferguson *et al* 2003). Less detailed projections are made out to a planning horizon of 150 years to examine the sustainability of forest values over the long term.

The methodology and data used in the sustained yield calculations for the current FMP were independently reviewed (Ferguson *et al.* 2003). Much of the data and contributing systems that were reviewed have been updated and applied in the calculation of the sustained yields for this Draft plan. However, consistent with the requirements of the RFA, a suitably qualified and experienced independent panel will review the calculations of sustained yields for the proposed forest management plan. This will occur prior to finalisation of the proposed FMP (further information is available in the *sustained yield information sheets*).

Tables 8 and 9 present estimates of the sustained yields for jarrah and karri that are associated with Scenarios 1 and 2. Table 10 presents estimates of the other bole volume, or lower grade logs, that are made available in the course of harvesting the sawlogs, and from the follow-up silvicultural treatments undertaken to facilitate regeneration, or growth of retained crop trees. The final figures will be based on the settings adopted following the public consultation process on this Draft plan, further updates to inventory and stratification datasets that are ongoing, further refinements to the modelling arising from work underway, and feedback from the independent panel review on sustained yield.

Table 8: Sustained yield (cubic metres) of first and second grade jarrah sawlogs for each scenario

Scenario	Net area of jarrah /wandoo forest available for harvesting (ha)	Range in average annual yield for 10 years (m^3)	Indicative level of average annual woodflow by geographic area (m^3)	
			North of Preston River	South of Preston River
1	796,500	101,000 – 137,000	56,000 – 75,000	45,000 – 62,000
2	783,100	95,000 – 125,000	56,000 – 72,000	39,000 – 53,000

Notes:

1. The range for each scenario is a result of the assumed levels of silvicultural activity such as early thinning of regrowth stands, log utilisation standards and the extent of access to lower yielding forest areas. In Scenario 1, the level at which _silviculture for water production' is undertaken also has a significant effect, with a more limited program being associated with the upper level of variation in sustained yield.
2. The operational and financial viability of accessing these projected supply levels will vary.
3. The woodflow from each supply zone may vary between years depending on the mix of forest made available in annual harvest plans.

Under each scenario, the proportion of the total jarrah sawlog supply that is in smaller size classes (sourced from regrowth forests) is projected to be similar or higher than during the current FMP, particularly for the supply zone north of the Preston River. The proportion of the total jarrah and wandoo forest that is cutover each year, will vary between the scenarios depending on the extent of thinning operations (such as ‗silviculture for water production', mine site rehabilitation, and thinning of young regrowth stands regenerated since the 1990s), and the structure and yield of the two-tiered forest areas. The projected area may vary up to 0.7 per cent (under Scenario 2) or up to 1.1 per cent (under Scenario 1) per annum of the total jarrah and wandoo forest within the plan area on lands vested in the Conservation Commission, inclusive of clearing for mining and the option for silvicultural treatment of water catchments (see the ‗Soil and water' chapter).

In general terms, the sustained yield figures in Table 9 have been calculated as a non-declining yield, and for karri sawlog the yield during the next decade is substantially less than subsequent decades, when the large area of regrowth stands regenerated since the 1970s reaches sawlog size. This projected increase in sawlog availability has implications for the scaling of industry and provides important context when considering the relative impact of climate change on the productive capacity of the karri forest.

Table 9: Sustained yield (cubic metres) of first and second grade karri sawlogs for each scenario

Scenario	Net area of karri forest available for harvesting (ha)	Range in average annual yield for 10 years (m^3)
1	59,900	54,000 – 70,000
2	59,100	44,000 – 56,000

Notes:
1. The range for each scenario is a result of the assumed levels of silvicultural activity such as early thinning of regrowth stands, log utilisation standards and the extent of access to lower yielding forest areas.
2. The operational and financial viability of accessing these projected supply levels will vary.

Under each scenario, the karri sawlog supply is sourced from the harvesting of two-tiered and even-aged regrowth forests, with an increasing proportion of sawlogs sourced from second thinning in regrowth stands. Much of the two-tiered karri scheduled for harvest under these scenarios are patches of small size (less than 10 hectares) dispersed among or adjacent to forests regenerated since 1970. Scenario 2 incorporates a lengthening of the notional rotation length for a portion of the older regrowth karri stands regenerated during the 1930s. The proportion of the total karri forest area within the plan area on lands vested in the Conservation Commission that is cutover each year varies between 1.0 and 1.1 per cent, with over 75 per cent of the annual harvesting likely to be thinning of regrowth stands regenerated since the 1930s.

As a consequence of harvesting the level of first and second grade jarrah and karri sawlogs identified in Tables 8 and 9 respectively, or undertaking silvicultural treatments designed to promote future sawlog growth, water production or ecosystem health, the following ranges of other bole volume of each species are projected to be made available:

Table 10: Availability of other bole volume (cubic metres)

Species	Log grade	Range in average annual availability for 10 years (m^3)	
		Scenario 1	Scenario 2
Jarrah	Bole logs other than first and second grade sawlog	495,000 – 710,000	463,000 – 528,000
Karri	Bole logs other than first and second grade sawlog	180,000 – 240,000	160,000 – 200,000
Marri	All bole logs	180,000 – 270,000	140,000 – 200,000

Notes:
1. The range is a result of such factors as the levels of sawlog-driven operations (Tables 8 and 9), the extent of silvicultural thinning and treatment programs, and the species composition of young regrowth stands.
2. The upper range figure for Scenario 1 incorporates the option for ‗silviculture for water production' for up to about 65,500 hectares (see the ‗Water' section of the ‗Soil and water' chapter).
3. The operational and financial viability of accessing these projected supply levels will vary.

While the figures in Table 10 estimate the volumes that would be made available, the actual level of harvest or removal for the non-sawlog material largely depends on suitable markets for these lower grade logs. For example, the level of marri bole logs removed to 2010 during the current FMP averaged only six per cent of the annual available volume (see the end-of-term audit of the current FMP – Conservation Commission 2012). Material that is not sold commercially from the harvesting operation may be left standing, remain on site and possibly be consumed in the subsequent regeneration or prescribed burning activities, or in some cases removed some time after the harvesting operation by public firewood gatherers. Included in the estimates of the other bole volume made available is therefore, the component of public firewood that would be gathered from areas following harvest events.

The lower grade logs made available from thinning that do not produce sawlogs, such as in young regrowth jarrah and karri stands, are included in Table 10. These figures assume that the timing and intensity of the thinning occur in accordance with the schedules in the silviculture guidelines, or in the case of ‗silviculture for water production', management option 2 as outlined in ‗Water' section of the ‗Soil and water' chapter. Consequently, the quantity of other bole volume generated each year can fluctuate considerably depending on the availability of markets, the scale of commercial and non-commercial thinning operations, the mix of forest types on the harvest plans, and the relatively lower precision of estimates for other bole volume compared to sawlog estimates. For these reasons the range in the figures in Table 10 for each species and scenario is relatively wide.

The figures in Table 10 refer to volume to a small end diameter of five centimetres in the regrowth stands, and to the crown break in the larger trees in two-tiered forests. Beyond crown break there are often additional merchantable logs within the crowns of larger, mature trees. This wood is referred to as ‗non-bole' logs, and it has *not* been included in the sustained yields, or the figures in Table 10. The limited data available suggest these non-bole logs can add up to an additional 10 per cent of the gross bole volume of individual trees.

Small volumes of wandoo, blackbutt and sheoak sawlogs are also expected to become available as a consequence of the harvesting of jarrah and karri sawlogs or harvesting for other purposes. The dispersed distribution and fine-scale mix of these species within the jarrah and karri forest gives rise to fluctuations in the availability of these species between years. Similar levels of sawlogs are expected to be generated as under the current plan: i.e. up to 1,300 cubic metres per annum of wandoo; up to 1,600 cubic metres per annum of blackbutt; and up to 1,900 cubic metres per annum of sheoak. These volumes are estimated to comprise less than 0.5 per cent of the standing inventory

volume for each of these species. Other bole volume of these species will also be made available in quantities that will vary depending on the structure and mix of forest accessed during the plan.

The maximum volumes allowed to be harvested (the ‗allowable cut') will be included in the next FMP. The FPC will be able to enter into contracts for the sale of wood within these maximum volumes. The FPC will also be able to contract for the removal and sale of forest products of species *other than* jarrah, karri, marri, blackbutt, wandoo and sheoak that become available in small quantities from approved operations, including timber harvesting and mine site clearing.

Salvage of wood products following disturbances

Several natural disturbances may lead to the death of trees, and this is provided for in the calculation of, and reduces, the sustained yield from what it would otherwise be. The expected level of future disturbance is modelled on past observations (including extent and frequency), however, given the current projections for climate change, it is possible that there will be a higher than expected level of mortality from drought, bushfire, pests and disease during the period of this Draft plan. It is not expected that smaller, scattered areas of impact from these disturbances will be salvaged. The decision to salvage will be based on a case-by-case evaluation by the Department of the likely impact on ESFM values. Further, the FPC will consider the merit of harvesting such areas, based on its assessment of safety risks, and likely costs and returns.

Death of trees has implications not only for productive capacity, but also for a range of other values. For example, destruction of immature karri forest or stands with poor seed crops, or areas of jarrah where lignotubers have not developed, can result in enduring change in vegetation structure, composition and density. It can also degrade the quality of the landscape and its appeal for recreation and tourism. There is significant benefit to a range of values through regenerating or rehabilitating affected areas. Harvesting of these sites allows for useable wood to be salvaged, and provides an opportunity to commence the process for regeneration or rehabilitation. However, as the wood of dead trees degrades quite quickly, achieving this requires that the usual assessment, planning and approval processes be undertaken in a timely fashion.

In the period of the current FMP, losses have resulted from bushfires including those at Waroona and Beraking, and more recently, in the Babbington forest block. During the winter of 2011, there were also patchy losses resulting from drought. Despite there being significant deaths in the overstorey, there was no major salvage of wood from dead trees in these areas. There were various reasons for this, including that in some cases there were safety concerns, and/or that affected areas were in land categories not available for timber harvesting, were relatively small and scattered, with insufficient available wood volumes to support a viable harvesting operation, and/or that capacity constraints meant that planning and approvals were not achieved in a timely enough way.

Management options for accounting for salvage wood

As indicated above, toward the end of each plan, allowances for mortality for the next planning period are re-calculated based on actual prior losses. This was done for the current FMP (see Ferguson *et al.* 2003) and will also be completed for the next FMP. However, an important question is how the salvage of wood from areas available for timber harvesting that is lost through major disturbances, in excess of expected levels of loss, should be addressed during the period of a (current) plan. This Draft plan puts forward two management options for public comment.

Management option 1 is all salvaged material to count towards allowable cut. In this option, *any* wood products salvaged from areas impacted by major disturbances such as bushfire (and potentially, drought and disease) would be counted towards the allowable cut for the particular wood products being removed. It would apply where the level of losses is *less than*, *equal to* or *higher than* that provided for in the calculation of sustained yields for the next FMP. However, there may be

reluctance from the wood processing industry to take wood from areas subject to these disturbances if it displaces other higher quality wood it would otherwise have been supplied with.

Management option 2 is not all salvaged material to count towards allowable cut. This option would only apply where the level of losses is *less than* that provided for in the calculation of sustained yields for the next FMP, in which case the wood removed would *not* be counted as a part of the allowable cut. The circumstances where this would apply would focus on situations where the log product mix from the potential salvage harvesting would cause a disincentive for the area to be harvested. If adopted, guidelines will be developed to set out the circumstances under which this would apply, including the threshold levels of losses. Salvaged wood removed *equal to* or *above* the level provided for in the calculation of sustained yields for the next FMP would still be counted.

The rationale for management option 2 includes two components. Firstly, the sustained yields have been discounted for the effect of these disturbances, and if they are *less than* this level, then the material that could be removed remains consistent with the assumptions used in the calculation of sustained yields. Secondly, as noted above, there may be reluctance from the wood processing industry to take wood from areas subject to these disturbances if it displaces other higher quality wood it would otherwise have been supplied with. This option removes this disincentive in some circumstances, and thus helps facilitate the process for regeneration or rehabilitation, which might not occur otherwise.

Goals

The plan proposes the following activities at the whole of forest and local scales for the purpose of seeking to provide for production of jarrah and karri sawlogs on a sustained yield basis and to maintain the quality of the sustained yield calculations for the subsequent plan (from 2024).

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department and FPC will have regard to:

Policy Statement 3: *Management of* Phytophthora *and disease caused by it*

Guidelines for Management of Phytophthora cinnamomi *and disease caused by it – Vol. 1*

Silvicultural Practice in the Jarrah Forest

Silvicultural Practice in Wandoo Forest and Woodland

Silvicultural Practice in the Karri Forest

Soil and Water Conservation Guideline

Code of Practice for Timber Harvesting in Western Australia

Manual of Management Guidelines for Timber Harvesting in Western Australia

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

54 The Department will prepare rolling three-year indicative timber harvesting plans that are to be:

54.1 developed in consultation with the FPC

54.2 consistent with the allowable cut to be included in the next FMP

54.3 approved by the Department‘s Director General

54.4 made publicly available.

55 The FPC will prepare annual timber harvesting plans that are to be:

55.1 developed in consultation with, to the requirements of, and approved by the Department's Director of Sustainable Forest Management

55.2 consistent with the allowable cut to be included in the next FMP

55.3 made publicly available.

56 The FPC will prepare coupe level timber harvesting plans, using the Department's planning checklist for disturbance activities, which are to:

56.1 be consistent with annual timber harvesting plans referred to in activity 55

56.2 provide sufficient information to enable the Department to evaluate the proposed operations

56.3 be approved by the Department's relevant Regional Manager prior to disturbance operations commencing.

57 The FPC and the Department will:

57.1 monitor the volume of all log categories removed from native forest in each year, separately recording for each of the commercial species the equivalent volume of first and second grade sawlogs, and other log grades

57.2 periodically monitor the grading and removal of sawlogs.

58 The FPC, and other proponents where required by the Department, will monitor and record the areas over which each different silvicultural or other treatments are applied in each year and provide suitable information on this to the Department in a format and at times required by the Department.

59 The Department will maintain a process to verify the information and retain the data referred to in activity 58.

60 When the FPC enters into a contract for the supply of wood other than first and second grade sawlogs, it will provide suitable information on this to the Department in a format and at times required by the Department, to enable the Department to calculate the equivalent volume of first and second grade sawlogs which would be derived from the volume taken under the contract.

61 The Department may use forest produce that becomes available for use from the carrying out of operations to which section 33(1)(cb) of the CALM Act applies, for the purposes of making improvements to any land to which the CALM Act applies.

62 The Department will continue to refine the data and methodology used for the sustained yield calculations by maintaining and enhancing the quality and coverage of the datasets, and the methodology, used in sustained yield calculations.

63 The Department will facilitate the salvage from areas available for timber harvesting of forest produce generated by management activities the primary purpose of which is not wood production, or natural events where salvage activities can contribute to regeneration and rehabilitation and do not significantly increase the level of disturbance or the risk of environmental impacts to the forest area.

Exotic species on State forest and timber reserves

Background

The current FMP defines ‗plantations' as areas of *'State forest and timber reserve planted with exotic species*'. The major plantation species in the plan area are radiata and maritime pine, and in accordance with the CALM Act, the objective for their management is to ‗*achieve the optimum yield in production consistent with the satisfaction of long-term social and economic needs*. Typically, the best available seedlings are used in plantations to suit inherent site conditions. Breeding programs are often based on selecting the plants that provide the best growth rates or wood quality, or that show resistance to pests, disease, drought and other damaging agents.

There are also areas of State forest and timber reserves that have been rehabilitated in the past with other exotic species, including non-local species of eucalypts (principally from the eastern states). This includes about 3,200 hectares in the Department's Swan and South West regions that have been replanted following mining for bauxite from 1966 to 1998. Along with another 390 hectares of various arboreta and trial plots, these areas provide a range of forest values, including their potential to provide wood resource, which is not part of the sustained yield for jarrah or karri. They are also *not* a part of the area base sought to be maintained to meet the plantation-based State Agreements referred to in the section ‗Maintaining forest area' earlier in this chapter. However, their relatively dispersed location within native forest poses a number of long-term biodiversity and potential weed management issues, and the intention is for these areas to be rehabilitated to native species in time, so they can be more self-sustaining.

For clarification, since the ongoing management intent differs for plantations, this Draft plan does *not* include within the definition of plantations these areas of ‗Other exotics' within arboreta and trial plots, or that have resulted from past mine site rehabilitation. Map 5 shows the consolidated areas of plantations and the bauxite mining rehabilitation component of ‗Other exotics' within the area covered by the plan.

Goal

The plan proposes the following activities at the whole of forest and local scale for the purpose of seeking to achieve the optimum yield in production from plantations on State forest and timber reserves, consistent with the satisfaction of long-term social and economic needs.

For the ‗Other exotics', the plan proposes the following activities at the whole of forest and local scale for the purpose of seeking to rehabilitate these areas to native vegetation, while providing for optimum yield in the interim.

Relevant policies and guidelines of the Department

For plantations, when undertaking the proposed operations (management activities) outlined below, the Department and FPC will have regard to:

Policy Statement 14: *Weeds on CALM land*

Policy Statement 19: *Fire management*

Policy Statement 45: *Environmental monitoring of pesticides used on CALM land*

Policy Statement 47: *Control of Sirex woodwasp in pine plantations*

Policy Statement 65: *Good neighbour policy*

Code of Practice for Fire Management

Guidelines for the Management and Rehabilitation of Basic Raw Material Pits

For ‗Other exotics', when undertaking the proposed operations (management activities) outlined below, the Department will have regard to the *Interim Guideline for the First Thinning of Bauxite Rehabilitation Areas Established Before 1988 with Exotic Species in the Wungong Catchment*.

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

64 **(Plantations):** The FPC will manage the silviculture and harvesting of forest products from plantations to optimise yield to meet legislated obligations including relevant State Agreement Acts, and other supply obligations. Where not inconsistent with this, plantations will be managed to take account of recreation use, and seek to minimise adverse impacts on this and other values when undertaking silvicultural operations and harvesting.

65 **(Plantations):** The FPC will prepare annual timber harvesting plans that are to be consistent with the supply requirement referred to in activity 64.

66 **(Plantations):** Where required by the Department, the FPC will prepare compartment level harvesting plans, having regard to the *Code of Practice for Timber Plantations* (2006), and using the Department's planning checklist for disturbance activities, that are to:

66.1 be consistent with annual timber harvesting plans referred to in activity 65

66.2 provide sufficient information to enable the Department to evaluate the proposed operations

66.3 be approved by the Department's relevant Regional Manager prior to disturbance operations commencing.

67 **(Plantations):** The FPC will:

67.1 monitor the volume of all log categories removed from plantations in each year, separately recording each of the main commercial species and log grade

67.2 periodically monitor the grading and removal of sawlogs.

68 **(Plantations):** The FPC will conduct its silvicultural operations in accordance with its Plantation Silviculture Guidelines which will be amended from time to time in consultation with the Department.

69 **(Plantations):** The FPC will monitor and record the areas over which each different silvicultural treatment is achieved in each year.

70 **(Plantations):** The FPC will continue to refine the data and methodology used for the yield calculations by maintaining and enhancing the quality and coverage of the datasets, and the methodology, used in yield calculations.

71 **(Plantations):** The FPC will:

71.1 where it is consistent with government policy, replant areas of plantation that are clearfelled, in accordance with the FPC's plantation management guidelines, as may be revised from time to time

71.2 rehabilitate areas of plantation that are clearfelled and are not to remain as plantation, in accordance with *Guidelines for the Rehabilitation of Plantation Areas* that are to be developed by the Department in consultation with the FPC.

72 **(Plantations):** The FPC will seek to ensure that appropriate tree breeding programs are maintained to achieve desired plantation outcomes.

73 **(Other exotics)**: Where operations are proposed, the FPC, and other proponents where required by the Department, will:

73.1 in consultation with the Department, develop annual programs of future silvicultural or other treatments, for stands of trees to promote stand vigour and growth rates, with a view to future rehabilitation of these areas to native vegetation

73.2 assess stand development before silvicultural or other treatments are scheduled, with a view to determining whether those treatments are then required

73.3 undertake or reschedule those proposed silvicultural or other treatments, according to the assessment referred to in activity 73.2 and prevailing and expected market conditions, where relevant.

74 **(Other exotics)**: The FPC, and other proponents where required by the Department, will monitor and record the areas over which each different silvicultural or other treatment is applied in each year and provide suitable information on this to the Department in a format and at times required by the Department.

75 **(Other exotics)**: The Department may seek proposals to facilitate the rehabilitation of these areas to native vegetation.

Other forest produce

Background

State forest and timber reserves also supply other forest produce such as public firewood, burls, craftwood, wildflowers, seeds and honey. Knowledge of demand for this other forest produce is not as well understood as that for sawlogs and other log grades, and fluctuates considerably. Supply is affected by a range of factors, including seasonal and temporal variability and access constraints. However, not all products are removed lawfully. The Department monitors availability and ecosystem condition and seeks to limit approved activities to a level that it deems can be maintained. Timber harvesting from native forests on private property is subject to the Environmental Protection (Clearing of Native Vegetation) Regulations under the EP Act. The Department administers the approvals process, and any resulting wood products do not count toward the sustained yield or allowable cut.

The management of the native flora industry in Western Australia is undertaken by the Department through the provisions of the WC Act, using a system of licensing, area and species-specific management, and monitoring to ensure the conservation of flora being harvested. Wildflowers and seed intended for sale are harvested on Crown land using a Commercial Purposes Licence, or a Scientific or Other Prescribed Purposes Licence, when taking flora for scientific or specified non-commercial purposes such as education, hobby, propagation or personal enjoyment. Persons who hold a Commercial Purposes Licence also require written endorsement from the Department to operate on Crown land managed by the Department. The endorsement identifies a specific area, and in some cases specific taxa, for each picker and may specify particular conditions relating to the access or harvest activity and quantities that may be harvested. Commercial Purposes Licence holders are required to submit quarterly returns detailing flora taken each month. Other licence types apply on non-Crown land, but these lands are outside the scope of this Draft plan.

Honey is collected by apiarists who access areas covered by the plan using a system of designated apiary sites registered with the Department. These apiary sites are assigned and managed using apiary site permits and licences, which may be issued for periods of up to seven years, and can be transferred between apiarists. Apiary site rentals are charged in accordance with the CALM Regulations.

The removal of craftwood from areas on a current harvest plan is authorised using a Minor Production Contract issued by the FPC, and requires payment of a royalty prior to the issuing of the contract. Burls are also removed during harvesting operations and these are either sold to people holding a Contract of Sale for the product, or by purchase at an auction conducted by the FPC. On occasions, wood products may become available as a result of other works (for example, those associated with boundary fencing or roading), and the Department may issue approval for their removal where this material is not sold through the FPC.

Public firewood collection

Firewood is sourced from within areas covered by the plan (where permitted) and sold by commercial operators managed by the FPC. The quantity of this ‗commercial firewood' is factored into calculations of and limits set for ‗other bole volume', which also considers requirements for retention of dead standing trees and coarse woody debris for habitat (also see the ‗Biological diversity' chapter). It also includes allowance for any firewood subsequently collected by the public from areas harvested during the period of the plan.

Community demand for collection of public firewood from lands covered by the plan remains strong, and currently firewood is only available from approved areas on State forests, timber reserves and potentially, smaller areas of freehold land held in the name of the Conservation and Land Management Executive Body (formerly the Department's Executive Director) and forest conservation areas (see the ‗Biological diversity' chapter regarding the latter). Typically, public firewood areas are made available some time after completion of harvesting activities managed by the FPC. The Department has a process for the identification and gazettal of ‗public firewood areas', and a corresponding process for the sale or issuing of authority for members of the public to collect firewood. The Department can identify areas as ‗fee payable' or as ‗free' public firewood areas, and often the latter occur within plantation areas where the firewood is mostly pine. Whether ‗fee payable' or ‗free', an authority and map are still issued. This process has not always been applied uniformly across the Department's administrative regions, but action is underway to move towards a uniform system.

There are management issues and costs (including staff time and signage) incurred by the Department for managing public firewood collection, and a range of issues arise, or can arise, from unmanaged/unauthorised activity, including rubbish dumping, spread of weeds, pests and disease (notably *Phytophthora* dieback), and felling of standing trees and/or removal of coarse woody debris, with potentially adverse biodiversity impacts, particularly in areas where there are relatively fewer ‗legacy' habitat elements (see the ‗Biological diversity' chapter).

Removal of firewood by the public is undertaken on the basis that a member of the public with a current authorisation may remove a maximum of one tonne of firewood per vehicle per visit from a designated area (a trailer connected to car is part of one vehicle). During the period 1 October to 31 May, an individual can purchase more than one authority at any one time, but can only collect up to one tonne per day. During the period 1 June to 30 September, an individual is limited to collecting a maximum of one tonne of firewood in any 60-day period from public firewood areas managed by the Department.

Surveys conducted in the Department's Swan Region in 2005, and repeated in 2010, estimated about half the public firewood removed during the survey period, was removed in vehicles that were not associated with a valid authority, and that about 30 per cent of the firewood collected was removed from areas outside the designated public firewood areas.

In the Swan Region, there is currently a dwindling available resource, and public firewood areas are becoming more distant from population centres, as a result of changes in the location and reductions in the amount of timber harvesting activities near Perth. Accordingly, it is expected that there will be increasing difficulty in providing access to any public firewood areas within reasonable proximity to

Perth and Mandurah within the first half of the period of this Draft plan, based on a continuation of the current approach.

The availability of public firewood areas nearer to the Perth-Mandurah area is also limited by the access limitations imposed by safety requirements associated with bauxite mining (in particular) in the northern jarrah forest, and from requirements to restrict access to Disease Risk Areas (DRA) to manage *Phytophthora* dieback. Should new mining operations be approved, further public access restrictions are likely.

As a result of changes to tenure category under the current FMP (for example, transfer of areas of State forest to national park), there are a number of communities in the south-west where access to public firewood resources within a reasonable distance is not available. People in these towns do not necessarily have available viable alternative fuel sources for heating and cooking compared to those living in regional centres such as Mandurah, Bunbury and Perth.

It is likely that in many localities, there will need to be an increasing reliance on commercial firewood suppliers (managed via the FPC) over time, and consideration may need to be given to providing access to other tenure types for public firewood in some localities, where sufficient resource is available (for example, forest conservation areas near Walpole and Denmark – also see the *2008 Walpole Wilderness Management Plan*, pages 198-201). Other potential sources may be worth considering and some further analysis is required, including the possibility of facilitating public access to private firewood resources, such as that which may be available from bluegum plantations after they have been harvested.

Management options for public access to firewood

This Draft plan presents three management options for comment, as follows:

Management option 1 is transporting firewood from disease risk areas, protectable areas, 'clean on entry' road sections, and possibly mine sites, to locations accessible to the general public. This would involve significant costs for the Department, which would need to be funded either from the public buying the firewood or from other sources. The Department would also have to identify and manage the stockpile areas, including providing the firewood in a way that is safe for the public to access and cut up. This option could also present problems in terms of managing risks to public safety.

Management option 2 is creating public firewood by thinning selected areas or accessing non-commercial plantation plots. Outside harvested areas, non-commercial thinning by cut-stump and/or notching is sometimes undertaken (for example, the Wungong catchment trial area). However, there are safety issues to consider and supply within a reasonable distance of roadsides will still be limited. Additional funds would be required to do this in more areas if the work was not undertaken as part of a commercial activity. For example, should markets develop to facilitate more commercial thinning in the northern part of the northern jarrah forest, this may assist in making more public firewood areas available for people in the Perth-Mandurah area. Other areas may be candidates for public firewood areas – including isolated, smaller plantation plots and arboreta that may no longer be required (although the aggregate area of these is not large).

Management option 3 is moving to a system where firewood is only available from commercial operators, at least in some areas. This may need the cooperation of the FPC in allowing for smaller scale contracts or for intermittent deliveries to small scale operators. If doing so did not provide a net return to the FPC, then provision of funds from Government to the FPC for a community service obligation may be required. In turn, the price received for firewood may need to increase significantly for it to become a viable commercial activity for the contractor and to support the management effort required by both the FPC and the Department. The FPC has indicated that in some cases their customers have tried to establish commercial outlets in smaller towns, but the businesses have been undermined by illegal operators who gain access to firewood without incurring the range of costs that

a legitimate operator has to pay. To improve the viability of this approach, the Department may need additional funds for patrols and enforcement.

Goal

The plan proposes the following activities at the whole of forest and local scales for the purpose of seeking to manage the removal of other forest produce, in a manner that, so far as is practicable and sustainable, satisfies public demand for that produce.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department and FPC will have regard to:

Policy Statement 3: *Management of* Phytophthora *and disease caused by it*

Guidelines for Management of Phytophthora cinnamomi *and disease caused by it – Vol. 1*

Policy Statement 13: *Commercial flora harvesting*

Policy Statement 41: *Beekeeping on public land*

Policy Statement 57: *DEC Enforcement and prosecutions policy*

Management of Commercial Harvesting of Protected Flora in Western Australia 2008– 2013

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

76 The Department will:

- 76.1 regulate the supply of other forest produce through the administration of relevant licensing legislation
- 76.2 maintain and, where appropriate, prepare guidelines for the management of other forest produce
- 76.3 where reasonable and practicable, monitor supply patterns for signs of non-sustainability
- 76.4 facilitate the salvage of other forest produce generated by management activities the primary purpose of which is not wood production, or natural events where salvage activities can contribute to regeneration and rehabilitation and do not significantly increase the level of disturbance or the risk of environmental impacts to the forest area.

77 The FPC will, subject to it reasonably expecting to achieve commercial returns, make wood available from integrated timber harvesting operations available to small processors and craftwood artisans, by auction or other appropriate means.

Regeneration and management of harvested native forest

Background

To maintain a range of values, harvested and other disturbed areas must be regenerated and, where necessary, the regeneration needs to be managed to maintain its vigour and productive capacity. Related to this is rehabilitation of mine sites and basic raw material pits, which is covered under ‗Developing self-sustaining ecosystems' in the ‗Ecosystem health and vitality' chapter.

In its report on the mid-term audit of the current FMP, the EPA (EPA 2010a) expressed concern about the effectiveness of regeneration in eastern parts of the jarrah forest (see Map 9). It is recognised that the regeneration in the eastern jarrah forest can occur over an extended period of time. Only a small number of the total seed that falls will germinate and survive the first summer. This is true of all jarrah stands, however due to the somewhat harsher and more variable climatic conditions, relatively lower survival rates occur in the eastern jarrah forest. Consequently, adequate regeneration will not always establish in a single regeneration event and it is anticipated that adequate stocking will be achieved after several regeneration events. Additionally, the coordination of harvesting, culling, site preparation, seed crop and burning opportunities is complex and delays in regeneration treatments sometimes occur. To confirm the progression towards an adequate stocking of regeneration, monitoring is undertaken. In its end-of-term audit report, the EPA (2012) noted regeneration burns are subject to competing priorities and that performance indicators should take this into account.

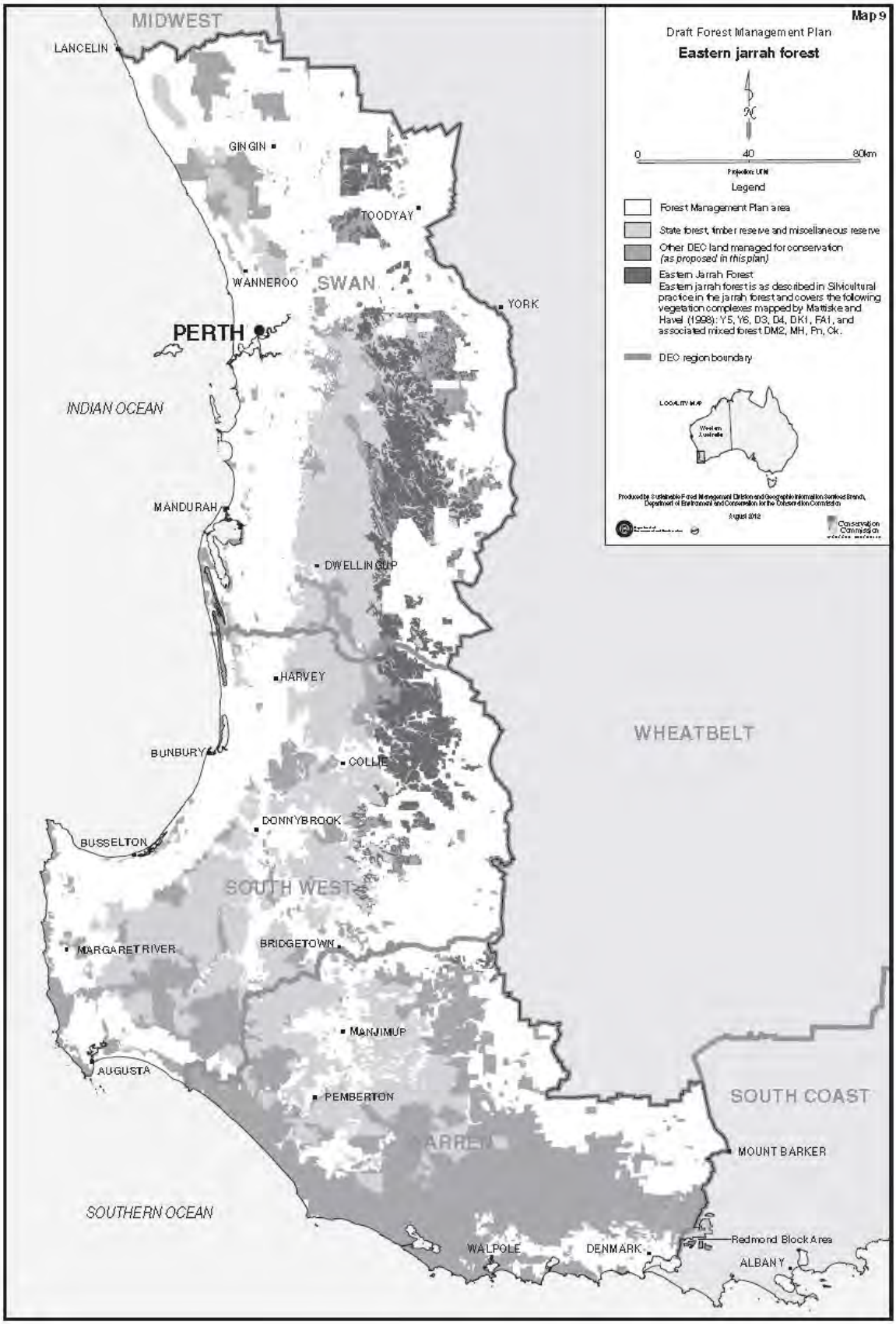
Monitoring of regeneration of forest by the FPC and by the Department (including through *FORESTCHECK*) has found that regeneration was being effectively achieved across both the karri and jarrah forests. Additionally, the issue and proposed changes to silvicultural practice were examined by Burrows *et al.* (2011), who found that:

> *…the performance assessments of regeneration in the eastern jarrah forests carried out by DEC on behalf of the FPC clearly demonstrate that recruitment of regeneration in these forests is acceptable. Recruitment of jarrah seedlings extends over an extended period compared to some eucalypt forest types; for example in wet eucalypt forests in Tasmania recruitment has generally ceased altogether about three years after harvesting. In the jarrah forests, recruitment continues for many years, and seedlings take many years to establish. The silvicultural systems that are applied in the jarrah forests recognise this, and retain a canopy and hence a seed supply, wherever regeneration is lacking. Further, the current approach of surveying a sample of the harvested areas at appropriate intervals (e.g. five years) is supported, as it is clear that recruitment is rarely an issue, given that the appropriate silvicultural system is applied in the first instance*.

Regeneration activities aim to re-establish the site species composition within the disturbed area, using propagules, on-site seed, on-site seedlings and other established growth that has been retained, or seedlings developed from seed from the same LMU. However, flexibility may be required in some cases in order to achieve desired outcomes. For example, where disease is present, or rainfall has declined, it may be appropriate to consider the use of disease- and/or drought- resistant varieties of those same species. In this case, the best source of seed or seedlings of some species may be from another area. Alternatively, if disease or drought resistant varieties are unavailable or unknown, then using mixed seed sources to maximise genetic diversity might be an appropriate alternative strategy. This would provide a broader source of variation which would allow greater potential to adapt to new perturbations such as disease or environmental change. Accordingly, the plan proposes a mechanism to accommodate this (see activity 79.4 below).

Activities to achieve effective regeneration and management of regrowth are guided by a range of subsidiary documents, including silviculture and fire management guidelines. Proposed changes to silviculture guidelines (see Appendix 14) are aimed at ensuring more effective regeneration and management of regrowth and two-tiered forest, including:

- maintenance of forest structure maps to assist selection of silvicultural objectives and monitoring to determine if appropriate silvicultural objectives are selected
- retention of larger marri trees (see the ‗Integrating forest management across the plan area' section in the ‗Biological diversity' chapter)
- the use of trees with mature spreading crowns as seed trees to improve regeneration success
- use of variable density thinning to ensure that individual trees are released from competition


Map 9
Draft Forest Management Plan
Eastern jarrah forest
N
0
40
80km
Legend
Forest Management Plan area
State forest, timber reserve and miscellaneous reserve
Other DEC land managed for conservation
(as proposed in this plan)
Eastern Jarrah Forest
Eastern jarrah forest is as described in Silvicultural practice in the jarrah forest and covers the following vegetation complexes mapped by Mattiske and Havel (1998): Y5, Y6, D3, D4, DK1, FA1, and associated mixed forest DM2, MH, Pn, Ck.
DEC region boundary
August 2012
MIDWEST
LANCELIN
GINGIN
TOODYAY
WANNEROO
SWAN
YORK
PERTH
INDIAN OCEAN
MANDURAH
DWELLINGUP
HARVEY
WHEATBELT
BUNBURY
COLLIE
DONNYBROOK
BUSSELTON
SOUTH WEST
MARGARET RIVER
BRIDGETOWN
MANJIMUP
AUGUSTA
PEMBERTON
SOUTH COAST
MOUNT BARKER
SOUTHERN OCEAN
WALPOLE
DENMARK
Redmond Block Area
ALBANY

- the identification and retention of dieback-resistant trees in areas of high disease impact and individual trees or groups of trees that exhibit resistance to disease or the effects of insect outbreaks
- salvage of sawlogs in stands impacted by fire and other damaging agents
- silvicultural burning to provide a mosaic of burnt and unburnt patches
- using significance and sensitivity of regeneration to prescribe fire in areas where multiple objectives exist
- timely use of prescribed low intensity fire in regrowth stands as soon as possible after the stand has developed sufficient height and bark thickness to tolerate fire
- that forest adjacent to fire sensitive regeneration be burnt to reduce the likelihood of loss of regrowth as a result of high intensity bushfire
- more timely completion of harvest operations in areas of regeneration release or establishment
- options for ‗silviculture for water production' (see the ‗Water' section of the ‗Soil and water' chapter)
- revised target stand density in jarrah forest subject to thinning.

Goal

The plan proposes the following activities at the whole of forest and local scales for the purpose of seeking to regenerate and manage harvested forest so as to maintain the productive capacity of that forest in the long term.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department and FPC will have regard to:

Policy Statement 3: *Management of* Phytophthora *and disease caused by it*

Guidelines for Management of Phytophthora cinnamomi *and disease caused by it – Vol. 1*

Silvicultural Practice in the Jarrah Forest

Silvicultural Practice in Wandoo Forest and Woodland

Silvicultural Practice in the Karri Forest

Soil and Water Conservation Guideline

Code of Practice for Timber Harvesting in Western Australia

Manual of Management Guidelines for Timber Harvesting in Western Australia

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

78 The FPC and other proponents will conduct native forest regeneration and tending operations in a manner that is in accordance with the Department's silviculture guidelines.

79 The FPC and other proponents will undertake native forest regeneration operations by:

79.1 using natural regeneration where reasonable and practicable, or

79.2 where natural regeneration is not reasonable and practicable, and where data are available on the underlying genetic diversity within regeneration species through

genetic analysis and an understanding of life history traits, use this information to inform choice of areas from which seed is sourced, or

79.3 where natural regeneration is not reasonable and practicable, and where the information referred to in 79.2 is not available, using as the first preference seed or plants propagated from seed collected from the same LMU as the area to be rehabilitated, or where seed is not readily available from this LMU, then using seed from adjacent LMUs, or

79.4 otherwise, subject to a process of approval by the Department, based on assessment criteria agreed between the Department and the Conservation Commission, using other seed sources, including mixed seed sources, where climate change, impact from damaging agents or some other identified management need requires it.

80 The Department, and the FPC and other proponents via the Department, will report to the Conservation Commission annually as to the circumstances where seed sources other than those referred to in 79.2 and 79.3 have been used in their native forest regeneration operations.

81 The FPC will seek to continue to develop markets, in particular for those log grades which are currently under-utilised, so as to facilitate the timely achievement of silvicultural objectives, as well as socio-economic outcomes.

82 The FPC and other proponents where required by the Department, in consultation with the Department will:

82.1 develop annual programs of future silvicultural treatments for stands of trees to promote stand vigour and growth rates that can be used to produce sawlogs, which are consistent with the silviculture guidelines

82.2 assess stand development when silvicultural treatments are scheduled, with a view to determining whether those treatments are then required

82.3 undertake or reschedule those proposed silvicultural treatments, according to the assessment referred to in activity 82.2 and prevailing and expected market conditions, where relevant.

83 The FPC will monitor and record the areas over which each different silvicultural treatment is achieved in each year and provide suitable information on this to the Department in a format and at times required by the Department.

Key performance indicators

Key performance indicators will be used to track the implementation of the next FMP. Six indicators have been selected to provide a broad cross-section of achievement of the activities related to the maintenance of productive capacity.

Key performance indicator 15	The area of native forest and plantations.
Performance measure	Change in: • the area of native forest and plantations • area of forest by land category, including the net area available for wood production • area of forest cleared • area of forest rehabilitated.
Performance target(s)	No permanent loss of net area of forested land except for those authorised by due process.

Key performance indicator 16	Removal of wood products compared to the allowable cut set in the FMP 2014-2013.
Performance measure	• Cumulative removals for jarrah and karri first and second grade sawlogs compared to the average annual sustainable yield. • Removal of other jarrah and karri logs below first and second grade. • Removal of logs of other species.
Performance target(s)	• The cumulative annual removals of first and second grade jarrah and karri sawlogs shall not exceed the equivalent inferred cumulative average annual allowable cut by more than five per cent at the end of years 3 and 6, and three per cent at the end of year 9 of the plan, and the total removals over the (10-year) period of the plan shall not exceed the allowable cut. • No more than the allowable cubic metres of other jarrah and other karri logs over the 10-year life of the plan. • No more than the allowable cubic metres of wandoo, blackbutt and sheoak sawlogs to be removed over the 10-year life of the plan.

Key performance indicator 17	Silvicultural outcomes for the area of forest cutover.
Performance measure	Annual area of each silvicultural outcome for each forest type harvested and/or silviculturally treated.
Performance target(s)	Proportion of selective cut in jarrah forest to decline. Proportion of thinning in jarrah forest to increase. Proportion of shelterwood (regeneration establishment) and gap (regeneration release) to decline for regrowth jarrah forest.

Key performance indicator 18	Time to regenerate harvested areas.
Performance measure	The time between completion of native forest harvesting of a coupe for regeneration and the completion of post-harvest regeneration treatment.
Performance target(s)	For karri and planted jarrah: • achieve more than 75 per cent of areas treated to be completed within 30 months • achieve 100 per cent of areas treated to be completed within 42 months. For jarrah which has not been planted: • achieve 100 per cent of areas treated to be completed within 30 months.

Key performance indicator 19	Effectiveness of regeneration of native forest and replanting of plantations.
Performance measure	The proportion of the sampled annual shelterwood (regeneration establishment) and gap (regeneration release) program that does not meet the acceptable stocking standard. The proportion of clearfelled plantation effectively replanted.
Performance target(s)	No more than five per cent of the area regenerated or replanted requiring remedial action.

Key performance indicator 20	Plantations are managed to optimise yields of forest products and meet obligations under State Agreements and production contracts.
Performance measure	Measurements of actual yield against projected yield by product. Quantity of forest products not salvaged in plantation areas lost in fires and to drought. Thinning and fertiliser regimes are implemented.
Performance target(s)	Maximum recovery of sawlog and veneer products following drought and fire events. All plantations thinned to schedule. Plantation nutrition and health are monitored and maintained.

Heritage

Background

Heritage comprises the things we value and want to protect as a community and as a culture. Heritage includes Aboriginal and other Australian cultural values, and natural heritage.

Natural heritage is strongly linked to features of the natural environment, such as soil and water (see the ‗Soil and water' chapter), biodiversity (see the ‗Biological diversity' chapter), and other features and places. Amendments in 2003 to the Commonwealth EPBC Act established the ‗National Heritage List' and the ‗Commonwealth Heritage List'. The legislation seeks to protect listed National Heritage values and Commonwealth Heritage places. There are no National Heritage listed places on the land that the plan applies to (as at July 2012). There are a number of Commonwealth Heritage places within the plan area that relate to built cultural heritage (for a list of Commonwealth Heritage places see www.environment.gov.au).

The focus of this chapter is cultural heritage valued by Aboriginal and other Australians.

Section 56 of the CALM Act prescribes the management objectives for each category of land to which the CALM Act applies, as described in Appendix 2. Management plans for lands managed by the Department may prescribe specific actions to protect, preserve, maintain or restore cultural heritage. Section 56(2) of the CALM Act includes measures to protect and conserve the value of the land to the culture and heritage of Aboriginal persons. In the plan area, interpretation and management of Aboriginal cultural heritage will be carried out in consultation with Noongar people. Some good models for this have already been developed, which may provide a useful guide (for example, Noongar Consultation Protocol Guidelines Swan and Canning Rivers Iconic Trails Project).

The Heritage of Western Australia Act prescribes the Department's obligations for any places within lands managed by the Department that are listed on the State ‗Register of Heritage Places'. In addition to the ‗Register of Heritage Places', section 45 of this Act requires local governments to establish and maintain an inventory of places of heritage significance within their boundary. These lists are referred to as ‗Municipal Inventories' and may contain sites that are not on the State ‗Register of Heritage Places', but which may occur on land that the Department manages or occupies.

Depending on the nature and significance of particular sites, places or objects, the Department may also have obligations under the *Maritime Archaeology Act 1973* and some other Commonwealth legislation, such as the *Historic Shipwrecks Act 1976* and the *Protection of Movable Cultural Heritage Act 1986*.

Goal

An overall goal of the plan is to protect and maintain Aboriginal and other Australian cultural heritage.

Identified values and threats

The plan seeks to protect and maintain the following heritage values, which fall into the following categories:

- *Aesthetic value* such as buildings that are representative of various architectural styles or periods are commonly significant for their aesthetic value, however these places often have social or historic value as well.

- *Historic value* reflects how a place reveals information about past events, practices and people. Some places with historic value contain no physical evidence, but their name may reveal their history.
- *Scientific value* is the potential of a place to yield information about environmental, cultural and historic processes. This value will largely depend on the importance of the data involved, on its rarity, quality or representativeness, and on the degree to which the place may contribute further substantial information.
- *Social (Aboriginal) value* is the cultural, spiritual, religious, social or other importance a place may have for Aboriginal people, the traditional owners of the land. Significance must be determined by the relevant Aboriginal people, through consultation.
- *Social (other Australian) value* is a special meaning important to a community's identity, perhaps through its use of the place or association with it. Places that are associated with events that have had a great impact on a community often have high social value.

It is the relative value that a place has in terms of its aesthetic, historic, scientific or social significance for the present and future communities, which determines the significance of each place.

Threats to these values include:

- inappropriate fire regimes
- theft
- vandalism
- disturbance activities including mineral extraction, construction or maintenance of facilities and infrastructure, timber harvesting, inappropriate recreation use, and uncontrolled vehicular access
- decay or erosion of fabric caused by;
  - the elements including wind, water, flooding, salinity and soil erosion
  - animal activity including termites and insects, trampling by feral animals, burrowing by animals and grazing
  - plant activity including revegetation, weed invasion, fungal disease and plant-caused structural decay
- identified, registered sites or values being impacted because of inadequate procedures or ineffective operational application of current procedures.

Aboriginal culture and heritage

Background

Aboriginal people have been living on and looking after country in the plan area for over 40,000 years. The cultural heritage of the Noongar people, who are the traditional owners of the south-west of Western Australia, reflects a society that developed a complex yet subtle relationship with their country. There is also significant diversity among Noongar people in the plan area, which includes the Ballardong, Yued, Whadjuk, Wardarndi, Pinjarup, Bibbulmun, Wilmun and Mineng subgroups. These groups are represented through the Whadjuk, Gnaala Karla Booja, Yued, Ballardong, South West Boojarah, Harris Family and Southern Noongar Wagyl Kaip native title claims. Ethnographic and archaeological evidence attests to the dynamic relationship between the Noongar people, the biota and landscapes of their country. Map 10 shows the current registered native title claims in the plan area.

Aboriginal cultural heritage encompasses laws and practices, connection to lands and waters and traditional ecological knowledge of the land and its biodiversity. This interconnectedness is explained

through traditional laws and customs, creation stories, songs, and other cultural practices transferred through generations to explain Aboriginal people's connection, 'world view' and knowledge of country.

Aboriginal cultural heritage involves both the archaeological record left by Aboriginal people, areas of mythological or ceremonial importance, places where historical events took place, and the ongoing physical and spiritual involvement of the people with the land. It is important that Aboriginal heritage is acknowledged and conserved, as it provides Noongar people with an essential emotional, physical and spiritual link to their cultural traditions, practices and identities. Moreover, it is recognised that many heritage places are still used today and provide a means of maintaining Noongar culture. The protection of Aboriginal heritage is therefore a matter of protecting Aboriginal cultural identity, and facilitating access to the land to look after these heritage places and values.

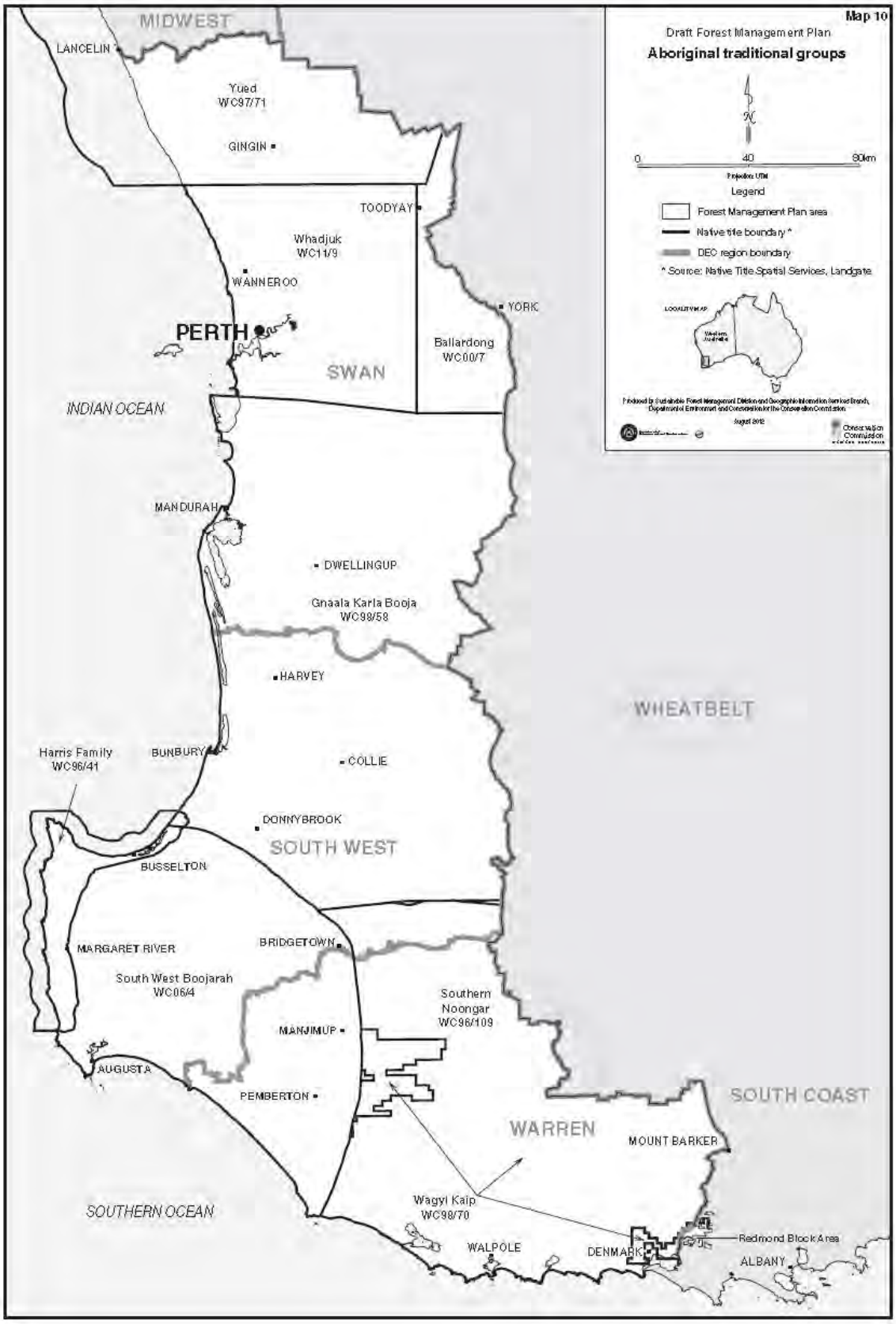
Amendments to the CALM Act require that the Department's management of lands and waters includes the objective to protect and conserve the value of the land to the culture and heritage of Aboriginal persons in a manner that does not have an adverse effect on the protection and conservation of the land's fauna and flora (see Appendix 2). The new provisions of the CALM Act and WC Act will also enable Aboriginal people to undertake customary activities, such as preparing and consuming food, preparing or using medicine, and engaging in artistic, ceremonial or other customary activities on land vested in the Conservation Commission. Facilitating Aboriginal customary access to lands covered by the plan will assist in conserving and protecting Aboriginal cultural heritage values, by enabling ceremonial and customary activities and promoting use for Aboriginal cultural purposes. The Department will work closely with Aboriginal communities to develop protocols for access for Aboriginal customary activities.

Additionally, these amendments to the CALM Act provide for joint management arrangements. During the term of the next FMP, if joint management is identified as a priority and there are sufficient resources and capacity to undertake it in particular areas, formal arrangements may be developed.

The Aboriginal Heritage Act was enacted to ensure that Aboriginal heritage within Western Australia could be properly protected and preserved. Under this Act, a person who excavates, destroys, damages, conceals or in any way alters any Aboriginal site (irrespective of whether it is on the 'Register of Aboriginal Sites') commits an offence, unless this is authorised under the Aboriginal Heritage Act.

As defined in the Aboriginal Heritage Act, Aboriginal sites may fall into one or more of the following categories:

- places of importance and significance where persons of Aboriginal descent have, or appear to have left any objects which are connected with the traditional cultural life of Aboriginal people, past or present
- any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent
- places associated with Aboriginal people which should be protected because of their historical, anthropological, archaeological or ethnographic significance to the cultural heritage of the State
- any place where traditional objects are traditionally stored.


Map 10
Draft Forest Management Plan
Aboriginal traditional groups
N
0
40
80km
Legend
Forest Management Plan area
Native title boundary *
DEC region boundary
* Source: Native Title Spatial Services, Landgate
MIDWEST
LANCELIN
Yued
WC97/71
GINGIN
TOODYAY
Whadjuk
WC11/9
WANNEROO
PERTH
YORK
Ballardong
WC00/7
SWAN
INDIAN OCEAN
MANDURAH
DWELLINGUP
Gnaala Karla Booja
WC98/58
HARVEY
WHEATBELT
Harris Family
WC96/41
BUNBURY
COLLIE
DONNYBROOK
SOUTH WEST
BUSSELTON
MARGARET RIVER
BRIDGETOWN
South West Boojarah
WC06/4
Southern
Noongar
WC96/109
MANJIMUP
AUGUSTA
PEMBERTON
SOUTH COAST
WARREN
MOUNT BARKER
Wagyl Kaip
WC98/70
SOUTHERN OCEAN
WALPOLE
DENMARK
Redmond Block Area
ALBANY

The Department of Indigenous Affairs and the Department of the Premier and Cabinet have released *Cultural Heritage Due Diligence Guidelines*. Good working relationships with Noongar people will assist in ensuring these guidelines are effectively applied and that relevant Acts are complied with. To minimise the impact of activities on Aboriginal cultural sites and values, it is likely that over time, parts of the plan area will need to be progressively assessed for their importance for Aboriginal heritage, including through archaeological and ethnographic surveys, and consultation with and involvement of Noongar representatives in decision-making, as appropriate.

Goals

The plan proposes the following activities for the purpose of seeking to:

- at the whole of forest, landscape and/or local scales, protect and conserve the value of the land to the culture and heritage of Aboriginal persons, in particular from any adverse material effect caused by:
  - entry on or use of the land by other persons, or
  - the taking and removal of the land's fauna, flora or forest produce

  but in a manner that does not have an adverse effect on the protection or conservation of the land's fauna and flora, and
- at the local scale, protect Aboriginal cultural sites.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to:

Policy Statement 18: *Recreation, tourism and visitor services*

Policy Statement 69: *Acknowledgment of Aboriginal traditional custodians*

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

84 The Department, and other proponents where required by the Department, will seek to prevent material adverse effects on Aboriginal culture and heritage in the plan area by:

84.1 where required, working with appropriate and representative Aboriginal groups and relevant agencies to identify cultural and heritage values and sites and gain their input into the management of these

84.2 facilitating access by Aboriginal people for Aboriginal customary purposes subject to the CALM Regulations

84.3 community consultation, involvement in decision-making and surveys that are to be undertaken in accordance with Department policies and guidelines that are to be developed as required by activity 85

84.4 ensuring compliance with the provisions of the Aboriginal Heritage Act by having regard to the State Government's *Cultural Heritage Due Diligence Guidelines* and conducting operations in a manner that is in accordance with Department policies and guidelines that are to be developed as required by activity 85.

85 The Department will develop, or maintain and update policies and guidelines on joint management, customary activities and Aboriginal heritage, and will work with appropriate and representative Aboriginal groups to identify appropriate opportunities for joint management of areas within the plan area.

86 The Department, and other proponents where required by the Department, will facilitate cross-cultural awareness and interpretive activities to inform and educate relevant staff, contractors and the wider community about Aboriginal culture and heritage values.

87 The Conservation Commission and the Department will develop a program for assessment of areas of the plan area for their importance for Aboriginal heritage, and the Department, and other proponents where required by the Department, will progressively undertake this assessment, in consultation with relevant stakeholders and agencies.

Key performance indicator

Key performance indicators will be used to track the implementation of the next FMP. One indicator has been selected related to the management of Aboriginal culture and heritage.

Key performance indicator 21	Consultation and involvement of Aboriginal people in management of lands covered by the plan.
Performance measure	Establishment of joint management arrangements. Establishment of local area arrangements and protocols for Aboriginal customary activities. Consultation with appropriate and representative Aboriginal groups for management plans.
Performance target(s)	Establishment of at least six joint management arrangements under the CALM Act by 2023. Local area arrangements and protocols for Aboriginal customary activities established and implemented within each district of the Department in the plan area by 2023. Appropriate and representative Aboriginal groups are consulted and invited to provide input into all management plans.

Other Australian cultural heritage

Background

Cultural heritage is a generic term which refers to the quality and attributes that are present at places which have aesthetic, historic, scientific or social significance for past, present or future generations. These qualities or attributes may be seen in the physical features at a place (such as buildings or relics), or can be associated with the history of the place.

The exploration and settlement of Western Australia has brought with it a wealth of cultural heritage. In the south-west there is evidence of past activities including timber towns, sawmills, transport systems, dams and weirs, tree nurseries, buildings, structures and other sites. There are also a rich folklore, traditions and the ongoing use and care for the land and forests.

The definition of cultural heritage significance in the Heritage of Western Australia Act means, in relation to a place, the relative value which that place has in terms of its aesthetic, historic, scientific or social significance, for the present community and future generations. There is a wide range of historic places on lands vested in the Conservation Commission, some of which are listed on the *State Register of Heritage Places* (for example, Yanchep Inn at Yanchep National Park and Ellensbrook in the Leeuwin-Naturaliste National Park). Under the Heritage of Western Australia Act, the crucial factor is that there must have been human activity associated with the place. Some places included on the ‗National Heritage List' and ‗Commonwealth Heritage List' under the Commonwealth EPBC Act may also occur (see ‗Background' section of this chapter).

The Department is developing a policy on management of other Australian cultural heritage, guided by the following:

- the Australia International Council on Monuments and Sites (ICOMOS) Charter for Places of Cultural Significance (Burra Charter) that sets the standard of practice for heritage owners or custodians (Australia ICOMOS 1999)
- the Heritage Tourism Strategy for Western Australia (Heritage Council of WA and Tourism WA 2006), which aims to increase heritage tourism experiences across the State, raise awareness of the importance of heritage, and encourage the ongoing conservation of Western Australia's heritage places
- the *State Cultural Heritage Policy* (Government of Western Australia, Heritage Council of WA, National Trust 2011), which sets out the State Government's policy objectives to recognise, protect and promote cultural heritage through a partnership approach
- the Government Heritage Property Disposal Process (Government of Western Australia and Heritage Council of WA 2011), which is designed to ensure government departments appropriately address cultural heritage in land acquisition and disposal.

There are cases in which the cultural heritage value is intrinsic in items themselves, and is not related to any particular 'place'. Such items may include photographs, films, tapes and discs, paintings and works of art, books and manuscripts, tools and machinery, as well as a myriad of other everyday objects. They are collectively referred to as 'movable cultural heritage' and the requirements for this are established in the Commonwealth Protection of Movable Cultural Heritage Act. Items which meet these criteria are considered to be part of the 'Distributed National Collection'.

Goals

The plan proposes the following activities at the whole of forest and local scale for the purpose of seeking to identify and manage places of other Australian heritage significance on land to which the plan applies, as far as is reasonable and practicable, to:

- recognise and determine the significance of other Australian heritage values
- protect and conserve the known other Australian heritage values.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to Policy Statement 18: *Recreation, tourism and visitor services*. Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

88 The Department will:

88.1 develop and implement appropriate policies, guidelines, manuals or instructions for management of other Australian cultural heritage, as required, that consider and, where necessary, align with the Heritage Tourism Strategy for Western Australia, *State Cultural Heritage Policy*, Government Heritage Property Disposal Process, and the Burra Charter

88.2 use agency procedures that ensure that the presence and type of heritage places are appropriately recorded, accessible to staff and considered prior to operations taking place

88.3 maintain a central database of other Australian heritage places and values

88.4 use agency procedures and set appropriate conditions as a part of Department approval processes to ensure that heritage places are effectively protected during permitted disturbance activities

88.5 promote awareness and understanding of the importance of protection and appreciation of the value of heritage places among staff, proponents, operators and visitors.

89 The Department, FPC and other proponents where required by the Department, will:

89.1 conduct their operations in a manner that has regard to approved heritage management policies, guidelines, manuals or instructions

89.2 cooperate with Commonwealth and State agencies, local governments and non-statutory organisations in relation to other Australian cultural heritage identification and conservation.

Socio-economic benefits

Background

The area covered by this Draft plan provides a diverse mix of raw materials and places that in turn provide a range of socio-economic benefits for the community. The most significant industries based on areas covered by the plan, in terms of revenue and direct and indirect employment, are the minerals, forest products and recreation and tourism sectors.

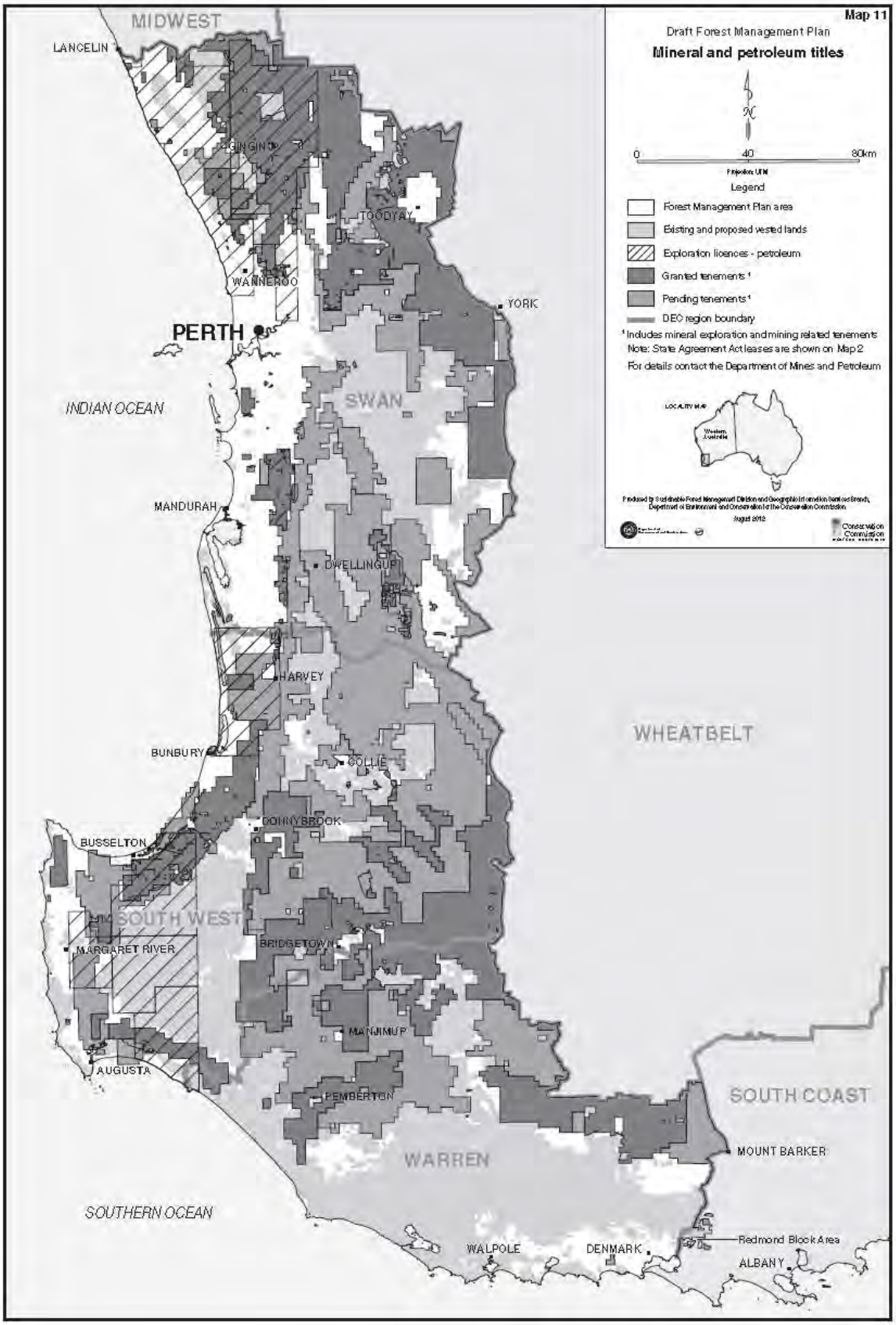
Bauxite/alumina, gold, coal, lithium (Greenbushes) and heavy mineral sands are the principal mining products, and in the plan area, the Department of Mines and Petroleum estimates that in 2010/2011 the annual value of minerals production was $5,740 million, providing direct employment for nearly 16,500 people. Map 11 shows mineral and petroleum titles, while Map 2 shows mining leases covered by State Agreements.

Timber harvesting from both native forest and plantations and the processing of logs sourced from those areas into wood products is a long established and important regional industry. The forest products industry also includes non-wood and other forest products sourced from areas covered by the plan (see the ‗Productive capacity' chapter). Increasingly, areas covered by the plan are also being valued and used for a wide range of recreation and nature-based tourism activities, which support economic activity and provide employment. Figures that relate to the socio-economic benefits from these industries associated directly with areas covered by the plan are not available, although there are broader figures for the State's south-west, as outlined in the following sections of this chapter.

A more complete list of the goods and services, including environmental services derived from areas covered by the plan, which provide various socio-economic benefits and help meet the spiritual needs of society, includes:

- clean and moderated flows of fresh water
- clean air
- sequestration of atmospheric carbon
- minerals and petroleum
- wood and non-wood forest produce
- nature-based recreation and tourism opportunities
- defence force training
- basic raw materials
- wildflowers and seeds
- apiculture (bee-keeping and honey production)
- genetic resources (for example, for the development of medicines).

Management of issues associated with some of these important goods and services is covered elsewhere in this Draft plan. Provisions relating to water are contained in the ‗Soil and water' chapter, while provisions relating to production of wood and other forest produce, such as honey, wildflowers and seeds, are covered in the ‗Productive capacity' chapter. Sequestration of atmospheric carbon is discussed in the ‗Climate change and carbon cycles' chapter.


Map 11
Draft Forest Management Plan
Mineral and petroleum titles
N
0
40
80km
Legend
Forest Management Plan area
Existing and proposed vested lands
Exploration licences - petroleum
Granted tenements [1]
Pending tenements [1]
DEC region boundary
[1] Includes mineral exploration and mining related tenements
Note: State Agreement Act leases are shown on Map 2
For details contact the Department of Mines and Petroleum
MIDWEST
LANCELIN
GINGIN
TOODYAY
WANNEROO
YORK
PERTH
INDIAN OCEAN
SWAN
MANDURAH
DWELLINGUP
HARVEY
WHEATBELT
BUNBURY
COLLIE
DONNYBROOK
BUSSELTON
SOUTH WEST
MARGARET RIVER
BRIDGETOWN
MANJIMUP
AUGUSTA
PEMBERTON
SOUTH COAST
WARREN
MOUNT BARKER
SOUTHERN OCEAN
WALPOLE
DENMARK
Redmond Block Area
ALBANY

Given current knowledge and uncertainties in respect of the likely magnitude and result of changes to climate from expected increases in atmospheric levels of greenhouse gases, management activities proposed throughout this Draft plan encompass an appropriate range of broad precautionary measures. Some social and economic benefits associated with the goods and services listed above may also be affected. For example, adjustments for the potential impact of climate change on the growth rates of jarrah and karri trees and stands have been applied when projecting future sustained yields, as explained in the ‗Productive capacity' chapter.

This chapter is focused on issues related to the forest products industry; recreation and tourism; visual amenity; basic raw materials; leases and licences; and genetic resources. A well designed and managed system of roads and bridges is also essential to ensure that the various socio-economic benefits can be accessed and delivered. These matters are discussed in the sections which follow.

Disturbance activities can have a range of environmental impacts. Mining operations cause significant disturbance, which involves clearing and fragmentation of forest cover. While the Conservation Commission and the Department provide input into the process, approval of mining and petroleum operations is governed by other legislation (see the ‗Legislative framework' section in the ‗Background' chapter). Measures to manage the impact of these activities are covered mainly in the ‗Biological diversity', ‗Ecosystem health and vitality' and ‗Soil and water' chapters. Measures to manage the impacts of timber harvesting activities are discussed further throughout this Draft plan, and a range of subsidiary documents and approval processes apply. The socio-economic benefits of recreation and tourism are the subject of this chapter, but the potential environmental impacts are dealt with in a number of chapters including the ‗Biological diversity', ‗Ecosystem health and vitality', ‗Soil and water' and ‗Heritage' chapters.

Goal

An overall goal of the plan is to seek to sustain social and economic benefits, through the provision of a range of goods and services valued by the community.

Forest products industry

Background

State forest and timber reserves within the area covered by this Draft plan provide both native forest hardwood and plantation-grown softwood forest products. The growing, transport and processing sectors within the forest products industry are geographically dispersed across the south-west. Substantial socio-economic benefits accrue from the industry to the local, regional and State economies and it remains important to social and economic wellbeing of many communities in areas covered by the plan. Studies have shown the annual value of production for the sector in the middle of the last decade was around $1,060 million (Schirmer 2008), with direct employment early this decade at nearly 3,500 (Dare and Schirmer 2012). However, these figures also include activity involving bluegum (*Eucalyptus globulus)* plantations (mostly on private land) and the associated woodchip processing industry.

In recent history, the native forest-based industry has been affected adversely by significant shifts in policy. The downsizing of the native forest-based industry arising from the 1999 RFA and subsequent decisions on management of karri and tingle forests, and the policy of protecting old-growth forest implemented through the current FMP, saw the quantity of jarrah and karri sawlogs available to industry reduced from more than 700,000 cubic metres to about 190,000 cubic metres. These changes resulted in significant business closures and changes in a number of south-west towns and communities.

There were nearly 1,000 job losses registered through the adjustment and retraining packages over a three-year period commencing late 2001. In total, the then State Government paid some $135 million in compensation, retraining, structural adjustment and associated programs as a result of policy changes. At the same time, support for industry restructuring was provided – for example, grants were provided for the upgrading of facilities to enable local value-adding of logs sourced from regrowth forests. The major development resulting from this initiative was the construction of a modern ‗small log line' at the Whitttaker's mill at Greenbushes.

At the start of the current FMP, many sawmills operated at levels that were below the capacity of equipment and the industry was challenged by reductions in log size and log quality that resulted from increases in the reserve system and protection of old-growth forest. This led to rationalisation within the industry, and the FPC worked with the remaining mills to increase their intake so that they could become more efficient. New sawn timber markets were also developed and the industry has been able to improve its financial viability somewhat over the course of the current FMP. However, the current viability depends on ongoing access to resource at the current level, and further reductions in volumes are likely to lead to further mill closures and associated socio-economic impacts in regional communities.

The scenarios for sustained yield that are included in this Draft plan (see the ‗Productive capacity' chapter) include a potential variation to the total log supply available from State forest and timber reserves, compared to that provided for in the current FMP. A *social and economic impact study* (URS 2012) on the impact of the implementation of the scenarios in this Draft plan has been completed, and is available to accompany the release of this Draft plan for public comment.

An initial study has been completed on behalf of the FPC of potential opportunities to further develop the local wood processing industry, given the level of native forest wood resource available under the current FMP. The study identified significant potential for new investment of up to $500 million, which would bring additional social and economic benefits, with potential for the direct employment of an additional 400 to 500 people in the south-west. In particular, the study indicated that there are potential opportunities for further value-adding of non-sawlog grade logs for engineered wood products, biofuels and bioenergy. To determine the level of interest, the FPC has sought expressions of interest in the use of these resources, which has identified several prospective investors. However, no commitments can be entered into until the allowable cut is determined for the next FMP (see the ‗Productive capacity' chapter).

In addition to exploring opportunities for new processing facilities, the FPC continues to work with the existing sawmilling industry to try to improve the level of utilisation of the available sawlog resource, and to maintain a level of supply that sustains current operations. This will help to ensure the forest products industry continues to provide important socio-economic benefits in the south-west region.

The industry will need to continue to adapt to the changing log size and quality mix. The viability of the industry as a whole will be enhanced by the diversification of processing opportunities and end-use markets, the development of new industries which match the available resources and employ state-of-the-art technology, and which more fully utilise the wood that is available and improve the efficiency of harvesting.

As outlined in the ‗Productive capacity' chapter, there has been an ongoing reduction in the area of pine plantations, and it is likely there will be further reductions during the term of the next FMP, particularly in the Gnangara, Pinjar and Yanchep areas. In time, this will have flow-on effects for the processing industry and associated socio-economic benefits.

Goals

The plan proposes the following activities at the whole of forest scale for the purpose of seeking to maintain the long-term viability of the forest products industry and to provide regional socio-economic benefits.

Identified values and threats

The plan seeks to protect, maintain and if possible increase the value of the contribution the forest products industry makes to the economic and social wellbeing in the area covered by the plan.

Threats to these values include**:**

- land use decisions taken without due consideration of the effects on the wood products industry
- other values taking precedence over productive activities within the land base available for productive activities
- access to forest areas being unnecessarily restricted or constrained in such a way that it adversely affects the efficiency or increases the costs associated with timber harvesting.

Operations proposed to be undertaken (management activities)

90 The Conservation Commission and the Department will work with the FPC as appropriate and seek to provide input into decision-making processes that may result in a reduced land base or restricted access to land available for timber harvesting activities.

91 The Department will work with the FPC to plan for a log product and wood quality mix that supports a viable forest products industry.

Key performance indicator

Key performance indicators will be used to track the implementation of the next FMP. One indicator has been selected related to the role of the plan in facilitating socio-economic benefits associated with the forest products industry.

Key performance indicator 22	Direct employment in the forest products industry.
Performance measure	The numbers employed in plantation and native timber harvesting, haulage, wood processing and downstream manufacture.
Performance target(s)	No target, trends to be reported.

Recreation and tourism

Background

The area covered by the plan provides important opportunities to meet the growing public demand for outdoor recreation and nature-based tourism in the south-west of Western Australia. Outdoor recreation contributes to public understanding and appreciation of nature, conservation and forest management, and makes an important contribution to the social, spiritual, psychological, physical and economic wellbeing of the community. A wide variety of activities are catered for, including picnicking, bushwalking, cycling, camping, swimming, fishing and canoeing. There are also two gazetted off-road vehicle areas within pine plantations north of Perth. If required, additional areas may be considered, to meet growing demand. On occasions, areas covered by the plan are utilised for activities such as organised car rallies and adventure racing.

The economic benefit derived from recreation and tourism in the south-west is derived in part from the areas covered by the plan (Carlsen and Wood 2004) and facilities provided by the Department (see Map 12). Research undertaken in 2011 in the South West Tourism Region[11], which extends well east of the plan area, estimated that direct tourist expenditure was $1.3 billion in 2007/08, with 2,931 tourism businesses operating in 2008/09 (Tourism Research Australia 2011).

The quality of recreational facilities and services provided by the Department has been underpinned by significant Government investment, much of which has occurred in the national parks created under the current FMP. Recreation and tourism assets such as the Valley of the Giants and Tree Top Walk, the Bibbulmun Track and Munda Biddi Trail are recognised as world-class facilities that provide an important basis for some south-west tourism and recreation industries. Some are of particular interest and form an important part of the experience for visitors (Carlsen and Wood 2004).

Appropriate planning is necessary to protect these facilities and values (see the 'Biological diversity' chapter regarding travel routes, including management options for the Munda Biddi Trail).

The Department's records show visitation to areas covered by the plan reached 6.9 million visits in 2010-2011, representing an increase of 2.1 million visits (43 per cent) since 2003-2004. Departmental records also indicate that the recreation and tourism experiences offered on land it manages earn consistently high visitor satisfaction, with an average visitor satisfaction level of 87.5 per cent in 2011. Demand for use of land vested in the Conservation Commission in the plan area for recreation and tourism is expected to continue to grow in line with population growth in the south-west. The population of Perth, for example, is expected to more than double from 1.6 million in 2007 to 3.4 million by 2056 (ABS 2011).

Planning and development of recreation and tourism facilities and services must involve integration with other forest planning and management activities at whole of forest, regional and local scales. 'High level' recreation master planning is required to integrate provision for recreation and tourism with other uses, and to plan for and manage the expected increase in demand in areas covered by the plan. Demand for certain types of recreation activities is increasing more than for others – analysis by the Department shows that mountain-biking, geocaching[12], trail bike riding, four-wheel driving and competitive adventure events are increasing in popularity. The various recreation activities are provided for subject to a range of environmental and regulatory considerations, including for example, requirements for drinking water catchment protection and disease management. The need to balance the provision of enjoyable and enriching visitor experiences with conservation and other values and uses is an important management challenge. Other related matters include managing visitor safety, unauthorised recreational activities and vandalism of recreational facilities.

There are a number of public drinking water catchments in forested areas covered by the Draft plan. These catchments are important for providing water to the Perth and south-west communities and are also used for a wide range of recreation activities. Management of recreation in these catchment areas is undertaken by the Department in conjunction with the Department of Water, the Water Corporation and other water utilities. In planning for recreation in these areas, the agencies have regard to the (then) Water and Rivers Commission (2003) Statewide Policy 13, *Policies and Guidelines for Recreation on Public Drinking Water Source Areas on Crown Land*, which recognises the importance of protecting water quality.

[11] TRA's 'South West Tourism Region' extends well east of the plan area. The figures do not include the 'Experience Perth Tourism Region' that is also partly within the plan area.

[12] An outdoor sporting activity where participants use navigational techniques to hide and seek containers.

Goals

The plan proposes the following activities at the whole of forest, landscape and/or local scales, for the purpose of seeking to provide opportunities for active and passive recreation and tourism that will meet public demand, so far as is practicable and sustainable, and to provide regional socio-economic benefits.

Identified values and threats

The plan seeks to protect and maintain the following values:

- the range and quality of recreation and nature-based tourism opportunities and experiences
- the associated physical and mental health benefits.

Threats to these values include**:**

- degradation of natural areas, assets and facilities that support recreation and tourism
- inadequate planning, leading to conflicts with other land uses or activities and/or recreation and tourism opportunities not matched to community demand
- poor design of assets and facilities leading to user dissatisfaction or safety risks
- inappropriate fire regimes, including uncontrolled bushfires.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to:

Policy Statement 15: *Community Involvement*

Policy Statement 18: *Recreation, tourism and visitor services*

Policy Statement 34: *Visual Resource Management on Lands and Waters Managed by CALM*

Policy Statement 53: *Visitor Risk Management in the Department of Environment and Conservation*

Policy Statement 62: *Identification and Management of Wilderness and Surrounding Areas*

DEC Parks and Visitor Services Strategy 2007 – 2011

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

92 The Department will:

92.1 maintain understanding of visitor and recreation demand including the knowledge, attitudes and activities of visitors in the area covered by the plan

92.2 continue to support and plan for recreation and tourism, and provide and maintain safe and appropriate recreation and tourism facilities and services, in locations and in a manner that seeks to meet demand and minimise conflicts with other ESFM values

92.3 consider possible additional areas for off-road vehicle use, in consultation with relevant stakeholders

92.4 work with relevant water agencies and utilities in planning for and managing tourism and recreation activities in water catchment areas

92.5 monitor and manage visitor use, including through regulating and licensing of appropriate commercial activities

92.6 seek to enrich visitor experiences and develop and nurture lifelong connections between the community and natural areas, by providing opportunities to learn, explore and interact with the natural and cultural environment.

Key performance indicator

Key performance indicators will be used to track the implementation of the next FMP. One indicator has been selected related to the management of recreation and tourism.

Key performance indicator 23	Number of visits made to lands covered by the plan and the level of visitor satisfaction.
Performance measure	Total visits to lands covered by the plan. The satisfaction visitors express with their experience.
Performance target(s)	Visitor satisfaction maintained at high levels.

Visual amenity

Background

The natural landscapes covered by this plan are valuable for their intrinsic qualities, for the quality of life and enjoyment of people, and for the economic benefits they bring. Identifying and protecting the visual amenity of natural areas seeks to ensure that those values are maintained for the social, spiritual and economic benefit of the community.

Visual landscape management seeks to ensure that all uses and activities are planned and implemented to complement rather than detract from the inherent visual qualities of the landscape. Management activities that disturb the landscape, in particular open-cut mining, large gravel pits, timber harvesting, prescribed burning, and construction for roads, utilities and recreation sites can have unwanted impacts if undertaken without appropriate planning.

The Department‘s visual landscape planning and assessment processes aim to identify and articulate the character of the landscape and the features that contribute to scenic quality and sense of place. Assessment of impacts from proposed operations and recommendations on mitigating measures can then be made to minimise impacts to that landscape.

Goal

The plan proposes the following activities at the landscape and local scales for the purpose of seeking to protect visual landscapes.

Identified values and threats

The plan seeks to protect and maintain the following values:

- scenic quality
- visual amenity
- sense of place.

Threats to these values include**:**

- poorly planned and implemented activities due to inadequate, or ineffective application of procedures
- inappropriate fire regimes, including uncontrolled bushfires.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to:

Policy Statement 19: *Fire management*

Policy Statement 34: *Visual Resource Management on Lands and Waters managed by CALM*

Code of Practice for Fire Management

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

93 The Department, the FPC and other proponents where required by the Department, will:

93.1 maintain and implement a visual landscape classification and management system

93.2 review where necessary and implement guidelines for the application of visual landscape management principles in land-use planning, codes of practice, operational guidelines and other relevant manuals

93.3 make submissions in relation to development proposals that may impact on visual landscapes on land to which the plan applies that are forwarded to them for comment or advice, with a view to seeking to reduce the effect of any proposed activity on the visual quality of the landscape.

94 **(Plantations):** The FPC will consider the impact of plantation operations on the visual quality of the landscape and where reasonable and practicable, will conduct those operations in a manner that seeks to reduce their impact on the visual quality of the landscape.

Access – roads and bridges

Background

A well-designed and managed system of roads and bridges within the area covered by the Draft plan is essential to ensure that socio-economic benefits are able to be delivered. Roads and bridges provide access for people and service industrial and recreational needs (including off-road vehicle recreation), provide easements for water, gas, electricity and communications, and connect towns and communities. They provide access for management, including access to facilitate rapid response to bushfires and other emergencies, and for haulage of logs and other forest produce. However, roads (and other cleared easements) can result in a loss of and fragmentation of native vegetation, with consequent impacts for a range of other ESFM values. These issues are dealt with in other chapters (see the ‗Biological diversity', ‗Productive capacity', ‗Soil and water' and ‗Climate change and carbon cycles' chapters).

As indicated in the ‗Water' section of the ‗Soil and water' chapter, the Department is finalising road operational guidelines that detail functional road types and categories, geometric design guidelines, road condition inspection procedures, risk assessment methods and traffic management, and a roads

database that includes information on the condition of strategic roads. The road operational guidelines will be progressively implemented and applied to all roads located on lands managed by the Department. A road classification system is being determined for application to all roads managed by the Department, and these roads will be managed in accordance with the classification parameters. In the interim, the design, construction and maintenance of unsealed roads managed by the Department is guided by the 2009 *Unsealed Roads Manual – Guidelines to Good Practice*, issued by the Australian Roads Research Board.

To access the full range of benefits available in the areas covered by the plan and in the context of competing funding requirements, it is important that strategic roads be identified and funding be provided for their construction and/or ongoing maintenance.

Goal

The plan proposes the following activities at the whole of forest, landscape and/or local scales, for the purpose of seeking to maintain a safe and adequate access network for land to which the plan applies to enable social and economic benefits to be realised.

Identified values and threats

The plan seeks to protect and maintain the value of a safe, well planned and maintained system of access roads, bridges and related infrastructure to provide for a range of management activities, including fire management and recreation use.

Threats to this value include:

- deterioration of the assets beyond the rate at which they can be maintained with existing resources
- accelerated deterioration associated with climate change and inappropriate fire regimes
- increasing recreation and tourism demand.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department and FPC will have regard to Policy Statement 40: *Road management*. Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

95 The Department will continue to review the access network in consultation with relevant stakeholders.

96 The Department will continue to seek resources to fund essential access infrastructure.

97 The Department, FPC and other proponents where required by the Department, will where reasonable and practicable, seek to retain, develop and maintain strategic access infrastructure in a manner and at locations that will service multiple needs.

98 The Department, and proponents where required by the Department, will undertake design, construction and maintenance operations for unsealed roads, and progressively rehabilitate redundant roads, in a manner that has regard to the 2009 *Unsealed Roads Manual – Guidelines to Good Practice*, issued by the Australian Roads Research Board and subsequently, have regard to relevant Departmental policy and guidelines, once finalised.

Basic raw materials

Background

This section is focused on activities associated with extraction of basic raw materials that is not covered and approved under the Mining Act. However, activity 103 is included (see ‗Operations proposed to be undertaken (management activities)', below), which relates to the role of the Conservation Commission and Department in commenting on proposals under that Act.

State forest and timber reserves contain supplies of gravel, shale, clay, sand, limestone and rock that together are known as basic raw materials (BRM). These materials are used for road making and building throughout the south-west, and those from State forest and timber reserves are provided to government agencies and local governments through leases issued under section 97 of the CALM Act. The Department also uses BRM for its own purposes in recreation and management activities and facilitates its supply for timber harvesting undertaken by the FPC, and is developing guidelines governing the use of BRM for roads used in timber harvesting.

Currently, BRM is removed from numerous, diffuse pits each of which has the potential to impact on the net area of native vegetation, including forest cover, and may provide a source for the spread of *Phytophthora cinnamomi*. The cumulative impact from the ongoing need to clear uninfested areas of native vegetation to provide dieback-free BRM for public works and infrastructure is a threat to local biodiversity and resilience, results in a reduction in carbon storage and has implications for ongoing capacity to produce a range of forest produce.

Each pit also requires a similar level of management input from the Department and it is considered that fewer pits could be used to provide the same quantity of BRM. In addition to minimising the area impacted and the potential for other unintended adverse environmental impacts, the use of fewer, larger-scale BRM pits has operational advantages, particularly where mobile crushers are used. This approach has great potential to improve the recovery of BRM from any pit area, and to improve rehabilitation outcomes by having the seed-bearing topsoil returned to the site within shorter timeframes. Fewer, larger pits can be managed more intensively and possibly fenced if necessary to minimise risk of unauthorised removal and unintended infestation with *Phytophthora cinnamomi*. It is expected that users of BRM should contribute to the cost of establishing, maintaining and rehabilitating these pits.

Other statements in relation to rehabilitation requirements for BRM pits are included in the ‗Developing self-sustaining ecosystems' section of the ‗Ecosystem health and vitality' chapter. Some additional, complementary statements are included in this section.

Goal

The plan proposes the following activities at the whole of forest, landscape and/or local scales, for the purpose of seeking to ensure the availability of BRM, and enable regional socio-economic benefits to be realised, while managing the environmental impact of the removal of BRM.

Identified values and threats

The plan seeks to protect and maintain the value of the availability of BRM that is suitable for the intended use. Threats to this value include**:**

- infestation by pathogens, such as *Phytophthora* species
- ineffective utilisation of the existing resources through poor pit management.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department and FPC will have regard to:

Policy Statement 2: *Local Government Authority access to Basic Raw Materials from State forest and timber reserves*

Guidelines for the Management and Rehabilitation of Basic Raw Material Pits

Policy Statement 3: *Management of* Phytophthora *and disease caused by it*

Guidelines for Management of Phytophthora cinnamomi *and disease caused by it – Vol. 1*

Proponents undertaking other disturbance operations will also have regard to this document where required by the Department.

Operations proposed to be undertaken (management activities)

99 The Department will seek to ensure that all BRM removals from lands vested in the Conservation Commission:

99.1 comply with relevant legislation, and policies and guidelines which will be reviewed

99.2 contribute to the ongoing implementation of the *State Gravel Supply Strategy*

99.3 where practicable, are sourced from a network of (fewer) strategic pits, which it will identify in consultation with relevant government agencies and BRM users.

100 The Conservation Commission will require that all BRM removal from land vested in the Conservation Commission is subject to the provision of certified returns to the Department for removals by the government agency or local government authority which has access to and is removing the BRM.

101 The Department, in consultation with the Conservation Commission, will develop management guidelines and processes to allow for sterilised BRM, including that from other land tenures, to be used on land to which the plan applies.

102 The Department, FPC and other proponents where required by the Department, will contribute to the maintenance of a database of areas from which BRM have been extracted, and will continue to progressively develop plans and works programs for the rehabilitation of these areas to standards agreed with the Department.

103 The Conservation Commission and Department will provide comment or advice in relation to proposals to extract BRM on land to which the plan applies that are forwarded to them, with a view to seeking:

103.1 the timely rehabilitation of all pits to acceptable standards as set by the Department, developed in consultation with relevant stakeholders

103.2 that the full cost of rehabilitation of areas from which BRM are extracted is borne by the organisation responsible for the extraction of those materials.

Leases and licences

Background

Leases and licences for access to and use of land to which the plan applies have been granted for uses such as communication towers, utilities, grazing, extraction of BRM, water storage, and for recreation and tourism facilities, including such things as restaurants, kiosks, caravan parks and other accommodation and activities such as tours and other commercial recreation activities (including organised events and commercial filming).

The Department enters into leases and licences where they meet the requirements of the CALM Act (and related regulations) and are consistent with ESFM principles. The objectives of leases and licences include:

- to facilitate the use of lands managed by the Department for purposes required by the community where this is compatible with the purpose of the land in question
- to provide a legal basis for partnerships between the Department and the private sector to provide recreation and tourism facilities, services and programs on lands managed by the Department.

The Department and the community benefit from these arrangements because leases and licences provide a means for private sector capital and expertise to be used to provide facilities and services that complement those provided by the Department, providing opportunities for recreation or other activities that might otherwise not be available.

Goal

The plan proposes the following activity at the local scale for the purpose of seeking to manage leases and licences for appropriate facilities and uses in order to provide regional socio-economic benefits while managing the environmental impacts associated with the leases or licences.

Identified values and threats

The plan seeks to protect and maintain the following values:

- recreation and tourism opportunities and experiences
- access for other uses consistent with the legislation.

Threats to these values include lack of compliance with lease and licence conditions.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to:

Policy Statement No 18: *Recreation, tourism and visitor services*

Policy Statement No 53: *Visitor Risk Management*

Policy Statement 55: *Commercial filming on CALM managed lands and waters*

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

104 The Department will issue and administer leases and licences for facilities, activities and uses in accordance with the provisions of the CALM Act.

Development of genetic resources (bioprospecting)

Background

The development of genetic resources via bioprospecting is a small but potentially valuable industry, which could provide important yields for pharmaceutical, industrial and agricultural chemicals from native flora. The Department has a contract with a bioprospecting company to assess the potential of specific flora. The Government is also developing new bioprospecting legislation that will establish a framework to manage the intellectual property and commercial benefits that can result from bioprospecting.

Goal

The plan proposes the following activity at the whole of forest scale for the purpose of seeking to promote, encourage and facilitate the controlled exploration of native flora for scientific, therapeutic and horticultural purposes and to provide regional socio-economic benefits while managing the environmental impacts associated with bioprospecting.

Identified values and threats

The plan seeks to protect and maintain the value of genetic resources and their potential value to people. Threats to these values include**:**

- unauthorised bioprospecting carried out beyond the legislative framework and contractual conditions
- the potential of flora remains unidentified
- the State does not receive appropriate recompense from the exploitation of the resource.

Operations proposed to be undertaken (management activities)

105 The Department will:

105.1 continue to administer the current agreement with the bioprospecting company

105.2 contribute to the development of modern bioprospecting legislation.

Plan implementation and management

Background

The effectiveness of management systems used will have an important bearing on the effectiveness of implementation of the plan's goals. Increasingly, organisations are adopting structured approaches to help ensure that they meet their obligations and commitments for environmental performance, and to embed the principle of continuous improvement. The elements of a system for environmental management include:

- environmental policy and commitment
- planning of environmental requirements
- implementation of environmental requirements
- measurement and evaluation of environmental performance
- review and improvement of environmental outcomes.

The FPC has an environmental management system certified to AS/NZS ISO 14001, which provides a standardised, systematic management framework. It also has certification to the *Australian Forestry Standard*, which requires conformance not only with the management system standards, but also with recognised forestry standards at an international level under the *Program for Endorsement of Forest Certification*. The FPC intends to maintain certification to both standards for the term of the next FMP.

The EPA has an expectation that the Conservation Commission and the Department will have an appropriate system for environmental management in place, commensurate with the scale and impacts of disturbance operations related to the plan. Key performance indicator 32 of the current FMP proposed that the Department adopt an environmental management system. Subsequently however, given the expected significant time and cost of developing and implementing such a system and the many competing priorities for the Department's limited resources, the Department recommended it enhance existing work processes and systems in line with relevant principles, while focusing resources on the operational implementation of the plan. Accordingly, a commitment to a system for environmental management will be demonstrated through the ongoing incorporation of these principles, including the commitment to continuous improvement.

In addition to responsibilities set by legislative requirements, and this Draft plan itself, there is a hierarchy of elements that together, combine to serve the purpose and intent of a system for environmental management.

In terms of the five elements listed above, the environmental policy requirements are framed by legislative obligations and applicable government policies, and documented in relevant position statements of the Conservation Commission and relevant policies of the Department. The policies, guidelines, manuals, codes of practice and other documents that are subsidiary to and referred to in various sections of this Draft plan are listed in Appendix 4.

Also included throughout this Draft plan are various goals, proposed operations (management activities), and key performance indicators, including associated targets and reporting arrangements. In addition, there is a range of risk assessment, planning and approvals processes used, and operational controls that apply to environmental aspects of disturbance operations down to the local

scale, that seek to protect identified values and minimise identified threats, and directly support the achievement of these goals.

The following sections provide an overview of the measures that address the other four elements of a system for environmental management.

Goal

The plan proposes the following activities for the purpose of seeking to ensure that management is undertaken in accordance with the plan and is continually improved so as to achieve desired outcomes.

Planning

Background

The planning element of the environmental management system requires the identification of significant environmental aspects, identification of legal requirements, and development of goals (sometimes referred to as objectives) for an environmental management program. This Draft plan effectively meets the essential elements of the planning element of a system for environmental management.

Environmental aspects

This Draft plan identifies the environmental aspects through the listing of identified values and significant threats to those values. The process of identifying the values and threats was achieved through the commissioning and/or review of relevant research and reports, the identification of issues from the Conservation Commission, staff of the Department and other agencies, silviculture review expert panel (Burrows *et al.* 2011) and issues identified during the mid- and end-of-term audits of the current FMP (Conservation Commission 2008b,and 2012).

The risks that might be posed to various environmental values by planned disturbance operations are identified and assessed in the planning processes, which applies down to the local scale. For example, as outlined in the ‗Productive capacity' chapter, detailed timber harvest plans are prepared by the FPC and submitted to the Department for assessment. In this process, planning checklists are used to identify significant values and manage risks at a site specific level. Guidance and other documents assist in this process as these include more general risks and detail routine operational controls. Harvesting operations are then conducted in accordance with relevant subsidiary documents and any specific site-level approval conditions imposed by the Department, which together seek to reduce environmental risks and/or ameliorate particular impact(s). This process serves to support the system for environmental management in an operational context.

However, there are other operations carried out by the Department and other proponents, such as infrastructure developments, which may also require similar consideration. Given this, a corresponding proposed operation (management activity) has been included below (106). Their planning processes should consider all of the matters identified in the Department's planning checklists.

Legal requirements

The environmental management system requires the identification and access to applicable legal requirements. Both the significant environmental aspects and legal requirements have led to the establishment of the various goals identified within this Draft plan. Relevant Western Australian statutes are available to staff of the Conservation Commission, Department and FPC through agency intranets and to the public and proponents at the *State Law Publisher* website (and the corresponding Commonwealth government facility provides access to relevant Commonwealth statutes). Legislative requirements are also identified in a range of subsidiary documents and planning checklists. A summary of the most relevant legislation is provided in the ‗Background' chapter of this Draft plan.

Many of the management activities undertaken by the Department and other proponents of disturbance operations have the potential to affect values or resources that other government and non-government bodies have a legal responsibility for, or an interest in. For example, the Department of Water and the Water Corporation have legislated responsibility for water supply and water quality from catchments, and Tourism WA has a responsibility for promoting tourism in the south-west. In these cases it is necessary for the Department (and/or proponent(s)) to consult with such bodies prior to taking any actions that will significantly affect their interests.

Environmental management program
An environmental management program is the key document of a system for environmental management. This Draft plan meets this requirement as it identifies goals and performance targets, and the proposed operations (management activities) to be undertaken to achieve those goals, along with identifying responsibility for their implementation.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to Management Guideline 1: *User guide for approvals matrix for operations on CALM Act reserves*.

Goal

The plan proposes the following activity at the local scale for the purpose of seeking to ensure potential environmental impacts are identified and addressed in planning for (other) disturbance operations. (For harvesting in plantations and native forest, see the ‗Productive capacity' chapter).

Operations proposed to be undertaken (management activities)

106 The Department, and other proponents where required by the Department, will prepare a plan of operations, using the Department's planning checklist for disturbance activities, which are to provide sufficient information to enable the Department to evaluate the proposed operations.

Implementation

Background

Implementation of a system for environmental management system requires that:

- resources, roles, responsibility and authority be defined
- people undertaking tasks that could cause an environmental impact are competent on the basis of appropriate education, training or experience

- policies, goals and targets and related subsidiary documents are documented, including operational controls that are developed and implemented to meet policies, goals and targets
- a suitable recording system and control of documents be maintained to ensure they are approved prior to use, reviewed, updated and available to those that need to use them
- emergency preparedness and response arrangements that seek to prevent or mitigate adverse environmental impacts are available and implemented
- internal and external communication is undertaken.

These are discussed in turn, next.

Roles, responsibility and resources

Statutory roles and responsibilities of key agencies are discussed further in other sections of this plan (see the _Background‘ section). In summary, the land subject to this plan is vested in the Conservation Commission, which has a number of functions as described in section 19 of the CALM Act. For areas with management plans, this includes developing guidelines for assessing their implementation, setting performance criteria, and assessing the performance of the Department and the FPC (as relevant) in implementing those plans. The Department manages land vested in the Conservation Commission according to available resources and management plans, which are approved by the Minister for Environment. The FPC is responsible for the harvesting and regeneration of native forest in State forests, timber reserves and plantations, and for the sale of forest products and some associated industry development issues.

In the mid-term audit of performance of the current FMP, concern was expressed regarding the legislative clarity of the Department‘s relationship with proponents and how they operate on Department-managed land (see Conservation Commission 2008b). In the same report, the Conservation Commission also raised some issues concerning roles and responsibilities. The EPA, in its report and recommendations on the mid-and end-of-term audits of performance on the current FMP (EPA 2010a and 2012), advised that the next FMP should aim to clarify the statutory roles and responsibilities of the Department and the FPC.

Accordingly, during the life of this plan, it is intended that the interagency arrangements between the Department and the FPC be formalised in writing to clarify and improve the current arrangements, and by the creation of several key additional elements. This includes that: the Department is formally recognised as the regulator, leading to the establishment of responsibilities for all parties in a compliant regulatory regime; a Regulation Policy is written by the Department to confirm the regulatory framework for all parties; there is phased certification of planning for and implementation of operational activities; Department and FPC staff and contractors receive common training and accreditation, where required; and that the public reporting of compliance monitoring, incident management and auditing is increased. Additionally, there may be advantages to be gained by closer consultation between the two agencies in ongoing development of and access to components of the environmental management system used by the FPC, such as the aspects and impacts register and incident reporting system. This will be explored as part of the process.

Resourcing is outside the scope of this Draft plan and is managed through ongoing government budget processes.

Competencies and training

Capacity building involves staff and contractors, as appropriate, and occurs through a combination of communications for awareness-raising, training and development activities. Various programs are conducted across a range of levels and required areas of understanding, skills and competencies by the Department, FPC and proponents of other disturbance operations, to highlight significant

environmental aspects and explain operational controls to mitigate potential impacts. The Department is a Registered Training Organisation and intends to remain so. Where of importance to achieving certain outcomes, particular focus areas for capacity building have been identified in other chapters.

The competency of people in doing their work is often assessed through the monitoring and evaluation program, which helps to identify the need for further training and improvements that may be required to the current approaches to training.

Operational controls

Implementation of the intent of this plan is supported at an operational level through detail in this plan and various subsidiary documents and processes (see Appendix 4).

In the mid-term audit of the current FMP (Conservation Commission 2008b), the Conservation Commission expressed concern about the lack of timely attention to preparation of certain subsidiary management guidelines required by that plan. The Department indicated that the consultation and approval processes required by the current FMP for amendment of guidance documents requires an unnecessary level of resourcing and presents an impediment to the review and updating of these documents. It is noted that it would be appropriate to have a hierarchy of consultation and approval levels commensurate with the nature of the document, where documents with an operational focus have lower requirements than those with a policy focus. This Draft plan proposes a more efficient process for approval of new and revised guidance documents, consistent with existing Department processes (see the Department's Policy Statement 1: *Department of Environment and Conservation – Key documents*). For the development or revision of certain subsidiary documents, the Conservation Commission will be consulted as identified in this Draft plan.

There are a number of related documents that cover timber harvesting in the Department and FPC. The Department's *Manual of Management Guidelines for Timber Harvesting in Western Australia* (Department's manual) was created prior to the separation of the Department and FPC. The Department's manual contained material that applies to contractors and staff of the Department and FPC. The FPC *Contractors' Timber Harvesting Manual, South West Forests* was created subsequently by the FPC, to enable the relevant parts of the Department's manual to be attached as a schedule to FPC timber harvesting contracts, with the intention of ensuring compliance with the Department's manual. There is thus some duplication between the two documents which creates potential for confusion (for example, when people are not aware of the different purposes and audience of the two manuals). The FPC has also separated out the elements within the Department's manual that relate to road construction and maintenance activities and created a *Contractors road construction and maintenance manual*. The FPC included additional operational controls that were not within the Department's manual. The current absence of a formal process for the Department to endorse these FPC documents could lead, inadvertently, to an unintentional deviation from the Department's manual. Accordingly, during the term of this plan, it is expected that the Department and the FPC will move towards the confirmation of an agreed set of procedures, including a single index identifying which guideline or requirement is applicable to each activity or circumstance. This process will also address the issue of maintaining the currency of operational guidance documents, for the staff of both agencies.

Documentation and control of documents

Control of documents and records occurs according to relevant legislation (such as the *State Records Act 2000*) and through various agency administrative protocols. The intranet and extranets of the Department and FPC employ a document control system to ensure only current documents are available to users.

Emergency preparedness and response

Responsibilities for emergency preparedness and response are determined by legislation and described in this plan and subsidiary documents (see the ‗Soil and water' chapter). For the Department, contact details can be found on its website at *Emergency Responses*.

The end-of-term audit report on the current FMP (Conservation Commission 2012) noted that there have been improvements in the working relationship and definition of roles and responsibilities between the Department and the Fire and Emergency Services Authority for bushfire management, and greater collaboration with WA Police and Main Roads WA for road and traffic management during emergencies.

Internal and external communication

There is a range of plans, methods and techniques within and between the Conservation Commission, the Department, FPC and proponents of other disturbance operations to facilitate communication regarding environmental aspects. Communication with external stakeholders is also important and is covered in the final section of this chapter.

All policies and subsidiary documents listed in this Draft plan (see Appendix 4) are available to the public and can be accessed through the weblinks provided.

Goal

The plan proposes the following activities at the whole of forest scale for the purpose of seeking to facilitate effective implementation of this plan.

Operations proposed to be undertaken (management activities)

107 The Department will:

- 107.1 as the regulator of timber harvesting activities on the area that is subject to this plan, prepare a regulation policy to confirm the regulatory framework
- 107.2 in conjunction with the FPC, develop and implement formal working arrangements, consistent with the regulation policy, to among other things, define roles and responsibilities, and establish an agreed process for approving and maintaining the currency of subsidiary documents.

108 The Department, FPC and other proponents where required by the Department, will ensure that staff and contractors involved in regulation, supervision and implementation of disturbance operations are competent, including through common training and accreditation programs, as appropriate.

109 The Department will prepare and/or revise subsidiary documents referred to by this plan having regard to the Department's Policy Statement 1: *Department of Environment and Conservation – Key documents*.

Monitoring and evaluation of performance

Background

Performance against the plan will be assessed through monitoring, auditing, checking and identification and reporting of non-conformance. A specific form of monitoring related to increasing knowledge and adaptive management is also included in this section and supports the commitment to continuous improvement.

Monitoring

Monitoring is the process of repeated measurement or observation, for specified purposes of one or more elements, usually according to prearranged schedules in space and time and using comparable data collection methods (adapted from Committee on National Parks and Protected Area Management, 2002). Monitoring will be used to assess performance against the goals of the plans and implementation of the proposed operations (management activities). The purpose of monitoring is to detect changes in the condition of the forest as a consequence of natural or management-induced processes and to assess the achievement of goals. The primary purpose of this information is to assist in current and future decisions to modify management. Several agencies undertake monitoring in the plan area – for example, the Department of Water and the Water Corporation have responsibility to monitor water quality and quantity. It is intended that reliable monitoring data and information available from other sources will continue to be used where relevant.

Key performance indicators are measured (as required) and used to assess whether the goals of the plan are being achieved. Since it is not possible, practical or cost effective to measure all the aspects of management, because of technical and resource impediments, the indicators apply to key goals of the plan. Further review and analysis of key performance indicators will occur in the period between this Draft plan and the proposed FMP and comments on the key performance indicators included in this Draft plan are welcomed.

The Department has a number of systems available that it can use to meet the requirements for monitoring, including *FORESTCHECK,* and others that enable it to report against performance indicators. For additional information on *FORESTCHECK*, see the ‗Biological diversity' chapter, and the *FORESTCHECK information sheet series*. In addition, the Department is developing guidelines to provide a framework for coordinating its broader forest monitoring activities. The Conservation Commission (2012) noted in its end-of-term audit of the current FMP that these had not yet been completed.

Auditing

Auditing is a systematic, independent and documented process for obtaining evidence and evaluating it objectively to determine the extent of compliance and performance against organisational requirements (adapted from AS/NZS ISO 14001). It provides an objective and impartial assessment of specific areas of performance. Auditing will include a combination of internal and external audits.

Auditing of operations is undertaken at several levels, with the key ones being:

- the Department undertakes internal audits of the efficiency and effectiveness of its operational systems and compliance audits of its field performance, and undertakes audits of FPC compliance, and the performance of other external operators on land managed by the Department
- the FPC undertakes internal audits of the efficiency and effectiveness of its management systems and compliance audits of its field performance

- independent external audits are undertaken to assess the conformance of the management systems of the FPC against both the AS/NZS ISO 14001 and Australian Forestry Standard.

The priority for auditing is based on an assessment of the risk that operations may pose to the achievement of management outcomes. Audits of compliance with guidelines and codes of practice quantify results, so audit is one of the means used to check that the required standard is being achieved in the field.

The Conservation Commission may also conduct audits on particular aspects of the implementation of the plan, either itself or through parties it might engage, and will make these publicly available. In addition to these audits, formal mid- and end-of-term reviews will be undertaken by the Conservation Commission (see the section ‗Review and modification', below).

Checking

Checking occurs at a range of levels and through various processes within all agencies. Staff of the Department are involved in planning processes for a range of proposed disturbance operations, in setting conditions of approval and checking for operational compliance. FPC staff also conduct checks of activities performed by harvesting and roading contractors.

Non-conformance, corrective and preventative action

Identification of non-conformance, determining underlying causes and implementing effective corrective and preventative action is an important component of the environmental management system. Where significant conformance issues are identified, the Department will formally notify the proponent of the operation and request remedial action. In its mid-term audit of the current FMP (Conservation Commission 2008b), the Conservation Commission expressed concern about the level of response to formal notifications about compliance issued to the FPC. It was identified that improvements to the systems around monitoring and audit are required. The Department and the FPC have been working together since 2009, progressively reducing the backlog of incident reports and to improve the attention to incidents, including through exploring and making adjustments to processes associated with the environmental and forest management systems used by the FPC (consistent with the principle of continuous improvement).

Knowledge and adaptive management

A commitment to increasing knowledge and undertaking adaptive management to address identified gaps or potential future gaps provides evidence of a commitment to continuous improvement.

Knowledge

Full and effective implementation of many of the proposed operations identified in this Draft plan will be facilitated by improvement in knowledge and understanding. Knowledge can be gained from various sources such as monitoring, review and audits, the formal reviews proposed for this Draft plan (see activity 119 below), and those conducted during the current FMP – the findings of which have been taken into account in developing this Draft plan.

Useful knowledge can also be obtained from ‗benchmarking', which considers other systems and techniques applied elsewhere (both in other locations and in other sectors), to see what might be usefully applied in addressing local management issues.

Research is also fundamental to improving knowledge and understanding of natural systems and the response to disturbances and management intervention. The Department maintains a research function that seeks to advance the understanding and means of protection of the State's biodiversity and the

sustainable utilisation of natural resources for which it is responsible. The Department's research function must accommodate the research needs of the biota throughout the whole of Western Australia, and in many areas, knowledge is less than for the area covered by this plan and the priority for conservation actions is often greater. Because of this, resources to undertake research will never be available to address all the issues that might be identified and prioritisation is necessary. The Department seeks to target scientific research to issues of high priority for, in particular, biodiversity conservation. Research program priorities are periodically reviewed and published as a strategic plan outlining the key future directions and priorities (see Department of Environment and Conservation 2007 – *Strategic Plan for Biodiversity Conservation Research 2008 – 2017*).

Adaptive management

Where knowledge is incomplete and the understanding of the impacts is uncertain, proposed operations identified in this Draft plan are conservative, based on the precautionary approach, and may be adapted as new knowledge becomes available from various sources (see the section 'Review and improvement', below). Adaptive management will be a key component of the management system that implements the approved plan, recognising that there is an incomplete knowledge of ecosystems and their response to natural perturbations and the effects of management practices. The capability to undertake adaptive management depends on the accumulation of knowledge concerning management practices, their implementation and impact on the environment.

Active adaptive management can be a powerful tool to improving management and its use is central to the application of a framework for evaluation of management effectiveness. Adaptive management and the more intensive 'active' adaptive management have been defined by the British Columbia Ministry of Forests (2005) as follows:

> *Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Its most effective form, "active" adaptive management, employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed."*

The Department's Biodiversity Conservation Appraisal System (DEC 2009d) provides guidance on the Department's approach to adaptive management and criteria to be used to assess adaptive management proposals. Active adaptive management projects must meet the following five criteria:

1. have a hypothesis for each objective
2. have accountability
3. build corporate knowledge
4. be explicit for all participants, and goal and objectives be understood
5. have appropriate experimental design.

Goals

The plan proposes the following activities at the whole of forest, landscape and/or local scales, for the purpose of seeking to build knowledge, including through adaptive management, and monitor and evaluate the extent to which management of land to which the plan applies is undertaken in accordance with the plan.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to:

Policy Statement 45: *Environmental monitoring of pesticides used by CALM*

Policy Statement 63: *Information Management Policy*

Science Policy Statement 45: *Information Management Policy*

Policy Statement 78: *Science Policy*

Science Policy Guideline 1: *Science Plans*

Science Policy Guideline 2: *Implementing Research Results*

Science Policy Guideline 3: *Publications, Reports and Manuscripts*

Science Policy Guideline 4: *Databases and their Management*

Science Policy Guideline 5: *Scientific ethics and etiquette*

Science Policy Guideline 6: *Establishment and documentation of Scientific Sites*

Management Audit Branch Charter

Biodiversity Conservation Appraisal System

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

110 The Department, in consultation with the Conservation Commission, will develop a protocol for each key performance indicator in the plan to specify how the measurement of the key performance indicator will be undertaken.

111 The Department and the FPC will cooperate with the Commonwealth in the implementation of the Montreal Indicators program.

112 The Conservation Commission, Department and the FPC will conduct audits in accordance with their respective annual audit program. Audit programs will be developed with consideration of the potential risk to achievement of the goals of the plan.

113 The Department will report audit results to the Conservation Commission and the FPC and publish a summary of audit results.

114 The FPC will report audit results to the Department and the Conservation Commission and publish a summary of audit results.

115 The Department, and other proponents where required by the Department, will:

- 115.1 seek to address knowledge gaps, including through relevant ‗benchmarking' activities and research programs, as appropriate
- 115.2 work collaboratively with other agencies and institutions on matters of mutual interest
- 115.3 maintain programs and activities that seek to ensure the expeditious transfer of new knowledge and understanding into improved management approaches and operational practices
- 115.4 conduct adaptive management projects in a manner that has regard to an adaptive management policy, to be prepared by the Department.

116 **(Plantations):** The FPC will undertake audits based on the potential risk to achievement of the goals of the plan, and which will evaluate the extent to which plantation operations are undertaken in accordance with the plan. Audits will be reported to the Department and the Conservation Commission.

Review and improvement

Background

Management reviews occur at planned intervals to ensure the plan is achieving the desired goals. The most significant management reviews are the mid-term and end-of-term performance reviews undertaken by the Conservation Commission (Conservation Commission 2008b and 2012). The performance review includes analysing results, identifying underlying causes and developing recommendations to improve performance.

Operations and management systems are also reviewed on an informal basis in the daily course of events, informed for example, by the results of checks carried out (see the section ‗Monitoring and evaluation of performance', above). However, a formal review provides a disciplined and systematic process to gather together monitoring results, audit reports, incident reports, results and reports on adaptive management projects and results from research and development projects, and use them to evaluate the effectiveness of organisational set up, responsibilities, staffing, training, work programs and performance. From this, management procedures and training programs can be adjusted as necessary. Formal reviews are carried out by senior management within the Conservation Commission, Department and FPC, particularly where there is a deviation from expected standards, in which case contributing causal factors and remedial actions are identified, and procedures modified and communicated in an effort to prevent recurrence.

A formal review of silviculture guidelines was a requirement of the current FMP and is also proposed in this Draft plan. For further information on the silviculture review that has been completed by Burows *et al.* (2011), see the ‗Productive capacity' chapter.

Goal

The plan proposes the following activities at the whole of forest scale for the purpose of seeking to ensure that the plan operations, policies and guidelines maintain their currency.

Operations proposed to be undertaken (management activities)

117 The Conservation Commission and the Department will:

- 117.1 evaluate the results from research, monitoring, audits and adaptive management projects to determine whether the plan, or guidelines and policies referred to in the plan, should be amended
- 117.2 amend the plan if required according to the CALM and EP Acts
- 117.3 take action that is reasonable and practicable to address problems identified in management systems.

118 The Department will initiate an expert review of silvicultural practices during the second half of the term of the next FMP. Among other things, the review will have regard to the results from *FORESTCHECK* and other research monitoring, audits, and adaptive management projects.

119 The Conservation Commission will undertake mid-term and end-of-term performance reviews of the extent to which management of land to which the plan applies has been undertaken in accordance with the plan, which will include consideration of the extent to which all key performance indicator targets have been achieved.

120 Where performance targets have not been achieved under activity 119, the relevant agency will investigate the cause and report, through the reports on the mid-term and end-of-term performance reviews, to the Conservation Commission, which will submit the report to the Minister for Environment.

121 The Conservation Commission will:

121.1 evaluate the need for revision of management practices in the context of its assessment and auditing function, in consultation with the Department

121.2 provide its advice through the reports on the mid-term and end-of-term performance reviews to the Minister for Environment.

Key performance indicator

Key performance indicators will be used to track the implementation of the next FMP. Three indicators have been selected to provide a broad cross-section of achievement of the activities related to the implementation, monitoring and evaluation, and review and improvement sub-sections of the plan.

Key performance indicator 24	Operational control.
Performance measure	The extent to which guidance documents have been prepared/reviewed and management modified to improve ESFM.
Performance target(s)	Guidance documents referred to in the operations proposed by the plan to be prepared/reviewed as required during the life of the plan.

Key performance indicator 25	Adaptive management.
Performance measure	The number and quality of formal adaptive management trials.
Performance target(s)	Adaptive management trials are to meet the five criteria specified in the Department's Biodiversity Conservation Appraisal System.

Key performance indicator 26	Development of scientific understanding of ecosystem characteristics and functions.
Performance measure	Expenditures on research and development related to ESFM; Person years of scientific research, by ecosystem or disciplinary area of study, in the field of ESFM; and/or Number of peer reviewed articles published annually on ESFM.
Performance target(s)	Scientific understanding of ecosystem characteristics and functions is to increase.

Stakeholder involvement

Background

The community has an opportunity to contribute to the management of land vested in the Conservation Commission for environmental, economic and social outcomes. There is a statutory role for public consultation in management plan development, which is provided for and explained in the 'Invitation to comment' section of this Draft plan. During the term of the Draft plan, the extent of circulation of draft and/or revised policies and guidelines for comment (to selected stakeholders or to the general public through advertisement) will be determined by the Director General or in some cases

by Ministerial direction, as outlined in the Department's Policy Statement 1: *Department of Environment and Conservation – Key documents*.

Volunteers are also involved in aspects of the Department's work and make an important contribution, including to various on-ground activities. The Department seeks to facilitate and encourage this (see the *Department's volunteer strategy 2012-2016*).

In addition to the broader community, many of the management activities undertaken by the Department have the potential to affect values or resources that other government and non-government bodies have a legal responsibility for, or an interest in. For example, the Department of Water and the Water Corporation have legislated responsibility for water supply and water quality from catchments and Tourism WA has a responsibility for tourism in the south-west. In these cases it is necessary for the Department to consult with such bodies prior to taking any actions that will significantly affect their interests.

Goal

The plan proposes the following activities at the whole of forest scale for the purpose of seeking to provide opportunities for the community, and relevant non-government organisations and government agencies to participate in plan implementation.

Relevant policies and guidelines of the Department

When undertaking the proposed operations (management activities) outlined below, the Department will have regard to:

Policy Statement 1: *Department of Environment and Conservation - Key documents*

Policy Statement 15: *Community Involvement*

Policy Statement 25: *Community Education and Interpretation*

Policy Statement 65: *Good neighbour policy*

DEC Volunteer Strategy 2012-2016

Proponents undertaking other disturbance operations will also have regard to these documents where required by the Department.

Operations proposed to be undertaken (management activities)

122 The Department, and other proponents where required by the Department, will undertake public consultation in relation to the development and review of management policies and guidelines, having regard to Policy Statement 1: *Department of Environment and Conservation - Key documents*.

123 The Department will:

- 123.1 develop and implement programs that seek to provide the community with educational opportunities and information on management of land that is subject to the plan
- 123.2 maintain public consultation processes
- 123.3 provide opportunities for community participation in voluntary activities and educational and social development programs relating to management of land that is subject to the plan
- 123.4 provide a range of opportunities for volunteers to be involved in land management activities.

Key performance indicator

Key performance indicators will be used to track the implementation of the next FMP. One indicator has been selected related to the management of stakeholder involvement.

Key performance indicator 27	Provide for public involvement activities and public education, awareness and extension programs and make available forest-related information.
Performance measure	Compilation of programs for public involvement, education, awareness and extension programs.
Performance target(s)	Available programs and numbers of the community exposed to programs increase over time.

Appendix 1: Management emphases by Landscape Management Units (LMUs)

Interpretation notes:

- the table provides an overview of key features identified by the Department that broadly distinguish one LMU from another
- management emphases reflect circumstances current at time of preparation and may be subject to change
- the listings of values, threats and management emphases are not exhaustive and should not be interpreted as being exclusive of other management activity – for example, threats associated with climate change and fire are widespread and apply across LMUs
- management plans listed in the table may be amended, reviewed or revoked during the term of the next FMP
- reservation percentages are based on land categories as proposed in this Draft plan, including the proposal for Whicher Scarp.

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
Swan Coastal Plain North of Perth (30) Area = 110,630 ha Formal reserves = 57% Remaining area = 43% Area management plans in place: Yanchep National Park Yellagonga Regional Park Herdsman Lake Regional Park Matilda Bay Reserve Swan Estuary Marine Park and Adjacent Nature Reserves.	Biodiversity	Cave ecosystems. Forest and woodland is largely regrowth and fragmented. Maintaining supply of overstorey legacy elements for habitat is important. Remnant vegetation. Threatened flora, fauna and ecological communities.	Unauthorised felling and removal of wood, including firewood. Loss of native vegetation through urban and peri-urban development. Mining and basic raw materials extraction. Unmanaged recreation. Groundwater extraction. Progressive removal of pine plantations.	Land use planning. Management to enhance water values Planning for and managing recreation demand. Fire management for biodiversity and community/asset protection. Invasive species management. Replanting of cockatoo habitat.
	Productive capacity	Honey production and wildflower picking. State forest important for wood production (plantations).	Progressive loss of pine plantations. European house borer.	
	Ecosystem health	Examples of healthy remnants of banksia and tuart woodlands and wetlands.	Inappropriate fire regimes. Invasive species.	
	Soil and water	Gnangara mound for water supply.	Inappropriate land use (e.g. unmanaged off-road vehicle recreation).	

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
	Carbon	Carbon store in plantations.	Progressive removal of pine plantations.	
	Heritage			
	Social and economic	Basic raw materials. Land development pressures. High recreation value and strong demand.	Inappropriate land use (e.g. unmanaged off-road vehicle recreation).	
Swan Coastal Plain South of Perth (31) Area = 41,430 ha Formal reserves = 76% Remaining area = 24% Area management plans in place: Swan Estuary Marine Park and Adjacent Nature Reserves Canning River Regional Park Woodman Point Regional Park Jandakot Regional Park Thomsons Lake Nature Reserve Beeliar Regional Park Rockingham Lakes	Biodiversity	Forest and woodland is largely regrowth and highly fragmented. Maintaining supply of overstorey legacy elements for habitat is important. Remnant vegetation. Threatened flora, fauna and ecological communities. Thrombolite ecosystems.	Unauthorised felling and removal of wood, including firewood. Loss of native vegetation through urban and peri-urban development. Mining and basic raw materials extraction. Inappropriate land use (e.g. unmanaged off-road vehicle recreation).	Land use planning. Management to enhance water values. Fire management for biodiversity and community/asset protection. Planning for and managing recreation demand. Invasive species management.
	Productive capacity	State forest important for wood production (plantations).	Progressive loss of pine plantations. Groundwater extraction.	
	Ecosystem health	Examples of healthy remnants of banksia and tuart woodlands and wetlands.	Inappropriate fire regimes. Invasive species. Tuart decline.	
	Soil and water	Jandakot mound for water supply.	Inappropriate land use (e.g. unmanaged off-road vehicle recreation).	
	Carbon			
	Heritage			

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
Regional Park Forrestdale Lake Nature Reserve Serpentine National Park Yalgorup National Park Lake McLarty Nature Reserve Leschenault Peninsula Conservation Park Benger Swamp Nature Reserve Leeuwin-Naturaliste National Park.	Social and economic	Basic raw materials. Land development pressures. High recreation value and strong demand.	Inappropriate land use (e.g. unmanaged off-road vehicle recreation).	
Dandaragan Plateau (8) Area = 13,600 ha Formal reserves = 100% Area management plans in place – none.	Biodiversity	Threatened flora, fauna and ecological communities (e.g. Boonanarring Nature Reserve). Granite outcrops.	Basic raw materials extraction. Unauthorised wildflower picking and unauthorised felling and removal of wood, including firewood. Inappropriate fire regimes.	Fire management for biodiversity. Management of unauthorised activity. Advice re water extraction licence proposals. Management of *Phytophthora* dieback disease.
	Productive capacity			
	Ecosystem health		*Phytophthora* dieback.	
	Soil and water		Groundwater extraction.	
	Carbon			
	Heritage	Aboriginal heritage (Mogumber).		
	Social and economic	High recreation value and increasing demand.		

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
North Western Dissection (21) Area = 42,800 ha Formal reserves = 70% Informal reserves & other protected areas = 10% State forest available for wood production = 20% Area management plans in place – none.	Biodiversity	Forest is largely regrowth and maintaining supply of legacy overstorey elements for habitat is important. Threatened flora and fauna. Riparian habitats associated with perennial streams.	Development pressures and inappropriate land use (e.g. unmanaged off-road vehicle recreation). Unauthorised felling and removal of wood, including firewood.	Fire management for biodiversity. Management of unauthorised activity. Aboriginal heritage protection. Management of invasive species and *Phytophthora* dieback disease. Maintain supply of legacy elements (larger overstorey trees).
	Productive capacity			
	Ecosystem health		*Phytophthora* dieback.	
	Soil and water	Important for water production and catchment protection with large investment in water supply infrastructure.		
	Carbon			
	Heritage	Aboriginal values in Avon Valley National Park.		
	Social and economic	Basic raw materials. Increasing demand for recreation (proximity to major population centres).		
Northern Upper Plateau (20) Area = 27,930 ha Formal reserves = 73% Informal reserves & other protected areas = 5% State forest available for wood production = 22%	Biodiversity	Forest is largely regrowth and maintaining supply of legacy overstorey elements for habitat is important. Riparian habitats.	Development pressures and inappropriate land use (e.g. unmanaged off-road vehicle recreation). Unauthorised felling and removal of wood, including firewood.	Fire management for biodiversity. Management of unauthorised activity. Aboriginal heritage protection. Management of invasive species and *Phytophthora* dieback disease. Maintain supply of legacy elements (larger overstorey trees).
	Productive capacity	State forest important for wood production (plantations and native forest).		

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
Area management plans in place – none.	Ecosystem health		*Phytophthora* dieback.	
	Soil and water	Important for water production and catchment protection with large investment in water supply infrastructure.		
	Carbon			
	Heritage	Aboriginal values (north and east of the Swan/Avon rivers).		
	Social and economic	Basic raw materials. Increasing demand for recreation (proximity to major population centres).		
North Eastern Dissection (16) *& east to Swan Region boundary* Area = 14,470 ha Formal reserves = 100% Area management plans in place: Nature Reserves of the Shires of York and Northam.	Biodiversity	Threatened flora and fauna. Maintaining supply of legacy overstorey elements for habitat is important.	Altered hydrology (from surrounding land use). Invasive species (feral animals).	Fire management for biodiversity. Water management (e.g. Drummond Natural Diversity Recovery Catchment). Management of invasive species. Management of unauthorised activity. Maintain the supply of legacy elements for habitat habitat.
	Productive capacity			
	Ecosystem health			
	Soil and water	Wetlands in Drummond Nature Reserve.		
	Carbon			
	Heritage	Aboriginal heritage.		
	Social and economic			

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
North Western Jarrah (22) Area = 104,990 ha Formal reserves = 27% Informal reserves & other protected areas = 16% State forest available for wood production = 57% Area management plans in place: John Forrest National Park Serpentine National Park.	Biodiversity	Threatened flora and fauna. Riparian habitats of perennial streams. Granite outcrops.	Development pressures and inappropriate land use (e.g. unmanaged off-road vehicle recreation). Unauthorised felling and removal of wood, including firewood. Mining and basic raw materials extraction. Inappropriate fire regimes.	Minimise the impact on biodiversity and other values from basic raw materials extraction, unmanaged/unauthorised activities, utility corridors. Maintain the quantity of water flowing to water supply reservoirs. Fire management for biodiversity and community/asset protection. Management of wood production activities from areas available including rehabilitated bauxite mine sites. Management of *Phytophthora* dieback disease.
	Productive capacity	State forest important for wood production. Rehabilitated bauxite pits are important for future wood production.		
	Ecosystem health		*Phytophthora* dieback.	
	Soil and water	Important for water production and catchment protection with large investment in water supply infrastructure.	Dense regrowth forests.	
	Carbon			
	Heritage			
	Social and economic	Basic raw materials. Increasing demand for recreation (proximity to major population centres).		

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
Northern Sandy Depression (18) Area = 89,420 ha Formal reserves = 53% Informal reserves & other protected areas = 11% State forest available for wood production = 36% Area management plans in place – none.	Biodiversity	Forest is largely regrowth and maintaining supply of overstorey legacy elements for habitat is important. Riparian habitats.	Unauthorised felling and removal of wood, including firewood. Mining. Inappropriate land use (e.g. unmanaged off-road vehicle recreation).	Minimise the impact on biodiversity and other values from basic raw materials extraction, unmanaged/unauthorised activities, utility corridors. Maintain the supply of legacy elements for habitat. Fire management for biodiversity. Management of wood production activities from areas available, including rehabilitated bauxite mine sites. Management of *Phytophthora* dieback disease.
	Productive capacity	State forest important for wood production.		
	Ecosystem health		*Phytophthora* dieback.	
	Soil and water	Important for water production and catchment protection with large investment in water supply infrastructure.	Altered hydrology (from surrounding land use).	
	Carbon			
	Heritage			
	Social and economic	Basic raw materials. Increasing demand for recreation as is close to major population centres (e.g. Bibbulmun Track and Munda Biddi Trail).		
Eastern Dissection (11) Area = 34,540 ha Formal reserves = 64% Informal reserves & other protected areas = 6% State forest available for wood production = 30%	Biodiversity	Forest is largely regrowth and maintaining supply of overstorey legacy elements for habitat is important. Riparian habitats. Remnant vegetation. Threatened flora and fauna.	Development pressures and inappropriate land use (e.g. unmanaged off-road vehicle recreation). Altered hydrology (from surrounding land use). Unauthorised felling and removal of wood, including firewood. Mining.	Fire management for biodiversity. Maintain the supply of legacy elements for habitat. Management of invasive species and *Phytophthora* dieback disease. Management of unauthorised activity.

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
Area management plans in place – none.	Productive capacity	State forest important for wood production.		
	Ecosystem health		*Phytophthora* dieback.	
	Soil and water	Important for catchment protection with large investment in water supply infrastructure.	Altered hydrology (from surrounding land use).	
	Carbon			
	Heritage			
	Social and economic			
Monadnocks Uplands Valleys (15) Area = 95,100 ha Formal reserves = 27% Informal reserves & other protected areas = 13% State forest available for wood production = 60% Area management plans in place – none.	Biodiversity	Granite outcrops. Riparian habitats.	Mining. Unauthorised felling and removal of wood, including firewood. Inappropriate land use (e.g. unmanaged off-road vehicle recreation). Inappropriate fire regimes.	Minimise the impact on biodiversity and other values from mining, basic raw materials extraction, unmanaged/unauthorised activities, utility corridors. Management of wood production activities from areas available including rehabilitated bauxite mine sites. Fire management for biodiversity and community/asset protection. Management of *Phytophthora* dieback disease.
	Productive capacity	State forest important for wood production. Rehabilitated bauxite pits important for future wood production.		
	Ecosystem health		*Phytophthora* dieback.	
	Soil and water	Important for catchment protection with large investment in water supply infrastructure.	Altered hydrology (from surrounding land use).	
	Carbon			
	Heritage			

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
	Social and economic	Basic raw materials. Increasing demand for recreation (proximity to major population centres, Bibbulmun Track and Munda Biddi Trail).		
Eastern Murray (12) Area = 27,110 ha Formal reserves = 37% Informal reserves & other protected areas = 8% State forest available for wood production = 55% Area management plans in place: Mooradung Nature Reserve.	Biodiversity	Granite outcrops. Forest is largely regrowth and maintaining supply of overstorey legacy elements for habitat is important. Riparian habitats. Remnant vegetation. Threatened flora and fauna.	Development pressures and inappropriate land use (e.g. unmanaged off-road vehicle recreation). Unauthorised felling and removal of wood, including firewood. Mining. Inappropriate fire regimes.	Fire management for biodiversity. Maintain the supply of legacy elements for habitat. Management of invasive species. Management of unauthorised activity. Management of mining-associated activity and impacts.
	Productive capacity	State forest important for wood production. Rehabilitated bauxite pits important for future wood production.		
	Ecosystem health			
	Soil and water	Important for catchment protection with large investment in water supply infrastructure.	Altered hydrology (from surrounding land use).	
	Carbon			
	Heritage			
	Social and economic	Gold mining and basic raw materials.		

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
Central Jarrah (5) Area = 316,280 ha Formal reserves = 17% Informal reserves & other protected areas = 16% State forest available for wood production = 67% Area management plans in place: Serpentine National Park Wellington National Park Westralia Conservation Park Wellington Discovery Forest Logue Brook Reservoir and Catchment Area Waroona Reservoir and Catchment Area Lane Poole Reserve and Proposed Reserve Additions.	Biodiversity	Threatened flora and fauna. Riparian habitats.	Development pressures and inappropriate land use (e.g. unmanaged off-road vehicle recreation). Unauthorised felling and removal of wood, including firewood. Mining.	Minimise the impact on biodiversity and other values from mining, basic raw materials extraction, unmanaged/unauthorised activities, utility corridors. Wood and water production, including from rehabilitated bauxite mine sites. Planning for and managing recreation demand. Management of *Phytophthora* dieback disease. Fire management for protection of infrastructure and rehabilitated native forest.
	Productive capacity	State forest important for wood production (plantations and native forest). Rehabilitated bauxite pits important for future wood production.		
	Ecosystem health		*Phytophthora* dieback.	
	Soil and water	Important for water production and catchment protection with large investment in water supply infrastructure.	Extent of regrowth forests.	
	Carbon			
	Heritage			
	Social and economic	Bauxite mining and basic raw materials. Recreation sites and opportunities. Utility corridors.		

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
Northern Upper Collie (19) Area = 120,770 ha Formal reserves = 48% Informal reserves & other protected areas = 10% State forest available for wood production = 42% Area management plans in place: Lane Poole Reserve and Proposed Reserve Additions.	Biodiversity	Threatened flora and fauna.	Fragmentation and incompatible surrounding land use. Altered hydrology (from surrounding land use). Unauthorised felling and removal of wood, including firewood. Invasive species.	Biodiversity management. Management of wood production activities. Planning for and managing recreation demand.
	Productive capacity	State forest important for wood production.		
	Ecosystem health			
	Soil and water	Important for catchment protection with large investment in water supply infrastructure.	Altered hydrology (from surrounding land use).	
	Carbon			
	Heritage			
	Social and economic	Recreation sites and opportunities.		
Central Blackwood (4) Area = 78,490 ha Formal reserves = 25% Informal reserves & other protected areas = 12% State forest available for wood production = 63% Area management plans in place – none.	Biodiversity		Development pressures. Unauthorised felling and removal of wood, including firewood. Off-estate pressures on fauna (e.g. illegal destruction of cockatoos in orchards).	Management of wood production activities. Fire management for community/asset protection. Neighbour issues management.
	Productive capacity	State forest important for wood production (plantations & native forest).		
	Ecosystem health		Utility corridors (fragmentation).	

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
	Soil and water	Hester Dam water supply for Hester townsite and potentially, Bridgetown. Kirup Dam water supply for Kirup and Mullalyup.		
	Carbon			
	Heritage			
	Social and economic	Mining and basic raw materials.		
Collie Wilga (7) Area = 58,800 ha Formal reserves = 34 Informal reserves & other protected areas = 13% State forest available for wood production = 53% Area management plans in place: Wellington National Park Westralia Conservation Park Wellington Discovery Forest.	Biodiversity	Remnant vegetation. Short-range endemics.		Management of mining-associated activity and impacts. Management of wood production activities. Neighbour issues management.
	Productive capacity	State forest important for wood production.		
	Ecosystem health		Contaminated sites. Utility corridors.	
	Soil and water	Important for catchment protection with large investment in water supply infrastructure.	Altered hydrology (from surrounding land use).	
	Carbon			
	Heritage			
	Social and economic	Coal mining. Recreation sites and opportunities. Utilities.		
Darkin Towering (9) *(mimimal Department-managed estate)*	Biodiversity	Remnant vegetation. Maintaining supply of overstorey legacy elements for habitat is important. Threatened flora.	Fragmentation and incompatible surrounding land use. Altered hydrology (from surrounding land use).	Biodiversity management.

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
Area = 2,660 ha Formal reserves = 100% Area management plans in place – none.	Productive capacity			
	Ecosystem health			
	Soil and water	Important for catchment protection with large investment in water supply infrastructure.	Altered hydrology (from surrounding land use).	
	Carbon			
	Heritage			
	Social and economic			
Margaret Plateau (14) Area = 31,690 ha Formal reserves = 94% Informal reserves & other protected areas = 2% State forest available for wood production = 4% Area management plans in place: Leeuwin-Naturaliste National Park.	Biodiversity	Cave systems. Remnant vegetation. Short-range endemics. Highly biodiverse area with east-west linkage intact to main north-south forest belt.	Clearing of native vegetation. Infrastructure/utilities to support population growth. Unauthorised felling and removal of wood, including firewood. Inappropriate land use (e.g. unmanaged off-road vehicle recreation).	Planning for and managing recreation demand. Minimise impact on biodiversity and landscape values from increased urbanisation of rural sub-division (land use planning). Fire management for biodiversity and community/asset protection.
	Productive capacity			
	Ecosystem health			
	Soil and water	Increasing demand for water to support growing population and intensification of agriculture. 10 Mile Brook Dam water supply for Margaret River, Cowaramup and Prevelly.	Off-estate land use impacts.	
	Carbon			
	Heritage	Aboriginal and European heritage.		

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
	Social and economic	High landscape values (including coastal vistas) and beach access. High and increasing use for recreation particularly in the warmer months.		
Abba Plain (1) *(mostly cleared farmland, minimal DEC-managed estate)* Area = 20 ha Formal reserves = 100% Area management plans in place – none.	Biodiversity	Threatened ecological communities (TEC). Maintaining supply of overstorey legacy elements for habitat is important. Threatened flora.	Fragmentation and incompatible surrounding land use. Inappropriate fire regimes. Invasive species. Mining proposals. Altered hydrology (from surrounding land use).	Biodiversity management (including strategic land purchase). Management of *Phytophthora* dieback disease.
	Productive capacity			
	Ecosystem health		*Phytophthora* dieback.	
	Soil and water			
	Carbon			
	Heritage			
	Social and economic	Mineral sands.		
Blackwood Plateau (2) Area = 296,820 ha Formal reserves = 33% Informal reserves & other protected areas = 14% State forest available for wood production = 53%	Biodiversity	Coastal plain/scarp ecotone. High flora species richness. Old-growth forest (to south). Short-range endemics – especially in tributaries of lower Blackwood River aquatic ecosystems.	Groundwater extraction. Inappropriate fire regimes. Unauthorised felling and removal of wood, including firewood. Inappropriate land use (e.g. unmanaged off-road vehicle recreation). Utility corridors. Mining and clearing in the Whicher Scarp area.	Fire management for biodiversity and community/asset protection. Management of wood production activities. Planning for and managing recreation demand. Management of *Phytophthora* dieback disease.

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
Area management plans in place: Leeuwin-Naturaliste National Park.	Productive capacity	State forest important for wood production (plantations and native forest).		
	Ecosystem health		*Phytophthora* dieback.	
	Soil and water	Yarragadee aquifer.	Groundwater extraction.	
	Carbon			
	Heritage	Aboriginal heritage (major rivers).		
	Social and economic	Basic raw materials. Wildflower picking. Recreation sites and opportunities. Whicher Scarp petroleum/gas (potential).		
Southern Dunes (25) Area = 70,440 ha Formal reserves = 100% Area management plans in place: Shannon and D'Entrecasteaux National Parks Leeuwin-Naturaliste National Park.	Biodiversity	Grasslands and coastal woodlands. Organic soils. TECs and threatened flora. Wetlands of national significance.	Invasive species. Inappropriate fire regimes. Unauthorised and inappropriate land use (e.g. unmanaged off-road vehicle recreation).	Fire management for biodiversity and community/asset protection. Planning for and managing recreation demand. Management of invasive species.
	Productive capacity			
	Ecosystem health			
	Soil and water	Erosion prone. Yarragadee aquifer outflow.		
	Carbon			
	Heritage	Aboriginal and European heritage.		
	Social and economic	Beaches and 4WD access for recreation, huts. Remoteness and coastal vistas.		

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
Blackwood Scott Plain (3) Area = 23,730 ha Formal reserves = 88% Informal reserves & other protected areas = 8% State forest available for wood production = 4% Area management plans in place: Leeuwin-Naturaliste National Park Shannon and D'Entrecasteaux National Parks.	Biodiversity	Organic soils. TEC and threatened flora. Wetlands and riparian systems (refugia). _Transition to forest' ecotone.	Altered hydrology (from surrounding land use). Groundwater extraction. Inappropriate fire regimes.	Fire management for biodiversity and community/asset protection. Biodiversity management. Land use planning. Management of *Phytophthora* dieback disease.
	Productive capacity			
	Ecosystem health		*Phytophthora* dieback.	
	Soil and water	Yarragadee aquifer _outcropping'.	Acid sulfate soil plume from mineral sands mine site. Groundwater extraction. Potential mining operations.	
	Carbon			
	Heritage	Aboriginal heritage (major rivers).		
	Social and economic	Water abstraction from Yarragadee aquifer for agricultural use.		
Northern Karri (17) Area = 108,310 ha Formal reserves = 27% Informal reserves & other protected areas = 18% State forest available for wood production = 55% Area management plans in place – none.	Biodiversity	Old-growth forest. Threatened flora and fauna.	Invasive species. Mining proposal.	Management of wood production activities. Fire management for biodiversity and regrowth forest protection. Planning for and managing recreation demand. Biodiversity management.
	Productive capacity	State forest important for wood production.		
	Ecosystem health		Gum leaf skeletoniser.	
	Soil and water	Town water supply (Manjimup). Millstream Dam water supply for Bridgetown, Greenbushes, Mullalyup, Balingup. Tanjanerup Dam water supply for Nannup.	Regrowth forest water use.	
	Carbon			
	Heritage			

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
	Social and economic	Recreation sites and opportunities (e.g. Bibbulmun Track, Munda Biddi Trail). Wildflower picking.		
Eastern Blackwood (10) Area = 8,110 ha Formal reserves = 89% Informal reserves & other protected areas = 1% State forest available for wood production = 10% Area management plans in place – none.	Biodiversity	Forest is largely regrowth and maintaining supply of overstorey legacy elements for habitat is important. Heartleaf and melaleuca thickets. Remnant forest and woodland. Threatened flora and fauna.	Feral animals. Fragmentation and incompatible surrounding land use.	Threatened species management. Fire management for biodiversity and community/asset protection.
	Productive capacity			
	Ecosystem health	Good condition of remnants.	Altered hydrology (from surrounding land use).	
	Soil and water	Catchment protection (water quality).		
	Carbon			
	Heritage			
	Social and economic			
Yornup Wilgarup Perup (32) Area = 118,580 ha Formal reserves = 47% Informal reserves & other protected areas = 14%	Biodiversity	Heartleaf and melaleuca thickets. Threatened flora and fauna.	Altered hydrology (from surrounding land use). Invasive species. Unauthorised felling and removal of wood, including firewood.	Threatened species management. Fire management for biodiversity and community/asset protection. Management of wood production activities.
	Productive capacity	State forest important for wood production.		

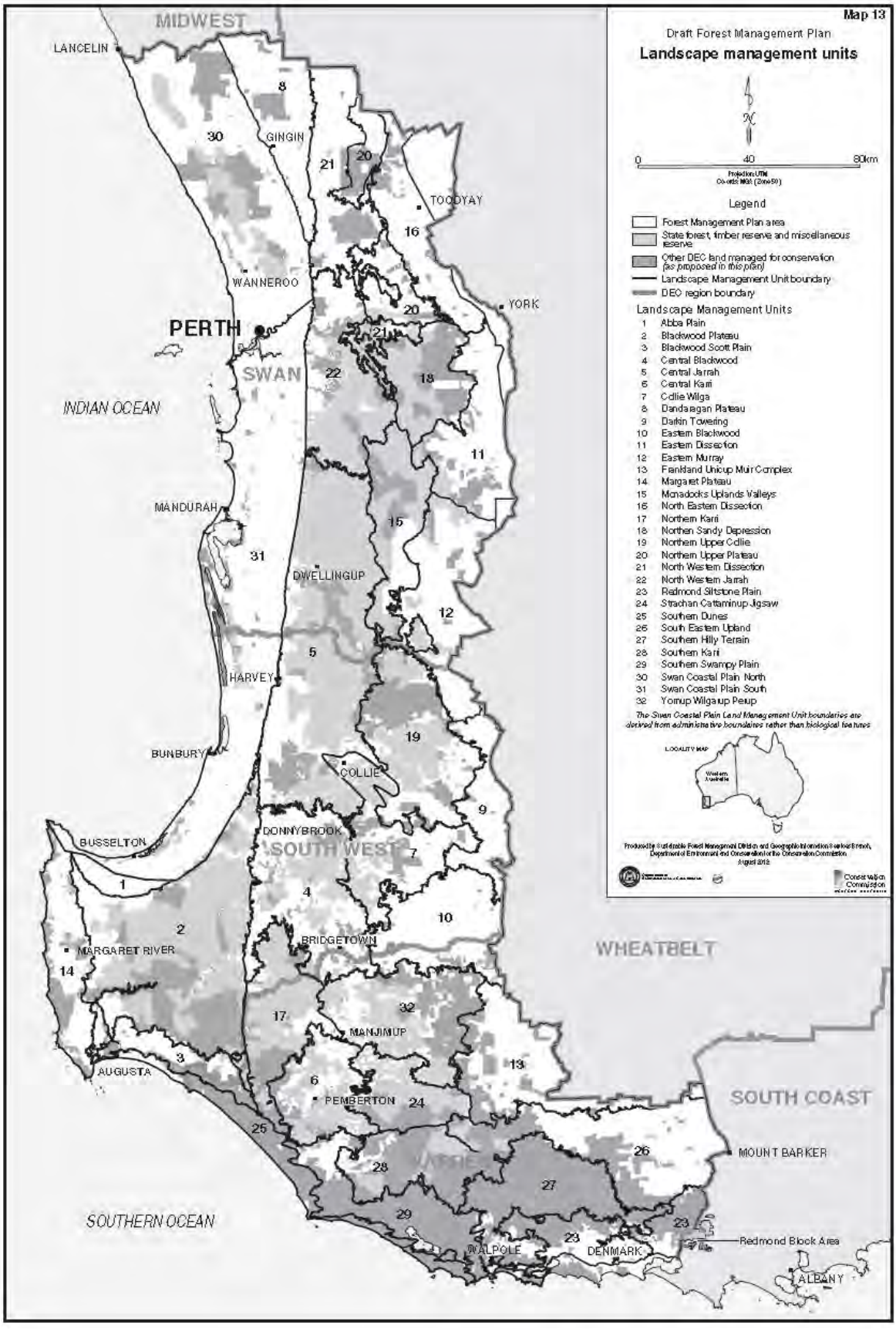
Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
State forest available for wood production = 39% Area management plans in place: Perup.	Ecosystem health		Altered hydrology (from surrounding land use). Invasive species. Unauthorised felling and removal of wood, including firewood.	
	Soil and water			
	Carbon			
	Heritage			
	Social and economic	Wildflower picking.		
Frankland Unicup Muir Complex (13) Area = 39,610 ha Formal reserves = 100% Area management plans in place: Perup.	Biodiversity	Organic soils. Ramsar wetlands. Remnant forest and woodland. Threatened flora and fauna.	Fragmentation and incompatible surrounding land use. Altered hydrology (from surrounding land use). Invasive species. Inappropriate fire regimes.	Recovery catchment management. Biodiversity management (threatened flora and fauna). Fire management for biodiversity and community/asset protection.
	Productive capacity			
	Ecosystem health		Invasive species.	
	Soil and water	Lake Muir Unicup Natural Diversity Recovery Catchment.		
	Carbon			
	Heritage			
	Social and economic			
Central Karri (6)	Biodiversity	Threatened fauna.	Invasive species.	Management of wood production activities. Planning for and managing
	Productive capacity	State forest important for wood production.	Inappropriate fire regimes.	

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
Area = 65,580 ha Formal reserves = 19% Informal reserves & other protected areas = 24% State forest available for wood production = 57% Area management plans in place – none.	Ecosystem health		*Phytophthora* dieback	recreation demand. Fire management for community/asset protection (including regrowth forest). Management of *Phytophthora* dieback disease.
	Soil and water	Town water supply (Pemberton).	Altered hydrology (from surrounding land use). Groundwater extraction.	
	Carbon			
	Heritage	European heritage.		
	Social and economic	Recreation sites and opportunities. Wildflower picking.		
Strahan Cattaminup Jigsaw (24) Area = 70,170 ha Formal reserves = 31% Informal reserves & other protected areas = 19% State forest available for wood production = 50% Area management plans in place: Shannon and D'Entrecasteaux National Parks.	Biodiversity	Old-growth forest. Threatened flora and fauna.	Invasive species.	Fire management for biodiversity and community/asset protection. Management of wood production activities. Planning for and managing recreation demand.
	Productive capacity	State forest important for wood production.		
	Ecosystem health		Unauthorised access.	
	Soil and water			
	Carbon			
	Heritage			
	Social and economic	Basic raw materials. Recreation sites and opportunities. Wildflower picking.		
Southern Swampy Plain (29) Area = 96,400 ha Formal reserves = 98% Informal reserves & other	Biodiversity	Granite outcrops. Organic soils. TEC. Threatened flora and fauna. Wetlands of national significance.	Feral animals. Inappropriate fire regimes.	Biodiversity management (threatened flora). Fire management for biodiversity and community/asset protection. Planning for and managing recreation demand.
	Productive capacity			

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
protected areas = 1% State forest available for wood production = 1% Area management plans in place: Shannon and D'Entrecasteaux National Parks.	Ecosystem health		*Phytophthora* dieback.	Management of *Phytophthora* dieback disease.
	Soil and water			
	Carbon			
	Heritage	Aboriginal heritage. Stock routes and huts.		
	Social and economic	Recreation sites and opportunities (eg, Bibbulmun Track, Munda Biddi Trail). Basic raw materials. Scenic quality.		
Southern Karri (28) Area = 100,000 ha Formal reserves = 75% Informal reserves & other protected areas = 7% State forest available for wood production = 18% Area management plans in place: Shannon and D'Entrecasteaux National Parks Walpole Wilderness and Adjacent Parks and Reserves.	Biodiversity	Old-growth forest.		Fire management for community/asset protection (including regrowth forest). Management of wood production activities.
	Productive capacity	State forest important for wood production.	Inappropriate fire regimes.	
	Ecosystem health	Large intact and healthy ecosystems.		
	Soil and water		Altered hydrology (from surrounding land use). Groundwater extraction.	
	Carbon			
	Heritage			
	Social and economic	Basic raw materials.		

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
South Eastern Upland (26) Area = 72,830 ha Formal reserves = 89% Informal reserves & other protected areas = 4% State forest available for wood production = 7% Area management plans in place: Walpole Wilderness and Adjacent Parks and Reserves.	Biodiversity	Forest is largely regrowth and maintaining supply of overstorey legacy elements for habitat is important. Remnant forest and woodland. Threatened flora and fauna.	Fragmentation and incompatible surrounding land use. Invasive species.	Fire management for biodiversity and community/asset protection. Management of invasive species (feral animals).
	Productive capacity			
	Ecosystem health			
	Soil and water	Catchment protection.	Altered hydrology (from surrounding land use).	
	Carbon			
	Heritage			
	Social and economic			
Southern Hilly Terrain (27) Area = 145,790 ha Formal reserves = 100% Area management plans in place: Walpole Wilderness and Adjacent Parks and Reserves.	Biodiversity	Forest is largely regrowth and maintaining supply of overstorey legacy elements for habitat is important. Granite outcrops. TEC. Organic soils. Threatened flora and fauna. Tingle forest types. Wetlands.	Feral animals. Inappropriate fire regimes.	Fire management for biodiversity and community protection. Planning for and managing recreation demand. Biodiversity management. Management of *Phytophthora* dieback disease.
	Productive capacity			
	Ecosystem health	Large intact area of native ecosystems.	*Phytophthora* dieback.	
	Soil and water	Potential water supply (Denmark).		
	Carbon			

Landscape Management Unit (see no. on Map 13)	Sustainability criterion	Key values or characteristics	Key threats	Management emphases
	Heritage			
	Social and economic	Recreation sites and opportunities. Scenic quality.		
Redmond Siltstone Plain (23) Area = 60,750 ha Formal reserves = 93% Informal reserves & other protected areas = 3% State forest available for wood production = 4% Area management plans in place: Walpole Wilderness and Adjacent Parks and Reserves.	Biodiversity	Forest is largely regrowth and maintaining supply of overstorey legacy elements for habitat is important. Grasslands and coastal woodlands. Organic soils. Threatened flora and fauna. Wetlands of national significance.	Inappropriate fire regimes. Invasive species.	Fire management for biodiversity and community protection. Biodiversity management. Management of *Phytophthora* dieback disease.
	Productive capacity			
	Ecosystem health		*Phytophthora* dieback.	
	Soil and water	Potential water supply (Denmark).		
	Carbon			
	Heritage			
	Social and economic			


Map 13
Draft Forest Management Plan
Landscape management units
0
40
80km
Legend
Forest Management Plan area
State forest, timber reserve and miscellaneous reserve
Other DEC land managed for conservation (as proposed in this plan)
Landscape Management Unit boundary
DEC region boundary
Landscape Management Units
1 Abba Plain
2 Blackwood Plateau
3 Blackwood Scott Plain
4 Central Blackwood
5 Central Jarrah
6 Central Karri
7 Collie Wilga
8 Dandaragan Plateau
9 Darkin Towering
10 Eastern Blackwood
11 Eastern Dissection
12 Eastern Murray
13 Frankland Unicup Muir Complex
14 Margaret Plateau
15 Monadocks Uplands Valleys
16 North Eastern Dissection
17 Northern Karri
18 Northern Sandy Depression
19 Northern Upper Collie
20 Northern Upper Plateau
21 North Western Dissection
22 North Western Jarrah
23 Redmond Siltstone Plain
24 Strachan Cattaminup Jigsaw
25 Southern Dunes
26 South Eastern Upland
27 Southern Hilly Terrain
28 Southern Karri
29 Southern Swampy Plain
30 Swan Coastal Plain North
31 Swan Coastal Plain South
32 Yornup Wilga up Peup
The Swan Coastal Plain Land Management Unit boundaries are derived from administrative boundaries rather than biological features
LOCALITY MAP
Western Australia
Produced by Sustainable Forest Management Division and Geographic Information Services Branch, Department of Environment and Conservation for the Conservation Commission
August 2012
Conservation Commission
MIDWEST
LANCELIN
GINGIN
TOODYAY
WANNEROO
YORK
PERTH
SWAN
INDIAN OCEAN
MANDURAH
DWELLINGUP
HARVEY
BUNBURY
COLLIE
DONNYBROOK
SOUTH WEST
BUSSELTON
MARGARET RIVER
BRIDGETOWN
WHEATBELT
MANJIMUP
AUGUSTA
PEMBERTON
SOUTH COAST
MOUNT BARKER
WALPOLE
DENMARK
ALBANY
Redmond Block Area
SOUTHERN OCEAN

Appendix 2

The purpose(s), and objectives of management plans, for land categories vested in the Conservation Commission

Land category	Objectives of management plans (CALM Act s56)	Management plan
Indigenous State forest or timber reserves [the purposes provided for under s55(1)(a) being: a. conservation; b. recreation; c. timber production on a sustained yield basis; d. water catchment protection; or e. other purpose being a purpose prescribed by the regulations.]	(1)(a) to achieve the purpose or combination of purposes provided for under s55(1a). (2)(a) protecting and conserving the value of the land to the culture and heritage of Aboriginal persons, in particular from any material adverse effect caused by — (i) entry on or the use of the land by other persons; or (ii) the taking or removal of the land's fauna, flora or forest produce; but (2)(b) in a manner that does not have an adverse effect on the protection or conservation of the land's fauna and flora. (3) If an objective set out in subsection (1) conflicts or is inconsistent with an objective set out in subsection (2), the objective set out in subsection (2) prevails.	The forest management plan
State forest or timber reserves planted with exotic species	(1)(b) to achieve the optimal yield in production consistent with the satisfaction of long-term social and economic needs (2)(a) protecting and conserving the value of the land to the culture and heritage of Aboriginal persons, in particular from any material adverse effect caused by — (i) entry on or the use of the land by other persons; or (ii) the taking or removal of the land's fauna, flora or forest produce; but (2)(b) in a manner that does not have an adverse effect on the protection or conservation of the land's fauna and flora. (3) If an objective set out in subsection (1) conflicts or is inconsistent with an objective set out in subsection (2), the objective set out in subsection (2) prevails.	The forest management plan

Land category	Objectives of management plans (CALM Act s56)	Management plan
National park and conservation park	(1)(c) to fulfil so much of the demand for recreation by members of the public as is consistent with the proper maintenance and restoration of the natural environment, the protection of indigenous flora and fauna and the preservation of any feature of archaeological, historic or scientific interest (2)(a) protecting and conserving the value of the land to the culture and heritage of Aboriginal persons, in particular from any material adverse effect caused by — (i) entry on or the use of the land by other persons; or (ii) the taking or removal of the land's fauna, flora or forest produce; but (2)(b) in a manner that does not have an adverse effect on the protection or conservation of the land's fauna and flora. (3) If an objective set out in subsection (1) conflicts or is inconsistent with an objective set out in subsection (2), the objective set out in subsection (2) prevails.	A relevant area management plan or in its absence the forest management plan, the provisions of the CALM Act and other relevant Acts
Nature reserve	(1)(d) maintain and restore the natural environment, and to protect, care for, and promote the study of, indigenous flora and fauna, and to preserve any feature of archaeological, historic or scientific interest (2)(a) protecting and conserving the value of the land to the culture and heritage of Aboriginal persons, in particular from any material adverse effect caused by — (i) entry on or the use of the land by other persons; or (ii) the taking or removal of the land's fauna, flora or forest produce; but (2)(b) in a manner that does not have an adverse effect on the protection or conservation of the land's fauna and flora. (3) If an objective set out in subsection (1) conflicts or is inconsistent with an objective set out in subsection (2), the objective set out in subsection (2) prevails.	A relevant area management plan or in its absence the forest management plan, the provisions of the CALM Act and other relevant Acts

Land category	Objectives of management plans (CALM Act s56)	Management plan
other land referred to in the CALM Act s5(1)(g) or 5(1)(h)	(1)(e) to achieve the purpose for which the land was vested in, or for which the care, control and management of the land were placed with, the controlling body (2)(a) protecting and conserving the value of the land to the culture and heritage of Aboriginal persons, in particular from any material adverse effect caused by — (i) entry on or the use of the land by other persons; or (ii) the taking or removal of the land's fauna, flora or forest produce; but (2)(b) in a manner that does not have an adverse effect on the protection or conservation of the land's fauna and flora. (3) If an objective set out in subsection (1) conflicts or is inconsistent with an objective set out in subsection (2), the objective set out in subsection (2) prevails.	A relevant area management plan or in its absence the forest management plan, the provisions of the CALM Act and other relevant Acts

APPENDIX 3

Management plans in force or in preparation within the plan area
(as of June 2012)

Final management plans (completed and approved)	Departmental region	Gazettal date
Forest Management Plan 2004-2013	Swan, South West, Warren	19/12/03 amended 01/11/11
Mooradung Nature Reserve	Swan	21/02/86
Nature Reserves of the Shires of York and Northam	Swan	10/07/87
Benger Swamp Nature Reserve	South West	12/02/88
Leeuwin-Naturaliste National Park	South West	21/04/89
Yanchep National Park	Swan	29/09/89
Waroona Reservoir and Catchment Area	South West	16/03/90
Logue Brook Reservoir and Catchment Area	South West	16/03/90
Matilda Bay Reserve	Swan	21/05/93
John Forrest National Park	Swan	19/08/94
Yalgorup National Park	Swan	15/08/95
Canning River Regional Park	Swan	05/12/97
Leschenault Peninsula Conservation Park	South West	08/01/99
Swan Estuary Marine Park and Adjacent Nature Reserves	Swan	07/04/00 amended 04/06/06
Serpentine National Park	Swan	03/10/00
Yellagonga Regional Park	Swan	15/07/03
Herdsman Lake Regional Park	Swan	03/12/04
Thomsons Lake Nature Reserve	Swan	27/05/05
Forrestdale Lake Nature Reserve	Swan	27/05/05
Beeliar Regional Park	Swan	20/10/06
Lake McLarty Nature Reserve	Swan	06/06/08
Wellington National Park, Westralia Conservation Park and Wellington Discovery Forest	South West	17/04/09
Walpole Wilderness and Adjacent Parks and Reserves	Warren	07/07/09
Woodman Point Regional Park	Swan	25/03/10
Jandakot Regional Park	Swan	05/08/10
Rockingham Lakes Regional Park	Swan	30/11/10
Lane Poole Reserve and Proposed Reserve Additions	Swan, South West	04/10/11
Shannon and D'Entrecasteaux National Parks	Warren	28/02/12
Perup	Warren	01/05/12

Final management plans (being finalised)	Region
Parks and Reserves of Yanchep and Neerabup	Swan
Leeuwin-Naturaliste Capes Area Parks and Reserves	South West
Tuart Forest National Park	South West

Draft management plans (being prepared)	Region
Swan Coastal Plain South	Swan

APPENDIX 4

Policies and key documents

There is a hierarchy of statues and documents that guide management.

Controlling document	Content	Custodian
Acts of Parliament	Bill that has been enacted by Parliament and which contains a sequence of provisions containing statements and rules designed to give effect to a particular national or State responsibility.	Parliament
Government policies, strategies and agreements	Policies on specific issues relevant to forest management that have a statutory or whole-of-government backing. They are developed to clarify uncertainty or fill gaps in legislation or to guide decisions where there are choices, especially in regard to contentious issues.	State Government, Australian Government
Management plan	Strategies for management utilising CALM Act requirements and relevant policies.	Conservation Commission
Corporate policies	Corporate level statement of principles and rules to guide decisions and actions in the conduct of the Department's business.	Conservation Commission and the Department
Corporate guideline	Corporate level set of procedures that will guide and direct actions by departmental staff to achieve consistency and required standards. Guidelines contain sufficient detail to ensure that processes are streamlined to a set routine.	Department Director
Codes of pactice	Details of the principles about tasks that are required and how tasks are to be performed to meet management requirements.	Department, FPC and other industry bodies depending on the activity
Operational policy	Divisional level statement of operational policy to guide decisions and actions by departmental staff.	Department Director
Divisional guidelines and procedures Alternative names: Standard operating procedures, protocols.	Divisional, Branch, Section, Unit or Regional level set of guidelines to guide and direct actions by departmental staff.	Department Director, Branch, Section, Unit or Regional Manager
Manual Alternative name: User guide	Branch, Region or functional level compendium of documents, mostly technical in nature to assist people to locate and use a particular system or process.	Department Director, Branch, Section, Unit or Regional Manager
Prescription	Branch, Region or District level documents that direct people how to undertake a particular task.	Department District/ Region/ Branch Manager

The following lists policies of the Department relevant to the plan.

Department of Environment and Conservation policies	
No.	**Title**
1	DEC Key Documents
2	Local Government Authority access to basic raw materials from State forest and timber reserves
3	Management of *Phytophthora* and disease caused by it
9	Conservation of threatened flora in the wild
10	Rehabilitation of disturbed land
13	Commercial flora harvesting
14	Weeds on CALM lands
15	Community involvement
18	Recreation, tourism and visitor services
19	Fire management
25	Community education and interpretation
29	Translocation of threatened flora and fauna
31	Management of reserves for the conservation of nature
33	Conservation of endangered and specially protected fauna in the wild
34	Visual resource management of lands and waters managed by CALM
40	Road management (this policy is under review and some content is no longer current)
41	Beekeeping on public land
44	Wildlife management programs
45	Environmental monitoring of pesticides used by CALM
47	Control of *Sirex* woodwasp in pine plantations
50	Setting priorities for the conservation of Western Australia's threatened flora and fauna
53	Visitor risk management in the Department of Environment and Conservation
55	Commercial filming on CALM managed lands and waters
57	DEC Enforcement and prosecutions policy
62	Identification and management of wilderness and surrounding areas
63	Information management policy
65	Good neighbour policy
69	Acknowledgment of Aboriginal traditional custodians
78	Science Policy
	Science Policy Guideline No. 1 – Science plans
	Science Policy Guideline No. 2 – Implementing research results
	Science Policy Guideline No. 3 – Publications, reports and manuscripts
	Science Policy Guideline No.4 – Databases and their management
	Science Policy Guideline No. 5 – Scientific ethics and etiquette

The following lists the key documents of the Department and other documents relevant to the plan.

Key Department of Environment and Conservation documents (cont.)
Biodiversity Conservation Appraisal System
Code of Practice for Fire Management
Code of Practice for Timber Harvesting in Western Australia
DEC Volunteer Strategy 2012 – 2016
DEC Parks and Visitor Services Strategy 2007 – 2011
Guidelines for conservation management plans relating to mineral exploration on lands managed by DEC
Guidelines for the management and rehabilitation of basic raw material pits
Identification and investigation of acid sulfate soils and acidic landscapes
Management Audit Branch Charter
Management Guideline No. 1 – user Guide for approvals matrix for operations on CALM Act reserves
Management of Commercial Harvesting of Protected Flora in Western Australia 2008 – 2013
Manual of management guidelines for timber harvesting in Western Australia
Phytophthora cinnamomi and disease caused by it – Volume I. Management Guidelines
Silviculture Guideline No. 1 – Silvicultural Practice in the Jarrah Forest
Silviculture Guideline No. 2 – Silvicultural Practice in Wandoo Forest and Woodland
SFM Interim Guideline No. 2 – Interim guideline for the first thinning of bauxite rehabilitation areas established after 1988 with native species in the Wungong Catchment
Silviculture Guideline No. 3 – Silvicultural Practice in the Karri Forest
SFM Interim Guideline No. 3 – Interim Guideline for the first thinning of bauxite rehabilitation areas established before 1988 with exotic species in the Wungong Catchment
SFM Guideline No. 4 – Guidelines for the Protection of the Values of Informal Reserves and Fauna Habitat Zones
SFM Guideline No. 5 – Soil and Water Conservation Guideline
SFM Guideline No. 6 – Guidelines for the Selection of Fauna Habitat Zones
SFM Manual No. 1 – Manual of Procedures for the Management of Soils Associated with Timber Harvesting in Native Forests
SFM Manual No. 3 – Manual for the Management of Surface Water
Treatment and management of soils and water in acid sulfate soil landscapes
Other relevant documents
Unsealed Roads Manual – Guidelines to Good Practice (Australian Roads Research Board 2009)*
Code of Practice for Timber Plantations in WA (FIFWA, AFG and FPC 2006)
WA Environmental Offsets Policy (Government of WA 2011)

* not available on line

The following lists policies and position statements of the Conservation Commission relevant to the plan.

Conservation Commission of Western Australia documents
Policy statement 3 (2008) – Basic Raw Materials Government and local government access to conservation estate
Policy statement 4 - (2006) – Minor Changes to Conservation Estate
Audit Policy (2008) for the performance assessment of conservation reserve and forest management plans and biodiversity management in Western Australia
Position Statement 1 (2011) – Fire Management
Position Statement 2 (2011) – Implementation of Conservation Reserve Proposals
Position Statement 3 (2011) – Mining in Terrestrial Conservation Reserves
Position Statement 4 (2011) – Mosquito Management
Position Statement 5 (2011) – Drainage
Position Statement 6 (2012) – Management Plans for lands vested in the Conservation Commission under the *Conservation and Land Management Act 1984*

APPENDIX 5

Reserve proposals (see page 202 for explanatory notes)

ID	FMP 2004-2013 ID	Locality name	Area (ha)[1]	Source	Proposal type	Status
1	1	Moore River	17,390	FMP 1994-2003 or earlier	Other, NP to NR	In progress
2	-	Moore River	370	Land acquisition	Other to NR	In progress
3	-	Moore River	950	Land acquisition	Other to NR	In progress
4	-	Red Gully	460	Land acquisition	Other to NR	In progress
5	-	Red Gully	730	Land acquisition	Other to NR	In progress
6	-	Mogumber	20	Land acquisition	Other to NR	In progress
7	-	Moore	40	Land acquisition	Other to NR	In progress
8	-	Beermullah	10	Land acquisition	Other to NR	In progress
9	3	Boonanarring	890	FMP 1994-2003 or earlier	Other to NR	In progress
10	8	Lake Muckenburra	70	FMP 1994-2003 or earlier	Other to NR	In progress
11	4	Caraban	2,200	FMP 1994-2003 or earlier	SF to s5(1)(h)	In progress
12	5	Caraban	3,330	FMP 1994-2003 or earlier	SF to CP	In progress
13	6	Yanchep	110	FMP 1994-2003 or earlier	SF to NR	In progress
14	7	Wabling	2,460	FMP 1994-2003 or earlier	SF to NR	In progress
15	9	Julimar	28,630	FMP 1994-2003 or earlier	SF, other to CP; Interim FCA	Not started
16	10	Julimar	30	FMP 1994-2003 or earlier	s5(1)(g), other to CP	In progress
17	11	Ridges	2,420	FMP 1994-2003 or earlier	SF to NP	In progress
18	12	Pinjar	690	FMP 2004-2013	SF to NR	In progress
19	13	Pinjar	5,000	FMP 2004-2013	SF to s5(1)(h)	In progress
20	15	Yongka (Melaleuca Park)	3,210	FMP 1994-2003 or earlier	SF to NR	In progress
21	16	Moondyne (Avon Valley)	5,170	FMP 1994-2003 or earlier	NR, other to NP	In progress
22	-	Toodyay/Moondyne (Avon Valley)	420	Land acquisition	Other to s5(1)(g)	In progress

APPENDIX 5 (cont.)

Reserve proposals

ID	FMP 2004-2013 ID	Locality name	Area (ha)[1]	Source	Proposal type	Status
23	17	Toodyay (Avon Valley)	3,470	FMP 1994-2003 or earlier	Misc res to NP	In progress
24	18	Toodyay (Avon Valley)	1,710	FMP 1994-2003 or earlier	Misc res to NP; Interim FCA	Not started
25	19	Morangup (Avon Valley)	940	FMP 1994-2003 or earlier	NR to NP	In progress
26	-	Clackline NR	40	Land acquisition	Other to NR	In progress
27	-	Bakers Hill	360	Land acquisition	Other to NR	In progress
28	-	Inkpen	40	Land acquisition	Other to NR	In progress
29	part 27	Helena (Helena Valley)	40	RFA	SF to NP	Not progressed
30	28	Flynn (Helena Valley)	3,950	RFA	DoW freehold to NP	Not progressed
31	35	Talbot	60	RFA	Other to NR	Not progressed
32	37A	Illawarra (Canning)	430	FMP 2004-2013	WAPC freehold to NP	Not progressed
33	33	Russell	3,360	FMP 1994-2003 or earlier	SF to CP	In progress[2]
34	41	Monadnocks	15,330	FMP 1994-2003 or earlier	s5(1)(g) to NP	In progress
35	43	Monadnocks	7,480	RFA	SF, DoW freehold to NP	In progress
36	44	Monadnocks	1,520	FMP 2004-2013	SF to NP	In progress
37	45	Flint	1,980	FMP 2004-2013	SF, TR to CP	In progress
38	46	Gibbs	2,280	Reinstated FMP(1994) - RFA	SF to CP	In progress
39	53A	Serpentine	30	FMP 1994-2003 or earlier	CP to NP	In progress[2]
40	53	Serpentine	40	FMP 1994-2003 or earlier	Other to NP	In progress[2]
41	54	Serpentine	120	RFA	Other to NP	Not progressed
42	54A	Serpentine	280	FMP 1994-2003 or earlier	NR to NP	In progress[2]
43	55	Darling Scarp	280	RFA	SF to NR	In progress
44	56	North Dandalup	60	FMP 1994-2003 or earlier	Other to NR	In progress[2]
45	55A	Darling Scarp	160	RFA	SF to CP	In progress
46	50	Monadnocks	4,990	FMP 1994-2003 or earlier	SF, UCL to NP	In progress
47	51	Monadnocks	690	Reinstated FMP(1994) - RFA	SF to NP	In progress
48	47	Wearne	1,530	FMP 2004-2013	TR to CP	In progress
49	48	Bannister	1,150	FMP 2004-2013	SF to CP	In progress

APPENDIX 5 (cont.)

Reserve proposals

ID	FMP 2004-2013 ID	Locality name	Area (ha)[1]	Source	Proposal type	Status
50	49	Gyngoorda	1,350	Reinstated FMP(1994) - RFA	SF to CP	In progress
51	52	Wandering	4,360	FMP 1994-2003 or earlier	Other, TR to CP	In progress[2]
52	58	Clifton south	560	FMP 1994-2003 or earlier	SF to NP	In progress
53	59	McLarty	660	FMP 1994-2003 or earlier	SF to NP	In progress
54	60	Marrarup	20	RFA	UCL to NR	In progress
55	61	Lane Poole	220	FMP 1994-2003 or earlier	Misc res to s5(1)(g)	In progress[2]
56	62	Icy Creek (Lane Poole)	180	FMP 1994-2003 or earlier	UCL to s5(1)(g)	In progress[2]
57	63	George	1,180	Reinstated FMP(1994) - RFA	SF to CP	In progress
58	64	George	140	FMP 2004-2013	SF to CP	In progress
59	65	George	550	FMP 1994-2003 or earlier	SF to CP	In progress
60	66	Myalup	690	FMP 1994-2003 or earlier	SF to NP	In progress
61	67	Myalup	220	FMP 1994-2003 or earlier	SF to NP	In progress
62	68	Wagerup (Yarloop)	10	FMP 1994-2003 or earlier	Other to NR	In progress
63	69	Clarke (Falls Brook)	400	FMP 1994-2003 or earlier	SF to NR; Interim FCA	Not started
64	70	Clarke (Falls Brook)	200	FMP 1994-2003 or earlier	SF to NR	In progress[2]
65	71	Clarke	290	Reinstated FMP(1994) - RFA	SF to NR	In progress
66	73	Lane Poole	4,330	RFA	SF, UCL to CP	In progress
67	-	Byrd Swamp	40	Land acquisition	Other to NR	In progress
68	74	Lane Poole	40	FMP 2004-2013	SF to NP	In progress
69	75	Lane Poole	1,480	RFA	SF to NP	In progress
70	76	Lane Poole	1,120	FMP 2004-2013	SF to NP	In progress
71	77	Lane Poole	38,110	FMP 1994-2003 or earlier	SF, s5(1)(g),TR, DoW freehold, other to NP	In progress
72	-	Stockyard/Stene (Lane Poole)	1,076	Land acquisition	Other to NR	In progress
73	78	Lane Poole	2,440	FMP 2004-2013	SF to NP	In progress

APPENDIX 5 (cont.)

Reserve proposals

ID	FMP 2004-2013 ID	Locality name	Area (ha)[1]	Source	Proposal type	Status
74	79	Lane Poole	3,810	FMP 2004-2013	SF, TR to NP	In progress
75	83	Leschenault Peninsula	500	FMP 1994-2003 or earlier	Other to CP	In progress
76	88	Westralia (Wellington)	1,130	FMP 1994-2003 or earlier	SF to CP; Interim FCA	Not started
77	90	Westralia (Wellington)	310	FMP 2004-2013	SF to FCA	Not started
78	91	Batalling	400	RFA	SF to NR	In progress
79	92	The Angle	920	RFA	Leasehold, TR to NR	In progress[3]
80	110	Nth Boyanup Rd	20	FMP 1994-2003 or earlier	Other to NR	In progress
81	-	Dardanup	140	SFM proposal	SF to CP	Not started
82	107	Dardanup	120	RFA	SF to NR	In progress
83	106	Boyanup	40	RFA	SF to NR	In progress
84	94	Bennelaking	5,630	FMP 1994-2003 or earlier	SF, UCL, other to CP	In progress[2]
85	93	Cordering	1,110	RFA	Leasehold, TR to NR	In progress[3]
86	-	Stratham	8	Land acquisition	Other to NR	In progress
87	-	Tuart Forest	30	Draft area management plan	Other to NP	Not started
88	-	Tuart Forest	60	Draft area management plan	Other to NP	Not started
89	111	Tuart Forest	30	FMP 1994-2003 or earlier	SF, UCL to NP	In progress
90	112	Tuart Forest	70	FMP 1994-2003 or earlier	SF to NP	In progress
91	122	Ryall	900	RFA	SF, TR, UCL to FCA	Not started
92	123	Ryall	280	FMP 1994-2003 or earlier	SF to CP; Interim FCA	Not started
93	124	Mullalyup	540	RFA	SF, UCL to FCA	Not started
94	125	Mullalyup	910	FMP 1994-2003 or earlier	SF to CP; Interim FCA	Not started
95	126	Harrington	690	RFA	SF to FCA	Not started
96	98	Camballan	430	FMP 1994-2003 or earlier	Leasehold to CP	In progress[3]
97	97	Camballan	6,650	Reinstated FMP(1994) - RFA	UCL, other, leasehold to CP	In progress[3]
98	96	Camballan	1,520	FMP 1994-2003 or earlier	UCL, other, leasehold to CP	In progress[3]

APPENDIX 5 (cont.)

Reserve proposals

ID	FMP 2004-2013 ID	Locality name	Area (ha)[1]	Source	Proposal type	Status
99	-	Arthur River	100	Land acquisition	Other to NR	In progress
100	-	Leeuwin-Naturaliste	10	Draft area management plan	Other to NP	Not started
101	114	Leeuwin-Naturaliste	8	FMP 1994-2003 or earlier	UCL to NP	In progress
102	115	Leeuwin-Naturaliste	7	RFA	Other to NP	In progress
103	-	Leeuwin-Naturaliste	5	Draft area management plan	UCL to NP	Not started
104	-	Yelverton NP	20	Draft area management plan	Other to NP	Not started
105	part 116	Yelverton (Yelverton) (R 47672)	50	RFA	Other to NP	Not started
106	117	Yelverton	440	RFA	TR to FCA	Not started
107	118	Whicher	290	RFA	SF to FCA	Not started
108	127	Mullalyup	1,250	FMP 1994-2003 or earlier	SF, CALM Executive Body freehold to CP; Interim FCA	Not started
109	130	Golden Valley	60	FMP 1994-2003 or earlier	CALM Executive Body freehold to FCA	Not started
110	part 128	Greenbushes	20	FMP 1994-2003 or earlier	CALM Executive Body freehold to NR	In progress
111	129	Greenbushes	330	RFA	SF to FCA	Not started
112	132	Kulikup	140	RFA	Other to NR	In progress
113	-	Leeuwin-Naturaliste	20	Draft area management plan	Other to NP	Not started
114	-	Leeuwin-Naturaliste	270	Draft area management plan	UCL to NP	Not started
115	-	Leeuwin-Naturaliste	9	Draft area management plan	Other to NP	Not started
116	-	Leeuwin-Naturaliste	20	Draft area management plan	UCL, other to NP	Not started
117	-	Bramley	10	Draft area management plan	SF to NP	Not started
118	-	Bramley	10	Draft area management plan	TR to NP	Not started
119	part 147	Bramley (R 47956)	30	RFA	Other to NP	Not started
120	148	Bramley	260	RFA	TR to FCA	Not started
121	part 147	Bramley (R 47956)	10	RFA	Other to NP	Not started
122	part 147	Bramley (R 47956)	3	RFA	Other to NP	Not started
123	-	Bramley	5	Draft area management plan	Other to NP	Not started

APPENDIX 5 (cont.)

Reserve proposals

ID	FMP 2004-2013 ID	Locality name	Area (ha)[1]	Source	Proposal type	Status
124	146	Mowen	1000	Reinstated FMP(1994) - RFA	SF to NR	In progress
125	142	Jarrahwood	160	RFA	Other to CP	In progress
126	143	St John Brook	3,550	Reinstated FMP(1994) - RFA	SF, other to CP	In progress
127	141	Ellis Creek	140	FMP 1994-2003 or earlier	SF to CP; Interim FCA	Not started
128	138	Greenbushes	530	FMP 1994-2003 or earlier	SF to NR; Interim FCA	Not started
129	137	Hester west	1,030	FMP 1994-2003 or earlier	SF, TR to CP; Interim FCA	Not started
130	135	Hester south	1,450	RFA	SF, other to FCA	Not started
131	-	Leeuwin-Naturaliste	8	Draft area management plan	Other to NP	Not started
132	-	Leeuwin-Naturaliste	20	Draft area management plan	Other to NP	Not started
133	150	Witchcliffe	1,060	FMP 1994-2003 or earlier	UCL to SF	In progress
134	150A	Witchcliffe	500	FMP 2004-2013	UCL to NP	In progress
135	156B	Butler (Butler)	1,260	FMP 2004-2013	SF to FCA (Ministerial condition)	Not started
136	166	Beaton	440	FMP 1994-2003 or earlier	TR to CP; Interim FCA	Not started
137	140	Dalgarup	950	FMP 1994-2003 or earlier	SF to NR; Interim FCA	Not started
138	139	Nelson	620	RFA	SF to FCA	Not started
139	167	Glenlynn	1,400	RFA	SF, TR, other to FCA	Not started
140	part 190	Kingston (Greater Kingston)	10	FMP 2004-2013	SF to NP	Not started
141	168	Wournbelup/Chowerup	2,160	RFA	UCL, other to NR	In progress
142	169	Wournbelup	600	FMP 1994-2003 or earlier	UCL to SF	In progress
143	170	Chowerup	700	FMP 1994-2003 or earlier	UCL, other to SF	In progress
144	-	Forest Grove	30	Draft area management plan	UCL, other to NP	Not started
145	-	Forest Grove	130	Draft area management plan	Other to NP	Not started
146	151	Leeuwin-Naturaliste	310	FMP 1994-2003 or earlier	Other to NP	In progress
147	-	Leeuwin-Naturaliste	480	Draft area management plan	UCL to NP	Not started
148	-	Leeuwin-Naturaliste	70	Draft area management plan	Other to NP	Not started
149	-	Leeuwin-Naturaliste	40	Draft area management plan	Other to NP	Not started
150	-	Leeuwin-Naturaliste	230	Land acquisition	Other to NP	In progress
151	-	Leeuwin-Naturaliste	40	Draft area management plan	Other to NP	Not started

APPENDIX 5 (cont.)

Reserve proposals

ID	FMP 2004-2013 ID	Locality name	Area (ha)[1]	Source	Proposal type	Status
152	-	**Hardey Inlet**	**140**	**Draft area management plan**	**NP to NR**	**Not started**
153	-	**Hardey Inlet**	**7**	**Draft area management plan**	**Other to NR**	**Not started**
154	-	Hardey Inlet	3	Draft area management plan	UCL to NR	Not started
155	-	Augusta	80	Draft area management plan	UCL, other to CP	Not started
156	-	Hardey Inlet	200	Draft area management plan	UCL, other to NR	Not started
157	-	Hardey Inlet	110	Draft area management plan	Other to NR	Not started
158	-	Scott River	8	Draft area management plan	Other to NP	Not started
159	-	Scott River	110	Draft area management plan	UCL, other to NP	Not started
160	-	Beerup	150	Land acquisition	Other to NR	In progress
161	-	Gingilup Swamps	440	Draft area management plan	UCL to NR	Not started
162	-	Gingilup Swamps	100	Draft area management plan	UCL to NR	Not started
163	-	Gingilup Swamps	10	Draft area management plan	Other to NR	Not started
164	-	Gingilup Swamps	120	Draft area management plan	Other to NR	Not started
165	161	Hilliger	9,090	RFA	SF, UCL, other to FCA	Not started
166	-	Easter	60	Draft FMP proposal	SF to FCA	Not started
167	. 176	One Tree Bridge	660	FMP 1994-2003 or earlier	SF, s5(1)(g), CALM Executive Body freehold, UCL to CP; Interim FCA	Not started
168	177	Lewin	50	FMP 1994-2003 or earlier	UCL, other to SF	In progress
169	178	Solai	30	FMP 1994-2003 or earlier	Other to SF	In progress
170	179	King Jarrah	190	FMP 1994-2003 or earlier	Misc res to SF	In progress
171	180	Dingup	230	FMP 1994-2003 or earlier	SF to CP; Interim FCA	Not started
172	194	Weinup	80	RFA	Other to NR	Not progressed
173	196	Talling (Tone-Perup)	30	FMP 1994-2003 or earlier	Other to NR	Not progressed
174	200	Bolbelup	1,500	RFA	TR, UCL to FCA	Not started
175	201	Bolbelup	40	FMP 1994-2003 or earlier	Other to SF	In progress
176	203A	Central (D'Entrecasteaux)	600	FMP 2004-2013	SF to NP	In progress

APPENDIX 5 (cont.)

Reserve proposals

ID	FMP 2004-2013 ID	Locality name	Area (ha)[1]	Source	Proposal type	Status
177	203	Quannup (D'Entrecasteaux)	4,510	FMP 1994-2003 or earlier	Leasehold to NP	In progress
178	-	Strickland (Beedelup)	180	Draft FMP proposal	SF, other, UCL to NP	Not started
179	184	Sir James Mitchell NP	180	FMP 1994-2003 or earlier	NP to SF	In progress
180	186	Nairn	60	FMP 1994-2003 or earlier	UCL to SF	In progress
181	-	Talling (Lake Muir)	620	Draft FMP proposal	UCL to NR	Not started
182	-	Quindinup (Bolbelup)	110	Land acquisition	Other to NR	In progress
183	202	Bokarup	480	FMP 1994-2003 or earlier	Other, UCL to NR	In progress
184	235	Chitelup (Lake Muir)	310	FMP 2004-2013	SF to NP	In progress
185	265A	Perillup	130	RFA	NR to FCA	Not started
186	270	Pardelup	3,670	RFA	SF, TR, other to FCA	Not started
187	271	Kwornicup Lake	10	FMP 1994-2003 or earlier	Other to NR	In progress
188	272	Denbarker	250	RFA	Other, leasehold (Aboriginal) to FCA	Not started
189	part 273	Mt Barker	60	RFA	UCL, other to FCA	Not started
190	274A	Denbarker	240	FMP 2004-2013	UCL, other to FCA	Not started
191	226	Northcliffe	30	FMP 1994-2003 or earlier	UCL to SF	In progress
192	227	Northcliffe	50	FMP 1994-2003 or earlier	UCL to SF	In progress
193	228	Northcliffe	60	FMP 1994-2003 or earlier	UCL to SF	In progress
194	225	D'Entrecasteaux	1,000	FMP 1994-2003 or earlier	SF to NP	In progress
195	224	Gardner	560	FMP 1994-2003 or earlier	UCL to SF	In progress
196	239A	Wye-Deep	3,020	FMP 2004-2013	SF to FCA	Not started
197	239B	Dawson	410	FMP 2004-2013	SF to FCA	Not started
198	239C	Dawson	70	FMP 2004-2013	SF, other to FCA	Not started
199	239D	Dawson	540	FMP 2004-2013	SF to FCA	Not started
200	245	Crown res 14325 (Walpole-Nornalup)	80	FMP 2004-2013	Other to NP	In progress
201	239E	Keystone-Swarbrick	950	FMP 2004-2013	SF, other to FCA	Not started

APPENDIX 5 (cont.)

Reserve proposals

ID	FMP 2004-2013 ID	Locality name	Area (ha)[1]	Source	Proposal type	Status
202	247A	Swarbrick	260	FMP 2004-2013	SF to FCA	Not started
203	241A	Collis	320	FMP 2004-2013	SF, s5(1)(g), UCL to FCA	Not started
204	247	Swarbrick (Walpole-Nornalup)	200	RFA	SF to NP	In progress
205	246	Walpole Townsite (Walpole-Nornalup)	60	FMP 2004-2013	UCL to NP	In progress
206	241B	Collis	170	FMP 2004-2013	SF to FCA	Not started
207	242A	Collis	1,110	FMP 2004-2013	SF, s5(1)(g) to FCA	Not started
208	243A	Trent	100	FMP 2004-2013	TR to FCA	Not started
209	244	Bow River (Mt Frankland south)	270	FMP 2004-2013	SF to FCA	Not started
210	256	Bow River (Mt Roe)	360	FMP 2004-2013	SF to FCA	Not started
211	260	Thames	320	FMP 2004-2013	TR to FCA	Not started
212	261	Styx	4,410	FMP 2004-2013	SF, other to FCA	Not started
213	262	Styx	20	FMP 1994-2003 or earlier	Other to SF	In progress
214	263	Thames	60	FMP 2004-2013	Other to FCA	Not started
215	275A	Harewood	3,180	FMP 2004-2013	SF, TR, other to FCA	Not started
216	276A	Denmark River	50	FMP 2004-2013	SF to FCA	Not started
217	277	Harewood	100	FMP 2004-2013	SF to FCA	Not started
218	278	Crown res 15623 (Mt Lindesay)	60	FMP 2004-2013	s5(1)(g) to FCA	Not started
219	279	Harewood south east (Mt Lindesay)	110	FMP 2004-2013	SF to FCA	Not started
220	284A	Hay	690	FMP 2004-2013	SF, UCL to FCA	Not started
221	286	Hay	910	FMP 2004-2013	TR to FCA	Not started
222	-	Redmond	80	Draft FMP proposal	UCL to SF	Not started
223	-	Redmond	1,210	RFA	TR to NR	Not started
Proposed addition to Whicher National Park						
224	-	Whicher Scarp	4,010	This Draft FMP	SF, TR to NP	Not started

CP:	Conservation park	**Other:**	Crown reserve or freehold land not vested in the Conservation Commission
DoW:	Department of Water	**s5(1)(g):**	CALM Act Section 5(1)(g) – land vested under the *Land Act 1933*
FCA:	Forest conservation area. An FCA is SF classified as such through Section 62(1) of the CALM Act	**s5(1)(h):**	CALM Act Section 5(1)(h) – land vested under the *Land Administration Act 1997*
FCA interim:	A transitory classification as FCA prior to proceeding to a formal reserve category	**SF:**	State forest
Misc res:	Land vested in Executive Director or former National Parks and Nature Conservation Authority	**TR:**	Timber reserve
NP:	National park	**UCL:**	Unallocated Crown land
NR:	Nature reserve	**WAPC:**	Western Australian Planning Commission
		WRC:	Water and Rivers Commission

[1] areas greater than 10 hectares have been rounded to the nearest 10 hectares

[2] provided for in *Reserves (National Parks, Conservation Parks, Nature Reserves and Other Reserves) Act 2004*, but depends on delisting of registered national estate areas

[3] progress depends on surrender of pastoral lease

APPENDIX 6

Establishment of a comprehensive, adequate and representative (CAR) reserve system

A purpose of the plan is to establish a conservation reserve system that meets world's best standards in terms of comprehensiveness, adequacy and representativeness.

The Guidelines for the National Reserve System (NRS) (Commonwealth of Australia 1999) aim for the reserve system to contain samples of all ecosystems identified at an appropriate regional scale. In doing so, the guidelines also aim to consider the ecological requirements of rare or threatened species and ecological communities and ecosystems, special groups of organisms such as those with specialised habitat requirements, wide ranging or migratory species or species vulnerable to threatening processes.

Comprehensive, adequate and representative

The terms comprehensive, adequate and representative together capture the desired concept of the ideal conservation reserve system. The following is an explanation of these terms when used to describe the reserve system (Commonwealth of Australia 1999):

Comprehensive *refers to the inclusion within protected areas of samples of each of the ecosystems discernible at the bioregional scale. It is the primary criterion because the likelihood of including functional assemblages of all species within a bioregion will be greatest when the full range of ecosystems present within an area is selected. The most appropriate ecosystem classification for reserve design will include attributes of vegetation structure and flora/fauna composition in conjunction with environmental attributes. Currently, there is no consistent description and mapping of such ecosystems at an appropriate scale across all Australian bioregions. Where bioregions currently lack such vegetation mapping, the best use should be made of all other available environmental classification and mapping information to define ecosystems.*

Adequate *refers to how much of each ecosystem should be included within a protected area network in order to provide ecological viability and integrity of populations, species and communities. The number of individuals (and hence area) needed for the long-term conservation of species varies appreciably between organisms. Species naturally occurring at very low densities (and/or requiring very large home ranges) and species, which may need to track resources, which ebb and flow across extensive landscapes, will need large areas maintained. The area requirements for such species can be estimated and these will provide some guidelines for minimum area requirements for the particular ecosystems in which they occur. In the absence of such estimates, the criterion of adequacy can be considered by aiming to conserve at least a substantial proportion of the extent of every ecosystem. As a general rule, the greater the extent reserved, the more likely that the ecological functioning and species composition of an ecosystem will be maintained. However, there is no single threshold value that guarantees this persistence for any or all ecosystems. Some ecosystems are much more threatened and less resilient than others and these may need higher levels of and more urgent protection. Replication across the range of geographic, environmental and biotic domains should be considered. The principle to apply is that ecosystems are represented within the protected area network at more than one site, hence providing some greater safeguard against catastrophic events.*

Representative *is comprehensiveness considered at a finer scale, and infers that the variability within ecosystems is sampled within the reserve system. The consideration of representativeness aims to ensure that information on species distributions and intrinsic/genetic variations is included in the reserve system. The essential thing is that known species and genotypes are adequately reserved with*

the aim of maximising their viability within a bioregion, not necessarily that they are represented in every ecosystem in which they have been recorded.

The reserve system proposed in the current FMP and this Draft plan is in two parts. Inside the RFA area (Map 1), an expanded reserve system was proposed in the RFA (Commonwealth of Australia and the State of Western Australia 1999) based on NRS principles, which was subsequently added to in the current FMP. Outside the RFA area, a different level of vegetation mapping is available and less native vegetation remains on which to base a reserve system, hence a different approach has been applied.

Inside the RFA area

Objectives for the CAR forest reserve system

The Commonwealth and the States agreed in what is known as the JANIS process (Commonwealth of Australia 1997) that the objectives for a CAR forest reserve system in the RFA process are to:

- *maintain ecological processes and the dynamics of forest ecosystems in their landscape context*
- *maintain viable examples of forest ecosystems throughout their natural ranges*
- *maintain viable populations of native forest species throughout their natural ranges*
- *maintain the genetic diversity of native forest species.*

Selection criteria for the CAR forest reserve system

The objectives for the CAR reserve system are implemented through biodiversity criteria that guide the selection of areas for inclusion. The JANIS criteria were that:

- *15 per cent of the pre-1750 distribution of each forest ecosystem should be protected*
- *at least 60 per cent of ecosystems recognised as vulnerable should be protected*
- *rare and endangered ecosystems should be reserved or protected by other means*
- *reserved areas should be replicated across the range of forest ecosystems*
- *the reserve system should maximise the area of high quality habitat for all known components of biodiversity wherever practicable, particularly of:*
  - *rare, vulnerable or endangered species*
  - *special groups of organisms*
  - *areas of high species diversity, natural refugia and centres of endemism*
  - *species whose distribution are not well correlated with any particular forest ecosystem*
- *reserves should be large enough to sustain the viability, quality and integrity of populations*
- *the full range of biological variation within each ecosystem should as far as possible be sampled*
- *in fragmented landscapes, remnants that contribute to sampling the full range of biodiversity are a vital part of the system and should be protected.*

Defining forest ecosystems

The JANIS criteria for a CAR reserve in Australia‘s forests defined ‗ecosystem‘ as: *An indigenous ecosystem with an overstorey of trees that are greater than 20 per cent canopy cover. These ecosystems should normally be discriminated at a resolution requiring a map-standard scale of 1:100,000. Preferably these units should be defined in terms of floristic composition in combination with substrate and position within the landscape (e.g. Beard 1979a and 1979b; Young and McDonald*

1989; Kirkpatrick and Brown 1991, and Ecological Vegetation Classes as identified in Victoria as appropriate).

To be effective in meeting the criteria, ecosystems must be mapped, differentiated between forest and non-forest, and be resolved at least at a scale of 1:100,000. There are seven systems that could be considered. These are (i) the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell 1995), (ii) the vegetation maps of Beard (Beard 1979c), (iii) the forest type mapping of the former Forests Department (Bradshaw *et al*. 1997), (iv) the vegetation complexes of Havel and Mattiske (2000), (v) the ecological vegetation systems of Havel (2000), (vi) the forest ecosystems devised for the RFA (Bradshaw and Mattiske 1997), and (vii) the LMUs based on Mattiske and Havel (2002).

IBRA was endorsed by the (then) Australian and New Zealand Environment and Conservation Council in 1995 and is used by the NRS Program as the framework for implementing its selection criteria. It combines climate, lithology and geology, landform, vegetation, flora and fauna and other available attributes into 85 biogeographic regions for Australia (Thackway and Cresswell 1995). The area of this draft plan is dominated by one IBRA region (Jarrah Forest) and includes parts of two others (Swan Coastal Plain and Warren). Some IBRA regions have been broken into sub-regional units. IBRA is not suitable at the scale required to evaluate representativeness of the reserve system because the scale is too coarse and there is no differentiation of forested and non-forested ecosystems. IBRA is best used as a strategic tool for identifying the relative reservation levels of ecological regions across Australia.

Beard (1979c) mapped the south-west at 1:250,000 scale using a structural classification based on growth form and foliage cover of the tallest stratum, with the dominant element of floristic composition also noted. This was later refined for use as the basis for implementation of the NRS throughout Western Australia (Hopkins *et al.* 1996). A limitation of the Beard classification is that it is not based on a quantitative analysis of floristic composition and in the jarrah forest some of the units cover very extensive areas.

Forest associations in the south-west of Western Australia were mapped by the former Forests Department using aerial photo interpretation in the 1950s and 1960s, with subsequent survey work by both the Forests Department and the Department (Bradshaw *et al.* 1997). It is a vegetation mapping based on the dominant tree species and discriminates forest from non-forest on the basis of canopy cover. It mapped 23 forest associations but did not include floristic composition of the understorey, hence was not suitable by itself for defining ‗forest ecosystems'.

At a finer level (1:50,000), Havel and Mattiske (2000) mapped vegetation complexes for the RFA region, extending and updating the mapping that had previously been undertaken by Heddle *et al.* (1980). These are based on soil, landform and floristics. In all they identified more than 300 vegetation complexes and mapped them, however, the complexes did not differentiate between forest and non-forest types so could not be used as the primary ecosystem definition.

Havel (2000) used the mapped vegetation complexes to identify and map ecological vegetation systems, being vegetation units appropriate to a 1:500,000 scale of mapping. There are some 100 units identified at this scale and each unit is generally an aggregation of a number of vegetation complexes. These maps do not differentiate between forest and non-forest communities.

Mattiske and Havel (2002) merged vegetation complexes as defined by Mattiske and Havel (1998) and ecological vegetation systems as defined by Havel and Mattiske (1998) and Havel (2000) into 30 more compact management units that reflected the underlying ecological patterns (see Appendix 1). The units were developed for land management purposes rather than as a basis for conservation reserve analysis or selection. The units also do not differentiate between forest and non-forest.

As there were weaknesses in all available vegetation mapping systems in relation to the definition of ‗forest ecosystems' for the purposes of defining a CAR reserve system in the south-west forests, it was necessary to define and map forest ecosystems for the purposes of the RFA. This was done by Bradshaw and Mattiske (1997). They used the existing forest associations (Bradshaw *et al.* 1997) to discriminate forest from non-forest communities. To subdivide the broader forest associations into units with similar floristic composition they used the understanding of vegetation complexes (Heddle *et al.* 1980; Havel and Mattiske 2000). These complexes are largely a reflection of floristic composition which is in turn primarily determined by a combination of climate, soils and landform. That subdivision resulted in 27 forest ecosystems being identified. Subsequently, the Whicher Scarp area has been recognised as an additional forest ecosystem.

Inclusion of high quality habitat

In the RFA process, habitats of species that are threatened were assessed for priority inclusion in the reserve system. In addition, areas important for disjunct and relictual populations, as well as centres of endemism and richness for flora, were also assessed for priority inclusion in the reserve system.

Providing security of land category and purpose to the CAR forest reserve system

The areas selected for the CAR reserve system need to be provided with security of land category and purpose. This is best done through the establishment of formal reserves but informal reserves (see Appendix 12) may also contribute to the CAR reserve system.

The contribution of informal reserves to biodiversity conservation in general and the CAR reserve system in particular has been contentious since informal reserves were introduced in the forest in the early 1970s. The debate became more focused with respect to their contribution to CAR reservation targets in the latter half of the 1990s with the Deferred Forest Assessment and the RFA that followed it.

The RFA agreed that CAR informal reserves are the following components of the informal reserve system:

- stream reserves of a width equal to or greater than 150 metres
- those informal reserves and adjoining areas of land that were accredited for the Deferred Forest Assessment
- diverse ecotype zones of an area equal to or greater than 40 hectares
- 400-metre wide travel route reserves in the area containing Karri Yellow Tingle ecosystem
- the Bibbulmun Track travel route reserve (400 metres wide).

This Draft plan carries forward the position adopted for the RFA and the current FMP when assessing the achievement of CAR targets.

Steps in identifying ecosystems for inclusion in the CAR forest reserve system

Based on the JANIS criteria, the RFA process analysed the adequacy of the reserve system set out in the FMP 1994-2003 and identified areas that could contribute to meeting the new targets using forest ecosystem mapping. In May 1999, the RFA determined a significant net addition to the reserve system resulting from the FMP 1994-2003.

In December 1999, following the report and recommendations of the Ministerial Advisory Group on Karri and Tingle Management (Ferguson *et al.* 1999), the then Government acted to protect karri and tingle forest ecosystems. This was done by excluding timber harvesting in sensitive areas of the forest blocks of Beavis, Burnett, Carey, Dawson, Deep, Gardner, Giblett, Jane, Keystone, Northcliffe,

Ordnance, Sharpe, Swarbrick, Thomson, Wattle and Wye. The Government did not at the time indicate whether these areas would be added to the reserve system.

Following the State election in February 2001, the new Government ceased timber harvesting in old-growth jarrah and karri forest ecosystems. This included those areas of karri and tingle protected by the previous Government in December 1999. The Government also announced its intention to include additional reserve areas, and to reinstate those reserve proposals from the FMP 1994-2003 that were not to proceed as an outcome of the RFA. Five of the reinstated reserve proposals are within State Agreement Act leases and were the subject of negotiation with the Agreement Act companies, the outcomes of which were reflected in the current FMP and are carried forward into this Draft plan.

The Government also commissioned an independent review (URS 2001) of the scientific, economic and community values of Gervasse, Lennard, Davis, Lowden, Arcadia, Yabberup, Mungalup and Westralia forest blocks surrounding the Wellington National Park, to advise on the merits of adding these areas to the park. In addition, the study also examined Palmer and Leach forest blocks north-east of Collie and Helms forest blocks on the Blackwood River west of Nannup. A review of the high conservation value of more than 100 forest blocks was undertaken by Ecoscape Australia (Ecoscape 2002), and the Government's decisions following both the URS and Ecoscape reviews were included in the current FMP and are also reflected in this Draft plan.

As noted above, the Whicher Scarp (see Map 4) has been recognised as a separate forest ecosystem and further reading on the biodiversity values of this area can be found in *Keighery et al. (2008).* As a consequence of the recognition of the Whicher Scarp as an additional forest ecosystem, additional formal reserves are required in this area if the reservation targets are to be achieved. Accordingly, in this Draft plan it is proposed that these areas be added to the Whicher National Park (see the _Biological diversity' chapter).

Outside the RFA area

Forest ecosystem mapping has not been undertaken across the plan area outside the RFA region (on the Swan Coastal Plain); hence it is not possible to integrate CAR reserve system development for both inside and outside the RFA region using consistent vegetation mapping.

In addition, the land vested in the Conservation Commission in the plan area outside the RFA area is largely already existing or proposed formal reserve. Therefore, the forest management plan cannot be the main mechanism for establishing a CAR reserve system outside the RFA area.

As a consequence, alternative mechanisms must be used to secure lands not vested with the Conservation Commission to establish a reserve network, and this is being addressed through a number of programs and planning instruments.

There have been a number of studies that have led to recommendations for protection of specific areas using the broad scale Beard vegetation association mapping as updated by Hopkins (Hopkins *et al*. 1996) as the basis for assessing priority. In particular the state-wide biodiversity audit of IBRA regions undertaken for (the then Commonwealth agency) Environment Australia assessed the representation of vegetation associations by International Union for Conservation of Nature protection categories (May and McKenzie 2003).

However, the vegetation association mapping of Beard is at a broad scale and is a structural system only. For the Swan Coastal Plain more detailed vegetation complex mapping is available (Heddle *et al*. 1980) and takes into account soil, landform and floristics. Regional floristic community types have also been determined for the area of the Swan Coastal Plain (Gibson *et al.* 1994; Government of Western Australia 2000c), although no mapping is available.

Consequently, the Heddle *et al*. (1980) vegetation complex mapping and floristic community type survey information are the primary regional datasets that need to be used for conservation planning on the Swan Coastal Plain. These datasets provide a consistent basis for assessment of the CAR reserve system and protected areas outside the RFA area. In addition, there is a wealth of information documenting conservation values at a site based level for comparison of areas to make recommendations for reservation.

In 1974, before much of this information was available, the EPA initially sought to identify suitable areas for reservation through the (then) Conservation Through Reserves Committee. The State was divided into 12 systems (geographical areas) (EPA 1993). The Swan Coastal Plain as now defined by the IBRA process (Thackway and Creswell 1995) is split across four of these EPA Systems, the majority being in the System 6 region (Darling; EPA 1983), the most southern tip in System 1 (South West; EPA 1976) and the areas north of the Moore River within Systems 4 (Wheatbelt; EPA 1975) and 5 (Northern Sandplains; EPA 1976). Some, but not all, of the recommended reserves in these reports were implemented over the following 10 years. Implementation of the recommendations was particularly difficult in the Perth metropolitan area where most of Western Australia's population lived and worked. Residential, infrastructure and industrial land use demands remain extremely high, as do land values.

In 1994, the EPA began an update of the system reports for the Swan Coastal Plain south of the Moore River, known as the *System 6 Part System 1 Update Program*. However in 1996, due to increased development pressure in the urban area, the full program was suspended and condensed to concentrate on the Perth Metropolitan Region. Originally named *Perth's Bushplan* it was to provide the regional context needed for environmental impact assessment. In 2000, the result of this process was renamed and released as *Bush Forever* that sought to establish a conservation reserve system on the Swan Coastal Plain portion of the Perth Metropolitan Region that was, as far as was achievable, comprehensive, adequate and representative (Government of Western Australia 2000a, b, c, d).

Bush Forever was a 10-year plan that sought representation of at least 10 per cent of each of the mapped 26 vegetation complexes (Heddle *et al.* 1980) that occur within the study area. A number of criteria (for example, areas containing rare or threatened communities or species) were used to select 287 regionally significant *Bush Forever* sites (51,200 hectares, representing almost 18 per cent of the area) to meet this aim. Protection of the identified areas was sought through a range of options from purchase and reservation to negotiated planning outcomes. This program complemented the formal reserves in this plan as it targeted the area where land vested in the Conservation Commission was least represented. While the original 10-year implementation phase of *Bush Forever* officially ended in 2010, the recommendations of the project continue to be implemented.

In parallel the EPA formally assessed the potential environmental impacts of the Greater Bunbury Region Planning Scheme and reviewed the protection of regionally significant natural areas in the Bunbury region on the Swan Coastal Plain (EPA 2003). Through this process the EPA developed an updated strategy for identifying natural areas of regional significance outside the Bush Forever study area (Appendix 3 of EPA 2003).

The review of the remainder of the Swan Coastal Plain with an equivalent of Bush Forever began in 2006 as the four year *Swan Bioplan* project. *Swan Bioplan* was a continuation of the original *System 6 Part System 1 Update Program* for the Swan Coastal Plain. By the end of the project, recommendations for the protection of regionally significant natural areas had been completed for the Peel Region (Keighery *et al.* 2006, EPA 2010b), Whicher Scarp (Keighery *et al.* 2008, EPA 2009b) and Busselton region (Webb *et al.* 2009). Regional survey work on the Dandaragan Plateau was also well advanced and the Greater Bunbury Region was effectively reviewed by the previous planning scheme assessment (EPA 2003).

In summary, the recommendations for conservation reserves required to complete a CAR reserve system on the Swan Coastal Plain have been made from the northern boundary of the Perth Metropolitan Region south to Dunsborough. The areas requiring further investigation are the Dandaragan Plateau, Darling and Gingin Scarps and the Swan Coastal Plain north of the Perth Metropolitan Region boundary.

The conservation and protection of tuart woodlands (which extend through a 400 kilometre coastal band from Jurien Bay to Busselton) of the Swan Coastal Plain has been proposed in the draft Government plan *Tuart Conservation and Management Strategy and Action Plan* (Government of Western Australia 2004a). Key recommendations of the strategy and action plan include: (i) the declaration of designated tuart woodlands as ‗environmentally sensitive areas' under the EP Act; (ii) the evaluation of tuart environmentally sensitive areas for their regional significance under *EPA Guidance Statement No. 10* (EPA 2006), where lands of the Swan Coastal Plain are planned for development; and (iii) the development of a network of regional parks across tuart's natural range covering tuart woodlands representative of each region. The development of the strategy and action plan was informed by the tuart atlas (Government of Western Australia 2003) and the associated ‗indicative high conservation' tuart woodland report (Government of Western Australia 2004b).

APPENDIX 7

Area reservation levels of forest ecosystems

	Total pre-1750 extent (ha)	Present extent within the plan area (ha)	Present extent on all lands vested in the Conservation Commission (ha)	CAR target (ha)	Formal reserves Area of ecosystem representation (hectares) Existing gazetted as at 30.06.2011 (Additions proposed) N.P. (ha)	N.R. (ha)	C.P. (ha)	5(1) (g),(h) (ha)	FCA (ha)	All formal reserves and FCA (ha)	Informal reserves (ha)	Other (fauna habitat zones) (ha)	Formal reserves, FCA, informal reserves, and other protected areas (ha)
Jarrah dominant													
Jarrah Blackwood	343,500	278,800	267,210	51,530	72,140	1,230	2,800	20		91,870	21,220	8,130	121,220
					(2,590)	(1,100)	(3,750)	-	(8,240)				
Jarrah Leeuwin	56,400	19,550	9,570	8,460	7,680	70	-	-		8,500	330	-	8,830
					(200)	(-)	(-)	(-)	(540)				
Jarrah Mt Lindesay	126,600	42,970	26,680	18,990	17,600	640	-	40		23,200	550	-	23,750
					(-)	(710)	(-)	-	(4,210)				
Jarrah North East	717,100	350,240	260,880	107,570	18,210	7,990	8,990	-		112,280	13,290	7,080	132,650
					(43,510)	(4,790)	(28,570)	(-)	(230)				
Jarrah- North West	670,600	499,600	448,510	100,590	38,240	1,640	10,270	13,220		94,710	34,730	22,150	151,590
					(21,640)	(1,380)	(5,040)	(250)	(3,020)				
Jarrah Rates Tingle	1,500	1,250	1,160	1,250	1,160	-	-	-		1,160	-	-	1,160
					(-)	(-)	(-)	(-)	(-)				
Jarrah Red Tingle	350	270	220	270	220	-	-	-		220	-	-	220
					(-)	(-)	(-)	(-)	(-)				
Jarrah Sandy	107,900	71,090	64,180	16,190	10,410	230	2,100	-		24,570	3,380	2,960	30,910
					(5,410)	(-)	(6,190)	(-)	(230)				
Jarrah South	557,300	438,920	420,280	83,600	191,760	31,510	20	390		234,430	32,350	8,300	275,080
					(220)	(880)	(1,050)	(-)	(8,590)				

APPENDIX 7 (cont.)

Area reservation levels of forest ecosystems

	Total pre-1750 extent (ha)	Present extent within the plan area (ha)	Present extent on all lands vested in the Conservation Commission (ha)	CAR target (ha)	Formal reserves Area of ecosystem representation (hectares) Existing gazetted as at 30.06.2011 (Additions proposed) N.P. (ha)	N.R. (ha)	C.P. (ha)	5(1) (g),(h) (ha)	FCA (ha)	All formal reserves and FCA (ha)	Informal reserves (ha)	Other (fauna habitat zones) (ha)	Formal reserves, FCA, informal reserves, and other protected areas (ha)
Jarrah Unicup	81,000	29,460	16,950	12,150	240	15,100	-	-		16,860	40	-	16,900
					(-)	(360)	(-)	(-)	(1,170)				
Jarrah Woodland	106,400	67,220	50,160	15,960	15,600	4,800	360	170		28,870	21,290	-	50,160
					(3,740)	(620)	(2,530)	(-)	(1,040)				
Jarrah Yellow Tingle	11,600	9,670	8,260	1,740	7,550	-	-	-		8,260	-	-	8,260
					(20)	(-)	(-)	(-)	(690)				
Sub total	**2,780,250**	**1,809,040**	**1,574,060**		**380,810**	**63,210**	**24,540**	**13,840**	**-**	**644,930**	**127,180**	**48,620**	**820,730**
					(77,330)	**(9,840)**	**(47,130)**	**(250)**	**(27,960)**				
Karri dominant													
Karri Main Belt	193,000	163,910	151,430	28,950	68,580	220	10	40		70,920	20,950	1,000	92,870
					(430)	(100)	(390)	(-)	(1,140)				
Karri Rates Tingle	1,100	860	790	860	790	-	-	-		790	-	-	790
					(-)	(-)	(-)	(-)	(-)				
Karri Red Tingle	7,200	5,860	5,220	1,080	5,140	-	-	-		5,220	-	-	5,220
					(80)	(-)	(-)	(-)	(-)				
Karri West Coast	14,500	6,270	4,750	2,180	4,200	50	-	-		4,700	10	-	4,710
					(420)	(-)	(10)	(-)	(20)				

APPENDIX 7 (cont.)

Area reservation levels of forest ecosystems

	Total pre-1750 extent (ha)	Present extent within the plan area (ha)	Present extent on all lands vested in the Conservation Commission (ha)	CAR target (ha)	Formal reserves Area of ecosystem representation (hectares) Existing gazetted as at 30.06.2011 (Additions proposed) N.P. (ha)	N.R. (ha)	C.P. (ha)	5(1) (g),(h) (ha)	FCA (ha)	All formal reserves and FCA (ha)	Informal reserves (ha)	Other (fauna habitat zones) (ha)	Formal reserves, FCA, informal reserves, and other protected areas (ha)
Karri Yellow Tingle	15,800	13,260	11,770	2,370	11,220	-	-	-		11,770	-	-	11,770
					(20)	(-)	(-)	(-)	(530)				
Sub total	**231,600**	**190,160**	**173,960**		**89,930**	**270**	**10**	**40**		**93,400**	**20,960**	**1,000**	**115,360**
					(950)	**(100)**	**(400)**	**(-)**	**(1,690)**				
Wandoo dominant													
Western Wandoo forest	363,200	146,600	99,530	54,480	22,640	10,430	7,630	10		64,900	6,600	1,640	73,140
					(8,000)	(900)	(15,230)	(10)	(50)				
Western Wandoo woodland	163,000	72,080	44,760	24,450	14,980	2,260	750	-		33,500	2,930	280	36,710
					(6,260)	(210)	(9,040)	(-)	(-)				
Sub total	**526,200**	**218,680**	**144,290**		**37,620**	**12,690**	**8,380**	**10**	**-**	**98,400**	**9,530**	**1,920**	**109,850**
					(14,260)	**(1,110)**	**(24,270)**	**(10)**	**(50)**				
Other													
Bullich and Yate	2,800	2,440	2,190	2,440	1,470	40	-	-		2,160	30	-	2,190
					(650)	(-)	(-)	(-)	(-)				
Darling Scarp	36,300	14,250	3,830	5,450	2,450	320	70	-		3,450	380	-	3,830
					(60)	(360)	(130)	(-)	(70)				

APPENDIX 7 (cont)

Area reservation levels of forest ecosystems

	Total pre-1750 extent	Present extent within the plan area	Present extent on all lands vested in the Conservation Commission	CAR target	Formal reserves Area of ecosystem representation (hectares) Existing gazetted as at 30.06.2011 (Additions proposed)				FCA	All formal reserves and FCA	Informal reserves	Other (fauna habitat zones)	Formal reserves, FCA, informal reserves, and other protected areas
					N.P.	N.R.	C.P.	5(1) (g),(h)					
	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)
Peppermint & Coastal Heath	80,100	70,830	62,330	12,020	55,920	1,420	-	10		62,180	150	-	62,330
					(4,530)	(300)	(-)	(-)	(-)				
Rocky Outcrops	26,400	12,440	12,620	3,960	6,370	20	90	70		8,380	4,240	-	12,620
					(1,400)	(-)	(390)	(-)	(50)				
Sand Dunes	11,300	11,300	11,320	1,700	11,070	-	-	-		11,320	-	-	11,320
					(250)	(-)	(-)	(-)	(-)				
Shrub, Herb, & Sedgelands	429,900	296,300	255,170	64,490	193,910	11,830	380	870		225,020	30,150	-	255,170
					(5,450)	(1,580)	(730)	(-)	(10,260)				
Swamps	15,300	8,070	6,650	2,300	3,270	2,630	120	20		6,270	380	-	6,650
					(10)	(180)	(-)	(-)	(20)				
Whicher Scarp	23,700	9,960	5,190	3,560	320	20	90	-		3,200	610	90	3,890
					(2,370)	(-)	(60)	(-)	(340)				
Sub total	**625,800**	**425,590**	**359,300**		**274,780**	**16,280**	**750**	**970**		**321,980**	**35,940**	**90**	**358,000**
					(14,720)	**(2,420)**	**(1,310)**	**(-)**	**(10,740)**				

APPENDIX 7 (cont.)

Area reservation levels of forest ecosystems

	Total pre-1750 extent (ha)	Present extent within the plan area (ha)	Present extent on all lands vested in the Conservation Commission (ha)	CAR target (ha)	Formal reserves Area of ecosystem representation (hectares) Existing gazetted as at 30.06.2011 (Additions proposed) N.P. (ha)	N.R. (ha)	C.P. (ha)	5(1) (g),(h) (ha)	FCA (ha)	All formal reserves and FCA (ha)	Informal reserves (ha)	Other (fauna habitat zones) (ha)	Formal reserves, FCA, informal reserves, and other protected areas (ha)
Total	**4,163,850**	**2,643,470**	**2,251,600**		**783,140**	**92,450**	**33,680**	**14,860**		**1,158,710**	**193,610**	**51,630**	**1,403,940**
					(107,260)	**(13,470)**	**(73,110)**	**(260)**	**(40,440)**				

Notes:

1. Ecosystem and tenure datasets have been updated since the RFA and the current FMP.
2. The RFA boundary has been extended to include the full extent of both the Darling Scarp and Whicher Scarp ecosystems.
3. Identification of the Whicher Scarp ecosystem has reduced the extent of the Jarrah Blackwood ecosystem.
4. Totals of rows and columns within the table may not be consistent due to rounding.

APPENDIX 8

Percentage reservation levels of forest ecosystems

	Total pre-1750 extent (ha)	Present extent within the plan area (% pre-1750)	Present extent on all lands vested in the Conservation Commission (% pre-1750)	CAR target (% pre-1750)	Formal reserves Ecosystem representation as a percentage of pre-1750 extent				FCA (% pre-1750)	All formal reserves and FCA (% pre-1750)	Informal reserves (% pre-1750)	Other (fauna habitat zones) (% pre-1750)	Formal reserves, FCA, informal reserves, and other protected areas (% pre-1750)
					Existing gazetted as at 30.06.2011 (Additions proposed)								
					N.P. (% pre-1750)	N.R. (% pre-1750)	C.P. (% pre-1750)	5(1) (g),(h) (% pre-1750)					
Jarrah dominant													
Jarrah Blackwood	343,500	81	78	15	21.0	0.4	0.8	-		26.7	6.2	2.4	35.3
					(0.8)	(0.3)	(1.1)	(-)	(2.4)				
Jarrah Leeuwin	56,400	35	17	15	13.6	0.1	-	-		15.1	0.6	-	15.7
					(0.4)	(-)	(-)	(-)	(1.0)				
Jarrah Mt Lindesay	126,600	34	21	15	13.9	0.5	-	-		18.3	0.4	-	18.8
					(-)	(0.6)	(-)	(-)	(3.3)				
Jarrah North East	717,100	49	36	15	2.5	1.1	1.3	-		15.7	1.9	1.0	18.5
					(6.1)	(0.7)	(4.0)	(-)	(-)				
Jarrah- North West	670,600	75	67	15	5.7	0.2	1.5	2.0		14.1	5.2	3.3	22.6
					(3.2)	(0.2)	(0.8)	(-)	(0.5)				
Jarrah Rates Tingle	1,500	83	77	100 extant	77.3	-	-	-		77.3	-	-	77.3
					(-)	(-)	(-)	(-)	(-)				
Jarrah Red Tingle	350	77	63	100 extant	62.9	-	-	-		62.9	-	-	62.9
					(-)	(-)	(-)	(-)	(-)				
Jarrah Sandy	107,900	66	59	15	9.6	0.2	1.9	-		22.8	3.1	2.7	28.6
					(5.0)	(-)	(5.7)	(-)	(0.2)				
Jarrah South	557,300	79	75	15	34.4	5.7	-	0.1		42.1	5.8	1.5	49.4
					(-)	(0.2)	(0.2)	(-)	(1.5)				

APPENDIX 8 (cont.)

Percentage reservation levels of forest ecosystems

	Total pre-1750 extent (ha)	Present extent within the plan area (% pre-1750)	Present extent on all lands vested in the Conservation Commission (% pre-1750)	CAR target (% pre-1750)	Formal reserves Ecosystem representation as a percentage of pre-1750 extent				FCA (% pre-1750)	All formal reserves and FCA (% pre-1750)	Informal reserves (% pre-1750)	Other (fauna habitat zones) (% pre-1750)	Formal reserves, FCA, informal reserves, and other protected areas (% pre-1750)
					Existing gazetted as at 30.06.2011 (Additions proposed)								
					N.P. (% pre-1750)	N.R. (% pre-1750)	C.P. (% pre-1750)	5(1) (g),(h) (% pre-1750)					
Jarrah Unicup	81,000	36	21	15	0.3	18.6	-	-		20.8	-	-	20.9
					(-)	(0.4)	(-)	(-)	(1.4)				
Jarrah Woodland	106,400	63	47	15	14.7	4.5	0.3	0.2		27.1	20.0	-	47.1
					(3.5)	(0.6)	(2.4)	(-)	(1.0)				
Jarrah Yellow Tingle	11,600	83	71	15	65.1	-	-	-		71.2	-	-	71.2
					(0.2)	(-)	(-)	(-)	(5.9)				
Sub total	**2,780,250**	**65**	**57**										
Karri dominant													
Karri Main Belt	193,000	85	78	15	35.5	0.1	-	-		36.7	10.9	0.5	48.1
					(0.2)	(0.1)	(0.2)	(-)	(0.6)				
Karri Rates Tingle	1,100	78	72	100 extant	71.8	-	-	-		71.8	-	-	71.8
					(-)	(-)	(-)	(-)	(-)				
Karri Red Tingle	7,200	81	73	15	71.4	-	-	-		72.5	-	-	72.5
					(1.1)	(-)	(-)	(-)	(-)				
Karri West Coast	14,500	43	33	15	29.0	0.3	-	-		32.4	0.1	-	32.5
					(2.9)	(-)	(0.1)	(-)	(0.1)				
Karri Yellow Tingle	15,800	84	74	15	71.0	-	-	-		74.5	-	-	74.5
					(0.1)	(-)	(-)	(-)	(3.4)				
Sub total	**231,600**	**82**	**75**										

APPENDIX 8 (cont.)

Percentage reservation levels of forest ecosystems

	Total pre-1750 extent (ha)	Present extent within the plan area (% pre-1750)	Present extent on all lands vested in the Conservation Commission (% pre-1750)	CAR target (% pre-1750)	Formal reserves Ecosystem representation as a percentage of pre-1750 extent				FCA (% pre-1750)	All formal reserves and FCA (% pre-1750)	Informal reserves (% pre-1750)	Other (fauna habitat zones) (% pre-1750)	Formal reserves, FCA, informal reserves, and other protected areas (% pre-1750)
					Existing gazetted as at 30.06.2011 (Additions proposed)								
					N.P. (% pre-1750)	N.R. (% pre-1750)	C.P. (% pre-1750)	5(1) (g),(h) (% pre-1750)					
Wandoo dominant													
Western Wandoo forest	363,200	40	27	15	6.2	2.9	2.1	-		17.9	1.8	0.5	20.1
					(2.2)	(0.2)	(4.2)	(-)	(-)				
Western Wandoo woodland	163,000	44	27	15	9.2	1.4	0.5	-		20.6	1.8	0.5	20.1
					(3.8)	(0.1)	(5.5)	(-)	(-)				
Sub total	**526,200**	**42**	**27**										
Other													
Bullich and Yate	2,800	87	78	100 extant	52.5	1.4	-	-		77.1	1.1	-	78.2
					(23.2)	(-)	(-)	(-)	-				
Darling Scarp	36,300	39	11	15	6.7	0.9	0.2	-		9.5	1.0	-	10.6
					(0.2)	(1.0)	(0.4)	(-)	(0.2)				
Peppermint & Coastal Heath	80,100	88	78	15	69.8	1.8	-	-		77.6	0.2	-	77.8
					(5.7)	(0.4)	(-)	(-)	(-)				
Rocky Outcrops	26,400	47	48	15	24.1	0.1	0.3	0.3		31.7	16.1	-	47.8
					(5.3)	(-)	(1.5)	(-)	(0.2)				
Sand Dunes	11,300	100	100	15	97.8	-	-	-		100.0	-	-	100.0
					(2.2)	(-)	(-)	(-)	(-)				

APPENDIX 8 (cont.)

Percentage reservation levels of forest ecosystems

	Total pre-1750 extent (ha)	Present extent within the plan area (% pre-1750)	Present extent on all lands vested in the Conservation Commission (% pre-1750)	CAR target (% pre-1750)	Formal reserves Ecosystem representation as a percentage of pre-1750 extent				FCA (% pre-1750)	All formal reserves and FCA (% pre-1750)	Informal reserves (% pre-1750)	Other (fauna habitat zones) (% pre-1750)	Formal reserves, FCA, informal reserves, and other protected areas (% pre-1750)
					Existing gazetted as at 30.06.2011 (Additions proposed)								
					N.P. (% pre-1750)	N.R. (% pre-1750)	C.P. (% pre-1750)	5(1)(g),(h (% pre-1750))					
Shrub, Herb, & Sedgelands	429,900	69	59	15	45.1	2.8	0.1	0.2		52.3	7.0	-	59.4
					(1.3)	(0.4)	(0.2)	(-)	(2.4)				
Swamps	15,300	53	43	15	21.4	17.2	0.8	0.1		41.0	2.5	-	43.5
					(0.1)	(1.2)	(-)	(-)	(0.1)				
Whicher Scarp	23,700	42	22	15	1.4	0.1	0.4	-		13.5	2.6	0.4	16.4
					(10.0)	(-)	(0.3)	(-)	(1.4)				
Sub total	**625,800**	**68**	**57**										
Total	**4,163,850**	**63**	**54**										

Notes:
1. Ecosystem and tenure datasets have been updated since the RFA and FMP 2004-2013
2. The RFA boundary has been extended to include the full extent of both the Darling Scarp and Whicher Scarp ecosystems.
3. Identification of the Whicher Scarp ecosystem has reduced the extent of the Jarrah Blackwood ecosystem.
4. Totals of rows and columns within the table may not be consistent due to rounding.

APPENDIX 9

Reservation of old-growth forest

Forest ecosystem	Area of old-growth forest on public land	CAR Target		Areas of old-growth forest in formal reserves and Forest Conservation Areas				Areas of old-growth forest in informal reserves and other protected areas		Total area protected (confined to land vested in the Conservation Commission)	
				Existing reserves at 30.06.11		Additional proposed reserves at 31.12.11					
	(ha)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Jarrah dominant											
Jarrah Blackwood	45,484	27,290	60	39,132	86.0	4,189	15.4	2,148	7.9	45,470	100.0
Jarrah Leeuwin	486	486	100	479	98.6	7	1.4	-	-	486	100.0
Jarrah Mt Lindesay	11,964	7,178	60	10,930	91.4	676	9.4	358	5.0	11,964	100.0
Jarrah North East	12,909	12,909	100	1,520	11.8	10,066	78.0	1,322	10.2	12,908	100.0
Jarrah North West	7,920	7,920	100	3,403	43.0	3,990	50.4	496	6.3	7,890	99.6
Jarrah Rates Tingle	1,091	1,091	100	1,091	100.0	-	-	-	-	1,091	100.0
Jarrah Red Tingle	214	214	100	211	98.4	3	1.6	-	-	214	100.0
Jarrah Sandy	2,223	2,223	100	14	0.6	2,198	98.9	11	0.5	2,223	100.0
Jarrah South	151,996	91,198	60	137,496	90.5	5,204	5.7	9,070	9.9	151,770	99.9
Jarrah Unicup	4,258	2,555	60	3,981	93.5	255	10.0	23	0.9	4,258	100.0
Jarrah Woodland	12,060	7,236	60	9,949	82.5	1,327	18.3	730	10.1	12,006	99.5
Jarrah Yellow Tingle	7,074	4,244	60	6,594	93.2	479	11.3	-	-	7,073	100.0
Sub total	**257,679**			**214,800**		**28,394**		**14,158**		**257,353**	
Karri dominant											
Karri Main Belt	52,110	31,266	60	45,305	86.9	510	1.0	6,157	19.7	51,972	99.7
Karri Rates Tingle	731	731	100	731	100.0	-	-	-	-	731	100.0
Karri Red Tingle	3,288	1,973	60	3,214	97.8	74	2.2	-	-	3,288	100.0

APPENDIX 9 (cont.)

Reservation of old-growth forest

Forest ecosystem	Area of old-growth forest on public land	CAR Target		Areas of old-growth forest in formal reserves and Forest Conservation Areas				Areas of old-growth forest in informal reserves and other protected areas		Total area protected (confined to land vested in the Conservation Commission)	
				Existing reserves at 30.06.11		Additional proposed reserves at 31.12.11					
	(ha)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Karri dominant											
Karri West Coast	522	522	100	471	90.4	50	9.6	-	-	522	100.0
Karri Yellow Tingle	6,956	4,174	60	6,760	97.2	196	2.8	-	-	6,956	100.0
Sub total	**63,607**			**56,481**		**830**		**6,157**		**63,469**	
Wandoo dominant											
Western Wandoo Forest	8,804	8,804	100	4,454	50.6	3,156	35.9	1,193	13.5	8,803	100.0
Western Wandoo Woodland	3,253	3,253	100	1,764	54.2	1,090	33.5	399	12.3	3,253	100.0
Sub total	**12,057**			**6,218**		**4,246**		**1,592**		**12,056**	
Other											
Darling Scarp	283	283	100	166	58.8	110	38.8	7	2.4	283	100.0
Whicher Scarp	-	-		-		-		-		-	
Sub total	**283**			**166**		**110**		**7**		**283**	
Total	**333,625**			**277,665**		**33,580**		**21,914**		**333,160**	

Notes:
Data presented are for old-growth forest within the RFA area.
1. Datasets contributing to the generation of old-growth forest have been updated since the RFA and FMP 2004-2013.
2. Old-growth forest on land vested in the Conservation Commission is current at 31.12.11 and on other public land at 31.12.01.
3. Darling Scarp includes jarrah and wandoo forest and woodland.

APPENDIX 10

Beard-Hopkins vegetation associations within the plan area

* Vegetation associations that occur within the plan area and have greater than 75 per cent of their occurrence in the plan area outside the RFA area		**Pre-1750 extent of vegetation associations**						
Beard-Hopkins code	**Description of vegetation association**	**Total within plan area**	**All land**				**Public land**	
			Within RFA		**Outside RFA**		**Outside RFA**	
		(ha)	**(ha)**	**% of Total**	**(ha)**	**% of Total**	**(ha)**	**% of Total**
*a23,32m,3Sc/a26m	Mosaic: Shrublands; *Acacia lasiocarpa* & *Melaleuca acerosa* heath / Shrublands; *Acacia rostellifera* & *Acacia cyclops* thicket	28,490	-	-	28,490	100	8,230	29
a31Sc	Shrublands; *Acacia decipiens*	8,790	8,790	100	-	-	-	-
agLc	Low forest: peppermint (*Agonis flexuosa*)	17,300	15,190	88	2,110	12	490	3
agLi	Low woodland; *Agonis flexuosa*	2,710	2,620	97	90	3	10	-
agSi	Shrublands; peppermint scrub, *Agonis flexuosa*	34,050	33,860	99	190	1	150	-
*aSZc	Shrublands; Acacia scrub-heath unknown spp	4,560	-	-	4,560	100	3,040	67
*b1,2Li	Low woodland; *Banksia attenuata* & *B. menziesii*	1,590	140	9	1,440	91	750	47
*bLi	Low woodland; Banksia	199,880	7,100	4	192,780	96	104,820	52
*bLi/dZc	Mosaic: Low woodland; Banksia / Shrublands; Dryandra heath	1,530	-	-	1,530	100	-	-
*bLi/mSc	Mosaic: Low woodland; Banksia / Shrublands; teatree thicket	41,050	-	-	41,050	100	14,590	36
c5e6Li	Low woodland; *Allocasuarina huegeliana* & York gum	6,720	3,380	50	3,350	50	-	-
c5Li	Low woodland; *Allocasuarina huegeliana*	70	70	100	-	-	-	-
chSc	Shrublands; *Calothamnus quadrifidis* & *Hakea trifircata* (Cape Naturaliste)	2,730	2,310	85	420	15	370	14
ds	Bare areas; drift sand	14,250	12,130	85	2,120	15	1,240	9
e1,3Tc	Tall forest; karri & marri (*Corymbus calophylla*)	160,230	160,230	100	-	-	-	-

APPENDIX 10 (cont.)

Beard-Hopkins vegetation associations within the plan area

* Vegetation associations that occur within the plan area and have greater than 75 per cent of their occurrence in the plan area outside the RFA area		**Pre-1750 extent of vegetation associations**						
Beard-Hopkins code	**Description of vegetation association**	**Total within plan area**	**All land**				**Public land**	
			Within RFA		**Outside RFA**		**Outside RFA**	
		(ha)	**(ha)**	**% of Total**	**(ha)**	**% of Total**	**(ha)**	**% of Total**
e1,68,74Tc	Tall forest; karri, red tingle & yellow tingle	5,390	5,390	100	-	-	-	-
e1,68Tc	Tall forest; karri & red tingle (*E. jacksonii*)	1,100	1,100	100	-	-	-	-
e1,74Tc	Tall forest; karri & yellow tingle (*E. guilfoylei*)	15,220	15,220	100	-	-	-	-
e1,75Tc	Tall forest; karri & Rates tingle (*E. brevostylis*)	780	780	100	-	-	-	-
e18,72Mi	Medium woodland; *Eucalyptus rudis* & blackbutt with some bullich, jarrah & marri (fringing Blackwood River)	9,040	9,040	100	-	-	-	-
e18mMi	Medium woodland; *Eucalyptus rudis* & *Melaleuca rhaphiophylla*	23,400	15,150	65	8,250	35	300	1
e1Tc	Tall forest; karri (*Eucalyptus diversicolor*)	68,590	66,730	97	1,860	3	820	1
e1Tc/e2,3Tc	Mosaic: Tall forest; karri / Tall forest; jarrah & marri	11,160	11,160	100	-	-	-	-
e2,18Mi	Medium woodland; jarrah & river gum	60	60	100	-	-	-	-
e2,3,18,agMi	Medium woodland-fringing; jarrah, marri, *Eucalyptus rudis* & *Agonis flexuosa*	63,560	63,560	100	-	-	-	-
e2,3,5,7Mi	Medium woodland; jarrah, marri, wandoo & yate	13,650	13,650	100	-	-	-	-
e2,3,5Mc	Medium forest; jarrah, marri & wandoo	6,780	6,780	100	-	-	-	-
e2,3,5Mi	Medium woodland; jarrah, marri & wandoo	206,520	79,240	38	127,280	62	4,010	2
e2,3,72Mi	Medium woodland; jarrah, marri & blackbutt	15,150	15,150	100	-	-	-	-
e2,3,Tc	Tall forest; jarrah & marri	1,250	1,250	100	-	-	-	-

APPENDIX 10 (cont.)

Beard-Hopkins vegetation associations within the plan area

* Vegetation associations that occur within the plan area and have greater than 75 per cent of their occurrence in the plan area outside the RFA area		**Pre-1750 extent of vegetation associations**						
Beard-Hopkins code	**Description of vegetation association**	**Total within plan area**	**All land**				**Public land**	
			Within RFA		**Outside RFA**		**Outside RFA**	
		(ha)	**(ha)**	**% of Total**	**(ha)**	**% of Total**	**(ha)**	**% of Total**
e2,3Lc	Low forest; jarrah & marri	650	650	100	-	-	-	-
e2,3Mc	Medium forest; jarrah-marri	2,433,470	2,417,710	99	15,750	1	2,190	-
e2,3Mc (e5)	Medium forest; jarrah & marri on laterite with wandoo in valleys, sandy swamps with teatree and banksia	66,390	66,390	100	-	-	-	-
e2,3Mc/e2Lc	Mosaic: Medium forest; jarrah-marri / Low forest; jarrah	17,870	17,310	97	560	3	90	1
e2,3Mc/e3,5Mi	Mosaic: Medium forest; jarrah-marri / Medium woodland; marri-wandoo	5,610	5,230	93	380	7	-	-
e2,3Mi	Medium woodland; jarrah & marri	2,550	730	29	1,820	71	1,480	58
*e2,3Mi/bLi/mLc	Mosaic: Medium forest; jarrah-marri / Low woodland; banksia / Low forest; teatree (*Melaleuca* spp.)	99,420	4,330	4	95,080	96	9,730	10
*e2,3Mi/bLi/mLc/c6Li	Mosaic: Medium forest; jarrah-marri / Low woodland; banksia / Low forest; teatree / Low woodland; *Casuarina obesa*	14,050	-	-	14,050	100	1,360	10
e2,3Mp	Medium sparse woodland; jarrah & marri	810	790	98	20	2	-	-
e2,3Mr bLi	Medium open woodland; jarrah & marri, with low woodland; banksia	17,450	16,720	96	730	4	-	-
*e2,3Mr bLi/e2,3,Mp	Mosaic: Medium open woodland; jarrah & marri, with low woodland; banksia / Medium sparse woodland; jarrah & marri	39,790	7,110	18	32,680	82	8,200	21
*e2,4Mi	Medium woodland; tuart & jarrah	56,040	-	-	56,040	100	17,490	31

APPENDIX 10 (cont.)

Beard-Hopkins vegetation associations within the plan area

* Vegetation associations that occur within the plan area and have greater than 75 per cent of their occurrence in the plan area outside the RFA area		**Pre-1750 extent of vegetation associations**						
Beard-Hopkins code	**Description of vegetation association**	**Total within plan area**	**All land**				**Public land**	
			Within RFA		**Outside RFA**		**Outside RFA**	
		(ha)	**(ha)**	**% of Total**	**(ha)**	**% of Total**	**(ha)**	**% of Total**
e2,5,45Mi	Medium woodland; jarrah, wandoo & powderbark	35,900	35,750	100	150	-	130	-
e2,5Mc	Medium forest; jarrah & wandoo (*E. wandoo*)	86,500	86,500	100	-	-	-	-
e2,5Mi	Medium woodland; jarrah & wandoo	150	150	100	-	-	-	-
e2,63Mi	Medium woodland, jarrah & *Eucalyptus haematoxylon* (Whicher Ra.)	19,210	19,150	100	60	-	10	-
e2,68Mc	Medium forest; jarrah & red tingle	2,160	2,160	100	-	-	-	-
e2,74Mc	Medium forest; jarrah & yellow tingle	7,390	7,390	100	-	-	-	-
e2,74Mc/e2,75Mc	Mosaic: Medium forest; jarrah & yellow tingle / Medium forest; jarrah & Rates tingle	100	100	100	-	-	-	-
e2,75Mc	Medium forest; jarrah & Rates tingle	1,180	1,180	100	-	-	-	-
e2bLi	Low woodland; jarrah-banksia	40,760	40,500	99	260	1	80	-
e2Lc	Low forest; jarrah	68,670	66,250	96	2,430	4	420	1
e2Li	Low woodland; jarrah	4,200	4,200	100	-	-	-	-
*e2Mb cbLi	Medium very sparse woodland; jarrah, with low woodland; banksia & casuarina	57,350	290	1	57,060	99	9,640	17
e2Mi	Medium woodland; jarrah (south coast)	37,440	37,440	100	-	-	-	-
e2Mr	Medium open woodland; jarrah	15,950	15,950	100	-	-	-	-
e2Tc	Tall forest; jarrah (*E. marginata*)	4,630	4,630	100	-	-	-	-

APPENDIX 10 (cont.)

Beard-Hopkins vegetation associations within the plan area

* Vegetation associations that occur within the plan area and have greater than 75 per cent of their occurrence in the plan area outside the RFA area		**Pre-1750 extent of vegetation associations**						
Beard-Hopkins code	**Description of vegetation association**	**Total within plan area**	**All land**				**Public land**	
			Within RFA		**Outside RFA**		**Outside RFA**	
		(ha)	**(ha)**	**% of Total**	**(ha)**	**% of Total**	**(ha)**	**% of Total**
*e3,18Mr	Medium woodland; marri & river gum	16,940	3,700	22	13,240	78	1,010	6
e3,37Mi	Medium woodland; marri & yate	1,270	1,270	100	-	-	-	-
*e3,4Mr	Medium open woodland; marri & tuart	1,210	-	-	1,210	100	-	-
e3,5,45Mi	Medium woodland; marri, wandoo & powderbark	60	60	100	-	-	-	-
e3,5Mi	Medium woodland; marri & wandoo	481,170	464,680	97	16,490	3	1,560	-
e37Mc	Medium forest; bushy yate (*E. cornuta*)	280	280	100	-	-	-	-
e37Mi	Medium woodland; yate (*E. occidentalis*)	800	800	100	-	-	-	-
e3Mc	Medium forest; marri	310	310	100	-	-	-	-
e3Mi	Medium woodland; marri	23,870	11,660	49	12,210	51	40	-
e3Mi (e2,5,18,c)	Medium woodland; marri with some jarrah, wandoo, river gum and casuarina	48,120	21,220	44	26,900	56	300	1
*e3Mr	Medium open woodland; marri	4,570	50	1	4,530	99	140	3
*e3Mr/mSc	Mosaic: Medium open woodland; marri / Shrublands; teatree thicket	450	-	-	450	100	-	-
*e4Mi	Medium woodland; tuart	50,370	-	-	50,370	100	15,270	30
*e4Mr	Medium open woodland; tuart	1,270	-	-	1,270	100	410	32
*e4Mr/bLi	Mosaic: Medium open woodland; tuart / Low woodland; banksia	510	-	-	510	100	-	-
*e4Ti	Tall woodland; tuart (*E. gomphocephala*)	3,140	10	-	3,140	100	2,320	74

APPENDIX 10 (cont.)

Beard-Hopkins vegetation associations within the plan area

* Vegetation associations that occur within the plan area and have greater than 75 per cent of their occurrence in the plan area outside the RFA area		**Pre-1750 extent of vegetation associations**						
Beard-Hopkins code	**Description of vegetation association**	**Total within plan area**	**All land**				**Public land**	
			Within RFA		**Outside RFA**		**Outside RFA**	
		(ha)	**(ha)**	**% of Total**	**(ha)**	**% of Total**	**(ha)**	**% of Total**
e5,45Mi	Medium woodland; wandoo & powderbark (*E. accedens*)	5,930	5,930	100	-	-	-	-
*e5,6,8Mi	Medium woodland; York gum, wandoo & salmon gum (*E. salmonophloia*)	210	-	-	210	100	-	-
e5,7Mi	Medium woodland; wandoo & yate	900	900	100	-	-	-	-
e5Mi	Medium woodland; wandoo	7,150	4,040	57	3,110	43	330	5
e5Mr	Medium open woodland; wandoo	400	400	100	-	-	-	-
e5Mr/xZc	Mosaic: Medium open woodland; wandoo / Shrublands; mixed heath	1,650	1,650	100	-	-	-	-
e67Si	Shrublands; mallee scrub, *E. decipiens*	70	70	100	-	-	-	-
e6Mi	Medium woodland; York gum	92,740	41,570	45	51,170	55	250	-
e7mMi	Medium woodland; yate & paperbark (*Melaleuca* spp.)	1,290	1,290	100	-	-	-	-
fl	Bare areas; freshwater lakes	12,980	9,280	71	3,690	28	2,590	20
jZc	Shrublands; *Jacksonia horrida* heath	7,160	7,160	100	-	-	-	-
*k3Ci	Succulent steppe; samphire	1,120	-	-	1,120	100	140	13
*m4Zc	Shrublands; melaleuca heath	3,410	-	-	3,410	100	1,880	55
*mangrove	Low forest; mangroves or thicket; mangroves	50	-	-	50	100	30	60
mcLc	Low forest; teatree & casuarina	20	10	50	10	50	10	50
mLc	Low forest; paperbark (*Melaleuca rhaphiophylla*)	3,500	1,030	29	2,470	71	280	8

APPENDIX 10 (cont.)

Beard-Hopkins vegetation associations within the plan area

* Vegetation associations that occur within the plan area and have greater than 75 per cent of their occurrence in the plan area outside the RFA area		**Pre-1750 extent of vegetation associations**						
Beard-Hopkins code	**Description of vegetation association**	**Total within plan area**	**All land**				**Public land**	
			Within RFA		**Outside RFA**		**Outside RFA**	
		(ha)	**(ha)**	**% of Total**	**(ha)**	**% of Total**	**(ha)**	**% of Total**
mLc xGc	Sedgeland; sedges with low tree savanna woodland; paperbarks over & various sedges	6,170	6,170	100	-	-	-	-
mLi	Low woodland; paperbark (*Melaleuca* spp.)	122,720	117,600	96	5,120	4	1,330	1
mLSi	Shrublands tree-heath; paperbark over teatree thickets	19,810	19,810	100	-	-	-	-
*mSc	Shrublands; teatree thicket	18,790	4,260	23	14,530	77	2,950	16
*pLc	Low forest; cypress pine	1,980	-	-	1,980	100	1,960	99
r	Bare areas; rock outcrops	6,800	6,610	97	190	3	40	1
*sl	Bare areas; salt lakes	7,340	170	2	7,170	98	6,390	87
*x14SZc	Shrublands; scrub-heath on the Swan Coastal Plain	10,310	-	-	10,310	100	3,160	31
*x14SZc/dZc	Mosaic: Shrublands; scrub-heath on the Swan Coastal Plain / Shrublands; dryandra heath	15,410	-	-	15,410	100	3,430	22
*x8SZc	Shrublands; scrub-heath on yellow sand plain banksia-xylomelum alliance in the Geraldton Sandplain & Avon-Wheatbelt regions	5,970	-	-	5,970	100	990	17
*x9SZc	Shrublands; scrub-heath Dryandra-Calothamnus assoc. with *B. prionotes* on limestone in the northern Swan Region	9,000	-	-	9,000	100	1,700	19
xGc	Sedgeland; reed swamps, occasionally with heath	40,390	35,540	88	4,850	12	1,910	5
xSc	Shrublands; thicket, mixed	30	30	100	-	-	-	-

APPENDIX 10 (cont.)

Beard-Hopkins vegetation associations within the plan area

* Vegetation associations that occur within the plan area and have greater than 75 per cent of their occurrence in the plan area outside the RFA area		**Pre-1750 extent of vegetation associations**						
Beard-Hopkins code	**Description of vegetation association**	**Total within plan area**	**All land**				**Public land**	
			Within RFA		**Outside RFA**		**Outside RFA**	
		(ha)	**(ha)**	**% of Total**	**(ha)**	**% of Total**	**(ha)**	**% of Total**
xSi	Shrublands; *Melaleuca incana*, *Hakea tuberculata*, *Viminaria juncea* scrub on ironstone, south coast	1,080	1,080	100	-	-	-	-
*xSZc	Shrublands; scrub-heath	3,280	-	-	3,280	100	1,320	40
xZc	Shrublands; mixed heath	4,470	1,670	37	2,790	62	2,790	62

Notes:
1. Vegetation association and tenure datasets have been updated since the current FMP.
2. The RFA boundary has been extended to include the full extent of both the Darling Scarp and Whicher Scarp ecosystems.

APPENDIX 11

Representation on public land of Beard-Hopkins vegetation associations that occur predominantly outside the RFA area

Beard-Hopkins code	Description of vegetation association	Pre-1750 extent (ha)	Present extent (ha)	Existing and proposed conservation reserves			Other land vested in the Conservation Commission (ha)	Other public land (ha)
				Area (ha)	% of pre-1750 extent	% of present extent		
a23,32m,3Sc/a26m	Mosaic: Shrublands; *Acacia lasiocarpa & Melaleuca acerosa* heath / Shrublands; *Acacia rostellifera & Acacia cyclops* thicket	8,230	7,060	2,570	31	36	-	4,490
aSZc	Shrublands; Acacia scrub-heath unknown spp.	3,040	2,980	2,220	73	74	-	770
b1,2Li	Low woodland; *Banksia attenuata & B. menziesii*	750	320	-	-	-	-	320
bLi	Low woodland; banksia	104,820	80,710	46,920	45	58	16,260	17,530
bLi/mSc	Mosaic: Low woodland; banksia / Shrublands; teatree thicket	14,590	14,180	10,190	70	72	2,300	1,680
e2,3Mi/bLi/mLc	Mosaic: Medium forest; jarrah-marri / Low woodland; banksia / Low forest; teatree *(Melaleuca* spp.)	9,730	6,440	2,690	28	42	1,070	2,680
e2,3Mi/bLi/mLc/c6Li	Mosaic: Medium forest; jarrah-marri / Low woodland; banksia / Low forest; teatree / Low woodland; *Casuarina obesa*	1,360	460	180	14	40	-	280
e2,3Mr bLi/e2,3,Mp	Mosaic: Medium open woodland; jarrah & marri, with low woodland; banksia / Medium sparse woodland; jarrah & marri	8,200	8,170	7,760	95	95	-	410
e2,4Mi	Medium woodland; tuart & jarrah	17,490	6,660	3,500	20	53	1,080	2,080
e2Mb cbLi	Medium very sparse woodland; jarrah, with low woodland; banksia & casuarina	9,640	3,840	680	7	18	210	2,940
e3,18Mr	Medium woodland; marri & river gum	1,010	300	-	-	-	60	230
e3Mr	Medium open woodland; marri	140	60	-	-	-	-	50
e4Mi	Medium woodland; tuart	15,270	11,400	7,640	50	67	90	3,670
e4Mr	Medium open woodland; tuart	410	390	370	90	95	20	-

APPENDIX 11 (cont.)

Representation on public land of Beard-Hopkins vegetation associations that occur predominantly outside the RFA area

Beard-Hopkins code	Description of vegetation association	Pre-1750 extent (ha)	Present extent (ha)	Existing and proposed conservation reserves			Other land vested in the Conservation Commission (ha)	Other public land (ha)
				Area (ha)	% of pre-1750 extent	% of present extent		
e4Ti	Tall woodland; tuart (*E. gomphocephala*)	2,320	1,820	1,530	66	84	290	-
k3Ci	Succulent steppe; samphire	140	70	70	47	92	-	10
m4Zc	Shrublands; melaleuca heath	1,880	1,740	1,540	82	88	-	200
mangrove	Low forest; mangroves or thicket; mangroves	30	-	-	-	-	-	-
mSc	Shrublands; teatree thicket	2,950	2,480	2,210	75	89	20	250
pLc	Low forest; cypress pine	1,960	1,550	-	-	-	-	1,550
sl	Bare areas; salt lakes	6,390	5,680	5,170	81	91	-	500
x14SZc	Shrublands; scrub-heath on the Swan Coastal Plain	3,160	1,700	760	24	44	-	950
x14SZc/dZc	Mosaic: Shrublands; scrub-heath on the Swan Coastal Plain / Shrublands; dryandra heath	3,430	2,170	1,390	41	64	-	780
x8SZc	Shrublands; scrub-heath on yellow sand plain banksia-xylomelum alliance in the Geraldton Sandplain & Avon-Wheatbelt regions	990	190	50	5	24	-	140
x9SZc	Shrublands; scrub-heath Dryandra-Calothamnus assoc. with *B. prionotes* on limestone in the northern Swan Region	1,700	1,660	-	-	-	1,530	140
xSZc	Shrublands; scrub-heath	1,320	1,300	1,270	96	98	10	20

Notes:
1. Vegetation associations and tenure datasets have been updated since the current FMP.
2. The RFA boundary has been extended to include the full extent of both the Darling Scarp and Whicher Scarp ecosystems.

APPENDIX 12

Informal reserves

The types and purpose of informal reserves are described below, along with the criteria for their inclusion in the Department's corporate database. Informal reserves are managed in accordance with the Department's *Guidelines for Protection of the Values of Informal Reserves and Fauna Habitat Zones* (DEC 2009a).

a) Informal reserve types in State forest and timber reserves

Informal reserves are those areas identified in the Department's corporate database as informal reserves, of the kind set out in the following table:

Informal reserve type	Purpose	Criteria for inclusion in Department's corporate database
Old-growth forest	Protect areas of old-growth forest outside the formal reserve system.	Areas of jarrah forest larger than two hectares where the effects of anthropogenic disturbance (e.g. dieback, timber production, mining, grazing) are either absent or now negligible. Areas of karri forest larger than two hectares where the effects of anthropogenic disturbance (e.g. timber production, mining, grazing) are absent and which are dominated by trees in the late mature to senescent growth stage. Areas of wandoo forest or woodland larger than two hectares where the effects of anthropogenic disturbance (e.g. mining, timber production) are absent.
River and stream zones	Provide forest undisturbed by timber harvesting. Protect water quality. Protect aesthetic and social values. Protect productive capacity, soil values and carbon pools.	A 60-metre wide corridor in the area of first, second and third order[13] streams, with all boundaries being at least 20 metres from the bank of the stream. A 150-metre wide corridor in the area of fourth order streams, with all boundaries being at least 50 metres from the bank of the stream. A 400-metre wide corridor in the area of fifth order streams, and streams of any higher category, with all boundaries being at least 100 metres from the bank of the stream.
Travel route zones	Protect aesthetic and social values.	A corridor that extends at least 200 metres from each side of Level 1 travel routes in the Warren Region[14]. A corridor that extends at least 100 metres from each side of Level 2 travel routes in the Warren Region. A corridor that extends at least 200 metres from each side of the Bibbulmun Track.

[13] Classification system for width and importance of streams, varying from one for minor streams, to seven for major streams or rivers).

[14] Classification system for viewer sensitivity levels. Level one includes highways and other main roads with high (e.g. greater than 75 vehicles per day) levels of usage (sealed or unsealed). Level two includes main roads with moderate levels of usage (sealed or unsealed).
Note: except for the Bibbulmun Track, and possibly, as proposed in this Draft plan, parts of the Munda Biddi Trail, travel route zones apply only in the Warren Region.

Informal reserve type	Purpose	Criteria for inclusion in Department's corporate database
Diverse ecotype zones	Protect sensitive ecosystems.	Rock outcrops, greater than 0.2 hectares, swamps and wetlands, heath, sedge, herb and low-density woodland communities. All zones to incorporate a buffer of undisturbed vegetation around them. Ecological characteristics will be used to determine the boundary of these zones, which are defined in the Department's corporate database by vegetation codes.
Less well reserved vegetation complexes	Provide additional protection for the less well reserved vegetation complexes that occur on State forest and timber reserves.	Vegetation complexes that have either: (i) less than five per cent of their pre-European area in existing or proposed formal and informal reserves; or (ii) between five and 10 per cent of their pre-European area in existing or proposed formal and informal reserves and less than 15 per cent of their pre-European area remaining. The less well reserved vegetation complexes currently on the Department's corporate database are identified in this appendix.
Poorly reserved forest ecosystem	Provide additional protection for a poorly reserved forest ecosystem that occurs on State forest and timber reserves.	Darling Scarp forest ecosystem that has less than 15 per cent of pre-European area in existing or proposed formal plus CAR informal reserves.
RFA accredited linkage zones	Provide low disturbance linkage zones.	The areas identified in the Department's corporate database that provide a link between the proposed Milyeannup National Park and an adjacent stream zone, and a corridor between the Helena and Flynn parts of the proposed Helena Valley National Park.

Note that fauna habitat zones are not informal reserves (see the _Biological diversity' chapter).

As explained in the _Biological diversity' chapter, some small areas were designated as _Areas previously classified as old-growth forest', as a type of informal reserve in the current FMP. These are areas in the corporate database classified as old-growth forest on the commencement of the current FMP, which were subsequently determined not to be old-growth forest or any other type of informal reserve. This category is a legacy, _default' category that does not provide protection to areas with any special conservation values that warrant protection as an informal reserve and accordingly, it is proposed that this category be discontinued.

b) Specific informal reserves

i) Travel routes proposed in this Draft plan

Level 1 travel routes (all or part of the following roads)

Bibbulmun Track
Cascades Track
Channybearup Road
Coronation Road
Davidson/Graphite Road
Deeside Coast Road
Diamond Tree Road
Donnelly Mill Road
Eastbourne Road
Glauders Road
Karri Forest Explorer Drive
Middlesex Road
Mockerdillup Road
Moons Crossing Road
Mordalup Road
Muir Highway
Pemberton North Road
Pemberton-Northcliffe Road
Pemberton-Northcliffe Tramway
Percival Road (part of Karri Forest Explorer Drive)
Perup Road
Rainbow Trail
Range Road (part of Karri Forest Explorer Drive)
River Road (south of Warren River)
Sears Road
Seven Day Road (west to Hewer Road)
Smiths Road (includes access road to 100 year forest)
South West Highway
Spring Gully Road (to Moons Crossing Road)
Stirling Road
Tom Road
Tramway Trail (part of Karri Forest Explorer Drive)
Vasse Highway
Wheatley Coast Road

Level 2 travel routes (all or part of the following roads)

Balbarrup Road
Black Point Road
Boorara Road
Corballup Road
Cutting Road
Donnelly Drive (Panda, Gordon and Mobil Roads)
Gardner River Road
Grays Road
Jangardup Road
Kuranda Road
Loverock Road (between Preston and Gardner River Roads)
Morgan Road (east of Manjimup)
Orchid Road
Peppermint Grove Road
Pneumonia Road
River Road (north of Warren River)
Rowes Road (entry to Brockman Sawpit)
Seaton Ross Road
Springdale Road
Waistcoat Road

As outlined in the ‗Biological diversity' chapter, this Draft plan also includes a management option for travel routes for part of the Munda Biddi Trail.

ii) Less well reserved vegetation complexes

Vegetation complexes with less than five per cent of pre-European area in existing and proposed formal plus informal reserves and that occur on State forest. The data regarding the reservation levels of these complexes are currently under review and the list will be updated for the proposed FMP. The current FMP listed the following complexes:

BLf (Balingup valley floors); BT (Bridgetown); Fo (Forrestfield); ML (Mumballup); NWg1 (Newgalup); SC (Sidcup); Wi (Williams); *Yd (Yelverton sandy deposits); Yw (Yelverton valleys and depressions); TP (Toponup)*

Vegetation complexes with between five per cent and 10 per cent of pre-European area in existing and proposed formal plus informal reserves, and less than 15 per cent of pre-European area remaining and that occur on State forest. The data regarding the reservation levels of these complexes are currently under review and the list will be updated for the proposed FMP. The current FMP listed the following complex:

NWf2 (Newgalup)

APPENDIX 13

Threatened species and ecological communities recovery plans relevant to the area covered by the plan

IUCN threat categories

Methods used to decide priorities for conservation action for threatened species are described in the Department's Policy No. 50: *Setting priorities for the conservation of Western Australia's threatened flora and fauna*. The IUCN has revised its categories of threat and criteria for the year 2000 Red List. All threat categories remain the same, however the lower risk category ‗conservation dependent' has disappeared. The Department currently retains this category within the ‗Priority' species listing. The threat categories are:

- *Critically Endangered* – A taxon is critically endangered when it is facing extremely high risk of extinction in the wild in the immediate future.
- *Endangered* – A taxon is endangered when it is not critically endangered but is facing a very high risk of extinction in the near future.
- *Vulnerable* – A taxon is vulnerable when not critically endangered or endangered but is facing a high risk of extinction in the wild in the medium term future.

Recovery plans

All taxa that are identified as critically endangered are conserved through the preparation and implementation of recovery plans or interim recovery plans. Taxa that are identified as endangered and vulnerable have recovery plans prepared, and are allocated research and management resources, in priority order. Recovery plans and interim recovery plans are prepared for a defined time period, but remain in operation until replaced, or the taxon is no longer listed as threatened.

Full recovery plans

Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan 2002-2012

Chuditch Recovery Plan 2012

Dunsborough Burrowing Crayfish (*Engaewa reducta*), Margaret River Burrowing Crayfish (*Engaewa pseudoreducta*) and Walpole Burrowing Crayfish (*Engaewa walpolea*) Recovery Plan 2007-2016

Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banskii naso*) Recovery Plan 2007-2016

Gilbert's Potoroo (*Potorous gilbertii*) Recovery Plan 2004

Muir's Corella (*Cacatua pastinator pastinator*) Recovery Plan

Orange-bellied and White-bellied Frogs Recovery Plan 1995 (2nd Edition) (1992-2001)

South Coast Threatened Birds Recovery Plan 2009-2018 (Noisy Scrub-bird, Western Ground Parrot, Western Whipbird)

Sunset Frog Recovery Plan 2002 (2001-2006)

Western Swamp Tortoise (*Pseudemydura umbrina*) Recovery Plan 2010 (4th edition)

Western Trout Minnow (*Galaxias truttaceus hesperius*) Recovery Plan 2008

Woylie (*Bettongia penicillata ogilbyi*) Recovery Plan 2012

Interim recovery plans

Andersonia annelsii	
Andersonia gracilis	
Banksia nivea subsp. *uliginosa*	Honeypot dryandra
Banksia squarrosa subsp. *argillacea*	Pingle
Boronia exilis	Scott River boronia
Brachyscias verecundus	
Caladenia bryceana subsp. *bryceana*	Dwarf spider orchid
Caladenia busselliana	
Caladenia caesarea subsp. *maritima*	
Caladenia huegelii	Grand spider orchid
Caladenia procera	
Caladenia viridescens	
Caladenia winfieldii	Majestic spider orchid
Calytrix breviseta subsp. *breviseta*	Swamp starflower
Chamelaucium sp. Gingin (N.G. Marchant 6)	Gingin wax
Conospermum undulatum	
Conostylis misera	Grass conostylus
Cryptandra congesta	
Darwinia apiculata	Scarp darwinia
Darwinia ferricola	
Darwinia whicherensis	
Drakaea confluens	
Drakaea elastica	Glossy-leaved hammer orchid
Eucalyptus balanites	Cadda Road mallee
Eucalyptus phylacis	
Gastrolobium papilio	
Grevillea acropogon	
Grevillea althoferorum subsp. *fragilis*	Split-leaved grevillea
Grevillea brachystylis subsp. *grandis*	Short-styled grevillea
Grevillea curviloba subsp. *curviloba*	Curved-leaf grevillea
Grevillea curviloba subsp. *incurva*	Narrow curve-leaf grevillea
Grevillea elongata	Ironstone grevillea
Grevillea fuscolutea	
Grevillea maccutcheonii	McCutcheon‘s grevillea
Grevillea rara	
Lambertia echinata subsp. *occidentalis*	Western prickly honeysuckle
Lambertia orbifolia subsp. Scott River Plains (L.W.Sage 684)	
Lasiopetalum pterocarpum	Wing-fruited lasiopetalum
Macarthuria keigheryi	
Marianthus paralius	
Petrophile latericola	
Pseudocheirus occidentalis	Western ringtail possum
Rhacocarpus rehmannianus subsp. *webbianus*	Webb‘s moss

Rulingia sp.Trigwell Bridge (R.Smith s.n. 20.6.89)	Trigwell's rulingia
Sphenotoma drummondii	Mountain paper-heath
Stylidium semaphorum	
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	
Synaphea sp. Pinjarra (R. Davis 6578)	
Synaphea stenoloba	Dwellingup synaphea
Thelymitra dedmaniarum	Cinnamon sun orchid
Verticordia apecta	Hay River featherflower
Verticordia fimbrilepis subsp. *fimbrilepis*	
Verticordia plumosa var. *ananeotes*	
Verticordia plumosa var. *pleiobotrya*	
Wurmbea calcicola	

Recovery plans for threatened ecological communities

Aquatic Root Mat Community Number 1 of Caves of the Leeuwin Naturaliste Ridge
Aquatic Root Mat Community Number 2 of Caves of the Leeuwin Naturaliste Ridge
Aquatic Root Mat Community Number 3 of Caves of the Leeuwin Naturaliste Ridge
Aquatic Root Mat Community Number 4 of Caves of the Leeuwin Naturaliste Ridge
Aquatic Root Mat Community Number 1 of Caves of the Swan Coastal Plain
Stromatolite like freshwater microbialite community of coastal brackish lakes
Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)
Perth to Gingin Ironstone Association
Stromatolite like microbialite community of coastal freshwater lakes
Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)
Sedgelands in Holocene dune swales of the southern Swan Coastal Plain
Shrublands and woodlands of the eastern side of the Swan Coastal Plain
Eucalyptus calophylla - Kingia australis woodlands on heavy soils, Swan Coastal Plain
Eucalyptus calophylla - Xanthorrhoea preissii woodlands and shrublands, Swan Coastal Plain
Melaleuca huegelii - Melaleuca acerosa (currently M. systena) shrublands on limestone ridges
Shrublands and woodlands on Muchea Limestone
Scott River Ironstone Association

Threatened flora management programs

An important strategy the Department is using to assist the listing, prioritisation and conservation management of vascular flora is the preparation of regional and district threatened flora management programs. These review the status of declared threatened flora and of priority taxa in a departmental region or district and determine local priorities and outline management needs.

Programs approved

Declared rare flora and other plants in need of special protection in the Northern Forest Region (now part of Swan Region).

Declared rare flora and other plants in need of special protection in the Metropolitan Area (now part of Swan Region).

Declared rare and poorly known flora in the Central Forest Region (now South West Region).

Declared rare and poorly known flora in the Warren Region.

Priority flora and fauna

Because of the State‘s large and diverse biota, there are many species that are known from only a few collections, or a few sites, but which have not been adequately surveyed. Such species may be rare or threatened, but cannot be considered for declaration as threatened flora or fauna until such survey has been undertaken. These species are included on supplementary conservation lists called the Priority Flora List and Priority Fauna List.

There are three categories of priority species covering these poorly known species. The categories are arranged to give an indication of the priority for undertaking further surveys based on the number of known sites, and the degree of threat to those populations. A fourth category of priority species is included for those species that have been adequately surveyed and are considered to be rare but not currently threatened. A fifth category of priority fauna are those listed as conservation dependent, being species which have been removed from the threatened fauna list but are still dependent on conservation programs for their ongoing survival. Special consideration is given to the management of priority species. Commercial harvesting of priority flora on Crown land is not permitted under Commercial Purposes Licence conditions.

APPENDIX 14

Silviculture in State forest and timber reserves

What is silviculture?

Silviculture is the theory and practice of growing and tending forests to achieve management objectives. Traditionally associated with timber production, modern silviculture now encompasses economic, environmental and social objectives to achieve ecologically sustainable forest management. It is applied to achieve a wide variety of outcomes including erosion control, wood production, catchment management, habitat for wildlife, maintenance of aesthetics, and provision for recreation.

Objectives may be complementary to, or conflict with one another. The silvicultural method(s) applied are therefore designed to achieve a balance between objectives, and those objectives may differ at the local and landscape scale in order to achieve the most optimal balance of objectives for the whole of forest.

History of silviculture in Western Australia

Karri

1880s to 1925
During this period, karri was logged at Denmark on the south coast and at Boranup near Augusta. Clearfelling was the silvicultural method practised, although this was not a deliberate policy, but rather, a result of no forest management and no intention of regenerating the forest. The cutover areas were destined to be turned into farms, however, the stands were burnt on completion and dense regeneration established from seed from trees not felled.

Most of the Denmark area was subsequently cleared for farming, however, most of the Boranup area was retained and became State forest and more recently national park.

1925 to 1940
The first deliberate silviculture was practised following the passing of the *Forests Act 1918*. Clearfelling was the method used and seed for regeneration came from cull trees, most of which were ringbarked following establishment of the regeneration. The Big Brook forest is an example from this period.

1940 to 1967
Around 1940 the silvicultural method changed to a selection method. The reasons for this were:

- a desire to reduce waste of smaller trees not used by the sawmill
- the need to leave trees on the area cutover to minimise pressure for clearing of the forest for farmland
- the need to cover greater areas of forest to salvage old and fire damaged trees
- to create access in the forest, particularly for fire control.

The maximum selection gap size was generally 120 metres in diameter (the seed dispersal limit), but typically gaps were down to 30 metres in diameter.

The method was a failure from a timber production perspective because:

- it was very difficult to conduct regeneration burns – in many cases they were either too cool to expose the seed bed to obtain successful regeneration, or too intense resulting in damage to the retained trees
- regeneration that did occur was suppressed by competition for light, nutrients and water from the retained trees, leading to an under-stocked forest
- retained trees declined due to their exposure
- the second harvest caused extensive damage to the regeneration as a result of the felling or the regeneration burn.

While regeneration could be established, it could not be sustained, making the approach unsustainable in the long term.

1967 to 1975

Clearfelling was resumed in 1967 to overcome the problems produced by the selection method. Regeneration was initially obtained through the use of seed trees, but hand planting came to dominate, with some hand seeding due to logistical problems associated with infrequent seed years (natural karri seed cycles are irregular) and the number of coupes to be burnt.

1975 to 2000

The advent of an export market for pulpwood provided the opportunity to harvest mixed karri / marri stands, by providing a market for marri, and the opportunity to remove it to facilitate successful regeneration. Trials of the regeneration of these types had demonstrated that adequate regeneration stocking of marri could be achieved from lignotubers and coppice without the need for a marri seed source, and the seed tree method continued using only karri seed trees. This heavier cutting also resulted in the adoption of road, river and stream zones to protect water, aesthetic and fauna values. The maximum gap size for a clearfell patch was set at 200 hectares, although this was rarely reached.

Clearfelling and planting complemented the seed tree program to provide for a more even annual regeneration program. Planting was initially done with open-rooted seedlings and later with potted stock, which developed from jiffy pots, copper-coated, then moulded root-trainer pots.

Stocking standards were more rigorously monitored from 1990. The planting rate for seedlings was initially 1250 seedlings per hectare but increased to 2000 seedlings per hectare in 1996 because of concerns about branch size. Concerns about soil compaction due to logging in moist soil conditions led to restrictions on winter (moist soil) operations and from 1990 compacted sites were ripped.

Seed tree operations require long lead times for planning to integrate seed cycles, nursery programs and multi phase harvesting. As planning uncertainties increased during the 1990s, with unresolved issues of reservation, it became increasingly difficult to manage seed tree regeneration and the method was last used in 1997.

The thinning of regrowth karri was introduced during this period, initially in the older regrowth stands regenerated from the mid-1930s. This was later expanded to include younger stands where the co-dominant height was greater than 30 metres. Site quality determines the age this occurs, but was about 20 years of age. The resulting product is small and predominantly suitable only for pulpwood, with just a small proportion of the material sold as sawlog.

The loss of markets for marri chipwood in 2000 resulted in a change to clearfelling practices. Limited culling of marri was undertaken to reduce competition for regrowth in mixed stands, but many stands were ‗partially' cut and consequently only partially regenerated with karri.

The reservation of all old-growth forest was introduced by the then Government in 2001. This reduced the level of harvest and restricted harvesting (for regeneration) to forest that was previously cutover.

2004 – present
Further changes occurred as a part of the implementation of the current FMP. The most significant of these were changes to the land base available for timber harvesting, including a large increase in formal conservation reserves and the creation of fauna habitat zones.

In addition, the maximum clearfell size was restricted to 40 hectares, partly by design and partly because of the patchy nature of the forests available for harvest. Coupe size in regrowth that is harvested and regenerated was restricted to 20 hectares. There was also increased focus on the provision of habitat, and the retention of secondary habitat trees in clearfell coupes.

Pressure from the newly established wine industry in the region, to limit smoke haze during the period when grapes are maturing, resulted in the restriction of most regeneration burns until after the grapes were harvested in early autumn. To enable burning to be achieved after the first rains, it became necessary to heap the debris and burn heaps rather than attempt broadcast burning. This required additional machine activity and required the coupes to be shallow-ripped between the heaps to facilitate successful planting. This method was also necessary to enable small or irregularly shaped coupes to be burnt safely. Successful regeneration using this method requires the use of planting and the additional application of phosphate fertiliser between heaps.

Over the 15 years from 1996 to 2010 (inclusive), the average annual area of karri forest cutover was 1,550 hectares. Table 11 shows the area and the proportion of this area cut to the karri silvicultural methods.

Table 11: Areas* cut to karri silvicultural methods from 1996 to 2010
(*Source: SILREC*)

	1996-2000		2001-2005		2006-2010	
Silvicultural method	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**
Thinning to promote growth (thinning)	900	10	3,040	46	4,810	65
Establish regeneration (seed tree)	10	0	0	0	0	0
Establish regeneration (partial clearfell)	20	0	850	13	110	1
Establish regeneration (clearfell)	8,310	90	2,670	40	2,170	30
Establish jarrah / karri regeneration	0	0	100	1	260	4
Total	**9,240**[1]	**100**	**6,660**	**100**	**7,350**	**100**

* figures rounded to nearest 10 hectares

[1] reduction in area clearfelled and total area harvested beyond 1996-2000 is a result of cessation of harvesting of old-growth forest and additions to the conservation reserve system, with consequent reduction in sustained yield

Jarrah

1870 to 1920
Early jarrah cutting was unmanaged and determined primarily by the demands of the export timber trade. If the forest was of poor quality, only the best trees were selectively cut, however, if the quality was high the forest was virtually clearfelled. In the prime jarrah forest around the town of Dwellingup, there are regrowth stands from this era of more than 1,000 hectares in extent.

1920 to 1940
A group selection method was introduced following the passing of the Forests Act. Where this was accompanied by the removal of cull trees that competed with the regrowth, small discrete patches of regeneration were successfully established.

1940 to 1984
Single tree selection replaced group selection from the 1940s to around 1970 when ‗heavier' cutting became more common. Single tree selection was not successful because competition from the remaining mature trees was such that regeneration was unsatisfactory.

1984 to 2003
A review of silvicultural practice in the mid 1980s led to significant changes in practice. While most of the many multiple use values had been catered for in the past, the potential for more intensive management made it imperative that they be more clearly enunciated and specifically catered for.

A combination of methods was used, depending on the structure of the forest and the condition of the existing regeneration:

- Gap creation (0.2 to 10 hectares) to release existing ground coppice, saplings (greater than two metres in height and less than 15 centimetre diameter) and small poles (poles are 15 to 45 centimetre diameter) so they can develop into trees.
- Shelterwood cutting and follow-up burning treatment to encourage the development of a ground coppice. This is practised where there is currently an inadequate quantity of ground coppice, saplings and small poles to regenerate the site successfully if the area was cut to gap.
- Thinning of immature stands that are still actively growing to promote growth on retained stems.
- Single tree selection in low quality stands.

Culling was reintroduced, this time using herbicides rather than ringbarking, and released regeneration was protected from fire for 10 to15 years. In effect this was a reintroduction of the 1930s practices with some modifications.

Areas that were infected with *Phytophthora cinnamomi* were selection cut with an emphasis on retaining resistant tree species such as marri and blackbutt.

Amendments to practice were progressively made to give specific attention to other values in both the planning stage and in silvicultural requirements. During this period, the management purpose of significant areas was changed from multiple use to conservation. Changes included the retention of habitat trees, logs and understorey in harvested areas; varied thinning intensity and gap sizes in different visual amenity zones; and varied basal area retention in zones of different salt sensitivity.

From 1988 bauxite mine rehabilitation was undertaken with planted or seeded native species, principally jarrah, marri and some blackbutt.

2004 to present
As highlighted above for the karri forest, further changes occurred as a part of the implementation of the current FMP. Those relating to the land base available for timber harvesting also applied to the jarrah forest. Other changes to practice in the jarrah forest included an increase in the number of habitat trees retained per hectare, additional protection for understorey habitat elements, a limitation on culling in gaps and a definition of dieback risk in terms of vegetation complex, for application of single tree selection in dieback. Changes to the guideline for the eastern jarrah forest included a reduction in the retained basal area of shelterwood, a decrease in the acceptable regeneration stocking requirements and increase in the use of coppice for regeneration.

Over the 15 years from 1996 to 2010 (inclusive), the average annual area of jarrah forest cutover was 12,651 hectares. Table 12 shows the area and proportion of this area cut to the jarrah silvicultural methods.

Table 12: Areas* cut to jarrah silvicultural methods from 1996 to 2010
(*Source: SILREC*)

	1996-2000		2001-2005		2006-2010	
Silvicultural method	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**
Thinning to promote growth	7,860	8	6,980	13	3,340	9
Release of regeneration (gap creation)	22,090	23	4,020	7	2,350	6
Establish regeneration (shelterwood)	41,240	42	24,950	46	12,830	34
Single tree selection (in dieback areas)	6,830	7	7,340	13	9,040	24
Selective cut	12,390	13	7,310	13	6,640	18
Other (mining and clearing for utilities)	6,770	7	4,560	8	3,230	9
Total	**97,180**[1]	**100**	**55,160**	**100**	**37,430**	**100**

* figures rounded to nearest 10 hectares

[1] reduction in area harvested beyond 1996-2000 is a result of cessation of harvesting of old-growth forest and additions to the conservation reserve system, with consequent reduction in sustained yield

Wandoo

1870 to 1920
This was a period of largely uncontrolled harvesting for sawlogs, mostly in the western side of the northern jarrah forest. Areas of wandoo in this general forest matrix were harvested in conjunction with jarrah.

1920 to 1950
Limited cutting took place on State forests until after World War II. However in 1937, a distillation plant for the production of tannin was established at Toodyay. This plant operated until 1972, when it ceased production. During this period clearfelling with seed tree retention was the preferred silvicultural method. This method was successful in producing sawlogs for general purposes and material for the tannin plant.

1950 to 1989
Felling in the northern forest was also undertaken to provide industrial charcoal to a plant at Wundowie from the 1950s through to the early 1980s. Clearfelling with seed tree retention remained the preferred silvicultural method, however sawlog production was undertaken on a girth limit method until 1989, in stands that were not suitable for clearfelling. There was a progressive reduction in the girth limit over time down to 25centimetres by 1989.

1989 to 2004
Sawlog harvesting was undertaken by selection, with the aim to create three cohorts of growth stages (regeneration, immature and mature). Regeneration burns were scheduled for autumn.

2004 to present
The current FMP provided for the ongoing harvesting of wandoo, but required a greater emphasis on the retention of habitat. It also increased the acceptable standard for successful regeneration from 10 seedlings on 50 per cent of ashbeds, to 10 seedlings on 70 per cent of ashbeds.

Silvicultural methods

Silvicultural methods usually, but not always, involve felling trees. They can be divided into treatments designed to regenerate forest stands, or intermediate treatments that sustain vigour and desired composition and stand structure. These are summarised below.

Karri

Thinning - to promote growth

Thinning is undertaken to reduce competition between trees and to accelerate growth on the trees that remain. Thinning in the karri forest is undertaken in both two-tiered and even-aged stands where the stocking of the regrowth stems is sufficient to enable the regrowth to be thinned. Smaller trees with crowns below the dominant trees are removed. In the karri forest, the capacity to sell the harvested logs as pulpwood means that there is a capacity to undertake thinning operations in regrowth stands from a young age. Both the timing and the intensity of the thinning vary with the site quality of the stand. First thinning is generally scheduled from age 20 to 30, with several subsequent thinning operations planned at intervals of 15 to 30 years prior to a clearfell at ages varying from 80 to over 150 years.

Post-harvest burning in thinned karri stands is generally conducted at least 18 months after the completion of harvesting. Burns may be conducted as either individual silviculture burns of the thinned patches, or integrated into a broader prescribed burn.

Clearfell with seed trees

In this method, a number of seed trees are marked and retained to provide seed for the regeneration of the stand. The understorey vegetation is flattened by machines to provide access for tree-markers and harvesting personnel, prior to harvesting commencing. The number and spacing of the seed trees vary with the height of the stand and quality of the seed trees. The site is prepared by pushing all logs and debris into windrows at least 20 metres from the boundary for burn security, ripping of extraction tracks and clearing debris from around the seed trees. All small trees and understorey that have not been marked for retention are included in the windrows or heaps. The harvesting debris is burnt with the intention to scorch the tree crowns and promote seed fall. Once the seeds are shed, the seed trees are harvested (up to two years after the burn) and then the regeneration is left to develop.

The success of regeneration is assessed following the first summer after regeneration, and any areas that are found to be below acceptable stocking are programmed for in-fill planting to reach the required target.

Due to the limitation on coupe size and restrictions for burning, this method has not been used since 1997 but remains the preferred method of regeneration if circumstances allow it to be used.

Clearfell

All trees to be removed in a stand are harvested at the same time and regeneration is sourced from seeds from surrounding trees, coppice, or artificial seeding or planting. The understorey vegetation is flattened by machines either as a separate operation known as scrub-rolling (particularly where manual falling is to be used), or as part of the machine harvesting and extraction. The size or extent of the clearfell patch will vary, but is limited to a maximum of 40 hectares in areas of mature forest and 20 hectares in areas of even-aged regrowth. In theses stands, harvest is followed up by pushing all logs and debris into windrows at least 20 metres from the boundary for burn security, and rough heaping of the harvesting debris within the coupe to facilitate burning.

Where there is a marri component, and no market for the material, culling may be carried out, usually undertaken using machines to push down culls. Where the basal area of marri greater than 50 centimetres diameter remaining after the harvesting operation is more than 12 square metres per hectare, no culling is done. Where the basal area of marri greater than 50 centimetres diameter is between six and 12 square metres per hectare, culling can be undertaken to enhance regeneration in gaps.

The debris is burnt in late autumn or early winter. Following the post-harvest burn, the coupe is ripped to alleviate compaction and to provide suitable conditions for planting of nursery grown seedlings.

The success of regeneration is assessed following the first summer after regeneration, and any areas that are found to be below target are programmed for follow-up treatment to reach the required target.

Jarrah

Thinning - to promote growth

Thinning is often undertaken to reduce competition between trees and to accelerate growth on the trees that remain. Due to the difficulty in selling small and poor quality trees from jarrah harvesting operations, thinning is undertaken as both a commercial and a non-commercial operation.

Non-commercial operations have been undertaken infrequently across the forest generally in conjunction with government responses to periods of social disruption (such as the program in the depression of the 1930s). These non-commercial operations focus on thinning from below where smaller trees with crowns below the dominant trees are removed. Non-commercial thinning is undertaken either by pushing with machines, or the application of herbicide by notching or foliar spraying. In areas with high visual sensitivity and on strategic burn boundaries, thinning may be carried out by falling of unwanted stems although this is usually more costly. There is a relatively small area of non-commercial thinning undertaken in rehabilitated mine sites.

Commercial thinning in the jarrah forest is undertaken predominantly in the regrowth and mixed aged stands that have previously been non-commercially treated. Commercial thinning may be followed up by some pushing by machines or notching with herbicide of unmerchantable competing stems, or foliar spraying of resulting coppice to enhance the vitality and growth of retained trees.

The scheduled timing and intensity of thinning operations vary across the range of site qualities in the forest. First thinning operations are typically scheduled to commence at 20 to 25 years in regrowth forest, although in the eastern jarrah forest early thinning to maintain stand vigour may be scheduled from as early as age 10. The period between subsequent thinning is likely to vary from 20 to 75 years, prior to regeneration treatments (shelterwood or gap creation) at a nominal age of 150 to 200 years.

Following thinning and follow-up culling, the stands are burnt as either a mild intensity post-thinning silviculture burn or integrated into adjoining prescribed burns.

Shelterwood - establish regeneration

The shelterwood method is applied in the jarrah forest when the stocking of ground coppice, saplings and small poles is below the level required for gap creation. The shelterwood harvest is undertaken to retain suitable trees to act as a seed source, to provide soil disturbance to enable seedling establishment and to reduce competition from the overstorey to allow seedlings to develop into ground coppice. The shelterwood area is burnt following harvest in a moderate intensity burn to provide an ashbed and to stimulate seed fall and seedling development.

Subsequent burns in the shelterwood stands are undertaken to facilitate ongoing seedling establishment and development. Stocking of seedlings, ground coppice, saplings and small poles is monitored and once the level required for gap creation is achieved, application of that method is considered.

Gap creation - release of regeneration

Gap creation is carried out in stands that have been assessed as having sufficient ground coppice, saplings or small poles. Once harvesting is completed, the stands are assessed to quantify the amount of unmerchantable trees that remain and are not marked for retention. No culling is done where the total basal area of retained trees remaining after the harvesting operation is more than 17 square metres per hectare.

Where the total basal area of unmerchantable trees remaining and not marked for retention after the harvesting operation is between 17 and six square metres per hectare, then culling is permitted. The culling is undertaken either by machine push-down or notching with herbicide. Once the post harvest culling has been completed, the silviculture burn is undertaken either as a specific burn to reduce the slash from logging or as part of a larger prescribed burn.

Once the regeneration has been released, the stands have a period of fire exclusion to allow the trees to reach a height and size that allows them to withstand a moderate intensity prescribed burn.

Single tree selection – in dieback areas

In the single tree selection method in dieback areas, the treatment allows for a portion of the merchantable trees to be removed while retaining a sufficiently high basal area to help avoid significant change in soil moisture conditions or soil warming. Species that are not susceptible to dieback, and trees and understorey plants that appear to be resistant to dieback, are preferentially retained.

These areas are generally burnt in a mild intensity silviculture burn.

Selective cut

Selective cut is a silvicultural outcome which results from the inability to achieve the desired outcome when treemarking a stand to a thinning, shelterwood or gap, because the number of retained trees is too high to release trees from competition, or facilitate regeneration. These stands require a subsequent harvest to achieve the intent of thinning, shelterwood or gap. However, markets for non-sawlog material are required to undertake these operations.

Selective cut stands are prescribed burnt in conjunction with burns for other purposes.

Wandoo

Thinning - to promote growth

The wandoo forest contains patches of even-aged stands resulting from past cutting. These stands are thinned to retain vigour and promote growth until they are mature and eventually require regeneration. There are few of these stands and thinning is not a significant part of the wandoo silviculture at this time.

Single tree selection

In mature stands the predominant silvicultural method is single tree selection, which aims to maintain a stand with three major growth stages – regeneration, intermediate and mature or senescent trees.

Wandoo has a strong capacity to coppice. Coppice, from stumps of saplings and small poles, can be an important source of regeneration. Although several stems may develop, in time one stem usually dominates, and will rapidly develop through to the pole and tree stage.
Wandoo regeneration is heavily dependent on a receptive ashbed for good survival and to allow seedlings to develop rapidly into ground coppice. Regeneration rarely occurs outside of ashbeds, and has a very low survival rate.

Wandoo regeneration is particularly fire sensitive and seedlings, ground coppice and saplings are killed by mild fire. Burns in these areas focus on achieving a mild fire intensity in the clumps of regeneration.

Review of silvicultural methods for this Draft plan

The current silvicultural practices applied in the south-west forests are based on research and the experience of almost a century of applied silviculture.

Over time, the focus of silviculture guidelines has broadened from the maintenance or enhancement of the productive capacity of the forest for timber production, to include all aspects of ESFM. The Department is undertaking a review of the current guidelines in order to:

- formally update the guidelines in the light of knowledge gained through application of current guidelines or from research or monitoring (such as *FORESTCHECK*)
- formally update the guidelines with respect to requirements of relevant reviews (particularly the 2011 *Review of Silviculture in Forests of South-West Australia*)
- update the guidelines with respect to ESFM and to ensure the guidelines link to the goals and activities of this Draft plan.

The first stage of the review is complete for jarrah and a number of proposed changes have been put forward (see below). The revised guideline will be completed in parallel with finalisation of the next FMP, so that the silvicultural settings adopted in the final plan are included in the revised guideline. Further development of the karri and wandoo guidelines is progressing and will also be completed in parallel with finalisation of the next FMP. A description of the basis of the current guidelines, and the proposal improvements, are summarised below.

Jarrah

Background
There are four basic characteristics of jarrah that underlie the current silvicultural practice:

- it regenerates from seed
- it develops a pool of ground coppice on the forest floor beneath the forest canopy
- when there is disturbance to the overstorey canopy (such as bushfire or windstorm), ground coppice will be released and begin development into mature trees
- jarrah regrowth forest is very tolerant of competition and takes a long time for natural attrition in the number of stems to occur through dominance, suppression and mortality of individual stems.

These points must be considered when developing and applying silvicultural practices to ensure the productive capacity of the forest is maintained.

In simple terms, where adequate stocking of ground coppice, saplings and small poles exists and the overstorey is mature, harvesting can be applied to remove the overstorey and allow regeneration to be released. Where these forms of regeneration are inadequate, regeneration from seed can be encouraged. Where a regrowth forest already exists from past disturbance, a thinning can be applied to remove suppressed trees and improve growth on the trees selected for retention.

These treatments translate into what has been commonly termed:

- thinning - to promote growth where a regrowth forest already exists
- gap creation - in mature forest where regeneration is adequate, and the regeneration is intended to be released (regeneration release)
- shelterwood - in mature forest where regeneration is inadequate, and regeneration establishment is required (regeneration establishment).

It should be noted that the application of shelterwood does not reflect the classic definition of this method. Jarrah regeneration does not require the protection of a retained overstorey to provide for development. It will in fact develop more rapidly in the absence of a retained overstorey. The retained overstorey is however a source of seed from which regeneration may establish and provide for the maintenance of forest values, during the extended period required for seedlings to develop to the ground coppice stage, where it is capable of release from overstorey competition.

The jarrah forest is naturally uneven-aged and one aim of silvicultural practice is to sustain this. However, rather than applying single tree selection, which results in difficulties with regeneration and damage to regrowth in subsequent cutting cycles, group selection methods are applied. The minimum size group for gap creation is about two tree heights or about 50 metres in diameter. The largest size group for gap creation is about 10 hectares, with this limit being set to help achieve objectives for visual amenity and biodiversity conservation, in particular.

Over much of its range, jarrah is the dominant species in the jarrah forest. Marri occurs to a lesser or greater degree depending on location. The proportion of marri increases progressively from the northern jarrah to the southern jarrah and karri forest. Other species of importance in the jarrah forest include wandoo, which occurs mainly on the eastern margins of the forest and blackbutt, which occurs in the moister, more fertile gully sites.

Proposed changes to the jarrah silviculture guideline

The main changes proposed to the existing jarrah guidelines are summarised as follows.

Changes to seed tree specifications
Tree marking standards for seed tree selection are proposed to be amended to include specifications for dominance, size, potential seed crop, phenotypic selection for vigour (especially in relation to insects and disease) and sawlog production in order to maintain genetic fitness and adequate regeneration.

In areas of high dieback impact, trees or groups of trees demonstrating resistance will be retained as will trees which exhibit resistance in the face of high insect pressures.

Fire management
A silvicultural burning regime which provides for a mosaic of fire frequencies within the forest is preferred.

Improve adaptive potential
Methods to improve the adaptive potential of jarrah will be investigated, including incorporating dieback resistant jarrah seed from seed orchards into the jarrah seed mix, establishment of dieback resistant jarrah seedlings in dieback affected areas, and a revision of the seed collection strategies to maximise the adaptive potential of the genetic base.

Revised habitat retention requirements
At a landscape level, the silviculture guidelines require the maintenance of heterogeneity of forest ages to maintain structural complexity and connectivity. The group selection approach used in the jarrah forest retains this heterogeneity where the forest is managed for timber production. Temporary exclusion areas will be used to provide variable forest ages and buffer large disturbances such as mine sites, and in other situations where the surrounding landscape does not provide for a continuum of forest habitat. The use and extent of temporary exclusion areas will be informed by the surrounding landscape context.

Requirements for the retention of coarse woody debris and habitat trees have been revised. Where practicable, additional mature marri with a high likelihood of containing hollows will be retained throughout the jarrah forest. Recruitment of marri in areas where marri abundance is relatively low will also be encouraged through retention of vigorous marri with potential to produce seed and replace existing habitat trees. Areas of relatively low marri abundance have been identified through inventory data of marri greater than 50 centimetres in diameter. Marri are considered to be in relatively low abundance in those LMUs where on average, for the inventory plots in that LMU, there are less than six marri per hectare exceeding 50 centimetres diameter. This equates to less than 75 per cent of average marri abundance (for trees greater than 50 centimetres diameter) across all inventory plots.

Preference for habitat treemarking will be given to trees that include nests of threatened fauna species where these have been identified during pre-harvest checks or observed by the tree marker.

Additional large logs, logs with hollows suitable as refuge for ground-dwelling fauna, stumps and other features which provide underground cavities will be protected and retained. Additional ground log retention will be required in areas known to support threatened fauna which depend on ground habitat. Tree marking training and harvest contractor inductions will assist staff and contractors to recognise nests, signs of use by fauna and the sorts of features utilised by fauna, to help protect these elements.

The retention of standing dead trees where it is safe to do so is also proposed. Standing dead trees can be retained in habitat groups and must be retained to create structural complexity in areas where logs are salvaged after fire.

Thinning
In the context of a changing climate resulting in increased temperatures and significantly reduced rainfall, thinning is a useful tool to assist the water balance of the forest to equilibrate with the current and future climate. Thinning to reduce inter-tree competition can have positive effects on productive capacity, forest health and vitality and biodiversity, and for this reason there is a proposed increased emphasis on thinning.

The use of thinning to promote structural complexity is also proposed. This technique, referred to as _variable density thinning‘, is proposed to be used to create complexity in large areas of uniform regeneration and in stands containing a range of tree sizes, to vary the spacing of trees and retained basal area in response to variation in tree size. In even-aged karri stands, thinning is also proposed to

be undertaken to provide compositional diversity, by ensuring retention of marri within these stands, where practicable.

Regeneration surveys
It is proposed that a monitoring schedule and procedure for regeneration surveys be developed and more realistic timelines for regeneration be set as part of the silviculture manual. Stratified monitoring of regeneration is proposed to be undertaken to assess the effects of reduced rainfall and higher temperatures on regeneration success, in order to inform future requirements for regeneration practices.

Seedbed preparation
The rationale for the use of soil disturbance for seedbed preparation, and removal or reduction of native plants as competition, will be clarified and additional strategies are proposed to be included within the revised silviculture guideline. These will be developed into post-harvest treatment requirements as part of a silviculture manual.

Reduction of mid-storey shrubs and small trees
It is proposed that the physical or chemical removal of the mid-storey shrubs and small tree species (such as *Persoonia* spp., *Banksia* spp. and *Allocasuarina fraseriana*) in jarrah forest will only be carried out where it is deemed essential for the establishment and survival of overstorey regeneration. Where removal is required for the regeneration of overstorey species, the mid-storey species and small trees will be thinned to a level to allow regeneration but still retain vegetation complexity. It is proposed that this will be clarified by additional strategies within the revised silviculture guideline and will be developed into post-harvest treatment requirements as part of a silviculture manual.

Salinity risk management
As a result of reduced rainfall and declining groundwater levels, the risk to stream water quality of groundwater rise dissolving and transporting salt stored in the soil profile has significantly reduced. As a result, it is proposed that the phased harvesting requirement in the Swan and South-West regions and part of the Warren Region be removed, a change supported by the expert panel in their review of silvicultural practices. However, ongoing monitoring of groundwater is proposed to continue so that management can respond should there be a return to a wetter climate with a rise in groundwater levels. It is proposed that the changed salinity management requirements resulting will be included in the revised jarrah silviculture guideline.

Water availability in a drying climate
A key finding of the *Review of Silviculture in Forests of South-west Western Australia* (Burrows *et al.* 2011) was the opportunity that silviculture provides to assist forests to adapt to climate change. There are two approaches in this Draft plan that aim to achieve a better water balance in the jarrah forest.

The first is a proposal to modify silvicultural practices to improve water availability and enhance ecosystem health. This approach is referred to as ‗silviculture for ecosystem health'. The purpose is to enhance ecosystem health and function, and biodiversity, through enhanced water availability. Enhanced water availability is achieved by reducing the density of vegetation in the stand. Areas that could be targeted for treatment are:

- areas with a high stand density that are subject to damage by insects or disease (except dieback) and where a reduction in stand density is likely to reduce damage by insects or disease
- catchments where a reduction in stand density is likely to maintain groundwater levels and streamflows so that these catchments can act as refuges from the hydrologic impacts of climate change
- the protection of granite outcrops from the impacts of high intensity bushfire through stand density management and prescribed burning of surrounding areas

- specific refugia, threatened flora communities and ecological communities that are at risk from the hydrologic effects of climate change.

A reduction in stand density reduces competition for water and has positive effects on vegetation health and vitality, increasing resilience to pest and diseases. A sufficient reduction in stand density increases the amount of water moving through the soil profile to groundwater and into streams. Existing practices or modifications to existing practices which may be used to enhance water availability in high value areas are:

- non-commercial thinning of immature jarrah stands (stem size less than 25 centimetre diameter) to a stand basal area slightly below those in the current jarrah silviculture guideline
- basal area reduction in selectively cut stands and the removal of limits to culling for high density, small diameter selective cut stands to reduce water use and encourage larger trees for habitat
- thinning across a range of stand structures and tree size classes to stand basal areas slightly below those in the current jarrah silviculture guideline, with subsequent thinning at shorter than normal intervals so as to maintain water availability to the high value area
- relatively more frequent low intensity fires to reduce density of understorey vegetation.

‗Silviculture for ecosystem health' is only expected to be operationally or economically feasible over a very small proportion of the area covered by the plan.

A second approach would place water production as the primary objective and is referred to as ‗silviculture for water production' (see the ‗Water' section of the ‗Soil and water' chapter). The purpose of this option would be to maintain or improve groundwater and streamflow levels. To achieve this, it is likely that the initial treatment would involve reducing stand density to a leaf area index (LAI) of not less than 0.6 (about 8 to 10 square metres per hectare of basal area) with a preference for larger trees. All trees (overstorey and mid-storey) other than marked habitat trees would be harvested or culled with the goal of reducing density while retaining diversity. Coppice and regeneration would be controlled to ensure that regeneration contributes an average of no more than 0.05 LAI (about one square metre per hectare of basal area). A subsequent silvicultural treatment would most likely occur when the stand density exceeds an average LAI of about 1.2 (about 13 square metres per hectare of basal area), which is likely to be around 10 years after the initial reduction in stand density, which would not be in the period of this Draft plan. Any subsequent treatments would be subject to review of the project's success as a part of the end-of-term review for the next FMP, and any future proposals would need to be included in the subsequent plan (from 2024).

As outlined in the ‗Water' section of the ‗Soil and water' chapter, ‗silviculture for water production' could potentially be applied to parts of selected catchments covering an aggregate area of up to 65,500 hectares. The area treated to produce water in these catchments could be reduced by excluding upper slopes from the treated area. The rationale for this variant is that many upper slopes do not have groundwater beneath them and treatment of them may provide little increase in streamflow while adding significant cost to the proposal. It is likely that this variant would reduce the area that would be treated by between one quarter and one third.

Where ‗silviculture for water production' is proposed, it would require the preparation of a silviculture guideline and a catchment management plan (see Appendix 15). A catchment management plan is a strategic level plan which sits between the FMP and the indicative three-year harvest plan. The plan will identify the longer-term risks and the strategies to address them in the application of silvicultural treatments for water production.

Karri

Background
Karri regenerates from seed and successful germination and growth of seedlings depends on seed falling onto recently-exposed mineral soil, following the removal of the overstorey canopy. It is important that the site is free of competing understorey vegetation to allow karri seedlings to become successfully established. Under natural conditions, exposure of mineral soil over large areas is achieved through intense bushfire.

Unlike jarrah, karri seedlings do not have a lignotuberous stage. Following successful establishment, they continue rapid growth into saplings and subsequently poles. Compared to jarrah, karri is more intolerant of competition and will succumb rapidly once suppressed. A newly regenerated forest may contain thousands of seedlings per hectare, but natural selection through competition will result in only about 150 of the most vigorous trees remaining after about 100 years. Although natural mature karri forest may contain trees of various ages, the result of local disturbances, even-aged patches of varying size are also common.

The regeneration characteristics of karri described above, coupled with its very large crown size at maturity, suit the application of a clearfell method of silviculture. This is similar to other tall forests around the world. The minimum size patch for effective management is about two hectares, while the maximum is constrained to 40 hectares for visual amenity and biodiversity reasons, in particular. This has been further reduced to a maximum gap size of 20 hectares in patches where even-aged regrowth is being clearfelled.

Karri is not found in large continuous tracts. It occurs as discrete stands where favourable soils occur and depending on site conditions and stand history, and varies in structure from pure karri to mixtures with other species to varying extent. The most frequently occurring species other than karri is marri. Mixed forest of karri, marri and jarrah are also common. The mix may also contain blackbutt in the moister, more fertile gullies.

Proposed changes to the karri silviculture guideline

The main changes proposed to the existing karri guidelines are summarised as follows.

Retention of habitat elements
Temporary exclusion areas are proposed to be used in karri forest to provide structural complexity and landscape heterogeneity in forest areas isolated within an agricultural landscape and other situations where the surrounding area does not provide for connectivity of forest habitat. The use and extent of temporary exclusion areas will be informed by the landscape context.

Some senescent trees are proposed to be retained in the karri forest in both clearfell and thinning operations to enhance structural complexity. Depending on the stand structure, the trees will be retained as single trees or groups with associated vegetation. The retention of coarse woody debris in the karri forest is proposed to be enhanced by requiring that some of the large logs be excluded from heaping and burning operations in karri forest.

The retention of a portion of the available standing dead trees for habitat and structure is proposed to be introduced, where it is safe to do so. It is proposed that standing dead trees can also be retained in habitat groups, and must be retained in areas where sawlogs are salvaged after fire to maintain structural complexity.

Thinning
The use of thinning to promote structural complexity is also proposed. This technique referred to as ‗variable density thinning', will be used to create complexity in large areas of uniform regeneration in the karri forest.

Wandoo

Background
Wandoo forest within the area of this plan generally occurs on the eastern periphery of the jarrah forest. It occurs as open forest and woodland associated with an open herbaceous or grassy understorey.

Wandoo regenerates from seed and, like jarrah, develops a lignotuber which may take a number of years to develop to a stage that is capable of dynamic growth into a sapling. The use of fire to establish ashbed for the effective establishment of seedlings is critical for regeneration. Ashbed is created where the crowns or boles of fallen trees are burnt away. Due to the close association with ashbed, regeneration tends to occur in clumps, which in turn leads towards an uneven-aged forest structure.

Following release from the lignotuber stage of development, wandoo is very sensitive to damage from fire. Any applied fire needs to ensure that this sensitivity is taken into account.

Proposed changes to wandoo silviculture guideline

The main changes proposed to the wandoo silviculture guideline are as follows.

Increased emphasis on habitat
It is proposed that requirements for the retention of coarse woody debris and habitat trees and habitat logs be increased. Where practicable, additional mature marri with a high likelihood of containing hollows are proposed to be retained in LMUs where the abundance of marri is considered to be relatively low. Recruitment of marri in these areas is also proposed to be encouraged through retention of vigorous marri with potential to produce seed and replace existing habitat trees.

Additional retention is proposed for large logs, logs with hollows suitable as refuge for ground dwelling fauna, stumps and other features which provide underground cavities. Additional log retention is proposed to be required in areas known to support threatened fauna that depend on ground habitat. Nests of sensitive fauna species that are identified during pre-harvest checks or observed on-site will be retained and protected from damage. Patches of standing dead trees in severely fire damaged stands will be retained to contribute to structural complexity.

Seedbed preparation
It is proposed that the rationale for the use of soil disturbance for seedbed preparation or reduction of native plants as competition be clarified by additional strategies and be developed into post-harvest treatment requirements as part of a silviculture manual.

Fire management
The planning process for prescribed burns in juvenile stands will include an assessment of the stocking of saplings that will withstand mild intensity fire. Forest areas adjacent to fire sensitive regeneration will be burnt where possible, to reduce the likelihood of high intensity bushfire in regrowth wandoo stands.

APPENDIX 15

Scope for content of catchment management plans

Objective of a catchment management plan

The objective of a catchment management plan is to identify and manage the risks associated with applying silvicultural treatments for water production.

The place of a catchment management plan in the planning hierarchy

A catchment management plan is a strategic level plan that is intended to apply for a defined period, which will identify the longer-term risks and the strategies to address these in the application of silvicultural treatments for water production. The shorter-term risks and the tactics to address these will be prescribed in lower level planning processes such as the planning checklist for disturbance activities. Any activity requiring the removal and sale of forest products will need to be included in indicative harvest plans prepared by the Department (three year) and the FPC (annual), and approved accordingly.

In the hierarchy of the Department's planning documents, catchment management plans sit between the FMP and the three-year indicative harvest plan. Catchment management plans may specify operational requirements to be addressed in the Department's planning checklist for disturbance activities, and will be supported by a number of the Department's manuals, procedures and forms.

Responsibilities

Catchment management plans will be prepared by the proponent and will require approval by the Department's Director General, who will consult with the Conservation Commission and Department of Water, and where applicable, the Water Corporation. Approved catchment management plans will be made publicly available.

Context

The catchment management plan seeks to identify the catchment scale and longer-term risks associated with extent, intensity, sequencing of operations and return cycles not addressed in the planning checklist for disturbance activities. With catchment-scale management for water production, the proportion of the catchment treated and the intensity of that treatment may be (by design) greater than that which would occur as a result of normal timber harvesting. There may also be considerations related to the timing of operations, associated follow-up treatments and return cycles.

Importantly, the catchment management plan is also the mechanism by which the proponent defines the proposed type and sequencing of operations at the whole of catchment scale, and outlines the expected end point of the treatments, together with the agreed measures that will be taken to manage the identified risks and monitor performance.

Proposed content of catchment management plans

Part A: Core elements of treatment

- location of treated areas, untreated areas including reserved areas
- identification of the type and intensity of treatments (for example, timber harvest, post-harvest silvicultural treatments, coppice or regrowth control, prescribed fire) with reference to the relevant guidance documents

- identification of the timing of treatments (by sub-catchment, hillslope or treatment area)
- identification of the period of, and nature of, commitment by the proponent
- indication of return cycles of treatment (for example, timber harvest, post-harvest silvicultural treatments, coppice or regrowth control, prescribed fire)
- description of the types of machinery or equipment to be used (by operation type, soil type or season), and the use of pesticides.

Parts B and C: Risk assessment of proposed treatment and operational controls to address significant risks

Assessment of the risk to forest values associated with the treatment specified in Part A. Specific areas to consider and/or activities required, where applicable, include:

ESFM category	Part B Value – area of risk	Part C – operational controls to address significant risks to forest values
Biological diversity	• habitat legacy elements • overstorey structure, composition and density • understorey structure, composition and density • threatened and priority taxa and ecological communities • taxa sensitive to disturbance • water dependent ecosystems and biota	• specifications for any additional habitat retention (if outside normal requirements) • review adequacy of formal and informal reserves in combination with untreated areas at a landscape scale and adjust if necessary
Ecosystem health and vitality	• disease, particularly *Phytophthora* dieback. • fuel loads, fire risk and fire regimes • community fire protection	• specification of road network to be used, access or other operational restrictions (a hygiene management plan will be required) • prescribed limits to the extent of operations that disturb understorey • management of prescribed fire to retain understory mosaic where possible • management of fuel loads around community infrastructure by prescribed fire or mechanical fuel modification
Soil and water	• soil disturbance • water quantity, in particular the proportion of the catchment by stages of stand development over the next 100 years and potential effects on water quantity (streamflow, soil moisture and groundwater)	• management of machine size or access restrictions in relation to moisture, soil type or slope • design criteria for surface water management structures (e.g. type and return interval)

ESFM category	Part B Value – area of risk	Part C – operational controls to address significant risks to forest values
Soil and water (cont.)	• expected additional water supply for human use • turbidity • stream salinity • contamination from pesticides	• specifications for location and management of the road network to be utilised • monitoring of strategic bores and streams • prescribed controls for use of pesticides • establishment of limits on proportion of the forest in the catchment being in the juvenile and immature stages of development
Carbon cycles	• implications for carbon stocks	• ensure silviculture guidance considers impact on carbon stocks and the use of wood products that maximises greenhouse mitigation benefits is encouraged
Productive capacity	• implications for sustained yields and flow of wood products from native forest • management of rehabilitated areas, exotic species and plantations	Where wood production is proposed: • ensure that there is effective and timely consultation with the FPC for all potential production contracts • ensure that the FPC is consulted regarding all potential products • ensure that production is within allowable cut and haul distance to processing centres is considered
Heritage	• Aboriginal heritage	• ensure appropriate consultation with relevant Aboriginal groups
Socio-economic benefits	• interaction of mining / non-mining disturbances • visual amenity • recreation	• visual landscape management requirements, including the management of impacts on tracks and trails • provision of community information / education

Part D: Community notification and information

Outline the types and frequency of community consultation and information, addressing the following critical periods:

(a) prior to catchment management operations commencing
(b) during key stages
(c) at completion.

Acronyms

AS/NZS ISO 14001	Standards Australia, 2004. AS/NZS ISO 14001:2004. *Environmental Management Systems - Requirements with Guidance for Use*
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BRM	Basic raw materials
CALM	Conservation and Land Management
CALM Act	*Conservation and Land Management Act 1984*
CAR	Comprehensive, adequate and representative – as applied to the conservation reserve system
CoE	Clean on Entry point to a (dieback) protectable area or road section
CP	Conservation park
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Environment and Conservation
DMP	Department of Mines and Petroleum
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986*
EPBC Act	(Commonwealth) *Environment Protection and Biodiversity Conservation Act 1999*
ESFM	Ecologically sustainable forest management
FCA	Forest conservation area
FHZ	Fauna habitat zone
FMP	Forest Management Plan
FPC	Forest Products Commission
GHG	Greenhouse gas
IBRA	Interim Biogeographic Regionalisation for Australia
ICOMOS	The International Council on Monuments and Sites
IOCI	Indian Ocean Climate Initiative
JANIS	The Commonwealth and the States agreed to what is known as the JANIS process (Commonwealth of Australia 1997), regarding the objectives for a CAR forest reserve system, as used in the RFA process
KPI	Key performance indicator
LAI	Leaf area index
LMU	Landscape management unit (see Appendix 1)
MAR	Mean average rainfall
NCAS	National Carbon Accounting System
NP	National park

NR	Nature reserve
NRS	National Reserve System
PER	Public Environmental Review
Ramsar	The Ramsar Convention, The Convention on Wetlands (Ramsar, Iran, 1971)
RFA	Regional Forest Agreement
SILREC	The Department's silvicultural treatments records system for native forests
TEC	Threatened ecological community
TR	Timber reserve
UCL	Unallocated Crown land
UNFCCC	United Nations Framework Convention for Climate Change
WA	Western Australia
WC Act	*Wildlife Conservation Act 1950*
WRC	Water and Rivers Commission

Glossary

Adaptive management	A process of responding positively to change. The term adaptive management is used to describe an approach to managing complex natural systems that builds on common sense and learning from experience, experimenting, monitoring, and adjusting practices based on what was learned.
Allowable cut	The maximum volume of a particular native forest log type that can be harvested during the period of the next FMP.
Basal area	The sum of the cross-sectional areas of trees in a given stand measured at 1.3 metres above the ground. It is usually expressed as square metres per hectare.
Biological diversity (Biodiversity) (described in CALM Act)	The variability among living biological entities and the ecosystems and ecological complexes of which those entities are a part and includes: (a) diversity within native species and between native species; (b) diversity of ecosystems; and (c) diversity of other biodiversity components.
Biological diversity component (described in CALM Act)	Includes habitats, ecological communities, genes and ecological processes.
Bioprospecting	The removal or use of biological and genetic resources of any organism or other organic substance for scientific research or commercial development.
Bole	The tree trunk from the ground to the crown break. The bole does not include the major branches supporting the crown.
Burra charter	The Australia ICOMOS charter for the conservation of places of cultural significance.
Catchment	The land area drained by a single stream, river, or drainage network.
Clean on Entry	A requirement at a defined, signposted point nominated in a Hygiene Management Plan that requires entering machinery and vehicles (typically) to be free of soil, plant and other material, to minimise the risk of spreading weeds, pests and diseases.

Clearfell	A silvicultural method in which all, or nearly all, trees in a defined area are removed at one time to allow regeneration to establish and develop as an even-aged stand.
Coarse woody debris	Dead woody material such as boles and branches on the ground or in streams.
Conservation dependent taxa	Taxa that are the focus of a continuing taxon-specific or habitat-specific program, the cessation of which would result in the taxon qualifying for one of the threatened categories within a period of five years. See Appendix 13.
Contract of Sale	A contract between the FPC and a buyer for the sale of forest products in accordance with the Forest Products Act, Forest Management Regulations 1993 and relevant policies and guidelines.
Coppice	A shoot (or shoots) arising from adventitious buds at the base of a woody plant that has been cut near the ground or burnt back.
Coupe	An area of forest that is planned for timber harvesting as a single unit. It may contain more than one silvicultural objective, such as a number of discrete gaps and areas of thinning.
Criterion	A category, condition or processes by which sustainable forest management may be assessed.
Culling	The reduction in the density of unwanted vegetation, usually to reduce competition to retained crop trees or for establishing or releasing regeneration.
Current FMP	The *Forest Management Plan 2004–2013* currently in force.
Critically endangered	A taxon is critically endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
Department, or the Department	The Western Australian Department of Environment and Conservation.
Dieback (*Phytophthora* dieback)	In the south-west of Western Australia a disease of plants caused by infection by the soil-borne organisms of the genus *Phytophthora*, of which *P. cinnamomi* is the most widespread.

Disturbance	Any relatively discrete event in time that disrupts ecosystems, communities, or population structure and changes resource availability or the physical environment. Disturbance may be natural (e.g. lightning caused fire) or human induced (e.g. timber harvesting).
Draft FMP, or Draft plan	The *Draft Forest Management Plan 2014-2023* as released by the Conservation Commission for public consultation.
Ecological community	An integrated assemblage of species that inhabit a particular area.
Ecologically sustainable forest management	Forest management and use consistent with the principles described in section 19(2) of the CALM Act.
Ecosystem	A community or an assemblage of communities of organisms, interacting with one another and the environment in which they live.
Ecotone	An ecological transition zone, often characterised by a shift to a different plant communities.
Endangered	A taxon is endangered when it is not critically endangered but is facing a very high risk of extinction in the near future.
Endemic	Flora or fauna that is confined in its natural occurrence to a particular region.
Environmental Management System (EMS)	A framework for the systematic management of an organisation‘s environmental obligations and objectives. Many organisations are certified as having an EMS that conforms to the AS/NZS ISO 14001 standard.
Evapotranspiration	Loss of water from an area of land through the transpiration of plants and evaporation from the soil.
Even-aged stand	A forest stand dominated by trees of a similar age. In native forests, this includes stands where the non-dominant age classes comprise less than 15 per cent crown cover.
Exotic species	Any species growing or living outside its natural range of occurrence. Normally this refers to species purposely or accidentally introduced into countries or regions where they do not historically occur.

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. With respect to the WC Act (Section 6), fauna is: (a) any animal indigenous to any State or Territory of the Commonwealth or the territorial waters of the Commonwealth; (b) any animal that periodically migrates to and lives in any State or Territory of the Commonwealth or the territorial waters of the Commonwealth; and (c) any animal declared as fauna pursuant to subsection (2), and includes in relation to any such animal – (d) any class or individual member thereof; (e) the eggs, larvae or semen; (f) the carcass, skin, plumage or fur thereof, but does not include any prescribed animal or prescribed class of animal.
Fauna Distribution Information System	Departmental database of taxonomy, conservation status of fauna species and advice on management practices.
Feral animal	An introduced or domestic animal now living in the wild.
First and second grade sawlog jarrah	A log cut from the bole of a jarrah tree that is a minimum of 2.1 metres in length, has a minimum under bark diameter of 200 millimetres and has a minimum of 30 per cent millable timber on the worst end face.
First and second grade sawlog karri	A log cut from the bole of a karri tree that is a minimum of 2.4 metres in length, has a minimum under bark diameter of 200 millimetres and has a minimum of 30 per cent millable timber on the worst end face.
Fire regime	The history of fire use in a particular vegetation type or area including the frequency, intensity, season and scale of burning over a period of time. It may also refer to proposals for use of fire.
Flora	The plants growing in an area; including flowering and non-flowering plants, ferns, mosses, lichens, algae and fungi. Usually restricted to species occurring naturally and excluding weeds. With respect to the WC Act (Section 6), flora is any plant (including any wildflower, palm, shrub, tree, fern, creeper or vine) which is: (a) native to the State or (b) declared to be flora pursuant to subsection (4), and includes any part of flora and all seeds and spores thereof.

Floristic	Of or relating to flowers, a flora, or the biogeographical study of plants.
Forest	An area, incorporating all living and non-living components, that is dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding two metres and with existing or potential crown cover of overstorey strata about equal to or greater than 20 per cent.
Forest block	A named administrative subdivision of the forest, varying in size from about 3,000 to 8,000 hectares.
FORESTCHECK	An integrated monitoring project, designed to provide information about changes and trends in biodiversity.
Forest ecosystem	An indigenous ecosystem with an overstorey of trees of more than 20 per cent crown cover. These ecosystems should normally be discriminated at a resolution requiring a map-standard scale of 1:100,000. Preferably these units should be defined in terms of floristic composition in combination with substrate and position within the landscape.
Forest produce	For the purposes of the CALM Act, ‗forest produce' includes trees, parts of trees, timber, sawdust, chips, firewood, charcoal, gum, kino, resin, sap, honey, seed, bees-wax, rocks, stone and soil but, subject to the foregoing, does not in Division 1 of Part VIII include minerals within the meaning of the Mining Act.
Forest products	As for the purposes of both the CALM Act and the Forest Products Act: (1) Subject to subsection (2) trees or parts of trees; timber, sawdust or chips; charcoal, gum, resin, kino or sap; and firewood. If they are located on public land or sharefarmed land. (2) When something referred to in subsection (1) has been removed under contract or arrangement entered into by the Commission, any residues that remain are not forest products for the purposes of this (Forest Products Act) Act.
Forest products industry	For the purposes of this plan, the wood products industry and upstream in-forest operations, including timber harvesting and log haulage.
Forest regeneration	The renewal of a forest arising from planting or from seed or the young plants on a site. The process by which a forest is renewed.

Formal reserve	See ‗Reserve – Formal'.
Gap	A discrete opening in the overstorey canopy that reduces competition and allows seedlings to become established and/or develop.
Global carbon cycles	The carbon cycle is the biogeochemical cycle by which carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the Earth.
Ground coppice	A growth stage where the lignotuber and root system have grown to the point that if surrounding competition is sufficiently reduced, the plant is capable of dynamic growth into a sapling. In jarrah, the lignotuber may be between five and 10 centimetres in diameter and the plant may take 20 years to reach this development stage under native forest conditions.
Group selection	The removal or retention of trees in relatively small groups with the object of creating a gap or retaining a group of younger trees to grow on. While there is no specific size of the group, it is generally considered to be of a size below which the edge effects dominate.
Guideline	A document type that guides and directs actions for achieving consistency and required standards. Guidelines permit some flexibility in their application.
Habitat	A component of an ecosystem providing food and shelter to a particular organism.
Heritage	Something inherited from past generations that is valued.
High salt risk	Refers to certain river systems within the historic intermediate rainfall zone (based on data up to 1978) that are least disturbed and as such, presumed to have the most intact aquatic ecosystems and consequently are the most environmentally sensitive to rises in saline groundwater.
Hygiene (in relation to dieback)	Actions that decrease the risk of the pathogen being introduced, spread or its impact intensified.
Hygiene management plan	The document including action(s) and map(s) that describes and controls how approved human access to uninfested protectable areas is to be managed, so that the role of human activity as a vector for establishing new centres of infestation is minimised.

Immature stand	The stand development stage beginning with the main lateral spread of tree crowns and finishing with the start of a mature stand.
Informal reserve	See ‗Reserve – Informal'.
Indicator	A measure (measurement) of an aspect of a criterion. A quantitative or qualitative variable that can be measured or described and that, when observed periodically, may demonstrate trends.
Land category	Section 5 of the CALM Act specifies the categories of land to which the Act applies and section 6 defines those land categories. For the purposes of the plan the land categories are: State forest, timber reserves, national parks, conservation parks, nature reserves, any other land reserved under the Land Act and vested by order under that Act in the Conservation Commission and any other land other than excluded waters, reserved under Part 4 of the Land Administration Act, the care control and management of which are placed by order under that Part with the Conservation Commission.
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 Management Unit	An agglomeration of vegetation complexes and ecological vegetation systems, as defined and mapped by Mattiske and Havel (2002), to form more compact management units that recognise the underlying ecological characteristics. See Appendix 1.
Landscape scale	A mosaic where the mix of local ecosystems and landforms is repeated in a similar form over a kilometres-wide area. Several attributes including geology, soil types, vegetation types, local flora and fauna, climate and natural disturbance regimes tend to be similar and repeated across the whole area. It could be a (sub) catchment or, for convenience, an administrative management unit such as a forest block or an aggregation of forest blocks. Landscape scale is usually tens of thousands to a few thousand hectares.
Leaf area index	Index of the one-sided green leaf area per unit ground surface area in broadleaf canopies.
Lignotuber	A woody swelling formed at the base of some eucalypts that has the ability to produce new shoots when the existing ones are destroyed.

Local scale	A discrete area of land to which one or more operations have been or are planned to be applied.
Mature stand	The stand development stage beginning with the formation of large persistent branches forming the outline of the crown as the crown reaches its maximum size, and finishing with the commencement of a senescent stand.
Minor Production Contract	An FPC Contract of Sale for a small one-off quantity of forest products (other than standing trees) under cash pre-paid arrangements.
Monitoring	A process of repeated measurement or observation, for specified purposes of one or more elements, usually according to prearranged schedules in space and time, using comparable data collection methods. Often used to assess a management program, condition of the environment and/or resources being managed, to help determine if desired activities, processes, outputs and outcomes are being achieved.
Montréal Process	An agreed on framework of criteria and indicators that provide member countries with a common definition of what characterises sustainable management of temperate and boreal forests.
Next FMP (2014–2023), or next FMP	The Forest Management Plan approved by the Minister for Environment to begin operation on 1 January 2014 for a period of 10 years (2014-2023).
Non-bole log	Wood from the branches of a tree above the crown break. The non-bole material in mature trees is not included in inventory and is additional to the sustained yield.
Old-growth forest	Ecologically mature forest where the effects of unnatural disturbance are now negligible. The definition focuses on forest in which the upper stratum or overstorey is in a late mature to senescent growth stage.
Other bole volume	Bole log products not meeting first or second grade sawlog standards.
Other exotics	Areas of exotic species including mine site rehabilitation, (about 3,200 hectares) and certain arboreta and trial plots (about 390 hectares). See ‗Plantations' and Map 5.

Patch	A group of trees resulting from a natural regeneration event or a past management activity such as gap creation and regeneration. May also refer to a particular, relatively small area of forest and/or other vegetation type(s).
Performance measure	Qualitative or quantitative measures developed to assess progress toward attainment of an objective.
Pest	Troublesome or destructive animals including insects, either introduced or native.
Pesticides	Includes herbicides, insecticides, fungicides and related products registered for use in pest control.
Phytophthora cinnamomi*, or *P. cinnamomi	Water mould. The pathogen that causes most *Phytophthora* dieback disease.
Plantation	State forest and timber reserve planted with exotic species being predominantly pine and not including areas of ‗Other exotics'. See ‗Other exotics' and Map 5.
Policy	A document containing principles and rules that outline an organisation's position and which guides decisions and actions taken in the conduct of its activities.
Prescribed burning	The controlled application of fire under specified environmental conditions to a predetermined area and at the time, intensity and rate of spread required to attain planned resource management objectives.
Proposed FMP	The Forest Management Plan 2014-2023 as forwarded to the EPA for assessment following modification (of the Draft FMP) as a result of the public consultation process.
Protectable area	Defines areas of land managed by the Department over which hygiene management rules for the plant pathogen *Phytophthora*, including clean on entry, will apply. These areas are generally free of disease.
Rare species	Taxa which are uncommon, not widely distributed, or occurring sparsely across their range.
Recovery plan	A plan that describes the actions required to achieve the recovery of threatened species or ecological community from the current threat of extinction or destruction. May be an Interim Recovery Plan when insufficient information is available to prepare a full recovery plan.

Regrowth forest	Native forest which is dominated by similar aged stems that have not reached the mature growth stage, originating from previous harvest events, such as gap creation, or other disturbances, such as bushfire.
Rehabilitation	The process necessary to return disturbed land to a predetermined surface, vegetational cover, land-use or productivity.
Reserve – conservation	An area set aside primarily for the conservation of natural ecosystems but which may allow a level of recreation consistent with the proper maintenance and restoration of the natural environment.
Reserve – formal	One of the land category categories of national park, nature reserve, conservation park, or CALM Act sections 5(1)(g) or 5(1)(h) reserves for the purpose of conservation.
Reserve – informal	An area set aside for conservation under an approved management plan; has had opportunity for the public to comment on changes to reserve boundaries; able to be accurately defined on a map; and is of an area and design sufficient to sustain the values it seeks to protect. See Appendix 11.
Reservoir Protection Zones	Areas around reservoirs and bores that act to control land or water based activities to protect water quality, as established by the Department of Water.
Resilience	The capacity of an ecosystem to withstand external pressures and, over time, return to its prior condition, including its ability to maintain its essential characteristics such as taxonomic composition, structural forms, ecosystem functions and processes (adapted from Thompson *et al*, 2009, who cite Holling 1973).
Riparian	Pertaining to the banks of streams, rivers or lakes.
Rotation	The period between regeneration establishment and the final harvest.
Salt sensitivity zone	The Swan and South West regions and parts of the Warren Region are classified as low salt sensitivity and other parts of the Warren Region are classified as moderate salt sensitivity (see Map 8).
Seed tree	1. A tree left standing for the purpose of providing seed for regeneration. 2. A silvicultural method in which trees are retained to provide seed for natural regeneration.

Senescent stand	The development stage that follows the mature stand and precedes natural death, usually involving a decreased ability to repair damage and degradation. Characterised by a dominance of dead branches in the tree crown, together with the formation of new branches from dormant buds.
Shelterwood	A jarrah silvicultural treatment that involves a partial reduction in the density of overstorey trees and action to establish regeneration under the remaining mature trees.
Silviculture	The theory and practice (silvicultural practices) of managing the establishment, composition, health, quality and growth of forests and woodlands to achieve specified management objectives.
Silviculture for ecosystem health	The development and application of silvicultural practices to provide for ecosystem health.
Silviculture for water production	The development and application of silvicultural practices to provide for water production.
Single tree selection	A silvicultural method where trees from a range of size classes are removed throughout the stand to promote growth of remaining trees.
Specially protected	Those species declared under the WC Act to be specially protected because they are deemed by the Minister to be likely to become extinct or are rare or otherwise in need of special protection.
Stand	A group of trees or patch of forest that can be distinguished from other groups on the basis of size, age, species composition, structural condition or other attribute.
Structure	When applied to a forest, is the horizontal and vertical distribution of the alive and dead vegetation.
Subsequent FMP	The Forest Management Plan 2024 – 2033.
Sustained yield, or Sustained timber yield	For the purpose of this plan, the first and second grade sawlog yield that a forest can produce for an extended period (to at least the year 2070) at a given intensity of management.
Taxa (taxon)	A defined unit (for example, species or genus) in the classification of plants and animals.

Thinning	A felling made to reduce the density of trees within a stand. Usually undertaken to improve the growth of trees that remain by reducing competition, without either permanently breaking the canopy or encouraging regeneration. May also be undertaken to enhance forest health, water production or achieve another objective.
Threatened and priority ecological community	Threatened species and communities are those under risk of extinction. Priority species and communities are those that may be threatened but for which there are insufficient survey data, and those that are rare but not threatened. Some of these and/or others may also be listed under the EPBC Act. Also see Appendix 13.
Threatened taxa	Taxa that are endorsed by the Minister as being specially protected under the WC Act because they are likely to become extinct or are rare, and are ranked as either vulnerable, endangered, critically endangered or presumed extinct. Threatened taxa may be at risk due to being naturally rare or geographically restricted, or have become so as a result of human activities, and are in danger of declining further, or becoming extinct, unless adverse factors acting on them can be identified and ameliorated.
Threatening process	Those processes which may result in the long-term reduction of biodiversity. Examples include predation and habitat change by introduced animals; competition and displacement by introduced plants and destruction and modification of habitat.
Timber	Sawn or other products derived from first and second grade jarrah and karri sawlogs.
Timber harvesting	The cutting, felling, and gathering of forest products undertaken as part of a planned sequence of silvicultural activities including the regeneration of the forest.
Treemarking	The procedure in which trees are marked for retention (or removal) prior to timber harvesting or other operations in a forest.
Turbidity	Discolouration of water due to suspended solids, chemicals or organic matter.

Two-tiered forest	Native forest stands of mixed age and structure, comprising mature trees intermixed with younger regrowth trees arising from regeneration following the death or removal of mature trees by previous harvests or other disturbances. Also referred to as ‗mixed age forest' or ‗uneven-aged forest'.
Uneven-aged stand	A stand of trees composed of three or more age classes, either intimately mixed or in small groups.
Vegetation complex	A combination of distinct site vegetation types, usually associated with a particular geomorphic, climatic, floristic and vegetation structural association.
Variable density thinning	Type of thinning used to introduce structural complexity into even-aged regrowth stands by, for example, leaving unthinned patches, retaining older trees and understorey elements, creating small gaps and varying the spacing of trees in thinned areas. In stands containing a range of size classes it can also be used to vary the spacing of trees and the retained basal area in response to variations in trees sizes.
Vulnerable taxa	A taxon is vulnerable when not critically endangered or endangered, but facing a high risk of extinction in the wild in the medium term.
Weed	A plant, often a self-sown exotic, growing where it is not wanted.
Weed – environmental	A naturalised non-indigenous plant species outside the agricultural context that adversely affects the health, survival or regeneration of indigenous species in natural vegetation communities.
Whole of forest scale	All land categories that are subject to the plan.
Wood	The material produced in the stems and branches of trees and other woody plants.
Woodflows	Projected supply of wood products arising from scheduling the area of forest available and the sequence of harvesting operations over an extended period of time.
Wood products	All timber and other wood products, inclusive of sawlogs, firewood, chiplogs and other log products supplied to the wood products industry.

Wood products industry	All sectors of the wood products industry, including sawmilling, poles and bridge timbers, engineered wood products, furniture, joinery, flooring and residue industries.
Woodstock™	Proprietary forest management planning software.
Yield	The amount of product produced from the forest by a particular management strategy.
Yield regulation	The process by which the yield of any product is controlled to achieve the stipulated levels in a management plan.

References

Abbott, I. and Williams, M.R., (2011). *Silvicultural impacts in jarrah forest of Western Australia: synthesis, evaluation and policy implications of the FORESTCHECK monitoring project of 2001 – 2006.* Australian Forestry 2011, Vol 74 (4), pp 350-360.

ABARES (2011). *Potential effects of climate change on forest and forestry; summary for south-western Western Australia*. Australian Bureau of Agriculture & Resource Economics & Sciences, Canberra, Australia.

ABS (2011). *Population Projections, Australia, 2006 to 2101*. Australian Bureau of Statistics, Canberra [http://www.abs.gov.au/ausstats/abs@.nsf/mf/3222.0]

Adams M.A., and Attiwill, P.M., (2011). *Burning issues: sustainability and management of Australia's southern forests*. The Bushfire CRC, CSIRO Publishing.

Adams, M.A., Grierson, P.F., and Burrows, C. (2003). *Fire, soils and plant nutrition in forests of south-west Western Australia: a focus on spatial and temporal variability*. In: *Fire in Ecosystems of South-west Western Australia: Impacts and Management*, Abbott I, and Burrows N, eds. Leiden: Backhuys Publishers, pp 189-203.

Allen, D. Macalady A.K., Chenchouni, H., Bachelet, D., Nate McDowell, B.D., Vennetier. M., Kitzberger, T, Rigling. A., Breshears, D.D., Hogg, E.H., Gonzalez, P., Fensham, R., Zhangm, Z., Castro, J., Demidova, N., Lim, J.H., Allard, G., Running, S.W., Semerci, A., and Cobb, N. (2010). *A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests*. Forest Ecology and Management 259 (4), pp 660–684.

Australia ICOMOS (1999). *The Burra Charter: The Australian ICOMOS charter for the conservation of places of cultural significance.* Australia ICOMOS (International Council on Monuments and Sites), Burra, South Australia.

Australian Roads Research Board (2009). *Unsealed Roads Manual – Guidelines to Good Practice.* Melbourne, Victoria.

Bates B.C., Hope P., Ryan B., Smith I., and Charles, S. (2008). *Key findings from the Indian Ocean Climate Initiative and their impact on policy development in Australia*. Climatic Change, Issue 89: pp 339-354

Beard, J.S. (1979a). *Vegetation Survey of Western Australia: The Vegetation of the Perth Area.* Vegemap Publications. Perth

Beard, J.S. (1979b). *Vegetation Survey of Western Australia: The Vegetation of the Pinjarra Area.* Vegemap Publications. Perth.

Beard, J.S. (1979c). *Phytogeographic regions.* In: *Western Landscapes*. (Ed. J. Gentilli). The University of Western Australia, Nedlands.

Berry, S., Keith, H., Mackey, B., Brookhouse, M., and Jonson, J. (2010). *Green carbon: the role of natural forests in carbon storage Part 2. Biomass carbon stocks in the Great Western Woodlands*. ANU E Pres.

Boer, M.M., Sadler, R. J., Wittkuhn, R.S., McCaw, L., and Grierson, P.F. (2009). *Long-term impacts of prescribed burning on regional extent and incidence of wildfires – eevidence from 50 years of active fire management in SW Australian forests.* Forest Ecology and Management 259, pp 132-142

Bradshaw, F.J. and Mattiske, E.M. (1997). *Forest Ecosystem mapping for the Western Australian RFA*. Report to the Steering Committee for the Regional Forest Agreement in Western Australia.

Bradshaw, F.J., Collins, P.M. and McNamara, P.J. (1997). *Forest Mapping in the South-west of Western Australia*. Department of Conservation and Land Management, Perth.

Bradstock. R, Boer, M., Cary, G., Price, O., Williams, R., Barrett, D., Cook, G., Gill, A.M., Hutley, L., Keith, H., Maier, S., Meyer, M., Roxburgh, S., and Russell-Smith, J. (in press). *Modelling the potential for prescribed burning to mitigate carbon emissions from wildfires in fire-prone forests of Australia.* International Journal of Wildland Fire 2012 (http://dx.doi.org/10.1071/WF11023). CSIRO Publishing.

British Columbia Ministry of Forests (2005). *Definitions of adaptive management*. At http://www.for.gov.bc.ca/hfp/archives/amhome/AMDEFS.HTM, accessed July 2012.

Burrows, N., Dell, B., Neyland, M. and Ruprecht, J. (2011). *Review of Silviculture in Forests of south-west Western Australia*. Report to Department of Environment and Conservation.

Canadell, J.G., and Raupach M.R., (2008). *Managing forests for climate change mitigation*. Science, Vol 320, 13 June, pp 1456-1457, www.sciencemag.com American Association for the Advancement of Science, 1200 New York Avenue NW, Washington DC, USA.

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*. Sustainable Tourism Cooperative Research Centre Campus Griffith University, Gold Coast, Australia.

Christensen, P.E.S., Liddelow, G. and Hearn, R. (2001). *Fauna Assessment in Timber Harvesting Coupes in Western Australia*. Unpublished report. Department of Conservation and Land Management, WA.

Climate Commission (2011a). *The Critical Decade: Western Australia climate change impacts*. Commonwealth of Australia, Department of Climate Change and Energy Efficiency, Canberra, Australia. Available at: http://climatecommission.gov.au/wp-content/uploads/4259-CC-WA-Key-Messages-4.2-Web.pdf

Climate Commission. (2011b). *The Critical Decade: Tasmanian impacts and opportunities*. Commonwealth of Australia, Department of Climate Change and Energy Efficiency, Canberra, Australia. Available at: http://climatecommission.gov.au/wp-content/uploads/Tasmanian-impacts-report_web.pdf

Committee on National Parks and Protected Area Management, (2002) *A Review of Current Approaches to Performance Measurement in Protected Area Management.* Queensland Parks and Wildlife Service, Brisbane, Queensland, Australia.

Commonwealth of Australia (1996). *The National Strategy for the Conservation of Australia's Biological Diversity*. Commonwealth Department of the Environment, Sport and Territories.

Commonwealth of Australia (1997). *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve (CAR) System for Forests in Australia*. A Report by the Joint ANZECC/MCFFA National Forest policy Statement Implementation Sub-Committee. Australian Government Publishing Service, Canberra.

Commonwealth of Australia (1999). *Australian Guidelines for Establishing the National Reserve System*. Environment Australia, Canberra.

Commonwealth of Australia (2004). *National Biodiversity and Climate Change Action Plan 2004-2007*. Natural Resource Management Ministerial Council, Department of the Environment and Heritage, Canberra.

Commonwealth of Australia (2010a). *Australia's Biodiversity Conservation Strategy 2010-2030.* Natural Resource Management Ministerial Council, Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Commonwealth of Australia (2010b). *Australia's Strategy for the National Reserve System 2009-2030*. Environment Australia, Canberra.

Commonwealth of Australia and the State of Western Australia (1999). *Regional Forest Agreement for the South-West Forest region of Western Australia*. Commonwealth and Western Australian Regional Forest Agreement Steering Committee, Canberra.

Conservation Commission of Western Australia (2004). *Forest Management Plan 2004-2013*. Perth, Western Australia.

Conservation Commission of Western Australia (2008a). *Walpole Wilderness Management Plan*. Conservation Commission of Western Australia Perth, Australia

Conservation Commission of Western Australia (2008b). *Forest Management Plan 2004-2013 mid-term audit of performance report*. Perth, Western Australia.

Conservation Commission of Western Australia (2010). *Performance assessment of Phytophthora dieback management on lands vested in the Conservation Commission of Western Australia*. Perth, Western Australia.

Conservation Commission of Western Australia (2012). *Forest Management Plan 2004-2013 end-term audit of performance report.* Perth, Western Australia.

CSIRO (2007). *Climate Change in Australia – Technical Report 2007.* CSIRO Bureau of Meteorology, Melbourne, Victoria.

CSIRO (2009). *Water yields and demands in south-west Western Australia. A report to the Australian Government from the CSIRO South-West Western Australia Sustainable Yields Project.* CSIRO Water for a Healthy Country Flagship, Australia.

DAFWA (2007). *Code of Practice for the use of Agricultural and Veterinary Chemicals in Western Australia*. Bulletin 4648, WA Department of Agriculture and Food, Perth, Australia.

Dare, M. and Schirmer, J. (2012). *Western Australia Forest Industry Survey.* Unpublished data CRC for Forestry, Hobart.

Department of Climate Change and Energy Efficiency (2011). *Overview of the report - Interactions between climate change, fire regimes and biodiversity in Australia: A preliminary assessment*. Australian Government Department of Climate Change and Energy Efficiency. www.climatechange.gov.au

Department of Environment and Conservation (2011). *Invasive Plant Prioritisation Process*. Department of Environment and Conservation. Perth, Australia.

Department of Environment and Conservation (2007). *A Strategic Plan for Biodiversity Conservation Research 2008 – 2017*, Department of Environment and Conservation. Perth, Australia.

Department of Environment and Conservation (2009a). *Guidelines for Protection of the Values of Informal Reserves and Fauna Habitat Zones*. Department of Environment and Conservation, Perth, Australia.

Department of Environment and Conservation (2009b). *Soil and Water Conservation Guideline*. Department of Environment and Conservation, Perth, Australia.

Department of Environment and Conservation (2009c). *Manual for the Management of Surface Water*. Department of Environment and Conservation, Perth, Australia.

Department of Environment and Conservation (2009d). *Biodiversity Conservation Appraisal System*. Department of Environment and Conservation, Perth, Australia.

Department of Environment and Conservation (2010a). *Guideline for the Selection of Fauna Habitat Zones*. Department of Environment and Conservation, Perth, Australia.

Department of Environment and Conservation (2010b). *Manual of Procedures for the Management of Soils Associated with Timber Harvesting in Native Forests*. Department of Environment and Conservation, Perth, Australia.

Dunlop, M., Hilbert, D., Ferrier, S., House, A., Liedloff, A., Prober, S.M., Smyth, A., Martin, T., Harwood, T., Williams, K., Fletcher, C., and Murphy, H., (in prep, 2012). *The Implications of Climate Change for Biodiversity Conservation and the National Reserve System: Final Synthesis.* Report prepared for the Department of Sustainability Environment, Water, Population and Communities, Canberra. CSIRO Climate Adaptation Flagship, Canberra (sometimes referred to as the ‗Final Synthesis Report').

Ecoscape (2002). *A review of high conservation values in Western Australia's south-west forests*. A report to the Conservation Commission of Western Australia. Ecoscape (Australia) Pty Ltd.

EPA (1975). *Conservation Reserves for Western Australia. System 4, 8, 9, 10, 11, 12*. Environmental Protection Authority, Perth, Western Australia.

EPA (1976). *Conservation Reserves for Western Australia. System 1, 2, 3, 5*. Environmental Protection Authority, Perth, Western Australia.

EPA (1983). *Conservation Reserves for Western Australia. The Darling System — System 6. Parts 1 and 2. Report 13*. Prepared by the Department of Conservation and Environment for the Environmental Protection Authority, Perth, Western Australia.

EPA (1993). *Red Book Status Report on the implementation of Conservation Reserves for Western Australia.* EPA Report No. 15. Environmental Protection Authority, Perth, Western Australia.

EPA (2003). *Greater Bunbury Region Scheme*. EPA Bulletin No. 1108, September 2003. Environmental Protection Authority, Perth, Western Australia.

EPA (2006). *Level of Assessment for Proposals Affecting Natural Areas Within the System 6 Region and Swan Coastal Plain Portion of the System 1 Region.* EPA Guidance Statement No. 10, June 2006. Environmental Protection Authority, Perth, Western Australia.

EPA (2009a). *South West Regional Ecological Linkages*. Environment Protection Bulletin No 8. Environmental Protection Authority, Perth, Western Australia.

EPA (2009b). *The Natural Values of the Whicher Scarp.* Bulletin No. 6, Environmental Protection Authority, Perth, Western Australia.

EPA (2010a). *Forest Management Plan 2004-2013: Mid-term audit of performance report*. Report 1362, Environmental Protection Authority, Perth, Western Australia, August.

EPA (2010b). *Strategic Environmental Advice on the Dawesville to Binningup Area.* Bulletin No. 1359, Environmental Protection Authority, Perth, Western Australia.

EPA (2012). *Forest Management Plan 2004-2013: End-term audit of performance report*. Report 1443, Environmental Protection Authority Perth, Western Australia, June.

Ferguson, I.F., Gardner, J., Hopper, S., Young, J. (1999). *Report to the Minister for the Environment by the Ministerial Advisory Group on Karri and Tingle Management*. Ministerial Advisory Group on Karri and Tingle Management, Perth.

Ferguson, I., Adams, M., Bradshaw, J., Davey, S., McCormack, R., and Young, J. (2003). *Calculating sustained yield for the Forest Management Plan (2004–2013). Stage 3 Report*. Report for the Conservation Commission of WA by the Independent Panel, Conservation Commission WA, p. 46.

Fischer, J., Lindenmayer, D.B., and Manning, A.D. (2006). *Biodiversity, ecosystem function and resilience: ten guiding principles for commodity production landscapes*. Frontiers in Ecology and the Environment, 4 (2), pp 80-86.

Gibson, N., Keighery, B.J., Keighery, G.J., Burbidge, A.H. and Lyons, M.N. (1994). *A Floristic Survey of the Southern Swan Coastal Plain*. Unpublished Report for the Australian Heritage Commission, prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.).

Gibson L, McNeill A, de Tores P, Wayne A, Yates C (2010). *Will future climate change threaten a range restricted endemic species, the quokka* (*Setonix brachyurus*), *in south west Australia?* Biological Conservation, 143 (11), pp 2453-2461.

Government of Western Australia (2000a). *Bush Forever. Volume 1 Policies, Principles and Processes*. Western Australian Planning Commission, Perth, Western Australia.

Government of Western Australia (2000b). *Bush Forever. Volume 1 Policies, Principles and Processes - Appendix 3: Site Implementation Guidelines - Practice Notes.* Western Australian Planning Commission, Perth, Western Australia.

Government of Western Australia (2000c). *Bush Forever. Volume 2 - Directory of Bush Forever Sites.* Department of Environmental Protection, Perth, Western Australia.

Government of Western Australia (2000d). *Bush Forever. Summary of Submissions on the Draft Perth's Bushplan 1998.* Western Australian Planning Commission, Perth, Western Australia.

Government of Western Australia (2003). *An atlas of tuart woodlands on the Swan Coastal Plain in Western Australia.* Prepared by the Department of Conservation and Land Management for the Government's Tuart Response Group.

Government of Western Australia (2004a). *Draft Tuart Conservation and Management Strategy and Action Plan*. Draft prepared by the Department of Conservation and Land Management on behalf of the Government of Western Australia.

Government of Western Australia (2004b). *Tools for identifying 'indicative high conservation' tuart woodlands.* Prepared by the Department of Conservation and Land Management for the Government's Tuart Response Group.

Government of Western Australia, Heritage Council of WA, National Trust (2011). *State Cultural Heritage Policy*. Perth, Australia.

Government of Western Australia and Heritage Council of WA (2011). *Government Heritage Property Disposal Process*. Perth, Australia.

Government of Western Australia (2011). *WA Environmental Offsets Policy.* Perth, Australia, September.

Havel, J.J. (2000). Ecology of the forests of south-western Australia in relation to climate and landforms. Ph.D. thesis, Murdoch University, Western Australia.

Havel, J.J. and Mattiske, E.M. (1998). *Regional Forest Agreement, Ecological Vegetation Systems. 1:500,000 map*. Department of Conservation and Land Management Western Australia, Perth and Department of Environment and Heritage, Canberra.

Havel, J.J. and Mattiske, E.M. (2000). *Vegetation Mapping of South-west Forest Regions of Western Australia* (6 maps). Reprint to CALM**Science** for the Regional Forest Agreement, Department of Conservation and Land Management, Como.

Heddle, E.M., Loneragan, O.W. and Havel, J.J. (1980). Vegetation Complexes of the Darling System Western Australia. In: *Atlas of Natural Resources Darling System Western Australia*. Department of Conservation and Environment, Perth.

Helms J.A. (ed). (1998). *The Dictionary of Forestry*. The Society of American Foresters, 210 pages.

Heritage Council of WA and Tourism WA (2006). *A Heritage Tourism Strategy for Western Australia*. Available at www.heritage.wa.gov.au/ (accessed 2012).

Hingston, F., Dimmock, G., Turton, A. (1981). *Nutrient distribution in a jarrah (Eucalyptus marginate Donn ex Sm.) ecosystem in south-west Western Australia*. Forest Ecology and Management 3: pp 183-207.

Holling, C.S. (1973). *Resilience and stability of ecosystems*. Ann. Rev. Ecol. Syst. (4), pp1-23.

Hopkins, A.J.M., Coker, J., Beeston, G.R., Bowen, P. and Harvey, J.M. (1996). *Conservation Status of Vegetation Types throughout Western Australia. Final report, Project No. N703*. Australian Nature Conservation Agency National Reserves Systems Cooperative Program.

Irvine, J., Law, B.E., Hibbard, K.A. (2007). *Postfire carbon pools and fluxes in semiarid ponderosa pine in Central Oregon*. Global change Biology 13, pp 1748-1760.

Keighery, B.J., Keighery, G.J., Madden, S., Longman, V.M., Green, B., Webb, A., McKenzie, B., Hyder, B., Ryan, R., Clarke, K.A., Harris, E., Whisson, G., Olejnik, C. and Richardson, A. (2006). *The Vegetation and Flora, Fauna and Natural Areas of the Peel Harvey Eastern Estuary Area Catchment (Swan Coastal Plain).* A report prepared for the Department of Environment and Conservation as a contribution to the Peel Harvey Eastern Estuary Area Catchment Environmental Assessment Project and the Swan Bioplan Project.

Keighery, B.J., Keighery, G.J., Webb, A., Longman, V.M. and Griffin, E.A. (2008). *A Floristic Survey of the Whicher Scarp.* A report for the Department of Environment and Conservation as part of the Swan Bioplan Project.

Kirkpatrick, J.B. and Brown, M.J. (1991). *Reservation Analysis of Tasmanian Forests. Forest and Timber Inquiry Consultancy* Series No. FCT91/16. Resouce Assessment Commission, Canberra.

Kirschbaum. M.U.F. (2001). *Role of forests in the global carbon cycle*. Chapter 16 in "Criteria and indicators for sustainable forest management." IUFRO 7 Research Series. Eds. R.J. Raison, A.G. Brown and D.W. Flinn. CABI Publishing. United Kingdom.

Landsberg, J., and Waring, R. (1997). *A generalised model of forest productivity using simplified concepts of radiation-use efficiency, carbon balance and partitioning*. Forest Ecology and Management, 95, pp 209–228.

Landsberg, J., and Sands, P. (2010). *Physiological Ecology of Forest Production: Principles, Processes and Models*. Academic Press, 352 pages.

Lindenmayer, D.B., Franklin, J.F., Fischer, J., (2006). *General management principles and a checklist of strategies to guide forest biodiversity conservation*. Biological Conservation, 131, pp433-445.

Mackey, B.G., Keith, H., Berry, S.L. and Lindenmayer, D.B. (2008). *Green carbon: the role of natural forests in carbon storage. Part 1, A green carbon account of Australia's south-eastern Eucalypt forest, and policy implications*. ANU E Press.

Maher, D., Yates, C., McCaw, L., (2010). *'Vulnerability of Forests in South-West Western Australia to Timber Harvesting Under the Influence of Climate Change'*. Department of Environment and Conservation, Perth.

Mattiske, E.M. and Havel, J.J. (1998). *Regional Forest Agreement, Vegetation Complexes, Perth, Pinjarra, Collie, Busselton/Augusta, Pemberton, Mount Barker, Western Australia. 1:250,000 maps*. Department of Conservation and Land Management Western Australia, Perth and Department of Environment and Heritage, Canberra.

Mattiske, E.M., and Havel, J.J. (2002). *Delineation of landscape conservation units in southwest region of Western Australia.* Mattiske Consulting Pty Ltd and Havel Land Consultants. Report for the Department of Conservation and Land Management, Western Australia, May.

May, J.E. and McKenzie, N.L. (eds) (2003). *A Biodiversity Audit of Western Australia's Biogeographical Subregions in 2002.* Department of Conservation and Land Management, Kensington, Perth, Western Australia.

McArthy, M.A., Gill, A.M. and Bradstock, R.A. (2001). *Theoretical fire-interval distributions*. International Journal of Wildland Fire 10, pp 73-77.

Mittermeier, R.A., Myers, N. and Mittermeier, C.G. (1999). *Hotspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*. Cemex, Mexico City.

Montreal Process Implementation Group for Australia (2008). *Australia's State of the Forests Report 2008*. Bureau of Rural Sciences. Canberra, ACT.

Moroni, M., Kelley, T., and McLarin, M. (2010). *Carbon in Trees in Tasmanian State Forest*. International Journal of Forestry Research, Volume 2010, Article ID 690462, 13 pages.

Moroni, M. (2011). *The role of forest management in greenhouse-gas mitigation: a contextual framework for Australia.* Report PRC 162-0910, Forest and Wood Products Limited. Tasmania, Australia.

Nabuurs, G.J., Masera, O., Andrasko, K., Benitez-Ponce, P., Boer R, Dutschke, M., Elsiddig, E., Ford-Robertson, J., Frumhoff, P., Karjalainen, T., Krankina, O., Kurz, W.A., Matsumoto, M., Oyhantcabal, W., Ravindranath, N.H., Sanz Sanchez, M.J., and Zhang, X. (2007). *Forestry (9)*, in Climate Change (2007): *Mitigation. Contribution of Working Group III to the Fourth Assessment report of the Intergovernmental Panel on Climate Change*. (Metz B, Davidson OR, Bosch PR, Dave R & Meyer LA (eds), Cambridge University Press, UK, and NY, USA.

Norris, J., Arnold, S., Fairman, T., (2010). *An indicative estimate of carbon stocks on Victoria's publicly managed land using the FULLCAM carbon accounting model.* Australian Forestry 73 (4), pp 209-219.

Pittock, A. (2009). *Climate Change: The Science, Impacts and Solutions.* CSIRO Publishing, Collingwood Victoria.

Polglase P., Paul, K., Khanna, P., Nkakuengama, J., O'Connell, A., Grove, T. and Battaglia, M. (2000). *Change in Soil Carbon following Afforestation or Reforestation*, National Carbon Accounting System Technical Report No. 20. Australian Greenhouse Office, Canberra.

Rab, M.A., Bradshaw, F.J., Campbell, R.G., and Murphy, S. (2005). *Review of factors affecting disturbance, compaction and trafficability of soils with particular reference to timber harvesting in the forests of south-west Western Australia*. Consultants report to Dept. of Conservation and Land Management, WA, Sustainable Forest Management Series, SFM Tech. Rep. No. 2, 146pp.

Raison, R.J., Keith, H., Khanna, P.K. and O'Connell, A.M. (1993). *Effects of repeated fires on nitrogen and phosphorous budgets and cycling processes in forest ecosystems.* pp347-363. In: "Fire in Mediterranean ecosystems". Report No. 5, Ecosystems Research report Series, Commission of the European Communities, Brussels.

Richards, G.P. (2001). *The FullCAM Carbon Accounting Model:Development, Calibration and Implementation for the National Carbon Accounting System. National Carbon Accounting System Technical Report No. 28*, Australian Greenhouse Office, Canberra, 50 pp.

Sampson, R.N. and Scholes, R.J. (2000). *Additional human-induced activities – Article 3.4*. In: *Land Use, Land-Use Change, and Forestry*. Special Report of the Intergovernmental Panel on Climate Change (Eds R. T. Watson *et al.*). Cambridge University Press, Cambridge. pp 181-281.

Schirmer, J. (2008). *Forestry, Jobs and Spending: Forest Industry Employment in Western Australia*. CRC for Forestry, Hobart.

Snowdon, P., Eamus, D., and Gibbons, P. (2000). *Synthesis of allometrics, review of root biomass and design of future woody biomass sampling strategies*. *National Carbon Accounting System Technical Report No. 17*. Australian Greenhouse Office, Canberra.

Steffen, W., Burbidge, A., Hughes, L., Kitching, R., Lindenmayer, D.B., Musgrave, W., Stafford Smith, M., and Werner, P. (2009). *Australia's Biodiversity and Climate Change: A Strategic Assessment of the Vulnerability of Australia's Biodiversity to Climate Change. Technical synthesis of a report to the Natural Resource Management Ministerial Council commissioned by the Australian Government*. Department of Climate Change, Canberra.

Thackway, R. and Cresswell, I.D. (Eds) (1995). *An Interim Biogeographic Regionalisation for Australia: a framework for establishing the national system of reserves, Version 4.0*. Australian Nature Conservation Agency, Canberra.

Thompson, I., Mackey, B., McNulty, S., and Mosseler, A. (2009). *Forest Resilience, Biodiversity, and Climate Change. A synthesis of the biodiversity/resilience/ stability relationship in forest ecosystems*. Secretariat of the Convention on Biological Diversity, Montreal. Technical Series No. 43, 67 pages.

Tourism Research Australia (2011). *Regional Tourism Profiles, Ref: 2010/11.* Tourism Research Australia, Canberra, at http://www.ret.gov.au/tourism/Documents/tra/Regional%20tourism%20profiles/2010-11/Regional_Tourism_Profiles_2010-11_FINAL.xls).

URS Australia (2001). *Assessment of the Scientific, Economic and Community Values and the Impact of Logging on salinity of Areas Subject to a Moratorium on Logging -Draft Report*. Prepared for the Conservation Commission of Western Australia.

URS (2012). *Social and Economic Impact Assessment of Implementation of the Draft Forest Management Plan 2014-2023*. Prepared for the Conservation Commission of Western Australia and the Department of Environment and Conservation. URS Australia, Perth..

Water and Rivers Commission (2003). *Policies and Guidelines for Recreation on Public Drinking Water Source Areas on Crown Land*. Statewide Policy 13 (Western Australia), July.

Water Corporation (2010). *Final Report, Water Forever: Lower Great Southern*. Water Corporation, October 2010.

Webb, A., Keighery, B., Keighery, G.J., Longman, V.M., Black, A. and O'Connor, A. (2009). *The Vegetation and Flora of the Busselton Plain (Swan Coastal Plain)*. Department of Environment and Conservation, Kensington.

Wiedinmayer, C. and Hurteau, M.D. (2010). *Prescribed Fire As a Means of Reducing Forest Carbon Emissions in the Western United States*. National Institute for Climatic Change Research, Northern Arizona University, Arizona, USA.

Whitford, K.R. and Mellican, A.E. (2011). *Intensity, extent and persistence of soil disturbance caused by timber harvestingin jarrah* (*Eucalyptus marginata*) *forest on FORESTCHECK monitoring sites*. Department of Environment and Conservation, Dwellingup, WA, Australia.

Whitford, K.R., Stoneman, G., Seymour, A., Murray, P., Eaton, L. and Tanimoto, M. (in press). *The effects of cording, timber load and soil gravel content on soil compaction during timber harvesting on moist soils*. Aust. For. 75.

Williams, R.J., Bradstock, R.A., Enright, N.J., Gill, A.M., Liedloff, A.C., Lucas, C., Whelan, R.J., Andersen, A.N., Bowman, D.J.M.S., Clarke, P.J., Cook, G.D., Hennessy, K.J. and York, A. (2009). *Interactions between climate change, fire regimes and biodiversity in Australia: a preliminary assessment*. Report by a CSIRO-led consortium for the Australian Government Department of Climate Change and Department of the Environment, Water, Heritage and Arts.

Wittkuhn, R.S., McCaw, L., Wills, A.J., Robinson, R., Andersen, A.N., Can Heurck, P., Farr, J., Liddelow, G. and Cranfield, R. (2011). *Variation in fire interval sequences has minimal effects on species richness and composition in fire-prone landscapes f south-west Western Australia*. Forest Ecology and Management 261, pp 965-978.

Yates, C., McNeill, A., Elith, J., and Midgley, G. (2010). *Assessing the impacts of climate change and land transformation on Banksia in the South West Australian Floristic Region*. Diversity and Distributions, Vol 16, pp187-201.

Young, P.A.R. and McDonald, T.J. (1989). *Vegetation mapping and description 'Warwick', South-eastern Queensland*. Department of Primary Industries, Brisbane.

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Map 3

Draft Forest Management Plan

Existing land categories

N

Scale 1:500 000

20 0 20 40km

Projection: UTM
Coordinates: MGA (Zone 50)

Legend

- National park
- Nature reserve
- Conservation park
- Other reserve[1]
- State forest, timber reserve and miscellaneous reserve
- DEC region boundary
- 2000 hectares (area guide)

[1] Reserves under the Land Act 1933 and the Land Administration Act 1997, that are vested or placed by order with the Conservation Commission, under Section 5(1)(g) and Section 5(1)(h) respectively, of the Conservation and Land Management Act 1984.

LOCALITY MAP

Data Directory

Theme	Source	Date	Custodian
Tenure	Dept of Environment & Conservation (DEC)	July 2011	Dept of Environment & Conservation (DEC)
Topography	DEC & Landgate	2010	DEC & Landgate
Management boundaries	Dept of Environment & Conservation (DEC)	Feb 2009	Dept of Environment & Conservation (DEC)

Produced by Sustainable ForestManagement Division and Geographic Information Services Branch,
Department of Environment and Conservation for the Conservation Commission

August 2012

Department of Environment and Conservation

Conservation Commission WESTERN AUSTRALIA

MIDWEST

SWAN

WHEATBELT

SOUTH WEST

SOUTH COAST

WARREN

INDIAN OCEAN

SOUTHERN OCEAN

LANCELIN · CALINGIRI · DOWERIN · BOLGART · GOOMALLING · GINGIN · BINDOON · YANCHEP · MUCHEA · TOODYAY · MECKERING · NORTHAM · BULLSBROOK · WANNEROO · CHIDLOW · YORK · MIDLAND · MUNDARING · PERTH · BEVERLEY · Rottnest Island · FREMANTLE · KELMSCOTT · ARMADALE · INDIAN OCEAN · Garden Island · ROCKINGHAM · KWINANA · BROOKTON · JARRAHDALE · MANDURAH · PINJARRA · PINGELLY · YEALERING · DWELLINGUP · WANDERING · BODDINGTON · WICKEPIN · WAROONA · CUBALLING · YARLOOP · NARROGIN · HARRISMITH · WILLIAMS · QUINDANNING · HIGHBURY · HARVEY · WAGIN · DUMBLEYUNG · DARKAN · AUSTRALIND · BRUNSWICK JUNCTION · BUNBURY · COLLIE · DARDANUP · KATANNING · DONNYBROOK · DUNSBOROUGH · BUSSELTON · KIRUP · BALINGUP · KOJONUP · COWARAMUP · BOYUP BROOK · GNOWANGERUP · MARGARET RIVER · NANNUP · BRIDGETOWN · MANJIMUP · AUGUSTA · PEMBERTON · ROCKY GULLY · MT BARKER · NORTHCLIFFE · WALPOLE · DENMARK · ALBANY

300 000mE 115°E · 400 000mE 116°E · 500 000mE 117°E · 580 000mE 118°E

6 570 000mN 31°S · 6 500 000mN 32°S · 6 400 000mN 33°S · 6 300 000mN 34°S · 6 200 000mN 35°S · 6 110 000mN

Map 4

Draft Forest Management Plan

Proposed land categories

𝒩

Scale 1:500 000

20 0 20 40km

Projection: UTM
Coordinates: MGA (Zone 50)

Legend

Proposed Tenure

- 🟧 National park
- 🟫 Nature reserve
- 🟥 Conservation park
- 🟨 Other reserve[1]
- 🟩 State forest, timber reserve and miscellaneous reserve
- 🟦 Forest conservation area[2]

Origins of Reserve Proposals

- ▨ 124 Proposed reserve from previous FMP's, not yet progressed
- ▨ 123 New reserve proposal
- ▩ 224 Proposed additions to Whicher National Park

Other

- DEC region boundary
- Major roads
- ☐ 2000 hectares (area guide)

[1] Reserves under the Land Act 1933 and the Land Administration Act 1997, that are vested or placed by order with the Conservation Commission, under Section 5 (1)(g) and Section 5 (1)(h) respectively, of the Conservation and Land Management Act 1984.

[2] State forest classified under Section 62 of the Conservation and Land Management Act as a forest conservation area.

LOCALITY MAP

Western Australia

Data Directory

Theme	Source	Date	Custodian
Tenure	Dept of Environment & Conservation (DEC)	July 2011	DEC
Topography	DEC & Landgate	2010	DEC & Landgate
Management boundaries	DEC	Feb 2009	DEC

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August 2012

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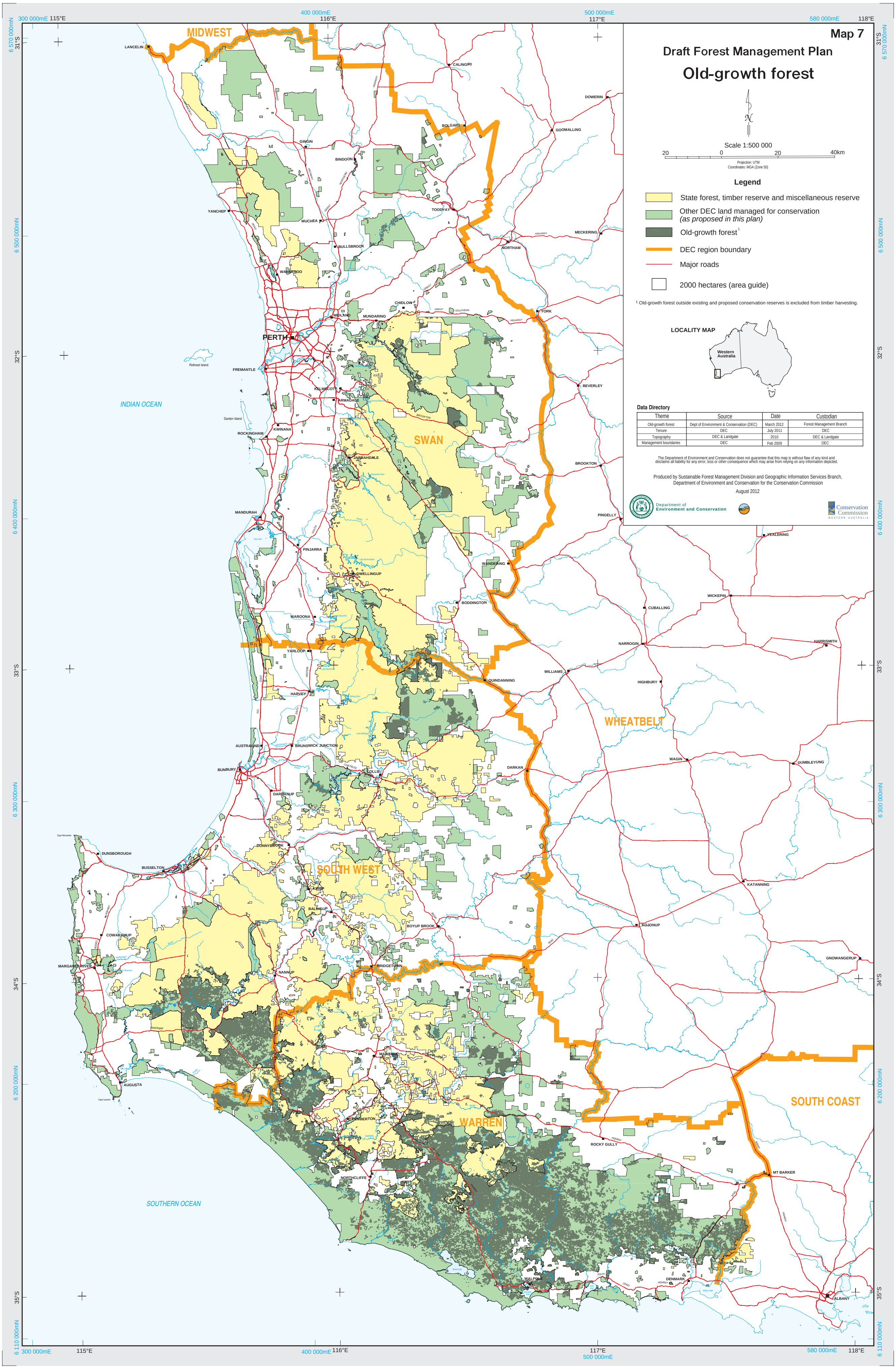
Environment and Conservation

Conservation Commission
WESTERN AUSTRALIA


Map 7
Draft Forest Management Plan
Old-growth forest
Scale 1:500 000
20 0 20 40km
Projection: UTM
Coordinates: MGA (Zone 50)
Legend
State forest, timber reserve and miscellaneous reserve
Other DEC land managed for conservation (as proposed in this plan)
Old-growth forest[1]
DEC region boundary
Major roads
2000 hectares (area guide)
[1] Old-growth forest outside existing and proposed conservation reserves is excluded from timber harvesting.
LOCALITY MAP
Western Australia
Data Directory
The Department of Environment and Conservation does not guarantee that this map is without flaw of any kind and disclaims all liability for any error, loss or other consequence which may arise from relying on any information depicted.
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August 2012
Department of Environment and Conservation
Conservation Commission WESTERN AUSTRALIA
MIDWEST
SWAN
WHEATBELT
SOUTH WEST
WARREN
SOUTH COAST
INDIAN OCEAN
SOUTHERN OCEAN
PERTH
LANCELIN
CALINGIRI
DOWERIN
BOLGART
GOOMALLING
GINGIN
BINDOON
YANCHEP
MUCHEA
TOODYAY
MECKERING
BULLSBROOK
NORTHAM
WANNEROO
CHIDLOW
YORK
MIDLAND
MUNDARING
FREMANTLE
BEVERLEY
KELMSCOTT
ARMADALE
KWINANA
ROCKINGHAM
JARRAHDALE
BROOKTON
MANDURAH
PINGELLY
YEALERING
PINJARRA
WANDERING
DWELLINGUP
BODDINGTON
WICKEPIN
CUBALLING
WAROONA
NARROGIN
HARRISMITH
YARLOOP
WILLIAMS
QUINDANNING
HIGHBURY
HARVEY
AUSTRALIND
BRUNSWICK JUNCTION
DARKAN
WAGIN
DUMBLEYUNG
BUNBURY
COLLIE
DARDANUP
DUNSBOROUGH
DONNYBROOK
BUSSELTON
KATANNING
BALINGUP
BOYUP BROOK
KOJONUP
COWARAMUP
GNOWANGERUP
MARGARET RIVER
BRIDGETOWN
NANNUP
AUGUSTA
MANJIMUP
PEMBERTON
ROCKY GULLY
MT BARKER
NORTHCLIFFE
WALPOLE
DENMARK
ALBANY
Rottnest Island
Garden Island
300 000mE
400 000mE
500 000mE
580 000mE
115°E
116°E
117°E
118°E
31°S
32°S
33°S
34°S
35°S
6 570 000mN
6 500 000mN
6 400 000mN
6 300 000mN
6 200 000mN
6 110 000mN

Theme	Source	Date	Custodian
Old-growth forest	Dept of Environment & Conservation (DEC)	March 2012	Forest Management Branch
Tenure	DEC	July 2011	DEC
Topography	DEC & Landgate	2010	DEC & Landgate
Management boundaries	DEC	Feb 2009	DEC

Map 12

Draft Forest Management Plan

Key recreation sites and facilities

MIDWEST

LANCELIN

GINGIN

Yanchep National Park

Avon Valley National Park

TOODYAY

WANNEROO

John Forrest National Park

Lesmurdie Falls National Park

YORK

PERTH

Helena National Park

SWAN

INDIAN OCEAN

Monadnocks Conservation Park (Proposed National Park)

Serpentine National Park

MANDURAH

DWELLINGUP

Yalgorup National Park

Lane Poole Reserve

HARVEY

Leschenault Peninsula Conservation Park

Wellington National Park

BUNBURY

COLLIE

Leeuwin-Naturaliste National Park

DONNYBROOK

BUSSELTON

Tuart Forest National Park

WHEATBELT

Bramley National Park

St John Brook Conservation Park

SOUTH WEST

BRIDGETOWN

MARGARET RIVER

Blackwood River National Park

Scott National Park

One Tree Bridge Conservation Park

MANJIMUP

AUGUSTA

WARREN

SOUTH COAST

PEMBERTON

Shannon National Park

Warren National Park

MOUNT BARKER

Mount Frankland National Park

Mt Lindesay National Park

D'Entrecasteaux National Park

Redmond Block Area

DENMARK

WALPOLE

ALBANY

SOUTHERN OCEAN

Walpole - Nornalup National Park

William Bay National Park

N

0 40 80km

Projection: UTM
Co-ords: MGA (Zone 50)

Legend

- Forest Management Plan area
- State forest, timber reserve and miscellaneous reserve
- Other DEC land managed for conservation *(as proposed in this plan)*
- DEC region boundary
- Bibbulmun Track
- Munda Biddi Trail
- Cape to Cape Walk Trail
- Karri Forest Explorer Drive
- Recreation site - day-use
- Recreation site - camping

Note: Inclusion of a name on this map does not imply its approval by the relevant nomeclature authority.

LOCALITY MAP

Western Australia

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August 2012

Department of Environment and Conservation

Conservation Commission WESTERN AUSTRALIA