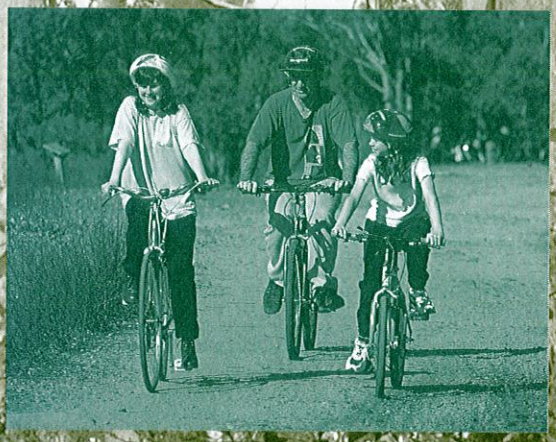

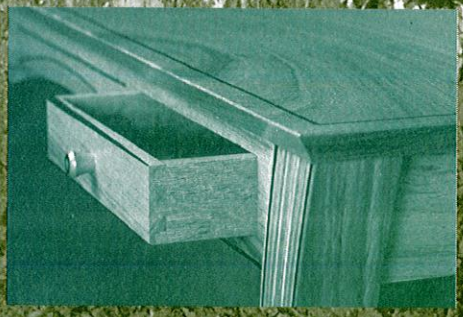

Draft forest management plan

Conservation Commission of Western Australia

July 2002

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of Western Australia

Draft **forest** management plan

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Invitation to comment

This draft forest management plan is an opportunity to provide information, express your opinion, suggest alternatives and have your say on how the south-west forests will be managed over the next 10 years.

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

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

It is important to indicate those strategies and recommendations you agree with as well as those with which you disagree. Your preference for one of the scenarios described, or a modification thereof, will be of particular assistance. Each submission is important, but those that give reasons for concerns, give support where appropriate and offer information and constructive suggestions are most useful.

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

All submissions will be copied to Forest Products Commission, as required for draft plans covering State forest and timber reserves, and to the Water and Rivers Commission and relevant water utilities, as required for draft plans covering land that is or includes a public water catchment area. Submissions will also be copied to the Environmental Protection Authority to assist their assessment of the final forest management plan.

Cover

Main pictures, from top:
Old-growth karri forest in Hawke block, part of the proposed Greater Hawke National Park, near Pemberton. Photo – Marie Lochman
Reflections in the proposed Blackwood River National Park. Photo – Chris Garnett
Insets, from top:
Pink enamel orchid. Photo – Babs and Bert Wells/CLM
Red-tailed phascogale. Photo – Babs and Bert Wells/CLM
Bike riding in John Forrest National Park. Photo – Gordon Roberts
Desk manufactured from native timbers. Photo – Chris Garnett

The draft management 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) Government legislation, management commitment or management policy;
- proposes strategies that would better achieve management objectives and aims; or
- indicates omissions, inaccuracies or a lack of clarity.

The draft management 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 strategy of the draft plan is still considered the best option; or
- contributes options that are not possible (generally due to some aspect of existing legislation, or Government policy).

Please send your written submission, by close of business 15 October 2002, to:

Conservation Commission of Western Australia
PO Box 3105 Broadway
NEDLANDS WA 6009

Email: vikkis@conservation.wa.gov.au

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Foreword

This draft forest management plan is released by the Conservation Commission of Western Australia (the Conservation Commission) for public comment, as part of the process of developing a new management plan for the forest ecosystems of south-west Western Australia. There have been progressive advances since forest management was introduced in this State in 1919, but this document represents a major development from previous forest management plans by:

- setting aside old-growth forest from timber harvesting;
- proposing the establishment of 30 new national parks and two conservation parks;
- reducing significantly the area of forest available for timber harvesting;
- being framed in line with the principles of ecologically sustainable forest management;
- providing management objectives and strategies and setting them at 'whole of forest', landscape and operational scales;
- providing key performance indicators;
- being the first plan under a new administrative structure that separates commercial timber operations from forest management, and creates an independent body to audit the implementation of the approved management plan;
- providing increased opportunities for public involvement in the preparation and delivery of the new plan;
- taking into account another decade of research, monitoring and management experience since the current management plan was written, resulting in proposals such as limiting timber harvesting operations in wet soil conditions, and increasing the number of habitat trees retained in harvested areas; and
- formalising adaptive management, a systematic approach to defining management actions, implementing them, monitoring their impacts and then adapting the management practice based on the results of the study.

There are reasons for optimism when considering the management of the State's south-west forests, particularly since many fauna species continue to find refuge in these forests when they have become extinct elsewhere. There are also serious threats to forest ecosystems, including dieback, feral predators, and weeds.

There is also a need to balance competing demands consistent with one of the principles of ecologically sustainable forest management, to integrate both long-term and short-term economic, environmental, social and equitable considerations. The Conservation Commission is mindful, for example, of the Government's commitments to improve forest conservation measures, and to support a sustainable timber industry. Similarly, forest conservation has to be balanced with other forest uses, such as mining, recreation, water supply, wildflower picking and bee-keeping.

The draft forest management plan puts forward two management scenarios for public comment as part of the process of finding an agreed balance. This process will be pursued between the draft and final plans and will be guided by public submissions. Scenario A leads to a lower limit for the sustained timber yield of jarrah and karri sawlogs, and Scenario B to an upper limit. The different management approaches are discussed through the 'Biological

diversity' chapter and summarised in section 3.2. The assumptions behind the calculation of the range of sustained timber yield figures are discussed in section 4.2.

The starting point is the current management practices that were the basis for the annual indicative timber yields announced in June 2001 of:

- 140,000 cubic metres of first and second grade jarrah sawlogs; and
- 40,000 cubic metres of first and second grade karri sawlogs.

Since these indicative figures were announced, there have been increases in the proposed area of State forest available for timber harvesting as a result of:

- the decision to retain as State forest some of the 'moratorium' blocks that had been set aside pending assessment;
- changes to the boundaries of the proposed Kingston National Park (initially mapped to cover 34,840 hectares) to make them consistent with the Government's policy (19,000 hectares);
- refinement of the boundaries of other proposed national parks which had been mapped conservatively to ensure no areas intended as new conservation reserves were affected when the 2001 timber harvest plan was revised to reflect the Government's forest policy.

These changes have increased the area of State forest available for timber harvesting by a total of 32,300 hectares and have allowed some rescheduling, so that the 2001 annual indicative yields are now revised to:

- 182,000 cubic metres of first and second grade jarrah sawlogs; and
- 42,000 cubic metres of first and second grade karri sawlogs.

At the same time, current management practices are being revised in the light of further research and an understanding of the principles of ecologically sustainable forest management described in section 19(2) of the *Conservation and Land Management Act 1984* (CLM Act). The Conservation Commission is responsible for advising the Minister for the Environment and Heritage on the application of these principles in the management of State forest and timber reserves and forest produce throughout the State (section 19(1)(h) of the CLM Act). The draft forest management plan fulfils a major component of the Conservation Commission's responsibility in this regard. It also indicates how these lands will be managed as a matrix with existing and proposed conservation reserves within the area covered by the plan, at an integrated 'whole of forest' level.

The two management scenarios presented in the draft plan, set out in section 3.2, include alternative approaches to issues including habitat retention, and buffers around the patches of old-growth that remain in State forest. These scenarios lead to a range of possible sustained yield figures, as set out in Table 1.

Table 1: Range of sustained timber yields from scenarios

	Annual lower limit	**Annual upper limit**	**Total unused prior allocation**
Jarrah	106,000 cubic metres	164,000 cubic metres	339,000 cubic metres
Karri	31,000 cubic metres	62,000 cubic metres	203,000 cubic metres

Note: Figures given are for first and second grade sawlogs. The unused prior allocations represent the volume of timber available under current contracts that the timber industry has agreed to forgo before 2003 on the understanding that it will be made available in the future.

The lower limit scenario is included as a more conservative option that preserves options for the protection of additional mature habitat zones and a stronger ecological linkage within the forest regions for the next 10 years. If this approach is not adopted at this stage, recognising that the information is not available to allow definitive answers, there may be reduced opportunities to achieve this level of connectivity in 10 years time when the next forest management plan is prepared. Equally if further work demonstrates that the approach adopted is unnecessarily conservative, there is an opportunity to relax the approach in the next plan period. The upper limit scenario places greater emphasis on the importance of social and economic considerations, while still taking into account the principles of ecologically sustainable forest management.

Under the Government's *Protecting our old-growth forests* policy a commitment was made to honour existing timber contracts, which under the present forest management plan are current until the end of 2003. The timber companies involved have agreed not to take all of the timber available under these contracts, leading to an unused prior allocation. Since these allocations were derived under a management plan that reflected a greater area of forest available for timber harvesting compared with the new plan, they have been treated separately in the scenarios. However, in recognition of the Government's commitment to honour existing contracts the Conservation Commission has concluded that the unused prior allocations should remain available for Government to decide the period over which they might be made available. This decision will be based on mitigating social and economic impacts.

The Conservation Commission recognises that the social and economic value of the forests for a range of uses, including water production, nature-based tourism and recreation resource is an alternative form of employment and economic driver for the communities in the region. The Commission will support the use of these resources in ways consistent with the objectives of the draft plan and in ways that maximise the socio-economic benefits to the community, including through the release of concessions for the development of appropriate nature-based tourism facilities to enhance the scope for visitors to experience, enjoy and learn more about the natural and cultural values of the forest environments.

Some aspects of achieving a socially equitable outcome are beyond the scope of the draft plan and are addressed at a whole of government level as part of a process of restructuring the native forest based timber industry. Other issues will be addressed through a socio-economic assessment of the draft forest management plan jointly undertaken for the Conservation Commission and the Forest Products Commission of Western Australia. The results of this study will be released along with this draft plan, and will be taken into account in developing the final plan.

Executive summary

Introduction

The draft forest management plan is the first plan since amendments to the *Conservation and Land Management Act 1984* (CLM Act) separated the management of forests from commercial timber operations. The amendments passed in November 2000 also described the principles of ecologically sustainable forest management and made it a function of the new Conservation Commission of Western Australia (the Conservation Commission) to advise the Minister for the Environment and Heritage on the application of these principles.

The draft plan covers all land categories vested in the Conservation Commission within the Swan, South West and Warren Regions of the Department of Conservation and Land Management (the Department). However, there is a focus on the management of State forest and timber reserves because it is primarily on these land categories that disturbance activities are permitted. State forest and timber reserves are vested in the Conservation Commission and the Department manages the land according to management plans prepared under the direction of the Conservation Commission and approved by the Minister for the Environment and Heritage. The Forest Products Commission is responsible for the harvesting and regeneration of the forest and the sale of forest products, and associated industry development issues.

A key component of the draft plan is implementation of the Government's *Protecting our old-growth forests* policy. When gazetted, the plan will replace the current Forest Management Plan 1994-2003 and those parts of the 1987 Northern Forest, Central Forest and Southern Forest Regional Management Plans that were not replaced by the current forest management plan.

The basis of the approach to forest management in the draft plan stems from the principles of ecologically sustainable forest management described in the CLM Act. That is, the economic and social values derived from the use of the forest should be provided through a management system that is based on a full consideration of its impacts on biodiversity and is precautionary in nature. As a consequence, the draft plan seeks to establish a comprehensive, adequate and representative reserve system that is supported by complementary off-reserve management that gives consideration to impacts on biodiversity conservation.

The draft plan has adopted the, slightly modified, Montreal Criteria of sustainability as the framework within which to set objectives, strategies and management actions in line with the principles of ecologically sustainable forest management. The Montreal Criteria represent a common understanding of what is meant by sustainable forest management. They are: the conservation of biodiversity, the maintenance of productive capacity, the maintenance of ecosystem health and vitality, the conservation and maintenance of soil and water, the maintenance of forests contribution to the global carbon cycle, the maintenance of heritage and the maintenance of socio-economic values.

The draft plan has adopted three scales of management: whole of forest, landscape and operational, to accommodate better the components of biodiversity. Objectives for management are set for each of the criteria for sustainability, where appropriate at each of the scales of management. The bulk of the draft plan is a description of the strategies that implement the objectives and the management actions that flow from the strategies. Key performance indicators are proposed at the conclusion of the discussion of each of the

strategies for a particular criterion, to monitor the achievement of the objectives and strategies.

In a number of areas the draft plan proposes new initiatives (such as a comprehensive biological survey and management at the landscape scale) or actions not being undertaken to the extent proposed (key performance indicators). Attainment of all the objectives and strategies will depend to some extent on the provision of necessary funds, which is subject to budgetary and other constraints, and the need for the Department to address other priorities throughout the State.

Biological diversity

Strategies addressing the objectives for this criterion include the establishment of formal and informal reserve systems, the retention of habitat elements during timber harvesting, protecting threatened species and threatened ecological communities, establishing goals for diversity in overstorey and understorey structure and providing special management for areas outside the reserve system that have poorly-represented vegetation complexes.

On the basis of present knowledge the formal reserve system proposed by the draft plan is considered to be comprehensive, adequate and representative for the majority of forest ecosystems, and in fact will exceed the national criteria for these values. A comprehensive biological survey could provide additional information to improve the CAR reserve system as part of the development of future forest management plans, and for this reason is proposed as a strategy in the draft plan. Formal reserves proposed in this plan total 1,229,600 hectares, or 50.5 per cent of the total area of land subject to the plan. This is an increase of more than 500,000 hectares on the reserve system proposed in the current forest management plan.

Within State forest and timber reserves an informal reserve system is prescribed that includes all old-growth forest outside formal conservation reserves; stream and river reserves; travel route zones; and diverse ecotype zones. Outside the reserve systems threatened species and threatened ecological communities will continue to be protected.

Setting goals for developing and sustaining a mosaic in the structure of the overstorey and understorey vegetation is a strategy that could not be effected in time for the draft plan. It is proposed to develop the structural goals during early stages of implementation of the approved plan.

Research undertaken during the life of the last plan suggested modifications are required to silvicultural practices and the retention of habitat elements to provide adequate opportunity for the recolonisation by flora and fauna of areas that have been subject to timber harvesting operations. It is not possible to be definitive with regard to such modifications. Consequently the draft plan has developed alternative management scenarios, documented the range of sustained timber yield that might result from them and now seeks public comment on them (see section 3.2 for a summary of the scenarios).

Productive capacity

Strategies addressing the objectives for this criterion cover sustaining the forest estate, harvesting forest products at sustainable levels, ensuring adequate regeneration or rehabilitation of disturbed areas and monitoring the impact of weeds, pests and diseases on productivity.

Harvesting forest products at a sustainable level is a key strategy for the maintenance of productive capacity. The draft plan presents a range of sustained timber yields for karri first

and second grade sawlogs (31,000 cubic metres per year to 62,000 cubic metres per year with an additional total of 203,000 cubic metres in unused prior allocations) and jarrah first and second grade sawlogs (106,000 cubic metres per year to 164,000 cubic metres per year with an additional total of 339,000 cubic metres in unused prior allocations). This range allows for different approaches in the way management practices might account for uncertainty with respect to biodiversity conservation and other factors. The purpose of the range is to focus public comment on the management proposals that give rise to the range and what they mean for ecologically sustainable forest management rather than the sustained yield figure itself.

Ensuring areas disturbed by timber harvesting or mining are adequately regenerated is addressed by a number of strategies. The draft plan recognises that regeneration has been difficult in eastern jarrah sites and that the loss of the market for marri woodchips has meant that stands with high marri content now pose some difficulties to regenerate jarrah and karri following harvesting. Amendment to the silvicultural guidelines are proposed to address these issues and the draft plan makes a commitment to monitor and review the success of these by mid-term.

Weeds, pests and disease can affect forest productivity. However, apart from the effect of jarrah dieback on productivity for timber, this is not a serious problem and the draft plan maintains the monitoring of the situation.

Ecosystem health and vitality

Strategies addressing the objectives for this criterion cover fire, dieback, weeds, pests and diseases.

The draft plan cannot be very prescriptive with respect to fire because the Government has announced the Environmental Protection Authority (EPA) will undertake a public review of fire management later in 2002. The approved plan will incorporate the results of the fire review as part of ongoing adaptive management. Notwithstanding the public review, the draft plan recognises the importance of fire to the maintenance of biodiversity and ecosystem health in the south-west forests as well as its role as a threat to life and property.

Minimising the artificial spread of the pathogen that causes jarrah dieback (*Phytophthora cinnamomi*) is maintained as the broad strategy to manage dieback in the draft plan area. The use of phosphite to protect specific plants threatened by *Phytophthora* will be undertaken. Proposals for the management of jarrah dieback are also subject to recommendations from an expert working group following the assessment by the EPA of the protocol for identifying protectable areas and their management. Again, outcomes from this process will be adopted into management during the implementation of the approved plan.

The draft plan maintains the Department's successful program to control the fox and thus sustain the recovery of many small native animals that have benefited from the reduction in predator pressure.

Weeds present a significant threat to the health and vitality of ecosystems in the plan area, however, the draft plan recognises that control of all weeds is impractical. Priority for control is based on the anticipated impacts on environmental values. The approach is then to develop a management plan to reduce impacts, implement the plan and monitor results.

Soil and water

The draft plan has increased the emphasis on the protection of soil and proposes a number of strategies aimed at managing operations to avoid damage to soil. These include limiting silvicultural operations in wet soil conditions to specified circumstances and the planning of snig track layout to minimise disturbance.

The declining run-off into dams that is a result of the prolonged dry spell experienced in the south-west emphasises the need to ensure forest management does not compromise water quality or quantity. The draft plan maintains the measures that have been effective in the past in protecting water resources. These measures include buffers on all streams and rivers and sustaining adequate tree cover in the intermediate and low rainfall zone to control saline water tables. However, the Water and Rivers Commission considers that the stream buffer system could be improved by targeting buffer widths to problem areas rather than the current uniform approach. The draft plan foreshadows trials to be conducted on this with the outcomes incorporated into management through the adaptive management framework.

The possibility of specifically manipulating forest cover to increase water yield into reservoirs is foreshadowed. The method and extent of any treatment will be discussed and analysed by the Department and the water authorities.

Global carbon cycles

The most significant way to sustain forest carbon pools is to prevent the forest being permanently cleared, which is also desirable for most other criteria and is a strategy of the draft plan under the 'Productive capacity' chapter. Otherwise, forest management as proposed in this draft plan to meet objectives for the maintenance of biodiversity, the maintenance of ecosystem health and vitality and the protection of soil and water is considered benign with respect to its impact on carbon pools. Therefore, no specific strategies for modifying practices for carbon management are proposed.

Climate change resulting from the increased concentration of greenhouse gases including carbon dioxide will affect many of the aspects of management discussed under the biodiversity, productive capacity, ecosystem health and vitality and soil and water chapters. As a consequence of this the socio-economic outputs will also be affected.

The magnitude and timing of the likely climatic changes and the consequential impacts on the various criteria are not clear and the Department is in the early stages of identifying them. As a consequence there are no specific strategies to ameliorate climate change impacts. However, it is considered the establishment of the comprehensive, adequate and representative reserve system coupled with complementary off-reserve management as the draft plan proposes is the basis of a precautionary approach to managing the impacts of climate change. During the life of the approved plan scenarios from climate modeling will be monitored and likely impacts assessed.

Natural and cultural heritage

Strategies addressing the objectives for this criterion seek to protect cultural and natural heritage and work with those with a special knowledge of heritage to identify and interpret heritage places.

The draft plan proposes to access Aboriginal knowledge on cultural matters through the identification of a network of knowledgeable men and women and the formation of an

Aboriginal consultative working group to advise the Department on the identification and management of Aboriginal cultural heritage places.

The Department has developed a draft policy on the management of non-indigenous heritage on land vested in the Conservation Commission. It involves a more systematic process to identify, record and manage heritage places in day-to-day operations.

Socio-economic benefits

The draft plan addresses the management of the socio-economic benefits flowing from the use of the forests for mineral and petroleum extraction, nature-based recreation and tourism, landscape amenity, timber, basic raw materials, wildflowers, apiary, miscellaneous uses through forest leases and the use of the flora for bioprospecting.

Mining is the largest economic activity undertaken in the draft plan area (mineral extraction totalled $4.7 billion in 2001 and directly employed 9,400) and current mining activities are essentially unaffected by the plan. To sustain this level of economic activity new resources have to be found and developed. Mineral and petroleum exploration is potentially affected by the reserve proposals in the *Protecting our old-growth forests* policy. These proposals include the reinstatement of six proposed reserves within State Agreement Act mining leases that were excluded in the Regional Forest Agreement (RFA). Under an Agreement Act, the Government is not able to change land categories within the mining lease that could prejudice the rights of the Agreement Act company, unless both parties agree. Five of the six reinstated reserve proposals overlap areas with known bauxite deposits or areas with high levels of mineral prospectivity, and the Government has negotiated substitute areas for reservation. The impact of other proposed reserves on mineral and petroleum exploration will be addressed during the process required to formalise a change in land category.

Implementation of the *Protecting our old-growth forests* policy has resulted in a decrease in the area of State forest and timber reserves, where forest uses including timber harvesting, extraction of basic raw materials and wildflower picking are permitted. As a consequence the socio-economic value of these uses will decrease significantly when this draft plan is implemented.

The economic value of the timber industry will depend on the sustained yield. However, it seems likely that revenue to the State from hardwood forests will decline from $70-80 million per annum to around $40 million with a loss of around 1,000 jobs.

The industry based on wildflower harvesting will lose a significant resource due to the creation of the Walpole Wilderness Area. The Government has established the Walpole Wilderness Area Stakeholder Reference Group to work through the boundary design and the impact on the community and industries, including wildflower harvesting.

Government has implemented programs, outside the draft plan process, to assist industries and communities affected by the changes resulting from implementation of the *Protecting our old-growth forests* policy.

The increase in the formal reserve system has provided greater opportunity for the development of industry flowing from nature-based recreation and tourism, and the Government has provided funding to stimulate this. Some of the new facilities being developed include the Karri Tingle Visitor Centre in the proposed Walpole Wilderness Area as well as a number of tourist drives and private sector low impact accommodation developments.

Plan implementation

Major strategies for the implementation of the draft plan include monitoring, review and adapting management where necessary, providing opportunity for the community and affected organisations to participate in plan implementation, developing comprehensive guidelines, development and implementation of an environmental management system, implementation of strategies and management actions through lower level planning, the continuation of knowledge accumulation and undertake audits of the carrying out of the draft plan strategies.

The draft plan proposes a significant increase in monitoring compared to the current plan. Systematic monitoring of components of biodiversity in the forest is introduced for the first time through FORESTCHECK and monitoring of the achievement of the draft plan objectives and implementation of the proposals is introduced through key performance indicators. The results of monitoring, particularly output from key performance indicators will be periodically made available to the public.

Much of the detail of forest management that interests and affects organisations and the public is not in the draft plan but contained in lower level plans and guidelines. Consultation with the wider community affected by the implementation of the proposals in the draft plan is proposed through a range of mechanisms.

A formal environmental management system is being developed for the Department to provide a systematic approach to management of operations that have the potential to impact on the environment. The environmental management system will complement that already developed for the Forest Products Commission. The roles and responsibilities of officers of the Department and the Forest Products Commission will be documented in respect to operations that have the potential to have a significant impact on the environment.

Guidance documents such as policies, codes of practice, manual and guidelines provide the detail for field implementation of the strategies and management actions in the draft plan. Following approval of the final plan, these will all be reviewed to ensure they properly reflect the new plan and the principles of ecologically sustainable forest management.

The Department and the Forest Products Commission will audit work practices to determine that they are achieving their objectives and complying with relevant guidelines. The Conservation Commission will review these audits and undertake its own audits of implementation of the approved plan.

1 Ecologically sustainable forest management

1.1 Principles of ecologically sustainable forest management

The Conservation Commission's desired outcome for the lands covered by the approved forest management plan is for biodiversity to be conserved, the health, vitality and productive capacity of ecosystems to be sustained, and the social, cultural and economic benefits valued by the community to be produced in a manner consistent with the principles of ecologically sustainable forest management.

The draft forest management plan proposes substantial increases to the conservation reserve system, in accordance with Government commitments under the *Protecting our old-growth forests* policy. In terms of forest ecosystems, (a classification system recognising 27 different ecosystem types within the Regional Forest Agreement (RFA) area), most environments are proposed to be protected in conservation reserves at levels in excess of the national criteria for a comprehensive, adequate and representative reserve system, and many are well in excess of these criteria. Five forest ecosystems do not meet the national criteria for reservation. Four are ecosystems with a limited natural range where the conservation target is 100 per cent of the remaining area, and the other is the Darling Scarp, an extensive ecosystem. Most of the remaining unreserved occurrences of these ecosystems are on private lands.

Conservation of biodiversity is one of the purposes for which State forest and timber reserves are managed, and a fundamental management consideration in ecologically sustainable forest management. 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).

Biological diversity and biodiversity components are defined in Section 3 of the CLM Act as:

'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; and
(c) diversity of other biodiversity components;

'biodiversity components' includes habitats, ecological communities, genes and ecological processes;

The principles from the National Strategy for the Conservation of Australia's Biological Diversity (see Appendix 1) to which Western Australia is a signatory, recognise that:

Central to the Conservation of Australia's biological diversity is the establishment of a comprehensive, representative and adequate 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 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.

As a result this draft forest management plan does not propose additional areas of conservation reserve beyond those proposals in the Government's old-growth forests policy, rather it emphasises the requirements for ecologically sustainable forest management and the maintenance of ecosystem function on the production forest lands as part of a commitment to ensuring that biodiversity is effectively conserved at the whole of forest level and across the region. This issue is addressed more fully in the 'Biological diversity' chapter.

Ecologically sustainable forest management is defined in various ways. In broad terms ecologically sustainable forest management may be considered to be 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.

The objectives and strategies in this draft plan are guided by the principles of ecologically sustainable forest management described in section 19(2) of the CLM Act. These principles highlighted here in boxes are referred to throughout the draft forest management plan.

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.

The decision-making process for the development of the new forest management plan has been designed to integrate both long-term and short-term economic, environmental, social and equitable considerations in two ways. First, this draft forest management plan provides for a range of socio-economic benefits, including timber harvesting and the utilisation of non-timber forest produce. One of the draft plan's whole of forest objectives is to provide for an increase in the socio-economic benefits derived from natural values to mitigate the impact on local communities of the reduced availability of timber supply.

Second, through public and Government agency response to the draft plan's scenarios and the findings of the social and economic study published separately, further information will become available leading to the development of a final management plan that more comprehensively integrates long-term and short-term considerations.

The draft forest management plan seeks to achieve balance (in part) by putting forward different scenarios for consideration during the public comment process that allow consideration of the various balances between conservation and socio-economic objectives. The main short-term socio-economic implications result from a reduced timber harvest from native forest that in large part reflects a reduction in the area available for timber harvesting after areas were designated for additions to the conservation estate as new national parks. In the long term the socio-economic benefits from the available harvest will be maximised through value-adding strategies.

For a number of years the community has expressed a very strong desire to see the natural heritage values of the forests protected. This desire goes beyond the specific criteria for conservation as expressed in policies for comprehensive, adequate and representative

conservation of forests. It is a broader recognition that the native forests of the south-west and particularly remaining areas of old-growth forest are a powerful cultural and conservation icon in contemporary society. Government commitments protecting all remaining old-growth forest and greatly expanding the national park and conservation reserve system are a response to this strong message from society.

The ability to deliver multiple social and economic goods and services over the long term requires the retention of State forest and timber reserves and conservation reserves and maintenance of the natural forest ecosystem processes that sustain them through an ecologically sustainable forest management approach. Though the focus of this draft plan is mainly on issues associated with timber harvesting, these principles apply to other forest users and the utilisation of non-timber produce of the forest. These uses include mining, basic raw materials such as gravel, bee keeping, commercial native flora picking, nature-based and cultural tourism, water supply/catchment management, bioprospecting, and the development and management of other utilities such as roads, power and water and communication infrastructure.

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. It is an accepted part of environmental decision making in Australia and is one of the principles of the Inter-Governmental Agreement on the Environment (Commonwealth of Australia 1992a). 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 the caution in management prescription is a matter of judgement and will depend on the level of uncertainty (including uncertainty over the nature of the problem, its cause, or its potential impact) and the seriousness of the potential environmental impacts.

In applying the precautionary principle to timber production in the native forest environments that are the focus of the draft forest management plan, it was necessary to identify the areas of uncertainty, and to consider the likely implications of the environmental changes caused by timber harvesting. This led to the development of two management scenarios representing a range of precaution from a higher degree (Scenario A) to a lower degree (Scenario B).

Ecological forestry could be considered as a conceptual framework for ecologically sustainable forest management in production forests in the south-west.

Ecological forestry approaches are based around the concept that any manipulation of the forest ecosystem should seek to emulate the known or inferred (from knowledge of the ecological processes) natural disturbance patterns of the region. The underlying assumption is that as native species and communities evolved under these natural disturbance regimes they will be better adapted to human induced disturbances that are within the natural range of variation of the severity, spatial and temporal patterns of disturbance (Hunter 1999).

The draft forest management plan identifies ecological forestry as a direction in which the Conservation Commission may wish to move rather than an objective. It is recognised that there will be issues that need to be resolved in considering this approach, including the extent to which it is achievable and practical. During the term of the forest management plan the Conservation Commission will participate in and encourage discussion of ecological forestry, including for example, the application of a broad range of site specific silvicultural treatments.

Adaptive management, a term applied to a specific management technique designed to provide measured improvements in management practice and outcomes, will also be formalised (see section 10.2). It is useful in situations where the knowledge of management impacts on ecosystems is incomplete. Adaptive management is a systematic approach to defining management actions, implementing them, monitoring their impacts and then adapting the management practice based on the results of the study. The systematic experimental nature of adaptive management is what distinguishes this approach from management through continuous improvement based on monitoring the results on management actions and adjusting management practice accordingly.

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 is not impaired. Again this is a fundamental component of sustainable use and, in relation to the timber industry, specifically the concept of sustainable yield. However, it is acknowledged that some uses such as mining are non-renewable.

Similarly, the retention of State forest and timber reserves as a sustainable source for long-term supply of the high quality jarrah and karri timber unique to this region and other forest produce is a very significant intergenerational equity issue that would be threatened either by non-sustainable harvesting that reduced the long-term supply of quality timber, or complete closure of long-term access to resources.

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

The National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996) contains nine principles (Appendix 1), the following of which are relevant to the application of the above principle in this document:

- biological diversity is best conserved *in situ*;
- central to the conservation of Australia's biological diversity is the establishment of a comprehensive, representative and adequate system of ecologically viable protected areas integrated with the sympathetic management of all other areas, including agricultural and other resource production systems.

This concept is also inherent in the principles underpinning the creation and management of national parks for the conservation of the natural landscape and ecological systems and for compatible nature-based recreation and appreciation in perpetuity. It is imperative in this regard that these core reserves are also managed in such a way as to retain their values over the very long term.

The draft forest management plan proposes a series of objectives and strategies designed to protect biodiversity in line with ecologically sustainable forest management principles, across the 'whole of forest' region, including specifically the conservation reserve system, and at landscape and operational scales. This is intended as a mechanism to provide a much better integration of management across conservation reserves and State forest and timber reserves

and facilitate complementary management. It is also a means to provide increased clarity to management objectives and a framework for their integration into management at all levels.

To facilitate discussion, the Conservation Commission has developed two scenarios that present different approaches, in particular different approaches to providing for biodiversity habitat across State forest and timber reserves to provide for ecological linkage and facilitate recolonisation of coupes following timber harvesting.

One scenario includes setting aside additional forest patches of approximately 200 hectares. These patches would be chosen for their mature habitat elements, and distributed across State forest and timber reserves. These retained areas, termed additional mature habitat zones, together with existing temporary exclusion areas and informal reserves would normally amount to 20 per cent of a forest block at any one time, but may be rotated in the long term, as alternative areas of regenerating forest reach structural maturity and are able to replace their function.

These additional habitat zones have been designed to provide some additional assurance (precaution) that there will be sufficient forest with a more mature structure retained at all times in patches that are large enough to retain populations of species to enable recolonisation of regrowth forest. Additional mature habitat zones could serve as further centres from which surviving populations can spread back out into the regenerating forest when it becomes sufficiently mature to support them. Additional mature habitat zones would also increase the networks of linkages within State forest and timber reserves, through and between harvested areas and reserves, to help maintain the capacity of the forest to sustain the movements of fauna species at differing scales.

These scenarios are described in more detail in section 3.2.

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

Actions under this principle do not fit within the statutory responsibility of the Conservation Commission or the Department. However, the Conservation Commission has a statutory role to provide advice on the above principles to the Minister for the Environment and Heritage and will do so in a separate document.

1.2 Structure of the draft forest management plan

In 1995, Australia and 12 other countries agreed to seven criteria and 67 indicators that together provide a common understanding of sustainable forest management at a whole of forest scale. These are referred to as the Montreal Criteria. In 1997 the Commonwealth and all State Governments involved in developing RFAs developed a set of principles and criteria for the assessment of RFAs across Australia (Commonwealth of Australia 1997a). The RFA principles for ecologically sustainable forest management were developed from and closely resemble the Montreal Criteria, but are more suited to the Australian context.

The nationally agreed criteria for ecologically sustainable forest management have been adopted to provide the framework for the draft forest management plan.

As with any framework, there are issues that could be placed under a number of the criteria or that have aspects that impinge on a number of the criteria. Fire management is an example, as it could be addressed as a component of sustaining biodiversity, as part of ecosystem health and vitality or under the socio-economic heading because of the threat fires pose to life and property. Rather than see an issue discussed in a number of chapters the most appropriate chapter has been selected for each issue.

The chapter headings and a summary of the issues addressed under each are:

- Biological diversity: establishment of the comprehensive, adequate and representative (CAR) conservation reserve system, threatened species and ecological communities management, threatening processes.
- Productive capacity: loss of vegetation cover, sustained yield of resource use, regeneration and rehabilitation following disturbance, insects and fungi impacting on productivity.
- Ecosystem health and vitality: disease, weeds and pests, fire management.
- Soil and water: quality and quantity of soil and water.
- Global carbon cycles.
- Natural and cultural heritage.
- Socio-economic benefits: minerals and petroleum, water, timber, nature-based recreation and visitor experiences, visual landscape management, gravel and other basic resources, apiculture, wildflowers, leases and bioprospecting.
- Plan implementation: monitoring, review, adaptive management, community involvement, management systems, knowledge, skills and training, policies, codes of practice and guidelines, performance indicators, auditing.

1.3 Management objectives and strategies

1.3.1 Site specific variation in silvicultural treatments

Current management strategies address site variability to a degree, particularly in relation to key issues that impact on timber production. There is a need for greater recognition that the forest ecosystem is very diverse and that different management approaches will be required in different ecosystems (landform, soils, climate and vegetation). The draft forest management plan covers an area large enough to experience a significant range of climatic characteristics and support a diverse range of forest and non-forest ecosystems. It is recognised that jarrah and karri forest dominated ecosystems respond very differently to major disturbances such as fire, and require very different silvicultural treatments.

At this stage, however, information on biodiversity values and ecological responses of fauna and flora are often not well known at the level of the individual forest ecosystem or site types. The Kingston study (Burrows 1994) was the first comprehensive integrated study to look at the impacts of timber harvesting treatments on jarrah forest ecosystem, including fauna. The Environmental Protection Authority (EPA) in Bulletin 912 (1998) indicated a concern that the Kingston forest ecology research had not been carried out on a representative range of sites. While additional studies are being conducted the comprehensive information is not yet available to inform management, although there is a wide range of site variation accommodated in existing silvicultural guidelines.

Any move toward more site specific silvicultural strategies would need to be practical in field application. Site variability would need to be easily recognisable in the field to avoid excessive reliance on professional judgement. Substantial variation to silvicultural strategies and guidelines during the life of the approved plan would require a process of public review.

A comprehensive biological survey of the forest regions and continuation of adaptive management practices to silviculture treatments across a range of forest ecosystem types will

contribute to understand better the patterning of biodiversity, particularly faunal distributions across the region and their responses to natural and human induced disturbance.

1.3.2 Tiered scales of biodiversity conservation for objectives and strategies

Ferguson *et al.* (2001) identified a need for explicit setting of whole of forest goals as an integral part of the forest management plan development process. This report also recognised a major shortcoming in the lack of specific non-timber objectives at the landscape or catchment scale. The draft forest management plan has sought to address this issue.

The principles of ecologically sustainable forest management have been used in the draft plan as a key framework to guide planning and decision-making. These principles need to be applied in a practical sense at various scales (or tiers) in managing the forest, reflecting both the scale and direct effects of operations locally, and as a component of an integrated management system linked into broader scales of strategic planning over longer timeframes. These tiers of management operating at different scales may variously apply to the whole of forest (State forest and timber reserves and conservation areas alike), or to issues that relate to production forests alone. All need to be applied as part of a fully integrated approach to management of the forest.

As part of this process it is recognised that there is a need for a mechanism to connect this draft region plan and area plans to guide integrated conservation management across existing and proposed conservation reserves and informal reserves at the whole of forest scale. The Conservation Commission will prepare for public comment conservation reserve management guidelines to provide this integrating management framework.

For the purpose of this document it is proposed to recognise three tiers of management at progressively smaller scales, each of which has a set of objectives for each Montreal criterion, appropriate to that scale of operation.

The Conservation Commission, as proponent of the new forest management plan, together with the Department of Conservation and Land Management and the Forest Products Commission, as the agencies implementing the plan, are committed to using their best endeavours to achieve the objectives set out in the plan through the implementation of the strategies and actions described. It is however recognised that external factors may hinder the achievement of the objectives and implementation of the strategies and actions. Should such factors arise, an appropriate response will be made in an open and transparent manner.

The proposed tiers of management are defined in Table 2.

Table 2: Scales of management, objectives and strategies

Definitions
Whole of forest All land categories that are subject to this plan. *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 blocks. Landscape scale is usually tens of thousands to a few thousand hectares. *Operational* A discrete area of forest to which one or more operations have been or are planned to be applied. Note: Unless stated otherwise, the objectives and strategies below are intended to apply to all lands covered by this plan. However, their application to plantations will be refined in the approved plan.
Biological diversity objectives
Whole of forest • To conserve biological diversity in a manner taking account of the principles of ecologically sustainable forest management. (Note – an objective similar to this one appears under each of the main headings to reinforce the need to integrate forest management across all values.) • To sustain biological diversity and ecological integrity in all ecosystems, through the proposed expansion and management of a comprehensive, adequate and representative conservation reserve system integrated with complementary management across State forest and timber reserves. • To develop an improved understanding of the biological diversity and the nature of and ecological responses to natural and key human-induced disturbances in the forest regions. • To maintain self-sustaining populations of native species and communities. • To protect threatened species and threatened ecological communities. *Landscape* Take all reasonable measures to: • Ensure a diverse representation and distribution of forest structures, habitat elements and seral stages through time. • Ensure that biological diversity (species richness) recovers between one rotation and the next. (Applies only to State forest and timber reserves.) • Protect ecologically sensitive communities and niches such as riparian zones, aquatic ecosystems, wetlands, granite outcrops and other non-forested complexes. • Prevent any species moving to a higher category of threat as a result of management actions and in particular that no species declines to irretrievably low levels.

Operational

To take all reasonable measures to:

- Retain key environments, habitats and habitat elements necessary to sustain flora and fauna species at sufficient levels to support recolonisation of regrowing forest once it has become suitable.
- Protect occurrences of conservation values identified as significant (such as declared rare flora and diverse ecotype zones) outside formal conservation reserves. (Applies only to State forest and timber reserves.)
- Ensure that impacts on flora diversity and abundance that arise from silvicultural treatments to reduce competition between understorey and commercial species remain within acceptable limits. (Applies only to State forest and timber reserves.)

Biological diversity strategies

Whole of forest

- Implement the proposed system of nature reserves, national parks, conservation parks and other reserves for conservation purposes.
- In forest areas outside the formal reserve system, implement a system of informal reserves that assists in meeting the comprehensive, adequate and representative targets for reservation of forest ecosystems. (Applies only to State forest and timber reserves.)
- Manage State forest and timber reserves so as to complement the formal and informal reserve system. (Applies only to State forest and timber reserves.)
- Prepare guidelines to integrate management of biodiversity conservation, conservation reserves and informal reserves.
- Undertake a comprehensive biological survey of the forest regions as soon as resources permit.
- Research the response of forest ecosystems to natural disturbance, with a view to improving forest management practices.
- Liaise, in consultation with the Department of Mineral and Petroleum Resources, with mineral and petroleum companies operating in the forest regions to encourage their continued cooperation in forest management and their adoption of strategies that are complementary to the forest management plan's objectives and strategies.
- During the term of the approved plan develop, through a process involving key stakeholders, structural goals for both the conservation reserves and State forest and timber reserves to complement each other and the plan's objectives.

Landscape

- Manage the overstorey and understorey vegetation structure to achieve a mosaic with spatial and temporal diversity.
- Implement a forest management regime consistent with either Scenario A or B or a modification thereof. (Applies only to State forest and timber reserves.)

Operational

- Implement the selected forest management regime referred to under the landscape strategies above.
- Ensure that the capacity to retain or regain original habitat elements over time is not compromised, including the retention of adequate habitat trees and potential habitat trees. (Applies only to State forest and timber reserves.)
- Identify, and ensure that management actions lead to the survival of all populations of threatened species and threatened ecological communities.
- Manage areas containing vegetation complexes poorly represented in formal and informal reserves and other significant flora to protect these values through the appropriate guidelines. (Applies only to State forest and timber reserves.)
- Manage areas functioning as corridors between formal reserves to protect this value. (Applies only to State forest and timber reserves.)
- Continue to develop knowledge of the impacts of forest management practices on the key components of biological diversity and ecosystem function and maintain guidelines and other subordinate documents that prescribe measures to limit impacts to within acceptable levels.

Productive capacity objectives

Whole of forest

- To sustain the productive capacity of ecosystems in a manner taking account of the principles of ecologically sustainable forest management.
- To limit the harvesting of timber to the sustained yield taking account of ecologically sustainable forest management. (Applies only to State forest and timber reserves.)
- To manage the removal of other forest produce from State forest and timber reserves to satisfy as much of the public demand as is appropriate, taking account of ecologically sustainable forest management. (Applies only to State forest and timber reserves.)
- To increase the scientific knowledge associated with forest management practices.

Landscape/Operational

- To rehabilitate or regenerate forest that has been disturbed to sustain in the longer term the range of flora composition and structural attributes consistent with relevant biological diversity objectives.
- To ensure that the impact of weeds, pests and disease on productive capacity is minimised and take action to reduce impacts where appropriate and practical within the context of ecologically sustainable forest management.

Productive capacity strategies

Whole of forest

- Minimise the loss of forest due to allocation to non-public use and the development of public utilities to that considered essential by Government.
- Ensure through regulation, monitoring and audit that timber harvesting does not exceed the sustained yield and is managed to comply with relevant guidelines. (Applies only to State forest and timber reserves.)
- Implement the recommendations of Ferguson *et al.* (2001) relating to refinement of sustained yield calculations during the life of the approved plan. (Applies only to State forest and timber reserves.)
- Ensure through regulation, monitoring and audit that the use of other forest produce is managed to comply with relevant guidelines. (Applies only to State forest and timber reserves.)

- Research and determine through a public process, ecologically sustainable limits for other forest produce. (Applies only to State forest and timber reserves.)
- Work with industry and government agencies to ensure that areas subject to mineral and petroleum activities, basic raw materials and other extractive activities are rehabilitated with the objective of restoring as many of the previous ecosystem values as possible, taking account of ecologically sustainable forest management.

Landscape /Operational

- Monitor the removal of timber and other forest produce and respond when required to ensure that its removal occurs in a manner taking account of ecologically sustainable forest management. (Applies only to State forest and timber reserves.)
- Monitor and ensure that post-harvest regeneration is consistent with targets set. (Applies only to State forest and timber reserves.)
- Monitor the forest for impact of weeds, pests and diseases on forest productivity and respond as appropriate.
- Liaise with mining and petroleum companies to ensure that acceptable standards of rehabilitation are met.
- Undertake adaptive management trials to maximise the effectiveness of forest management practices such as river and stream buffers and key silvicultural treatments. (Applies only to State forest and timber reserves – see 'Plan implementation' chapter for management actions.)

Ecosystem health and vitality objectives

Whole of forest/Landscape

- To sustain forest ecosystem health and vitality in a manner taking account of the principles of ecologically sustainable forest management.
- To use and respond to fire in a manner that optimises the maintenance of forest ecosystem health and vitality, ecosystem heterogeneity and processes, promotes conservation of biological diversity and adequately protects life and property.
- To ensure that the impact of weeds, pests and disease on forest ecosystem health and vitality is minimised and take action to reduce impacts where appropriate and practical within the context of ecologically sustainable forest management.
- To identify and mitigate external threats to forest ecosystem health and vitality.

Operational

- To use fire in a manner that reflects site specific variations as far as resources permit.
- To prevent as far as is practicable the introduction, spread and impact of weeds, pests and disease that might cause extensive damage in forests.

Ecosystem health and vitality strategies

Whole of forest/Landscape

- Develop a comprehensive fire management plan that achieves the forest management objectives.
- Refine the fire management plan by active participation in the proposed EPA review of fire management in the forest region and through adaptive management.
- Continually improve protocols for the management of *Phytophthora cinnamomi* and the disease caused by it.
- Monitor the impact of weeds, pests and disease on forest ecosystem health and vitality and where necessary and possible control the weed, pest or pathogen.

Operational

- Protect forest ecosystem health and vitality, biological diversity and other forest values by adopting appropriate hygiene standards, monitoring and where necessary controlling weed, pest and pathogen infestations.
- Ensure that only locally occurring species propagated from local seed sources are used in rehabilitation/regeneration areas, unless there are over-riding considerations that prevent it.

Soil and water objectives

Whole of forest/Landscape

- To sustain soil and water resources in a manner taking account of the principles of ecologically sustainable forest management.
- To ensure that operations and activities do not damage the soil in a manner that could compromise the conservation of biological diversity, maintenance of productive capacity, and forest ecosystem health and vitality.
- To ensure that operations managed by the Department and Forest Products Commission sustain the quality and quantity of water necessary to support intended beneficial uses.

Operational

- To prevent damage to soil that results in a significant loss of stored seeds/regenerative propagules or significant disturbance/damage to its physical or chemical properties.
- To ensure operations managed by the Department and Forest Products Commission do not cause more than localised and temporary deterioration in the ecological integrity and water quality and quantity to flow of streams, wetlands and their associated vegetation.

Soil and water strategies

Whole of forest /Landscape

- Review and implement guidelines that protect soil structure and the surface seed store, including through limiting operations that require heavy machinery to times when dry soil conditions prevail, with the exception of karri thinning operations, and minimising roading requirements.
- Ensure stream water quality and flows are protected through appropriate soil conservation prescriptions and stream buffering.

Operational

- Schedule silvicultural operations that require heavy machinery, including timber harvesting, for times when dry soil conditions prevail, except for specified circumstances. (Applies only to State forest and timber reserves.)
- Design and locate snig tracks to minimise the area of soil disturbance. (Applies only to State forest and timber reserves.)
- Control and regulate operations, including the management of hydrocarbons to minimise spills and to ensure that soil conservation objectives are met.
- Ensure that impacts on soils that arise from silvicultural treatments to maximise the regeneration of commercial species remain within acceptable limits. (Applies only to State forest and timber reserves.)
- Undertake any soil rehabilitation or vegetation regeneration work on heavily used areas like snig tracks and landings as soon as possible after the completion of the operation to maximise the chance of regeneration from stored seed/propagules. (Applies only to State forest and timber reserves.)

Global carbon cycles objectives
Whole of forest • To sustain the forest's contribution to global carbon cycles in a manner taking account of the principles of ecologically sustainable forest management. • To sustain or increase the net carbon sink of the forests. • To ameliorate where possible, the predicted effects of climate change.
Global carbon cycles strategies
Whole of forest • Incorporate carbon management considerations into management planning and guidelines. • Incorporate the best available scenarios of likely future climate into management planning.
Natural and cultural heritage objectives
Whole of forest/ Landscape • To protect natural and cultural heritage values in a manner taking account of the principles of ecologically sustainable forest management. • To ensure that places on land vested in the Conservation Commission with natural and cultural heritage values are identified, recorded, assessed and managed according to best practice. *Operational* • To develop procedures that ensure that the presence and management of natural and cultural heritage places are considered prior to an operation taking place. • To work with traditional custodians and other people with special knowledge on the interpretation, protection and management of their cultural heritage.
Natural and cultural heritage strategies
Whole of forest/Landscape • Identify and record heritage places on databases. • Protect natural and cultural heritage places through an appropriate mix of management, and/ or reservation where appropriate. *Operational* • Protect and manage significant Aboriginal cultural heritage jointly with Aboriginal people. • Work with Aboriginal people and other people with special knowledge to interpret their cultural heritage places and values.

Socio-economic benefits objectives
Whole of forest • To sustain and enhance socio-economic benefits to meet the needs of the public in a manner taking account of the principles of ecologically sustainable forest management. • To generate social, cultural and economic benefits through the provision of a range of goods and services that are valued by the community and are produced in a manner taking account of the principles of ecologically sustainable forest management. • To provide for an increase in the socio-economic benefits derived from natural values to mitigate the impact on local communities of the reduced availability of timber supply.
Socio-economic benefits strategies
Whole of forest • Minimise the impact of mineral and petroleum activities on other forest values. • Provide nature-based recreation opportunities and visitor experiences in a manner taking account of the principles of ecologically sustainable forest management. • Maximise socio-economic benefit derived from the harvesting of timber, taking account of the principles of ecologically sustainable forest management. (Applies only to State forest and timber reserves.) • Manage disturbance activities to as far as possible sustain the inherent visual qualities of the landscape in a regional context. • Provide for necessary basic raw materials extraction in a manner taking account of the principles of ecologically sustainable forest management. • Regulate access for the apiculture industry in a manner taking account of the principles of ecologically sustainable forest management. • Regulate the commercial harvesting of protected flora so that the conservation of the species is not jeopardised and in a manner taking account of the principles of ecologically sustainable forest management. (Applies only to State forest and timber reserves.) • Provide leases for facilities and uses where they meet the requirements of the CLM Act and have regard to the principles of ecologically sustainable forest management. • Promote, encourage and facilitate the controlled exploration for native flora for scientific, therapeutic and horticultural purposes.

Plan implementation objective
• To ensure that forest management complies with the forest management plan and is continually improved so as to achieve best practice.
Plan implementation strategies
• Monitor key characteristics of the environment and management operations and review and continually improve forest management both routinely and through adaptive management trials as previously identified. • Undertake adaptive management trials to improve forest management practices in the areas of prescriptions for river and stream buffers and key silvicultural treatments. • Provide opportunities for Government agencies, non-government organisations and the community to participate in policy development and plan implementation. • Provide opportunities for community involvement in voluntary activities and educational and social development programs on ecologically sustainable forest management. • During the term of the plan to continue to explore opportunities to refine forest management to the understood natural disturbance limits of the ecosystem(s) present, including specifically recognising and allowing for site specific variations. • Develop, refine and implement a formal ISO 14001 accredited environmental management system. • Develop mechanisms to provide for lower level management actions to be consistent with the objectives and strategies of the approved plan. • Identify, document and communicate roles and responsibilities in management. • Generate and transfer knowledge and develop the necessary skills and competencies in staff. • Develop, make public and maintain a comprehensive suite of operational guidance documents to control operations that incorporate best practice taking account of the principles of ecologically sustainable forest management. • Track the achievement of the objectives of the approved plan and the implementation of the plan's strategies through the key performance indicators and in other ways. • Audit implementation of the approved plan and the compliance of operational guidance documents with the plan's objectives and strategies.

1.4 Environmental impact of the draft proposals over the plan period

This section outlines the likely impacts the proposals in the draft plan will have on the environment. Impacts are discussed relative to the way in which the operations are currently being undertaken and the impact they may be having now.

1.4.1 Biodiversity

Reservation for biodiversity conservation

The extent of karri forest ecosystems in the draft plan area prior to 1750 was estimated to be 231,600 hectares and the total extent now is 190,160 hectares. Implementation of this draft plan will result in 92,560 hectares of the extant distribution formally reserved for biodiversity conservation (48 per cent) and a further 22,800 hectares informally reserved, including all

defined old-growth outside the formal reserve system, on land vested in the Conservation Commission. The area of karri forest available for timber harvesting (excluding informal reserves) is 61,000 hectares, which is 32 per cent of the extant area of forest.

The proportion of the karri forest in existing or proposed formal reserves in 1992 was approximately 30 per cent (Department of Conservation and Land Management 1992b).

The increase in reservation of jarrah forest since 1992 shows a similar trend. Prior to 1750 there was estimated to be around 2.78 million hectares of jarrah ecosystems in the draft plan area but the current extent is 1.81 million hectares. On implementation of this draft plan 610,000 hectares will be formally reserved for biodiversity protection (33.8 per cent) and a further 157,000 hectares in forest conservation areas or informally reserved. There are 804,000 hectares in State forest and timber reserve available for timber harvesting.

The proportion of jarrah forest in existing or proposed formal reserves in 1992 was approximately 21 per cent (Department of Conservation and Land Management 1992b).

The total area of land vested in the Conservation Commission in the draft plan area is 2.47 million hectares of which 1.1 million hectares (49 per cent) is in the existing or proposed formal reserve system. A further 227,000 hectares are forest conservation areas or in the informal reserve system where timber harvesting is excluded. The large increase in forest and associated ecosystems managed primarily for the conservation of biodiversity means that the risk of negative impact of the draft plan proposals on biodiversity at the landscape and whole of forest scale will be reduced from the last plan period.

Changes in forest structure

Changes in forest structure can be used at a whole of forest scale as an indicator of the impact of timber harvesting and mining on biodiversity because it reflects the availability of habitat, particularly critical habitat associated with mature and senescent trees.

Karri forest

The draft plan provides a range for the sustained yield of karri from 31,000 to 62,000 cubic metres per year for first and second grade sawlogs, and at least a further 80,000 cubic metres per year of other bole logs. In addition, there is a further 203,000 cubic metres of unutilised allocation from the current plan period is to be made available over a future period yet to be decided. The range results from alternatives in the retention level of mature habitat at the forest block level, varying the rotation length for some stands and varying other management settings.

To produce 62,000 cubic metres of first and second grade sawlog would necessitate the harvesting by clearfelling and thinning of an estimated average of 2,000 hectares of karri/marri forest (three per cent of the karri forest available for timber) per year. The non-regrowth component of the harvesting that would be clearfelled is expected to average 800 hectares per year.

The estimated effect on karri forest structure from this level of timber harvesting over the life of the plan is shown in Table 3.

Table 3: Estimated karri forest structure after 10 years

Forest structure[1]	Whole of forest vested in the Conservation Commission (176,450 hectares)		Percentage change over the 10 years
	2000[2] Percentage	2012 Percentage	
Establishment	9	4	-5
Juvenile	18	15	-3
Immature	23	32	+9
Mature and senescent	50	49	-1
Total	**100**	**100**	

[1] *See Appendix 2 for an explanation of forest development stages.*
[2] *Last date of data update.*

The changes in structure that will result from the upper end of the range of harvesting levels does not produce a significant change in structure for the mature and senescent stages that provide tree hollows required by some fauna. Consequently, at the whole of forest level there should be minimal adverse effect on biodiversity and other values dependent on large old trees. The decline in the area of forest in the establishment and juvenile stages (decrease of eight per cent) can be attributed to the reduction in area cut over compared to the last plan period and within that a decrease in the area clearfelled and regenerated. Regrowth karri in the stage before the crown separates from the scrub layer is advantageous to species, such as the quokka and scrub wren, who use the low dense structure for shelter or foraging. However, a similar benefit is obtained from dense scrub under a mature canopy, consequently the decrease in the establishment and juvenile stage is not seen as environmentally significant.

The proportion of mature and senescent stages is currently high (50 per cent) and under the current policy settings will remain high into the future. To sustain the mature and senescent stages in the very long term there needs to be adequate area of younger stages moving forward to replace them. At the whole of forest level the area is currently adequate. However, particularly in the formal reserve system, the spatial distribution of the younger developmental stages will need to be monitored and addressed in future management plans.

Structure can also be modified by intense wildfire that kills the standing trees. The change in proportion of structural stages resulting from wildfire is not expected to be significant over the 10-year period of the plan compared to changes from timber harvesting. This is because the frequency and extent of fires with the intensity required to kill mature trees is low and although juvenile karri is sensitive to fire it can be quickly replaced. Nevertheless, wildfire does have the potential to reduce the amount of old-growth karri because karri is fire sensitive in the senescent stage.

Jarrah forest

Jarrah forest harvesting will include areas of wandoo also being harvested, however, these will be insignificant in relation to jarrah forest harvested. The sustained yield for jarrah is presented in the draft plan as a range from 106,000 to 164,000 cubic metres per year. In addition a further 339,000 cubic metres of unutilised allocation from the current plan period is available over some future period. As for karri the range results from different mature forest retention levels at the forest block level and varying allowances for risk and other management objectives. The maximum sustained yield of first and second grade jarrah sawlog within the given settings for the suite of sustained use objectives has been calculated

to be 164,000 cubic metres per year. In deriving this sawlog volume approximately 500,000 cubic metres of other bole logs could be generated each year.

The estimated area to be harvested to obtain the upper end of the range of the sawlog volume is in the order of 10,000 to 15,000 hectares per year. This area figure is expected to fluctuate according to the mix of site quality and previous cutting history of the areas made available each year. Breaking the area down into annual estimates of the expected area of each silvicultural objective category over the life of the approved plan is problematic because the silvicultural treatment to be applied is dependent on the structure and condition of the forest, which requires a ground survey prior to the harvesting of each area. The average proportion of each silvicultural objective for the past three years harvesting is shown in Table 4.

Table 4: Average proportion of jarrah silvicultural objectives used since 1998

Silvicultural objective used	Area/yr (ha)	Percentage
Thinning to promote growth	1,440	8
Release of regeneration (cutting to gap)	4,165	23
Establish regeneration (shelterwood)	7,375	41
Single tree selection (selection)	975	5
Selective (selection)	3,050	17
Other (includes clearing for mining)	995	6
Total	**18,000**	**100**

Source: Department of Conservation and Land Management Annual Reports

The relative proportions harvested to each silvicultural objective will vary in the future due to the likely increase in the extent of thinning and proposed variations to the silvicultural guidelines that may alter the extent of shelterwood. The area mined is expected to average up to 1,000 hectares per annum. The existing silvicultural guidelines set a limit of approximately 10 hectares on the size of the gap created when harvesting to release regeneration. At present around 60 per cent of gaps are less than two hectares. The average gap size is anticipated to be similar as there will be less harvesting in the Warren Region where gap sizes tended to be larger because of the broad areas of mature forest.

The impact of timber harvesting on jarrah forest structure during the life of the approved plan will be:

- The 10,000 to 15,000 hectares per year estimated to be disturbed by jarrah timber harvesting activities over the 10-year period of the draft plan represents one per cent (excluding informal reserves) of the total jarrah forest type or 1.9 per cent of the area available for timber harvesting if the maximum area is cut over.
- Over the 10 years of the plan the total area cut to gaps would, if the proportion of cutting to gap is similar to the past three years, be in the order of 4,000 hectares per year (three per cent of the jarrah forest available for harvesting). However, this is expected to be an over estimate as the area cut to gap is likely to fall because there will be less mature forest available for harvesting.

The extent of the timber harvesting operation coupled with operational scale measures to conserve biodiversity will ensure the objectives for biodiversity are achieved.

Species conservation

The draft plan provides for the ongoing implementation and continuing development of recovery plans for threatened species. Procedures for the identification and protection of

threatened species during operations that may disturb them are continued. Major threat abatement programs such as Western Shield will be maintained.

The review of the silvicultural guidelines has adopted findings from the Kingston study and recommended increased habitat retention at the operational level and additional fox baiting before and following harvesting operations. These measures will reduce the impact on fauna at the operational level from timber harvesting through additional habitat and easing predator pressure on animals that are made vulnerable by habitat disturbance.

The decrease in the extent of harvesting and the implementation of the increased habitat retention and increased predator control will manage the risk to threatened fauna species from timber harvesting operations proposed in the draft plan.

Mechanical disturbance of the vegetation and soil occurs incidentally during commercial timber harvesting but may also be undertaken after commercial timber harvesting to reduce competition to jarrah advance growth and to enable jarrah seedlings to establish following germination. The shelterwood silvicultural treatment is often accompanied by such disturbance to enable jarrah seedlings to develop a lignotuber. Disturbance has been found to reduce the abundance of understorey plants compared to undisturbed areas (Burrows *et al.* 2002). The draft silvicultural guideline for jarrah proposes inclusion of the use of coppice management as well as shelterwood in eastern jarrah forest. This with the overall reduction in the area harvested because of the reduction in the sustained yield will result in much less disturbance to the understorey vegetation and soil and as a consequence less impact on understorey species abundance from timber harvesting.

Conservation of wildflower species subject to harvesting will be maintained through licence endorsements that control species harvested, the areas they can be harvested from and the methods by which they may be harvested. Harvesting of wildflowers is expected to decrease because of the reduction in area available as a result of the reservation proposals. As a consequence, potential threats to species conservation will diminish commensurately.

No immediate change to the number of apiary sites will result from implementation of the draft plan, therefore there will be no change to any impact feral bees may have on biodiversity. However, apiary sites may be reduced for biodiversity conservation reasons when area management plans are developed for the formal reserves proposed in this draft plan.

Nature-based recreation and tourism will increase during the life of the plan as demand rises through population growth and as additional people are attracted to the new facilities that are to be provided within the proposed new parks. The impact of visitors on the forest will therefore increase. However, the overall impact of the recreating public on the forest is not considered to be significant because most activity is narrowly focused and the impact can be controlled through good site design.

1.4.2 Productive capacity

Regeneration of harvested forest

Conducting a regeneration burn then planting with nursery grown seedlings will be the main means to regenerate clearfelled karri forest. The purpose of the regeneration burn is to remove the timber harvesting debris, bare the soil to provide a suitable seed bed, reduce competition for the regenerating tree and stimulate germination of understorey species. The karri forest is stratified into four zones for the purposes of seed provenance and each strata is regenerated using plants grown from seed collected from the same zone.

Success rate of karri regeneration is usually very high, averaging in excess of 98 per cent of sample plots meeting the prescribed stocking for the four years to 1999. (Department of Conservation and Land Management 1995, 96, 97, 98). Understocked areas are refilled ensuring all areas harvested are fully regenerated. It is expected a similar success rate will be maintained for the period of this draft plan. The success of regeneration operations is a performance indicator and will be reported annually.

The area of jarrah forest requiring regeneration will receive a regeneration release burn then be assessed for success against a standard prescribed in the jarrah silvicultural guideline. Areas not meeting the standard will receive remedial treatment. Regeneration success is a performance indicator and will be reported annually.

'Eastern' jarrah forest has traditionally been that forest in the low rainfall zone that is characterised by widely spaced trees and a low herbaceous understorey. Seedling regeneration in this area has been more difficult to achieve and its survival less reliable because of the lower rainfall. In the past this has resulted in an extensive use of shelterwood harvesting to promote seedling establishment and subsequent lignotuber development with mixed success. The review of silvicultural guidelines has proposed that regeneration in this type include coppice management as well as encouraging seedling/lignotubers through shelterwood treatment. This will ensure greater certainty for successful regeneration in these more difficult site types.

1.4.3 Ecosystem health and vitality

Fire

Prescribed fire will be applied to the land in the draft plan area over the 10-year period for the following purposes:

- biodiversity conservation (on all land categories);
- asset protection (on all land categories); and
- 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 total area of high intensity karri regeneration burning to be undertaken is not available from the strategic yield modelling but it will be in the order of 800 hectares of the non-regrowth component of the harvest.

The area of land to which prescribed fire has been applied has been steadily declining since the 1970s. This is the result of increasing constraints on undertaking prescribed burning. If prescribed burning is retained at current levels there could be 100,000 to 150,000 hectares of low intensity (less than 500 kilowatts per metre) burning prescribed each year to achieve the above objectives. The adequacy of this to meet the objectives above is uncertain and the subject of ongoing discussion and review.

Areas subject to fire for silvicultural management may have several prescribed burns over the life of the plan. However, most areas subject to prescribed burning will only have one prescribed fire over the 10-year period and when burnt the time since the last burn will generally be in the range of eight to 15 years.

Wildfires can be expected to occur each summer and based on past experience it is likely that over the 10 years of the draft plan there will be in the order of 300 to 400 wildfires burning over 10,000 to 20,000 hectares each year. If fuel quantity continues to increase over broad

areas of the forest the risk of occurrence of extensive, high intensity wildfire that will have a negative impact on the maintenance of biodiversity and the protection of life and property will rise. If wildfire size is kept to small to moderate areas, they will add to the diversity of fire regimes at the landscape and whole of forest scales and will be accommodated in fire planning for diversity in time since last fire.

The impact on the environment of prescribed burning and wildfire during the life of this plan is not easily estimated. This is because fire impact depends on the many factors including the intensity of the fire, the season in which it occurs, the size of the fire and the time since the previous fire (fire regime). It is insufficient to consider the impact of a single fire. Neither is it clear what the fire regime is that may be considered to have a neutral impact on the biodiversity. There is considerable evidence that fire frequency in the jarrah forest has declined since European settlement. Therefore there is uncertainty as to whether the use of fire proposed in this plan might be too little or too much for the maintenance of biodiversity.

A public review of fire management in the draft plan area is to be undertaken by the EPA, consequently the management proposals may change.

Disease and insects

Management of *Phytophthora cinnamomi* dieback will be examined during the life of the approved plan. In the meantime, management will continue to be based largely on hygiene in operations to restrict the spread of the pathogen. The reduction in the area subject to timber harvesting (projected to average 10,000 to 15,000 hectares per year of jarrah forest compared to 18,000 hectares per year over the past three years) and associated activities in the next plan period will lessen the overall risk of spread of the pathogen given hygiene standards remain consistent.

No management activities proposed in this draft plan have been found to be linked to an insect outbreak. Rather, climatic factors appear to be the main determinant of the outbreak of insects such as jarrah leaf miner. As such the operations proposed are not expected to cause any additional insect problem.

Weeds and pests

Weed problems associated with proposals in the draft plan will come from disturbance to the vegetation and soil that provides the opportunity for colonisation by weeds from available seed sources. Timber harvesting is the main cause of disturbance, however, fire, recreation and tourism developments and other uses such as apiary sites and wildflower picking will also contribute. The problem is worst when the area disturbed is close to a source of weeds such as a farm. With respect to timber harvesting, provided regeneration of the forest is adequate the native vegetation will eventually suppress the weeds as it reoccupies the site. The proposals are not seen as adding to the weed problem.

Timber harvesting proposals in the draft plan will add to the problem presented by the fox for native fauna. It does this by increasing the foxes access through the forest and disturbing the habitat of vulnerable animals. The silvicultural guidelines propose increased fox baiting to ameliorate the impact.

1.4.4 Soil and water

Soil

Timber harvesting when soils are wet, particularly in karri forest, leads to soil damage due to compaction and puddling. It is an objective of the draft plan to prevent physical damage to soil that impedes plant growth. A strategy to achieve this is to limit harvesting to dry-soil conditions except for prescribed conditions and while this has been a long standing aim in forest management, the reduction in the size of harvesting operations will make achievement feasible.

With greater emphasis on dry-soil harvesting, the reduced scale of timber harvesting operations and the continuation of existing soil conservation measures, the impacts on soil will be less during the next plan period than for the current plan.

Water quality

Forest streams are the best preserved streams in the south-west. This is because catchments are largely uncleared and prudent forest management causes much less damage to aquatic systems than alternative, more intensive land uses (Ruprecht *et al.* 2002). Streams in forested areas with no clearing for agriculture typically have an annual flow-weighted mean salinity under half the limit for water to be defined as fresh, i.e. 500 milligrams per litre of total soluble salt.

The most immediate risks to water quality from the draft plan proposals arise from salinity and turbidity. Salinity may result from excessive basal area removal in catchments with high water table levels and high stored salt leading to increased salinity in water and turbidity from poor practice in operations such as road construction and road maintenance close to reservoir intake areas leading to increased sediment. These risks are controlled through operational guidelines and provided they are adhered to the impact should be negligible. The draft plan has monitoring and auditing to check on compliance with guidelines.

The overall risk to the quality of water in streams from timber harvesting is therefore low and will fall commensurate with the decline in disturbance activity associated with the reduction in timber harvesting. The retention of undisturbed buffers as informal reserves on all streams and measures to control any soil erosion in harvesting coupes will be maintained and should keep risks to maintenance of water quality suited to potable supply at minimal levels. Protecting the integrity of stream zones is fundamental to the strategy to sustain the quality of water for biodiversity and consumptive uses. Salinity levels of selected streams and the maintenance of stream zone integrity are performance measures and will be reported on.

The Department, with the Water and Rivers Commission, the Water Corporation and the Forest Products Commission, will test enhanced stream protection measures in the early part of the implementation of the approved plan. Results will be reported in the mid-term review.

Water quantity

The quantity of water released from the forest in stream flow available to be harvested is dependent on the amount used by the vegetation. The denser the vegetation the more water it uses and the less water is available for harvesting. Proposals in the draft plan that lead to higher vegetation density will have a negative effect on water yield.

The reduced level of native forest harvesting will have a generally negative effect on water yield over the 10-year period. This is because the overall density of tree cover will remain

higher leading to greater water use hence less available for run-off. The effect is not likely to be significant given the scale of the harvesting relative to the catchment area. However, it may be possible to make a positive contribution to water yield by targeting timber harvesting and the draft plan has foreshadowed an examination of timber management to increase water yield if Government believes it is warranted.

The rehabilitation of degraded dieback sites in the high rainfall zone will reduce water yield from these sites. However, the draft plan has not proposed the rehabilitation of all these sites, rather only those with a high priority, which would include consideration of the impact on water yield, will be treated.

Water use by the pine forest at Gnangara is affecting the recharge of the Gnangara mound ground water supply. An agreement is in place with the Water Corporation to limit tree density. The Forest Products Commission is managing the agreement and nothing in the draft plan will affect that agreement.

1.4.5 Global carbon cycling

Loss of stored carbon in the world's forests has played a large part in the increasing atmospheric concentrations of carbon dioxide. However, this has resulted from their destruction rather than ongoing management. The strategies in this draft plan are to maintain the forest area and sustain its productivity. Under these circumstances the impact of the draft plan proposals on carbon cycling and the atmospheric concentrations of carbon dioxide is expected to be neutral.

1.4.6 Natural and cultural heritage

Aboriginal heritage

The impact of forest management actions on Aboriginal heritage sites is generally low because the law protects sites and procedures are in place to avoid known sites. Where a site is affected by an operation it will be because it was unknown or the consequence of an error. Proposals in the draft plan for increased participation by Aboriginal people in the identification and management of heritage should improve management of this value.

Other heritage

New policies and practices have been developed for the management of other cultural heritage and the implementation of this should see an improvement in the management of cultural heritage.

2 Framework for plan development

2.1 Legislative framework

Section 18 of the CLM Act establishes the Conservation Commission and section 19 sets out the Commission's functions. Among those functions are to have State forest and timber reserves vested in it (section 19(1)(a)).

Sections 33(1)(a)(i) and 33(3)(a) of the CLM Act provide for the Department to manage lands to which the Act applies, according to those operations prescribed in management plans. Where management plans do not exist, operations may be directed by the Minister for the Environment and Heritage as being compatible with the land purpose (section 33A(2)(b)), or undertaken because they are 'necessary' to protect and preserve values on the land (section 33A(1)).

Section 56(1) of the CLM Act prescribes broad purposes for the management of each land category (Appendix 3). Part V of the CLM Act requires the Conservation Commission to prepare, conduct public consultation, and submit for approval by the Minister for the Environment and Heritage, management plans for the land vested in it. The Conservation Commission has developed the draft forest management plan through the agency of the Department, acting jointly with the Forest Products Commission in respect of State forest and timber reserves and the Water and Rivers Commission and the Water Corporation in respect of public water catchment areas.

Current planning policy provides for a hierarchy of plans at (i) strategic level (regional plans); (ii) local level (area plans where operations address the scale of individual or groups of parks and reserves; and (iii) issue level (plans for specific issues such as threatened species recovery plans). The draft forest management plan is a regional management plan for the area specified in the scope.

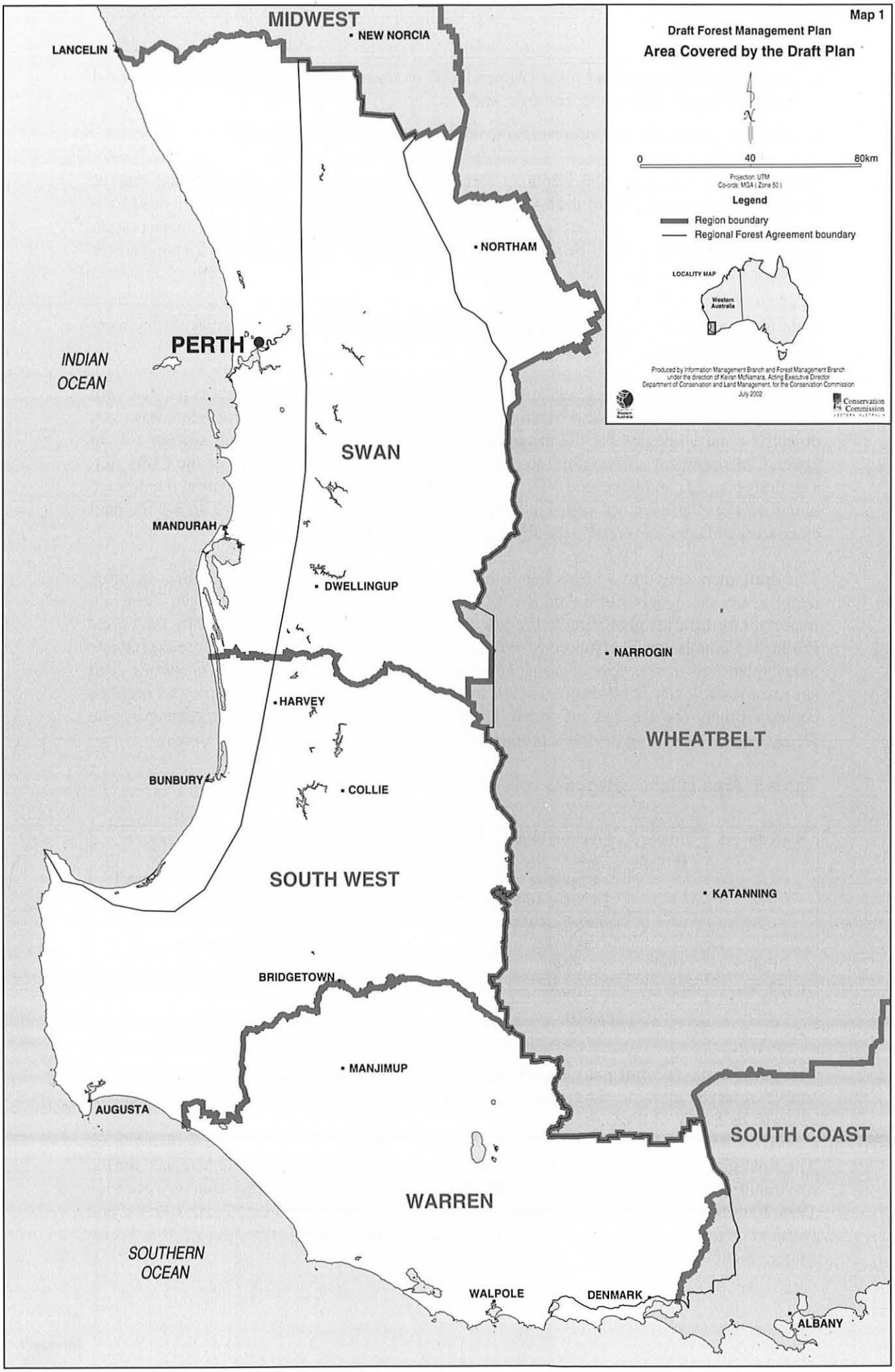
The draft plan builds on the Forest Management Plan 1993-2004 by giving effect to the Government's *Protecting our old-growth forests* policy.

2.2 Scope and purpose

The draft plan applies within the geographic area of the Swan, South West and Warren Regions (Map 1) of the Department other than marine waters. The boundaries of the proposed plan area differ from those of the RFA because that process was focused on the tall forests whereas the draft plan covers the Department's administrative regions.

The draft plan covers the management of existing State forest and timber reserves vested in the Conservation Commission (Map 2) that will remain as such following full implementation of the conservation reserve proposals in the draft plan (Map 3). It also covers freehold land held in the name of the Executive Director that contains native vegetation, which while not vested in the Conservation Commission, is taken into account in the draft plan because its productive capacity contributes to the sustained timber yield figures. Nature reserves, national parks, conservation parks or other land referred to in section 5(1)(g) and (h) of the CLM Act that has a conservation purpose (Map 3) are to be managed according to:

- the requirements of the CLM Act, the *Wildlife Conservation Act 1950* and other relevant State and Commonwealth legislation;


Map 1
Draft Forest Management Plan
Area Covered by the Draft Plan
0
40
80km
Projection: UTM
Co-ords: MGA (Zone 50)
Legend
Region boundary
Regional Forest Agreement boundary
LOCALITY MAP
Western Australia
Produced by Information Management Branch and Forest Management Branch
under the direction of Keiran McNamara, Acting Executive Director
Department of Conservation and Land Management, for the Conservation Commission
July 2002
Conservation Commission
MIDWEST
NEW NORCIA
LANCELIN
NORTHAM
PERTH
INDIAN OCEAN
SWAN
MANDURAH
DWELLINGUP
NARROGIN
HARVEY
WHEATBELT
BUNBURY
COLLIE
SOUTH WEST
KATANNING
BRIDGETOWN
MANJIMUP
AUGUSTA
SOUTH COAST
WARREN
SOUTHERN OCEAN
WALPOLE
DENMARK
ALBANY

- existing area management plans (Appendix 4) or those developed in the life of the final plan applicable to the particular area; and
- relevant policies of the Conservation Commission and the Department.

The draft plan recognises the whole of forest context and the role of the formal reserve systems in the development of the management strategies. It is recognised there is a need for a mechanism to integrate this draft plan with future area management plans for conservation reserves. The Conservation Commission will prepare for public comment management guidelines to achieve this.

State forest and timber reserves proposed as formal reserves will be managed as if they were those land categories.

State forest and freehold land held in the name of the Executive Director that is planted with exotic species for commercial production are not covered in detail in the draft plan, however, objectives and strategies for the management of these lands are set out in section 1.3. In general, management will conform to the requirements of section 56(1)(b) of the CLM Act. The draft plan has no relevance for CLM Act marine conservation reserves within the defined boundaries, as these are not vested in the Conservation Commission. Table 5 shows the land categories and areas covered by the objectives and strategies in the draft plan.

The draft plan does not address the pricing and allocation of harvested timber, as these matters are the responsibility of the Forest Products Commission. However, they are important to the draft plan because the pricing structure for forest products set by the Forest Products Commission is required to ensure the long-term viability of the forest products industry and cover the cost of management of the forest products located on public land (*Forest Products Act 2000* section 12(1)). In addition, section 59(c) of the same Act requires contract prices for the sale of forest produce to recover the full cost incurred by the Department in managing the forest products and managing and protecting the land.

Table 5: Area of land categories covered by the draft plan (as at 30.6.02)

State forest (ha)	**Timber reserve** (ha)	**Freehold land held by the Executive Director and miscellaneous reserve** (ha)	**State forest planted with exotic species** (ha)	**Existing and proposed nature reserves, national parks, conservation parks, CLM Act section 5(1)(g) and 5(1)(h) lands, and State forest classified as forest conservation area** (ha)
1,124,700	44,300	6,700	50,300	1,251,400
1,226,000				1,251,400

The purpose of the draft plan is be to set out the operations proposed for State forest and timber reserves and the objectives and strategies (guidelines) for their management as required by Part V of the CLM Act.

The final plan will operate for 10 years from the date it is approved by the Minister for the Environment and Heritage. Once approved, the plan will revoke the Forest Management Plan 1994-2003 and those parts of the three 1987 Regional (Southern Forest, Central Forest and Northern Forest) Management Plans that were current during the life of the Forest Management Plan 1994-2003.

During the period of the plan adaptive management will result in progressive refinement of the stated strategies in response to new information.

2.3 Roles and responsibilities in management

State forest and timber reserves are vested in the Conservation Commission and the Department manages the land according to management plans prepared under the direction of the Conservation Commission and approved by the Minister for the Environment and Heritage. The Forest Products Commission is responsible for the harvesting and regeneration of the forest and the sale of forest products, and associated industry development issues.

The Conservation Commission's responsibilities include:

- developing the forest management plan; and
- auditing the implementation of the plan.

The Department's responsibilities include:

- complying with the management plan and any Ministerial conditions under the *Environmental Protection Act 1986* (EP Act) in relation to its implementation;
- undertaking strategic yield scheduling;
- preparing regional indicative timber harvesting plans;
- maintaining the databases on forest structure, composition and history of treatment;
- preparing, maintaining and distributing environmental codes of practice and management guidelines; and
- providing data to enable the Conservation Commission to report on compliance and any Ministerial conditions on the implementation of a forest management plan.

The Forest Products Commission's responsibilities include:

- complying with the management plan and any Ministerial conditions under the EP Act in relation to its implementation;
- participation in the preparation of the regional indicative timber harvesting plans and preparation of the annual plans;
- liaison with the preparation of the environmental code of practice and incorporation of those objectives and standards into its own management guidelines;
- compliance with the Department's environmental guidelines and its own management guidelines;
- reporting on that compliance to the Department;
- monitoring forest product removals to ensure they do not exceed the set levels; and
- management of native forest regeneration programs to achieve forest structural goals.

A memorandum of understanding between the Department and the Forest Products Commission sets out the broad relationship and responsibilities of the two organisations with respect to management of the forest for timber values. Working arrangements will be developed and maintained that give detailed guidance on the responsibilities for each party with respect to:

- plantations on land vested in the Conservation Commission;

- the operation of nurseries and seed production orchards on land vested in the Conservation Commission;
- financial arrangements; and
- information, information systems and intellectual property.

The EPA has a specific role under the EP Act to assess the new forest management plan, and to monitor the conditions the Minister for the Environment and Heritage may set in relation to the implementation of the plan. It also has a broad informal role to oversee the condition of the environment and will achieve that by informal monitoring of the performance indicators used to measure the implementation of the new plan.

2.4 Contributing processes

2.4.1 Technical input

Several formal technical reviews and decision-making processes have been set up specifically to provide input to the development of the draft plan however some are not yet complete. The findings of these reviews will be made publicly available. In addition, a number of recent past reviews have been available for input.

Specifically set up work for the forest management plan and still to be completed and incorporated:

- the Independent Expert Panel review of the sustained yield of timber in the context of ecologically sustainable forest management (Ferguson *et al.* 2001) – the Panel will assess the yield proposed for the final plan prior to assessment by the EPA;
- the second report of the review committee in relation to Ministerial Condition 11 (jarrah silviculture) on the implementation of the Forest Management Plan 1994-2003; and
- the social and economic study.

Recent past work and work specifically set up to inform the development of the forest management plan that is completed:

- the assessment of high conservation value forest (Ecoscape Australia 2002);
- the first report of the review committee in relation to Ministerial Condition 11 (jarrah silviculture) on the implementation of the Forest Management Plan 1994-2003 (Burrows 2001);
- the assessment of the scientific, economic and community values and the impact of timber harvesting on salinity of the proposed 25,000 hectare expansion of the Wellington National Park near Collie, Palmer and Leach blocks near Collie, and Helms block near Nannup (URS Australia 2001);
- the review by the Water and Rivers Commission of stream and river buffers to ensure their adequacy in protecting waterways from salinity, degradation and turbidity (Water and Rivers Commission 2001);
- the review by the EPA of the modified policies and programs relating to the control and management of dieback caused by the plant pathogen *Phytophthora cinnamomi* (EPA 2001);
- the report and recommendations of the Ministerial Advisory Group on Karri and Tingle Management (Ferguson *et al.* 1999);

- the suite of reports for the RFA (Commonwealth of Australia and State of Western Australia 1999) including the Comprehensive Regional Assessment (Commonwealth of Australia and State of Western Australia 1998a, b); and
- the compliance reports provided by the Department to the EPA and the EPA assessment report (Bulletin 912).

2.4.2 Community input

Community input has significantly influenced the development of this draft plan. The Conservation Commission has appointed a public involvement coordinator to manage this process, which began with public displays in centres across the south-west, and the development of an extensive mailing list.

The Conservation Commission held five public meetings (in Collie, Manjimup, Margaret River, Mundaring and Perth) to assist the development of the Discussion Paper released in late January 2002 for two months public review. A Round Table group of stakeholders is meeting regularly and providing input. Many issues have been raised at these meetings. A Science Forum was held in March and a communiqué is being developed from the workshops. The results of these inputs have been summarised and are available on the Conservation Commission website, together with other information about the development of a new forest management plan, at: http://www.conservation.wa.gov.au/forest_plan.html

Public comment is sought on this draft and further public forums will be held during the period for public submissions.

2.4.3 Environmental Protection Authority involvement

Where a proposal is likely to have a significant effect on the environment, such as a proposed forest management plan, Part IV of the EP Act provides for a decision by the EPA on whether the proposal should be assessed. Where the EPA under Part IV assesses a proposal, the EP Act provides the mechanism for a decision by the Minister for the Environment and Heritage on whether, and under what conditions, the proposal may be implemented. The EPA will not assess this draft plan under Part IV of the EP Act but will assess the final plan prior to it being submitted to the Minister for the Environment and Heritage for approval. In assessing the final plan the EPA will utilise the public submissions made on the draft proposal.

2.5 Relationship with existing management plans

There are currently four regional plans and 23 area plans under the CLM Act for the geographical area to be covered by this draft forest management plan. A further nine area plans are in preparation (Appendix 4).

The four regional plans in force are the Forest Management Plan 1994-2003 and parts of the Regional Management Plans 1987-1997 for the Northern Forest, Central Forest and Southern Forest Regions. The two sets of regional plans for the forests existed because the 1987 plans were jointly produced by the Lands and Forest Commission and the National Parks and Nature Conservation Authority (both bodies now replaced by the Conservation Commission) whereas the Forest Management Plan 1994-2003 was produced only by the Lands and Forest Commission. This meant that the Forest Management Plan 1994-2003 could not revoke the earlier plans in full.

The plan approved from this draft will replace all aspects of the Forest Management Plan 1994-2003 and revoke it and the three Forest Region Management Plans 1987-1997.

2.6 Other relevant legislation

The Wildlife Conservation 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* also contains provisions relating to the protection of nationally-listed threatened species and ecological communities. In that part of the draft plan area covered by the RFA, 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 that Act for environmental assessment are not triggered for forestry operations. The Commonwealth has also confirmed that its obligations under the *Australian Heritage Commission Act 1975* for the protection of listed and interim listed national estate places have similarly been met (RFA clause 20).

As discussed in section 2.4.3, the final forest management plan will be assessed under Part IV of the EP Act. Additionally, development proposals on or affecting State forest and timber reserves within the draft plan area, such as for many mining proposals, infrastructure or tourism developments, may also be assessed by the EPA.

The *Bush Fires Act 1954* provides some regulation on the control of wildfire and the use of prescribed fire, however, it is not aimed at biodiversity conservation.

The *Soil and Land Conservation Act 1945* provides mechanisms for the protection of soil resources.

Water Allocation Plans prepared by the Water and Rivers Commission, and Source Protection Plans prepared by the Water and Rivers Commission and the Water Corporation, include objectives and policies that the Department takes into account when planning at strategic and operational levels. The protection of water resources in the plan area is covered by the *Country Areas Water Supply Act 1947* and the *Metropolitan Water Supply Sewerage and Drainage Act 1909.*

The draft plan sets management objectives and strategies, one of which is for a sustained yield of timber. The draft plan gives an estimated range for sustained yield based on varying management practices and the final plan will recommend a sustained yield figure based on public comment on those practices. The Conservation Commission and the Department have limited roles in the harvesting and sale of forest products. That is the responsibility of the Forest Products Commission through the Forest Products Act. To coordinate and implement effectively their respective roles and responsibilities in the management, harvesting and sale of forest products, the Department and the Forest Products Commission have signed a memorandum of understanding pursuant to section 33(1)(bb) of the CLM Act and section 10(1)(l) of the Forest Products Act.

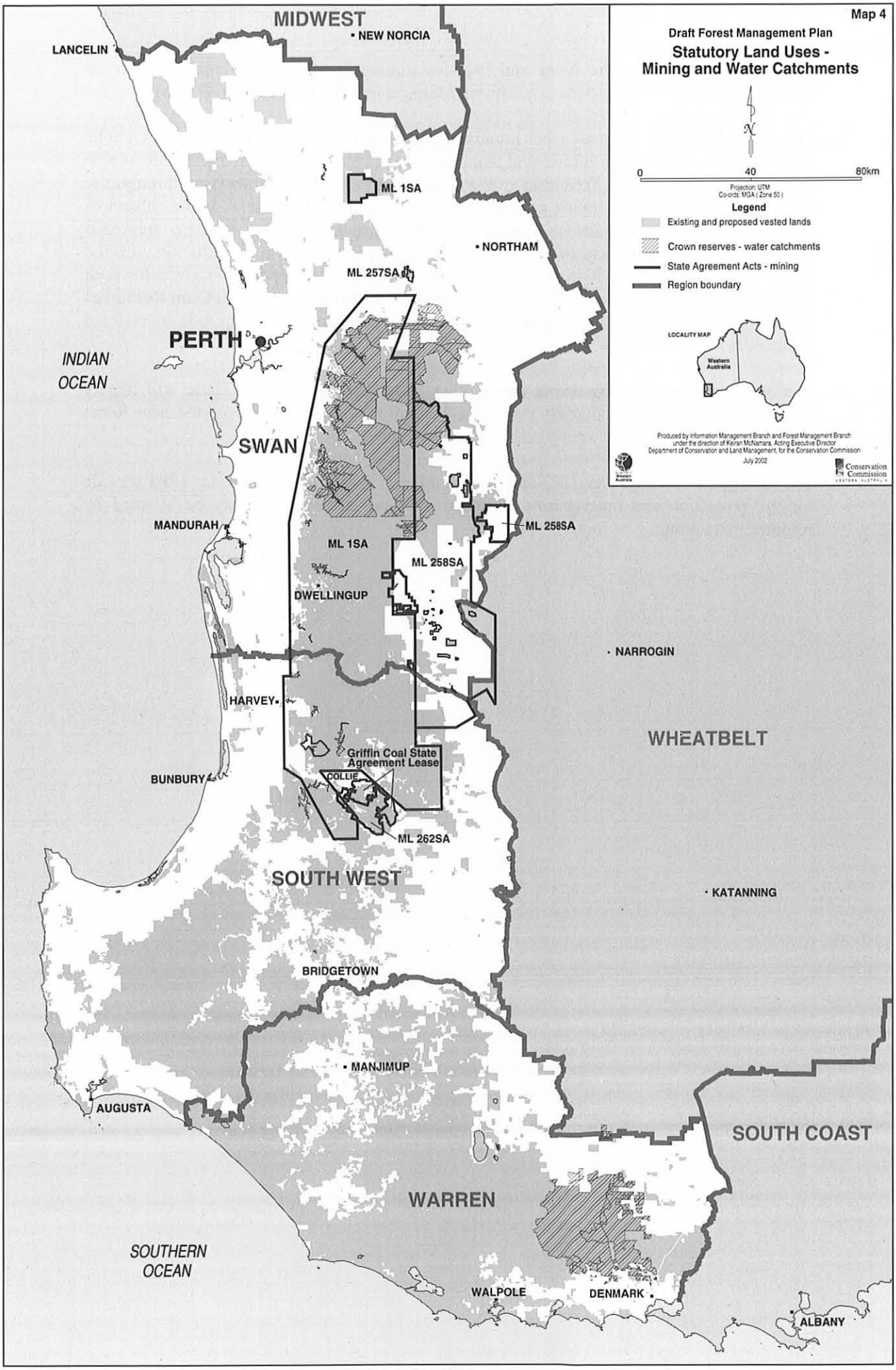
State Agreement Acts are in force for the major mining projects operating on land that is the subject of this draft plan (Map 4), the most significant being for bauxite mining. The CLM Act does not generally preclude land vested in the Conservation Commission from mining or development projects. Section 4(1) of the CLM Act states that, with some exceptions, nothing in the Act will derogate from the operation of any Act relating to minerals or petroleum or any Agreement Act for a development project. However, all mining and industrial development projects are required to undergo environmental, heritage and native title assessments and address State initiatives such as a forest management plan. State Agreement Act project companies are 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 provides advice to the companies on issues that may arise.

Mining activities within the Alcoa and Worsley mining leases are continually monitored through respective liaison groups (e.g. Mining Management Program Liaison Group).

The *Mining Act 1978* controls other mineral resource activities, with the major operations including gold, tantalum-tin-lithium and titanium minerals mining. Mineral exploration is also conducted under this Act. Petroleum exploration and production is authorised through the *Petroleum Act 1967*. Exploration activities conducted under both these Acts are subject to stringent conditions intended to protect the environment and with specific approvals developed by the Department of Mineral and Petroleum Resources in consultation with the Department. Mineral extraction activities are allowed only after approval is given for each specific project proposal submitted to the Department of Mineral and Petroleum Resources following consultation with the Department. In addition, all significant proposals are referred to the EPA for assessment.

The State supplies pine log timber under other State Agreement Acts. These will largely determine the level of production from pine plantations during the life of the new forest management plan.

The *Aboriginal Heritage Act 1972* and the *Heritage of Western Australia Act 1990* provide for the protection and management of human cultural heritage that may be affected by resource extraction.


Map 4
Draft Forest Management Plan
Statutory Land Uses -
Mining and Water Catchments
N
0
40
80km
Projection: UTM
Co-ords: MGA (Zone 50)
Legend
Existing and proposed vested lands
Crown reserves - water catchments
State Agreement Acts - mining
Region boundary
LOCALITY MAP
Western Australia
Produced by Information Management Branch and Forest Management Branch
under the direction of Keiran McNamara, Acting Executive Director
Department of Conservation and Land Management, for the Conservation Commission
July 2002
Conservation Commission
MIDWEST
NEW NORCIA
LANCELIN
ML 1SA
NORTHAM
ML 257SA
PERTH
INDIAN OCEAN
SWAN
MANDURAH
ML 1SA
ML 258SA
ML 258SA
DWELLINGUP
NARROGIN
HARVEY
WHEATBELT
Griffin Coal State Agreement Lease
COLLIE
BUNBURY
ML 262SA
SOUTH WEST
KATANNING
BRIDGETOWN
MANJIMUP
AUGUSTA
SOUTH COAST
WARREN
SOUTHERN OCEAN
WALPOLE
DENMARK
ALBANY

2.7 Values within the draft plan area

A management plan is to have the objective of achieving or promoting the purpose for which the land is vested or the purpose for which the care, control and management of the land are placed with the Conservation Commission (CLM Act s 56(1)). For State forest this is one or more of the following CLM Act 55(1a):

(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.

For national park and conservation park it is recreation and conservation, and for nature reserve it is essentially conservation (Appendix 3).

2.7.1 Conservation

Conservation is now generally referred to as the conservation of biological diversity (biodiversity). Biodiversity is the variety of all life forms: the different plants, animals and micro-organisms, their genes and the communities and ecosystems of which they are part.

Biodiversity is usually recognised at three levels: genetic diversity, species diversity and ecosystem diversity.

Genetic diversity is the genetic differences within and between each species. Chromosomes, genes and DNA – the building blocks of life – determine the uniqueness of each individual and each species.

Species diversity is measured most simply by the number of species. So far, about 1.75 million species have been identified world-wide, mostly invertebrates such as insects. Estimates of the number of species in the world range from two million to 100 million, with a best estimate of somewhere near 10 million (World Resources Institute 2001?).

Communities are the sum of species in ecosystems and, as a whole, provide many of the processes that support specific ecosystems and provide ecological services. Ecosystems are much more than the sum of their parts. The myriad of interactions their component species provides an important third level of biological diversity in addition to those of genes and species. Ecosystem diversity is the variety of ecosystems such as those that occur in deserts, forests, wetlands, lakes, rivers and agricultural landscapes.

Australia is one of only 12 megadiverse nations that include some 60 to 70 per cent of all known species (Beattie 1995). A large portion of its species and most of its ecosystems are found nowhere else. Western Australia, comprising about one-third of the Australian continent, has a very high proportion of the nation's biodiversity. In particular, the south-west, from Shark Bay to the western edge of the Great Australian Bight, is one of only 25 megadiverse 'hot spots' in the world (Mittermeier *et al.* 1999), only two of which are located in developed countries.

The south-west is particularly noteworthy for its flora. Typically Australian genera (such as banksia) exhibit by far the greatest diversity in the south-west and 25 per cent of the plant genera are restricted to the area. The flora is richest in the coastal and inland kwongan heaths of the transitional rainfall zone, and poorest in the high rainfall forests and arid zone (Hopper

1979). The uniqueness of the forest ecosystems has been described for the jarrah by Dell *et al.* (1989) and for the karri by Christensen (1992).

The conservation of biodiversity has become an objective of most countries in the world. It was adopted as an aim by many nations (including Australia) that ratified the Convention on Biological Diversity developed at the 1992 'Earth Summit' held in Rio de Janeiro. In 1996 the Commonwealth and all Australian State and Territory Governments adopted *The National Strategy for the Conservation of Australia's Biological Diversity* (Commonwealth of Australia 1996), which followed from Australia's ratification of the Convention on Biological Diversity.

To conserve biodiversity it is necessary to manage natural resources in an ecologically sustainable way. This will require continuing improvement in the understanding of the conservation biology of the State's species and ecological communities, the development of special skills and a continuing development of a conservation ethos in society.

Conserving biodiversity is everyone's responsibility. However, the Conservation Commission and the Department have a major role to play as Parliament has entrusted valuable publicly-owned natural resources and natural areas to their stewardship. The CLM Act 19(1)(a)(c) and (d) sets a function of the Conservation Commission to develop policies for the preservation of the natural environment on the land vested in it and to advise the Minister on policies for the conservation of biodiversity and biodiversity components. Similarly the Department has the function to be responsible for the conservation and protection of flora and fauna throughout the State.

This draft plan is the mechanism by which the Conservation Commission seeks to conserve biodiversity and biodiversity components in the forests and associated ecosystems of the Swan, South West and Warren administrative regions of the Department while providing a level of social and economic uses sought by the public that is consistent with the biodiversity conservation objectives.

2.7.2 Nature-based recreation and visitor experiences

Forests of the south-west region and their associated landscapes provide a diverse and economically valuable resource for recreation and tourism in a wide variety of forms. The Department has 653 recreational assets throughout the south-west region registered on its recreation facility database. An estimated 4.6 million visits for the purposes of recreation and tourism were made in 2000/2001 to land vested in the Conservation Commission, underscoring its value for recreation and tourism.

2.7.3 Timber production

Society has gained considerable wealth from the extraction and use of timber. Approximately 1.4 million tonnes of hardwood log timber were produced in the 1999/2000 financial year. The draft plan will see that reduce significantly, however, native timber products will continue to be economically important produce as a result of the Government's commitment to promote value adding and downstream manufacturing. The outdoor, fine and feature grade furniture industries, for example, generate a high level of employment which can be developed in regional centres of the south-west.

2.7.4 Water catchment protection

There are 45 surface water catchments in the area covered by this draft plan that provide water for public drinking supplies and many streams that supply farm dams. Included in the

surface water catchments are nine major storage reservoirs in the forest north of Bunbury that provide 50 per cent of Perth's water and a great proportion of that for the Goldfields and Great Southern Towns Water Supply Scheme. The protection of these catchments is vital for the well-being of Western Australians living in these areas of the State.

2.7.5 Other values not specifically mentioned in the CLM Act

Minerals

Mineral extraction from land in the draft plan area in 2001 totalled more than $4.7 billion, of which $4.2 billion came from State forest. Royalty payments to the State Government contributed $94.8 million to the State's economy, and the sector directly employed 9,400 during the period. Other significant community benefits, including company and personal taxes and flow-on employment for services and goods needed by the industry, are not documented but would be large. The region supplies a significant proportion of the world demand for a number of these minerals.

Soil

Soils and the organic matter they contain provide the physical, chemical and biological foundation necessary to support and sustain life systems and ecological processes. They are fundamental to biodiversity conservation and the productive capacity from which many social and economic benefits are derived.

Cultural heritage

Heritage comprises the things communities value and want to keep as culture. The concept of heritage can be applied to natural and cultural environments. Cultural environments include sites, structures, facilities and exhibits (the built components), as well as the social, religious and spiritual value placed on land and sea-scapes. In this sense the south-west ecosystems are cultural environments with significant cultural values. Within the draft plan area there exist significant Aboriginal cultural values, 'other peoples' cultural values, and natural cultural values. The draft plan will seek to conserve and protect these values and integrate them with other values described in the draft plan.

Carbon

South-west ecosystems are major carbon reservoirs and play an important role in the global carbon cycle. There is broad scientific agreement that higher atmospheric concentrations of carbon dioxide will result in changes to the Earth's climate patterns. An objective of the draft plan will be to manage the south-west ecosystems to help reduce carbon dioxide build-up or at least limit their contribution to it.

3 Biological diversity

The conservation of biodiversity has broad economic, intrinsic, altruistic, and environmental value. At its simplest level, conserving the diversity of organisms will support the ability of ecosystems to function, reproduce and remain productive following disturbance.

The south-west of Western Australia is an area of mega-diversity for flora, however, the centres of this diversity are in the northern and southern sandplains and the Wheatbelt rather than the forests. Most species of vascular plant and vertebrate animals occurring in the south-west forests are widespread and not confined to the forest. Whereas the level of endemism for the vascular flora of the South-west Botanical Provinces is around 68 per cent (Marchant 1973), the level of endemism for well studied taxa of plants, vertebrates and invertebrates in State forest dominated by trees was estimated to be only 3.7 per cent by Abbott and Christensen (1996).

Nevertheless, human activities can impact adversely on biodiversity by removing or altering habitats, introducing invasive species, or reducing the population or ranges of species. Most loss of biodiversity in the south-west is associated with clearing, particularly on the Swan Coastal Plain and the woodlands to the east of the area covered by this draft plan. Therefore management activities, particularly those where the objective is to produce the commercially sought goods and services, must be done in a way that does not irreparably damage the ability of the ecosystems to recover.

3.1 Objectives

Whole of forest objectives

- To conserve biological diversity in a manner taking account of the principles of ecologically sustainable forest management.
- To sustain biological diversity and ecological integrity in all ecosystems, through the proposed expansion and management of a comprehensive, adequate and representative conservation reserve system integrated with complementary management across State forest and timber reserves.
- To develop an improved understanding of the biological diversity and the nature of and ecological responses to natural and key human-induced disturbances in the forest regions.
- To maintain self-sustaining populations of native species and communities.
- To protect threatened species and threatened ecological communities.

Landscape objectives

Take all reasonable measures to:

- Ensure a diverse representation and distribution of forest structures, habitat elements and seral stages through time.
- Ensure that biological diversity (species richness) recovers between one rotation and the next.
- Protect ecologically sensitive communities and niches such as riparian zones, aquatic ecosystems, wetlands, granite outcrops and other non-forested complexes.

- Prevent any species moving to a higher category of threat as a result of management actions and in particular that no species declines to irretrievably low levels.

Operational objectives

To take all reasonable measures to:

- Retain key environments, habitats and habitat elements necessary to sustain flora and fauna species at sufficient levels to support recolonisation of regrowing forest once it has become suitable.
- Protect occurrences of conservation values identified as significant (such as declared rare flora and diverse ecotype zones) outside formal conservation reserves.
- Ensure that impacts on flora diversity and abundance that arise from silvicultural treatments to reduce competition between understorey and commercial species remain within acceptable limits.

3.2 Summary of management scenarios

The two scenarios put forward for public comment are summarised below. The options for additional mature habitat zones, further reservation and buffers for the informal reserves for old-growth forest are discussed in this section. Further information about the unused prior timber allocation and the analysis of the range of sustained timber yields produced by the scenarios are discussed in section 4.2. Proposals under consideration as part of the revision of the current silvicultural guidelines are summarised in Appendix 5.

The scenarios provide a range of management options that generate a lower and upper limit to the sustained yield while taking into account the principles of ecologically sustainable forest management. In arriving at a final forest management plan the scenarios will be varied in response to public and other agencies comment. This process will integrate long and short-term economic, environmental, social and equitable considerations leading to a single scenario for forest management. In order to arrive at a position for the final plan the balance between biological diversity conservation and socio-economic objectives will be sought by, for example:

- Reducing the requirement for additional mature habitat zones under Scenario A while still achieving their purpose. This could involve varying the proportion of forest retained by increasing the size of the area within which each additional 200-hectare zone is to be retained from the present value of 1,000 hectares (i.e. a reduction from 20 per cent to, say 18 per cent). Another option would be to waive the requirement when in close proximity to an existing or proposed conservation reserve (e.g. if within two kilometres, or five kilometres).
- Including a provision for buffers around old-growth patches under Scenario B or, conversely, reducing the width of the buffers under Scenario A from 40 to, say, 25 or 10 metres.
- Varying proposals to increase the number of habitat and potential habitat trees retained when in the vicinity of an additional mature habitat zone containing suitable alternatives.

Scenario A for jarrah

- assumes the existing and proposed reserve system and management actions that lead to the revised annual indicative yield for first and second grade sawlogs of 182,000 cubic metres;
- introduces additional mature habitat zones;
- allows for an increase in formal reserves as an outcome from the assessment of high conservation value areas or the finalisation of reserve boundaries;
- introduces a 40-metre buffer for informal reserves for old-growth forest;
- allows for a revision of the current silvicultural guidelines;
- allows for a higher impact than Scenario B on the sustained timber yield from risk management factors currently being assessed (dieback rate of spread, impacts of climate change and disease);
- allows for a higher impact than Scenario B on the sustained timber as a result of current work to update data;
- leads to a consequent sustained timber yield calculated at 106,000 cubic metres per annum, with an additional total of 339,000 cubic metres from the unused prior timber allocation.

Scenario B for jarrah

- assumes the existing and proposed reserve system and management actions that led to the revised annual indicative yield for first and second grade sawlogs of 182,000 cubic metres;
- allows for a revision of the current silvicultural guidelines;
- allows for a lower impact than Scenario A on the sustained timber yield from risk management factors currently being assessed (dieback rate of spread, impacts of climate change and disease);
- allows for a lower impact than Scenario A on the sustained timber as a result of current work to update data;
- leads to a consequent sustained timber yield calculated at 164,000 cubic metres per annum, with an additional total of 339,000 cubic metres from the unused prior timber allocation.

Scenario A for karri

- assumes the existing and proposed reserve system and management actions that led to the revised annual indicative yield for first and second grade sawlogs of 42,000 cubic metres;
- introduces additional mature habitat zones;
- allows for an increase in formal reserves as an outcome from the assessment of high conservation value areas or the finalisation of reserve boundaries;
- introduces a 40-metre buffer for informal reserves for old-growth forest;
- allows for a revision of the current silvicultural guidelines;
- allows for a higher impact than Scenario B on the sustained timber yield from risk management factors currently being assessed (dieback rate of spread, impacts of climate change and disease);
- allows for a higher impact than Scenario B on the sustained timber as a result of current work to update data;
- leads to a consequent sustained timber yield calculated at 31,000 cubic metres per annum, with an additional total of 203,000 cubic metres from the unused prior timber allocation.

Scenario B for karri

- assumes the existing and proposed reserve system and management actions that led to the revised annual indicative yield for first and second grade sawlogs of 42,000 cubic metres;
- introduces shorter rotation lengths in less than 5 per cent of regrowth stands, as explored by the independent panel (Ferguson *et al.* 2001) reviewing the sustained timber yield in the context of ecologically sustainable forest management (100 hectares per annum in total, cut in maximum patches of 20 hectares, in regrowth older than 75 years rather than the nominal 100 years as currently applies);
- introduces enhanced flexibility in accessing two tiered stands, as examined by the Ferguson Panel (temporary exclusion areas (TEAS) must be left around clearfelled areas for 30 years, but bigger TEAS than required are sometimes created as a result of the 40-hectare limit on clearfelled areas; the Ferguson Panel explored making these additional areas available for harvesting after five years, rather than 30);
- allows for a revision of the current silvicultural guidelines;
- allows for a lower impact than Scenario A on the sustained timber yield from risk management factors currently being assessed (dieback rate of spread, impacts of climate change and disease);
- allows for a lower impact than Scenario A on the sustained timber as a result of current work to update data;
- leads to a consequent sustained timber yield calculated at 62,000 cubic metres per annum, with an additional total of 203,000 cubic metres from the unused prior timber allocation.

Note: It would be prudent not to consider all of the volume indicated in Scenario B for karri as available until an analysis of accessibility was undertaken.

3.3 Strategies

Management strategy
Implement the proposed system of nature reserves, national parks, conservation parks and other reserves for conservation purposes.

Background

The establishment of a comprehensive, adequate and representative reserve system is fundamental to the conservation of biodiversity in the forest. The formal conservation reserve system proposed in this draft plan is based on the National Reserve System principles to select areas to meet CAR targets (Appendix 6) and additional reserves as a result of Government policy decisions, most notably the *Protecting our old-growth forests* policy.

The land categories included in the formal reserve system are nature reserves, national parks, conservation parks, and CLM Act section 5(1)(g) and (h) reserves with a conservation purpose. The proposed reserve system makes the following additions (Appendix 7) to the gazetted reserves in the draft plan area:

- reserves proposed in the Government's *Protecting our old-growth forests* policy (with alternative areas for those reinstated reserve proposals within State Agreement Act mining leases, as described in Appendix 8);
- reserves proposed in the Regional Forest Agreement but not yet gazetted;
- reserves proposed in the 1994-2003 Forest Management Plan but not yet gazetted; and
- reserves proposed in the 1987 Regional Forest Management Plans but not yet gazetted.

Proposals to change land category will be subject to the normal review process. This involves consultation with affected Government and local government authorities (including the Department of Mineral and Petroleum Resources and the Water and Rivers Commission over issues such as existing mining tenements and future dam sites respectively). Local community advisory groups will also be consulted as part of the process of determining final reserve boundaries. The boundaries of the proposed conservation reserves shown in Map 5 may therefore be refined during this consultation process. Wherever boundary changes are made, a similar level of protection of conservation and other values will be sought. The agreement of both Houses of Parliament is required to changes involving Class A reserves or State forest.

Where different reserve proposals have been made for the same area, the most recent proposal is put forward in this draft plan.

The design of the reserve system has had to be addressed in two separate parts, that inside the RFA area and that outside, because of the different level of vegetation mapping available (see Appendix 6).

Reserve system inside the RFA boundary

The areas and percentage of forest ecosystems in the proposed reserve system inside the RFA boundary are detailed in Appendix 9 and Appendix 10 respectively. The figures shown are calculated using forest ecosystem mapping prepared for the RFA to assess how CAR targets were being met. The CAR targets for ecosystem representation are for the whole of the RFA area, some of which occurs outside the area covered by this draft plan. However, as this only amounts to some 4,500 hectares of a jarrah ecosystem and 2,400 of the shrub, herb and sedgelands ecosystem, it is considered reasonable for the targets to stand.

The data in Appendix 9 are summarised for existing and proposed formal reserves in Table 6.

Table 6: Reservation levels of forest ecosystem categories (within the RFA area)

Forest ecosystem category	Total pre-1750 extent (ha)	Present extent on all lands in the three regions (ha)	Formal conservation reserves (ha)			
			Existing reserves (Additions proposed)			
			National park	Nature reserve	Conservation park	5(1)(g) and (h)
Jarrah dominant	2,783,950	1,806,650	137,750 (363,670)	13,620 (9,750)	12,760 (60,190)	12,650 (240)
Karri dominant	231,600	190,160	48,920 (42,850)	250 (130)	10 (400)	0 (0)
Wandoo dominant	526,200	218,680	25,290 (30,900)	5,040 (780)	8,310 (24,220)	0 (0)
Other	594,600	408,570	163,100 (131,770)	7,590 (1,540)	270 (2,190)	520 (20)
TOTAL	**4,136,350**	**2,624,060**	**944,250**	**38,700**	**108,350**	**13,430**

Note: In addition the following areas are protected from timber harvesting in proposed forest conservation areas and informal reserves: 157,160 ha jarrah dominant forest; 22,880 ha karri dominant forest; 8,790 ha wandoo dominant forest; and 39,280 ha other forest ecosystems.

Within the RFA boundary the existing and proposed formal reserve system contains 26.7 per cent of the pre-1750 extent of forest ecosystems, and 42 per cent of their current extent. Forest conservation areas contain a further 0.5 per cent and informal reserves a further 5 per cent of the pre-1750 extent. This means 32.2 per cent of the pre-1750 extent of forest ecosystems is set aside from timber harvesting.

Jarrah dominant ecosystems are represented in existing and proposed formal reserves at 22 per cent of the pre-1750 extent and 33.7 per cent of their current extent. Karri dominant ecosystems are represented at almost 40 per cent of the pre-1750 extent and 48.6 per cent of their current extent.

However, five ecosystems could not be represented at their target level. These were: Jarrah Rates Tingle, Jarrah Red Tingle, Karri Rates Tingle, Bullich and Yate, and Darling Scarp. Because of their limited extent the target for the first four ecosystems was all of the current extent and for the more widespread Darling Scarp it was 15 per cent of the pre-1750 extent. Protection of these ecosystems on private land is required to meet the target levels.

A reserve system based on floristic assemblages alone may not be comprehensive, adequate or representative, however, a better assessment would require a systematic regional biological survey of a broader range of taxonomic groups than is currently available. The completion of such a survey is a strategy of this draft plan.

Reservation levels for old-growth forest are summarised in Appendix 11. All defined old-growth forest on land vested in the Conservation Commission is now protected either in the

reserve system or by informal reserves in State forest (Map 6). Some old-growth forest occurs on public land not vested in the Conservation Commission. The only significant extent is for the ecosystem Jarrah Leeuwin where the 38 hectares represents nearly six per cent of the extant area.

Appendix 7 and Map 5 show those reserves that were approved in the 1987 Regional Management Plans, the 1994-2003 Forest Management Plan, and the RFA, but which have not yet been gazetted. They also include the reserve proposals in the Government's old-growth forest policy (mapped with indicative boundaries).

Reserve system outside the RFA boundary

The land within the draft plan area outside of the RFA boundary is on the Swan Coastal Plain between the Moore River and Cape Naturaliste and south of the South Coast Highway between the Irwin and Wilson inlets and the north east of the draft plan area. Forest ecosystem mapping has not been undertaken in this area.

This land has a multiplicity of land categories, including a large amount of private ownership that is extensively cleared. Unlike the RFA region the 166,500 hectares of land vested in the Conservation Commission is a small proportion of the total land area (14 per cent) making the task of establishing a CAR reserve system much more difficult. In addition, most of the land vested in the Conservation Commission (61 per cent) and the majority of the native vegetation (75 per cent) is already part of the formal reserve system hence has a conservation priority for its management. Formal reserves vested in the Conservation Commission are best represented in the area between Perth and the Moore River and on the south coast and between Mandurah and Bunbury. There is very little of the formal reserve system in the Perth Metropolitan Region (Perth to Mandurah) and between Bunbury and Cape Naturaliste.

The Beard-Hopkins vegetation association mapping (e.g. Beard 1979b and Hopkins *et al.* 1996) is the only mapping that is complete across the region, although the map boundaries require field checking as they are inconsistent with other vegetation mapping where there should be strong correlation. The Beard-Hopkins mapping has been used to identify the vegetation associations that occur predominantly (more than 75 per cent of their extent) outside the RFA region and to assess their level of representation on land vested in the Conservation Commission (see Appendix 12). The information in Appendix 12 should only be used as a guide to the level of representation in the reserve system of these vegetation associations.

There are 75 Beard-Hopkins vegetation associations that occur within the total draft plan area, of which 42 occur predominantly outside the RFA region (Appendix 12). Of these 42 vegetation associations, seven have no presence on public land. Of the 35 associations with a presence on public land, only 19 have a representation in existing and proposed conservation reserves greater than 15 per cent of their estimated pre-1750 occurrence. Ten of the remaining 16 have virtually no representation in formal reserves. For only one vegetation association (Shrublands, scrub-heath Dryandra-Calothamnus assoc. with *Banksia prionotes* on limestone in the northern Swan Region) is there enough of the association on land vested in the Conservation Commission outside the reserve system to raise the representation level to 15 per cent (Appendix 13).

The mechanisms for development of the reserve system within the draft plan area but outside the RFA are described in Appendix 6.

Further reservation

The old-growth forests policy includes a commitment to:

complete a rigorous assessment of other high conservation value areas to be included in the reserve system within one year of election.

An independent assessment has been completed and is being considered by Government. Pending the decision on whether or not further forest areas will be added to the formal conservation reserve system, Scenario A assumes an impact on the sustained yield from further reservation, and Scenario B assumes no impact (see section 3.2).

Potential threats	1. Areas not managed appropriately prior to the change in land category and purpose. 2. Changes in land category and purpose progress too slowly. 3. Reserve system that is not comprehensive, adequate or representative.
Management actions	1. Undertake the consultation processes for progressing the land category changes proposed in the approved forest management plan to establish the conservation reserve system. 2. Manage the proposed formal conservation areas in this draft plan in accordance with guidelines for their proposed land category and purpose. 3. Work with the Departments of Environmental Protection and Planning and Infrastructure, and other agencies to establish and implement processes to achieve a CAR reserve system outside the RFA area.

Management strategies

In forest areas outside the formal reserve system, implement a system of informal reserves that assists in meeting the comprehensive, adequate and representative targets for reservation of forest ecosystems.

Manage State forest and timber reserves so as to complement the formal and informal reserve system.

Background

While a system of formal reserves is the first important step in conserving regional biological diversity, it is not considered sufficient to sustain and protect ecological processes in isolation from the rest of the environment (Department of Conservation and Land Management 1992a). To achieve the biological diversity conservation objectives it is necessary for management in forest disturbed for productive uses to be sensitive to biodiversity conservation at the landscape and operational scale. One mechanism to achieve this is to establish a network of areas at the landscape and operational scale where disturbance of the vegetation is strictly limited.

State forest and timber reserves can be set aside for biodiversity conservation and the protection of other values as forest conservation areas (a statutory land classification that can exclude timber harvesting) or as informal reserves (areas protected by the provisions of a management plan). See Appendix 3 for further details. Forest conservation areas and informal reserves may contribute to the CAR reserve system (see Appendix 6).

Informal reserves need to be protected from disturbance during management activities in adjacent forest and managed for their biodiversity conservation values (see Appendix 14 for

interim management guidelines). Scenario A provides for an extension to the informal reserves for old-growth patches through buffers of non-old-growth forest. The scenario considers a 40-metre wide buffer, based on one tree height in the jarrah forest. However, a smaller buffer could be appropriate if its key purpose was to prevent accidental damage to old-growth forest from machinery operating in adjacent areas.

Additional areas, such as those required to meet the current specification to limit the distance between patches of mature karri forest to no more than 400 metres and the additional mature habitat zones discussed in Scenario A, are not informal reserves as they may be replaced in the future when other areas develop similar characteristics.

A management plan has no authority to impose informal retention of forest in areas subject to open-cut mining under a State Agreement Act. Nevertheless, the Department will seek to have informal reserves or their intent respected by all forest users.

Potential threats	1. Informal reserves not implemented as prescribed. 2. Established informal reserves not protected from disturbance. 3. Management of informal reserves not appropriate for their conservation objective.
Management actions	1. Implement and manage the informal reserve system in accordance with the specifications set out in codes of practice and management guidelines. 2. Require and audit compliance with management guidelines for the protection and management of informal reserves.

Management strategy

Ensure that the capacity to retain or regain original habitat elements over time is not compromised, including the retention of adequate habitat trees and potential habitat trees.

Background

While a system of formally and informally reserved areas in which disturbance is restricted is the first important step in conserving fauna populations, it is not sufficient to fully meet the objective of sustaining populations of fauna at the operational scale post-disturbance from timber harvesting. Such populations can be sustained by supplementing the main strategies with the retention of key habitat components that might otherwise be lost.

The Department has conducted research over the past seven years on the impact of the current silvicultural prescriptions for jarrah on a range of biodiversity components (Kingston study) including:

- ground-dwelling mammals e.g. woylie and chuditch;
- arboreal mammals e.g. western ringtail and common brushtail possums;
- herpetofauna;
- invertebrates;
- birds;
- vascular plants; and
- cryptograms.

The ongoing study is providing information on the retention of habitat components at the operational scale to meet the objective to sustain viable fauna populations. Results to date indicate that 42 species of birds, mammals and reptiles use hollows in standing trees although seven of these mainly use hollows in logs on the ground (Abbott and Whitford 2002). Species identified as most vulnerable to loss of tree hollows include rufous tree-creeper, common brush-tail possum, wambenger, sacred kingfisher, red-capped parrot, and western rosella. Habitat components that require retention to provide for all species include:

- mature trees with hollows and intermediate age trees that provide or can produce hollows in the mid term; and
- logs, stumps and balga (grass trees) for ground habitats.

The Department's silvicultural guidelines provide for the retention of habitat components in timber harvesting operations. The current review and update of silvicultural guidelines examines retention levels in the light of ongoing research and recommends amendments where research suggests it is prudent to do so. See Appendix 5 for a summary of proposed changes.

When forest is harvested in advance of clearing for mining (Map 4), specifications for retention of habitat components in the silvicultural guidelines do not apply.

Scenario A considers setting aside even further areas of State forest to increase the proportion of mature habitat elements retained in forest blocks. These areas, termed additional mature habitat zones, would provide additional sources for species to recolonise harvested patches. A target of 200-hectare patches per 1000 hectares across each forest block is considered, based on the range considered necessary for a viable sub-population of western ring-tail possums. It should be stressed that the mature habitat zones are intended to protect a full range of biodiversity values and are not solely for the conservation of a few species. These patches are selected for their mature habitat characteristics, although it is recognised that because of past cutting, mining and dieback extent, a range of stand structures may contribute to the 200-hectare patch. Mature forest within areas already set aside from timber harvesting, such as formal reserves, old-growth, stream zones and other informal reserves, can contribute to mature habitat zones. While the selection of additional zones to meet the target patch size would aim to consolidate or link with formal and informal reserves, the additional habitat zones would eventually be available for harvest once their habitat function could be succeeded by older patches of adjacent regenerated forest.

The Conservation Commission recognises that further work is needed to refine the proposal for additional mature habitat zones before they could be adopted. Issues to be explored include the need for additional zones in close proximity to large reserves, the distribution of the additional mature habitat zones, and whether it would be necessary to retain habitat trees as well as additional mature habitat zones.

Potential threats	1. Inadequate information on habitat requirements of species that led to ineffective retention standards. 2. Non-compliance with the retention guidelines that led to a loss of some populations at the landscape scale.
Management actions	1. Undertake research on the effect of habitat loss on key faunal species and review the habitat requirements as information becomes available. 2. Maintain standards for the protection of selected habitat components in codes of practice and other guidelines. 3. Audit the implementation of the habitat protection requirements.

Management strategy

Liaise, in consultation with the Department of Mineral and Petroleum Resources, with mineral and petroleum companies operating in the forest regions to encourage their continued cooperation in forest management and their adoption of strategies that are complementary to the forest management plan's objectives and strategies.

Background

Much of the land subject to this plan in the Swan and South West Regions is also within a State Agreement Act lease area (see Map 4). The proposals in this draft plan do not bind the operations of the State Agreement Act Mining Act or Petroleum Act leaseholders.

The Conservation Commission recognises that, in the northern jarrah forest mining is a significant disturbance to forest structure. Hence, complex strategies for the retention of informal reserves and habitat elements to sustain biodiversity in the presence of timber harvesting may be pointless in the medium term if the area is to be mined.

The nature of open-cut mining tends to leave a mosaic of mined and unmined forest, however, the extent to which that meets the Conservation Commission's objectives as set out in this draft is unclear. The Conservation Commission intends to explore the achievement of its strategies with mining companies.

Potential threats	1. Structural and habitat retention strategies to sustain biodiversity in timber harvesting operations potentially impacted on by mining operations.
Management actions	1. Review the current structural mosaic within the mining envelope. 2. Liaise with mining companies on the practicality of achieving the proposals in the draft plan.

Management strategy

Prepare guidelines to integrate management of biodiversity conservation, conservation reserves, and informal reserves.

Background

The draft forest management plan is a regional plan covering all land categories vested in the Conservation Commission within the plan area. However, the focus of the draft plan's management proposals is State forest and timber reserves where the objectives for management allow greater disturbance of the vegetation for the production of goods and services. It is expected that more detailed proposals for management of the conservation reserves will be contained in area management plans that are yet to be developed for the much of the proposed reserve system.

State forest and timber reserves comprise approximately half of the area subject to the draft plan. To work toward the achievement of ecologically sustainable forest management it is necessary to consider implementation of many of the objectives and strategies proposed in the draft plan at a whole of forest scale rather than just on State forest and timber reserves. This is reflected in the use of scales to set objectives and strategies detailed in the chapter 'Ecologically sustainable forest management'.

In particular, strategies to sustain biodiversity in the draft plan area include actions that must be integrated across the reserve system and State forest and timber reserves. The most notable is the establishment of a mosaic of overstorey and understorey structures at the landscape scale. For the mosaic of structures, because different disturbance regimes are allowable in conservation reserves and State forest, the different land categories can provide different elements of the range of structures desired within the landscape. Therefore their management must be complementary if landscape scale strategies are to be achieved.

The Conservation Commission will prepare a set of guidelines for planners to ensure that area management plans for reserves adequately integrate ecologically sustainable forest management requirements outside their boundaries with the management of the reserve.

Potential threats	1. Area management plans not in sympathy with draft plan whole of forest objectives and strategies.
Management actions	1. Conservation Commission to prepare high-level guidelines for the preparation of area management plans for conservation reserves in the draft plan area.

Management strategy

Identify, and ensure that management actions lead to the survival of all populations of threatened species and threatened ecological communities.

Background

Threatened flora, fauna and ecological communities occur throughout State forest and timber reserves, and on other lands. Their continued survival and ability to recover is potentially affected by a range of independent 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 threaten them. These activities include road and dam construction, open cut mining, timber harvesting, wildflower harvesting, planned burning, recreational facility development and public use and access.

The Department prepares recovery plans (Appendix 15) for threatened flora, fauna and ecological communities, on a priority basis (Department Policy No. 50). Management procedures and systems have been developed that address the protection of threatened species and ecological communities. These 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' (Department Policy No. 9, 'Conservation of Threatened Flora in the Wild'; Department Administrative Instruction No. 24, 'Protection of Endangered Flora in Departmental Operations'; Department Policy No. 33, 'Conservation of Threatened Fauna in the Wild'; Department Administrative Instruction No. 44, 'Protection of Endangered and Specially Protected Fauna in Departmental Operations').
- The development of the Forest Vertebrate Fauna Distribution Information System (Christensen *et al.* 2001). The system combines the vegetation complexes mapped for the RFA into 52 fauna habitats and correlates those habitats with the likely presence in them of 297 vertebrate fauna species. It can then be used to predict the likely occurrence of sensitive species, relative to forest management activities.

Broadscale programs to address threatening processes, such as Western Shield to control foxes, have proved markedly successful and will be maintained.

Potential threats	1. Not all threatened species or ecological communities identified and listed. 2. Listed threatened species decline or threatened ecological communities reduce in area and composition. 3. Listed threatened species taken in a management activity.
Management actions	1. Maintain a process for identifying and listing threatened species and ecological communities and for listing priority species and ecological communities (those that may be threatened but for which there are insufficient survey data and those that are rare but not threatened). 2. Develop and implement recovery plans for threatened species and ecological communities. 3. Maintain and implement procedure, based on risk assessment, to identify threatened species and ecological communities requiring protection from proposed management activities.

Management strategies

Manage the overstorey and understorey vegetation structure to achieve a mosaic with spatial and temporal diversity.

During the term of the approved plan develop, through a process involving key stakeholders, structural goals for both the conservation reserves and State forest and timber reserves to complement each other and the plan's objectives.

Background

The maintenance of biological diversity and the provision of the full range of species and community components at the landscape and operational scales are dependent on a diverse representation of overstorey and understorey vegetation structures through time and space.

Overstorey structure

A stand of trees can be categorised into distinct phases or developmental stages as it grows from seedling to senescence and the structural characteristics of each stage have significance for biodiversity and other forest values (see Appendix 2).

Timber harvesting and regeneration, mining and rehabilitation and intense fire change overstorey structure from mature components to juvenile components. If unregulated, they have the potential to lead to a forest structural distribution skewed to the juvenile structures to the detriment of some key components of the biodiversity. On the other hand, a forest composed of predominantly mature stages of development may not have enough younger stages moving through to replace them when they die. Therefore, goals for the structure of the overstorey are a means of ensuring that the stages of development are represented in the proportions necessary to sustain stability in forest structure at the whole of forest scale and meet biodiversity conservation objectives.

The formal and informal reserve systems are mechanisms introduced to, among other things, provide the means of sustaining mature seral stages in the overstorey at the landscape and operational management scale. Thus structural goals provide a direct means of integrating forest managed for timber production and that managed primarily for biodiversity conservation.

The previous forest management plan set structural goals for karri and jarrah forest at the whole of forest scale, to maintain a balanced distribution of structural stages and ensure the critical stage, mature and senescent, did not decline below a minimum level (see Appendix 2). These goals are retained for the draft plan although greater flexibility in rotation lengths; as proposed by Ferguson *et al.* (2001) will be explored without impacting significantly on the goals.

While a whole of forest goal is a useful starting point it provides no framework for the geographic distribution of the structural stages – a structure meeting the whole of forest goal could be highly skewed spatially. The scale of existence of forest fauna is generally between the landscape and the operational scale, so the whole of forest goal needs to be translated to goals at these scales to manage for the maintenance of biodiversity. However, it is premature to set structural goals at the landscape scale because of uncertainties that cannot be resolved prior to completion of this planning process. These are:

- The lack of information on the relationship of fauna with forest structure. For example, it is known that some 42 forest-dwelling species use hollows that mainly occur in mature and senescent trees (Abbott and Whitford 2002). What is not known is how many hollows individual species require to sustain a viable presence at the operational and landscape scale and what that might mean in terms of a goal for mature structure at these scales. Nor has management reached a stage where it is possible to quantify desirable representation of fauna species at different scales.
- The appropriate landscape scale unit.
- The implications of alternative structural goals for other values.
- Finalisation of the reserve boundaries and harvest levels.

Notwithstanding these uncertainties there has long been an implicit management objective to sustain fauna at the operational scale and the establishment of the informal reserve system and the retention of structural components in silvicultural guidelines are strategies that have been and are employed in this draft plan, to achieve that end. The specifications for these, particularly the retention of structural components in harvesting, have been based on some research, informed estimation and a precautionary approach. However, an inability to be able to quantify the benefit these measures provide for biodiversity conservation makes explicit trade-offs, particularly with timber, difficult.

Therefore, while the objectives for retention of structural components at the operational scale have not been explicit, the guidelines for doing so have been quite prescriptive and readily capable of compliance checking. Current measures to provide structural diversity at the operational level are described in silvicultural guidelines (Appendix 5).

While the uncertainties listed are never going to be definitively resolved, it is possible to establish a best estimate position by drawing together existing expertise. It is proposed to develop the goals during the first five years of the approved plan using an expert system approach to assess a range of structural scenarios from the operational to the landscape scale for their adequacy in meeting biodiversity and other draft plan objectives.

Understorey vegetation structure

The early, middle and late successional stages of understorey vegetation often suit different fauna species, making it desirable to sustain a mosaic of understorey stages, particularly at the landscape scale.

The structure of shrub vegetation in the forest and associated ecosystems is essentially determined by fire: its frequency, seasonality and to a lesser extent, intensity. The management of fire will therefore be the mechanism to manipulate the understorey to meet objectives for structural diversity. The appropriate distribution of seral stages is problematic. However, work on fire-sensitive species of trees subject to natural periodic stand replacing fire shows that they develop a distribution of age classes that is a negative exponential, i.e. most area in the younger stages and a rapidly decreasing area with increasing age (van Wagner 1978). The situation for understorey vegetation in the south-west should be analogous and provides some guidance to the development of the mosaic. Fire is also used to achieve other land management aims, such as regeneration of cut-over forest, and to reduce fuels to lessen the risk of wildfire to life and property (see 'Ecosystem health and vitality').

Fire management is complex because it must integrate such diverse objectives and consequently is the subject of considerable public interest. Government has committed to a public review of fire management to be undertaken by the EPA. The question of goals for structure of understorey vegetation will be addressed in the public review.

Potential threats	1 Structural diversity of the overstorey inadequate to sustain biodiversity at the landscape and operational scale. 2 Diversity of understorey vegetation structure inadequate to sustain diversity.
Management actions	1. Sustain the whole of forest overstorey structural goals established in the Forest Management Plan 1994-2003 (Appendix 2) with flexibility in rotation length. 2. Undertake an expert system approach to determining a suitable landscape scale unit and the overstorey structural objectives for it. 3. Implement overstorey structural goals at the operational scale as defined in guidelines. 4. Develop, with public input, guidelines for the establishment and maintenance of understorey structural diversity at the landscape and operational scale.

Management strategies

Manage areas containing vegetation complexes poorly represented in formal and informal reserves and other significant flora to protect these values through the appropriate guidelines.

Manage areas functioning as corridors between formal reserves to protect this value.

Background

The criteria for a CAR reserve system (see Appendix 6) do not set quantitative targets for vegetation complexes, as they do for forest ecosystems. However, vegetation complexes have been examined and used in reserve design to enhance representativeness, geographic replication, and protection of remnant elements of biodiversity within forest ecosystems.

Vegetation complexes were also used in the assessment of high conservation value forest to see if those complexes less well represented justified additional reservation as a component of high conservation value. The Conservation Commission generally took the view that protection of vegetation complexes that were less well represented in the reserve system could best be undertaken through site specific management.

Areas may also be especially significant in terms of providing linkages or corridors between formal reserves and may warrant specific consideration of that value in its management.

It is intended that areas of State forest containing vegetation complexes that are less well reserved and functioning as a corridor between formal reserves will receive more sensitive management. This could entail, for example ensuring the linkage zone or vegetation complex is not uniformly disturbed and having longer return cycles for disturbance operations.

Potential threats	1. Management not sensitive to site specific values.
Management actions	1. Identify less well represented vegetation complexes and forest with significant value as a corridor between formal reserves. 2. Develop management guidelines designed to protect the respective values.

Management strategies

Undertake a comprehensive biological survey of the forest regions as soon as resources permit.

Research the response of forest ecosystems to natural disturbance, with a view to improving forest management practices.

Continue to develop knowledge of the impacts of forest management practices on the key components of biological diversity and ecosystem function and maintain guidelines and other subordinate documents that prescribe measures to limit impacts to within acceptable levels.

Background

Biological survey

While there have been local surveys of the fauna and flora in the draft plan area and it is considered that there is a good broad understanding of the biodiversity, a systematic biological survey has never been undertaken. Systematic biological surveys are the best means of assessing the biodiversity of a region and designing a conservation reserve system.

A systematic regional biological survey of a broader range of taxonomic groups than is currently available would provide better information on which to base management for the conservation of biodiversity. However, the conservation knowledge in the forests is higher and the risks to biodiversity lower than in many other areas in the State.

Disturbance of forest ecosystems

Understanding the effect of natural and human-induced disturbance on ecosystems and their functioning is fundamental to management. This knowledge is used to plan the timing, scale and mechanics of operations so that the objectives for biodiversity can be met while achieving

other objectives. Reviews of the response of components of the biodiversity to disturbance, both natural and human caused, were undertaken and published in the RFA process.

Knowledge on the response of ecosystems to disturbance is gained through research and monitoring. Research is ongoing and is described under the strategy *Generate and transfer knowledge and develop the necessary skills and competencies in staff* in the 'Plan implementation' chapter of the draft plan. Systematic monitoring has not been undertaken previously and is an initiative of this draft plan. The monitoring proposed is discussed under the strategy *Monitor key characteristics of the environment and management operations and continually improve forest management both routinely and through adaptive management trials as previously identified.* This strategy is also in the 'Plan implementation' chapter.

Potential threats	1. Some biodiversity components not adequately catered for.
Management actions	1. Prepare a case for a biological survey of the draft plan area. 2. Undertake the survey when resources and priorities permit.

3.4 Key performance indicators

Key performance indicators are being used to track the achievement of the approved plan's objectives and its implementation. The background to the development of key performance indicators is described in the 'Plan implementation' chapter under the heading key performance indicators.

Five indicators have been selected to provide a broad cross-section of the objectives related to conserving biodiversity.

Key performance indicator 1	The representation of forest ecosystems in reserves.
Performance measure	Area of each forest ecosystems by land category (existing and proposed separately).
Performance target(s)	25 per cent of the individual areas proposed for the reserve system to have security of land category and purpose by the end of the plan.
Reporting	Biennial.
Response to target shortfall	Identify reasons for reserve not being established in report for Conservation Commission and address those within the control of the Department.

Key performance indicator 2	The status of (critically endangered, endangered, vulnerable, conservation dependent) forest-dwelling species and ecological communities at risk of not sustaining viable breeding populations as determined by listing.
Performance measure	List of species and ecological communities and their status that tracks movements of species between protection categories.
Performance target(s)	No species or ecological community will move to a higher category of threat as a result of management activities.
Reporting	Every time the lists are revised.
Response to target shortfall	Investigate the cause and report to the Conservation Commission.

Key performance indicator 3	The status of selected threatened or conservation dependent species that are the subject of management actions to protect them.
Performance measure	The trap success for animals at selected monitoring sites.
Performance target(s)	As per recovery plans.
Reporting	Annual.
Response to target shortfall	Investigate the cause and report to the Conservation Commission.

Key performance indicator 4	The extent of compliance by forest users with requirements to protect informal reserves and habitat prescribed in codes of practice and guidelines.
Performance measure	Proportion of samples in compliance.
Performance target(s)	More than 85 per cent of areas sampled to be in compliance.
Reporting	Annual.
Response to target shortfall	Investigate the cause and report to the Conservation Commission.

Key performance indicator 5	Compliance with the size and distribution of timber harvesting cells (gaps in jarrah and clearfelled areas in karri), excluding areas harvested in advance of mining.
Performance measure	The proportion of cells in compliance with the prescribed limits.
Performance target(s)	More than 85 per cent of areas sampled to be in compliance.
Reporting	Annual.
Response to target shortfall	Investigate the cause and report to the Conservation Commission.

4 Productive capacity

Sustaining forest ecosystem productivity is closely linked with the conservation of soils and hydrological regimes in forest catchments, however, these are dealt with under their own criterion for sustainability. The long-term productive capacity of an ecosystem is also related to ecosystem resilience, disturbance and stress.

Society depends on forests directly or indirectly for a wide range of extractive and non-extractive goods and services. Sustaining productive capacity is therefore necessary to enable continued supply of the full range of goods and services to future generations. Opportunities to provide goods and services sustainably are linked to the productive capacity of the forest. If the productive capacity of the forest is exceeded, there is the risk of ecosystem decline. For forests to continue to function, it is necessary to sustain the presence of the forest itself, to understand the levels of goods and services now provided and to determine supply levels that are likely to be ecologically sustainable. The nature and degree of any changes and the factors that account for variations in productive capacity should be examined.

The nature of the extractive goods and services provided from forests will change over time as a consequence of changes in social and economic demands, technology, and actions taken in the forest to provide the goods and services. The use of tools and knowledge to measure progress toward sustainability will also change, but the basic premise of sustainability remains.

It is often useful to monitor changes in productive capacity as a measure for ecological processes that may be difficult to measure in other ways. Changes in capacity could be a signal of unsound forest management or unforeseen agents affecting ecosystems. Significant changes in the ecosystem could be taking place that might reduce the ability of the ecosystem to sustain biodiversity, ecosystem health, or soil and catchment protective functions.

4.1 Objectives

Whole of forest objectives

- To sustain the productive capacity of ecosystems in a manner taking account of the principles of ecologically sustainable forest management.
- To limit the harvesting of timber to the sustained yield taking account of ecologically sustainable forest management.
- To manage the removal of other forest produce from State forest and timber reserves to satisfy as much of the public demand as is appropriate, taking account of ecologically sustainable forest management.
- To increase the scientific knowledge associated with forest management practices.

Landscape/Operational objectives

- To rehabilitate or regenerate forest that has been disturbed to sustain in the longer term the range of flora composition and structural attributes consistent with relevant biological diversity objectives.
- To ensure that the impact of weeds, pests and disease on productive capacity is minimised and take action to reduce impacts where appropriate and practical within the context of ecologically sustainable forest management.

4.2 Strategies

Management strategy
Minimise the loss of forest due to allocation to non-public use and the development of public utilities to that considered essential by Government.

Background

The productive capacity of the forest is diminished if it is alienated and cleared, or retains its land category but still cleared (e.g. for public utilities).

Alienation and permanent clearing of forest in the area of the draft plan is no longer a significant issue and where alienation does occur it is usually as part of an exchange with other landowners that seeks a neutral or net benefit to the forest estate. However, roads to service industrial, domestic and recreational needs, easements for energy transmission and distribution, dam sites, inundated areas and pipelines, and townsites and their associated facilities continue to result in semi-permanent loss of forest area hence productive capacity.

Productive capacity is also lost when forest is cleared when open-cut mining takes place or when disease changes the community structure and composition. Rehabilitation can restore the sites productive capacity depending on the extent of disturbance and the quality of the rehabilitation.

Planning is undertaken by the Forest Products Commission to ensure that the supply of plantation logs will meet commitments under relevant State Agreement Acts. This requires that the productive capacity of the plantation resource base be maintained, usually by replanting to pine following the clearfelling of the stands. However, since many plantations were first established, land use priorities have shifted and re-establishment of pines may not always be the most suitable use for the land.

An example is the plantations at Gnangara (north of Perth) that will be progressively revegetated to native species following their final harvest. This is the result of a Government decision to increase recharge to the underground water resources and, at the same time, provide a large natural area within the northern metropolitan area of Perth. Replacement resource is being sought through sharefarms on agricultural land. Other areas are the Peel and Hamel plantations.

The Ludlow plantation where pines have been interplanted within the tuart forest is another case. The plantation is situated in close proximity to the Tuart Forest National Park and an option for the regeneration of this land following felling of the pine is to enrich the standing tuart forest and include it into the national park. If this were to occur, alternative areas would then need to be replanted to pine if the resource base is to be maintained. Government has made no decision on the area yet.

Potential threats	1. Forest cover progressively lost without any attempt to make up the loss. 2. Unnecessary loss of forest because road or utility requirements not coordinated.
Management actions	1. Work constructively with other organisations so that where alienation of land is necessary, it is balanced by an exchange that provides neutral or positive net gain of productive capacity and ecological values. 2. Promote strategic roads that suit multiple access purposes and the consolidation of utilities on common sites and corridors. Rehabilitate unwanted roads. 3. Wherever possible, guide mining away from areas of high productivity forest.

Management strategies

Ensure through regulation, monitoring and audit that timber harvesting does not exceed the sustained yield and is managed to comply with relevant guidelines.

Monitor the removal of timber and respond when required to ensure that its removal occurs in a manner taking account of ecologically sustainable forest management.

Implement the recommendations of Ferguson *et al.* (2001) relating to refinement of sustained yield calculations during the life of the approved plan.

Background

Calculating a sustained yield

The process of calculating a sustained yield involves projecting the likely woodflows from that portion of the public forest estate in which timber harvesting is a permissible use. The jarrah and karri forest where timber harvesting is not a permissible use includes the formal reserve system of national park, conservation park, nature reserve and CLM Act section 5(1)(g) and (h) reserves with a conservation purpose; State forest classified as a forest conservation area; and other areas of State forest protected for biodiversity or other reasons such as stream zones, travel route zones, diverse ecotype zones and old-growth forest patches.

The future woodflows from the native forests are projected for up to 200 years into the future in order to ensure that the level of harvest permitted during the next decade (i.e. the period of a forest management plan) can be sustained. These woodflows are a function of the areas available for timber production, the condition and inherent growth potential of these areas, the silvicultural and management practices employed, and the provisions adopted to accommodate likely impacts on the future growth and vigour of the forest both during the period of the plan and beyond. The woodflows also depend on the structural goals and other management settings applied to sustain the provision of other products (e.g. water) and values (e.g. aesthetic) from the forest.

The steps in the calculation of sustained yield for the jarrah and karri forests are outlined in Appendix 16, and have been described in detail in Ferguson *et al.* (1997), Turner (1998) and Ferguson *et al.* (2001). They include defining the net areas available for harvest; estimating

the standing volume for the areas; projecting future growth or volume; and then modelling the potential woodflows to determine sustained yield.

In order to facilitate the calculation of a sustained yield within the context of the principles of ecologically sustainable forest management, an independent panel was appointed to review the data, method and systems used for native forests in Western Australia. This review panel used a risk assessment and management approach to evaluate the process of calculating a sustained yield, and in its first stage report recommended a number of refinements to the calculations to ensure consistency with ecologically sustainable forest management (Ferguson *et al.* 2001). Progress has been made in addressing those recommendations that will impact on yield but further work is required prior to finalisation of the plan. The process for calculating sustained yield figures also includes an independent verification by the review panel of the figures in the approved forest management plan.

When calculating a sustained yield the objective has been to determine a non-declining yield of first and second grade sawlogs. Third grade and non-sawlogs are generated as a consequence of the production of the higher quality sawlogs. Consequently, while the sustained yield of sawlogs may be steady or non-declining, the projected supply of the non-sawlog grades can fluctuate over time depending on factors such as the type of forest areas being harvested, the range of silvicultural practices applied and variations in market conditions.

Analysis of scenarios to inform the determination of a sustained yield

The estimation of a sustained yield requires definition of such inputs as the area of forest available for timber production, the silvicultural and management practices to be applied, and other objectives to be met. Varying any of these inputs will generate a different scenario and hence set of sustained yield figures.

In June 2001, the Government announced the indicative yields of 140,000 cubic metres per year for jarrah first and second grade sawlogs, and 40,000 cubic metres a year for karri first and second grade sawlogs. Further development of the 2001 data, silviculture and other components of the ecologically sustainable forest management settings are now at various stages of completion. Consequently, in this draft, the Conservation Commission has developed two scenarios to inform the range within which the sustained yield for the final plan will occur (see section 3.2).

The following settings and assumptions were used to calculate the sustained timber yield figures generated under each scenario.

Area basis

The area available for timber production when the 2001 indicative figures were calculated excluded all existing and proposed conservation reserves from the *Protecting our old-growth forests* policy, all areas that at the time were subject to a harvesting moratorium pending an assessment of conservation values, and all informal reserves (including old-growth areas in State forest). The boundaries for the proposed reserves were an initial interpretation of the policy document.

Subsequent decisions by Government on the moratorium areas and the refinement of some proposed park boundaries have increased the area available for timber production. The revised indicative yield figures are 182,000 cubic metres per year for jarrah and 42,000 cubic metres per year for karri.

Scenario A incorporates the new area base and then allows for potential decisions that would reduce the area available for timber harvesting through:

- additional mature habitat zones;
- further reservation from the high conservation value assessment; and
- buffers around old-growth forest informal reserves.

In this analysis, forest with mature characteristics for additional mature habitat zones was defined as areas with a mature crown cover exceeding 20 per cent for jarrah and wandoo, or 25 per cent for karri.

Scenario B incorporates the new area base and makes no allowance for further changes.

Silviculture and planning

The revised indicative yields are based on the current silvicultural guidelines. The application of these guidelines (Jarrah Guideline 1/95 and Karri Guideline 2/95, as updated following the Ministerial Advisory Group on Karri and Tingle) assumed:

- jarrah areas were harvested to a range of silvicultural objectives including gap creation, shelterwood and thinning;
- karri areas were clearfelled or thinned;
- a maximum gap size of 10 hectares in jarrah and a maximum clearfell patch size of 40 hectares in karri;
- habitat tree retention in jarrah gap creation of four trees/hectare;
- retention of 20 per cent of banksia thickets when pushing to reduce competition to the establishment or release of jarrah advance growth;
- the application of Ministerial Conditions attached to the Forest Management Plan 1994-2003; and
- the maintenance of the whole-of-forest structural goals in the Forest Management Plan 1994-2003 and modifications following the Ministerial Advisory Group on Karri and Tingle.

The current silvicultural guidelines are in the process of being revised. New measures, such as a proposed increase in the number of habitat trees retained in jarrah forest harvested to gap, will reduce the indicative sustained yield figures.

Timber supply targets

The indicate yields were based on an annual jarrah sawlog harvest of 324,000 cubic metres and an annual karri sawlog harvest of 149,000 cubic metres until the end of 2003, consistent with the Government's commitment to honour existing timber contracts. As industry restructure occurs and negotiations progress, industry has indicated that it is prepared to take less than the contracted volumes now on the understanding that the timber forgone before 2003 will be made available in the future. Table 7 shows the scheduled supply levels and a likely commitment arising from the restructuring, as well as the possible volume of timber made available for reallocation under the scenarios.

Table 7: Timber supply volumes to December 2003

Year	Jarrah sawlogs (first and second grade)		Karri sawlogs (first and second grade)	
	Scheduled commitment (m^3)	Supplied/likely commitment (m^3)	Scheduled commitment (m^3)	Supplied/likely commitment (m^3)
2001	324,000	273,000	149,000	124,000
2002	324,000	190,000	149,000	65,000
2003	324,000	170,000	149,000	55,000
Total	972,000	633,000	447,000	244,000
Volume available for future allocation	**339,000**		**203,000**	

Provision for risks and impacting processes

Future yields can be put at risk from a range of factors. Explicit provisions were made, as described in Ferguson *et al.* (2001), for:

- known disease impacts (such as dieback and Armillaria);
- insect degradation of timber quality; and
- wildfire events.

Other factors, such as the impact on future yield of poorly-stocked areas (arising from a variety of causes such as frost or disease) were adjusted for by reducing the area of forest contributing to future yields.

The overall reliability of the data used to calculate the sustained yield is another risk factor. The datasets have been examined through various review processes, and with the work programmed for completion in time for the final plan, found to be satisfactory. The Department's datasets will continue to be monitored through the life of the plan.

Data updates

The sustained yield figures calculated for the scenarios have been based on current datasets, pending the completion of work to update some of them. This includes the results of a new karri inventory and the reclassification of datasets for the eastern jarrah forest on the basis of vegetation complexes rather than rainfall zones.

Other assumptions

Calculation of the woodflows also assumed that the available logs were harvested to current product specifications, that the range of areas made available over time were economically viable for the timber industry to access, and that silvicultural and other stand treatments occur in a timely fashion. Consequently, variations to these conditions could impact on the scheduled sawlog woodflows.

The sustained yield of jarrah, karri and other species from the two scenarios

The scenarios identify an upper and lower figure within which the final sustained yield figure will occur once projects underway are complete, and decisions are made on alternative management approaches. The process of determining the range was informed by a combination of modelled scenarios, previous silvicultural analyses undertaken for the Ferguson Panel on sustained yield, inferences drawn from a knowledge of the current datasets and the anticipated effects of the various processes. For example, some of the factors will impact on the longer-term woodflows generated from the forest but have minimal impact on setting the non-declining yield during the period of the plan.

Scenario A for jarrah and karri produces lower limits for the sustained yields from a culmination of settings such as the introduction of additional mature habitat zones, further reserve design setting aside more State forest from timber production, adapted silviculture, enhanced sensitivity of high impact dieback spread, and data updates indicating lower inventory.

Scenario B for jarrah and karri produces upper limits for the sustained yields from the implementation of adapted silviculture, greater flexibility of patch size constraints in clearfelling two-tiered karri, shorter rotations on a portion of jarrah and karri regrowth estates, and no decrease from the data updates, sensitivity and reserve design processes.

Estimates of the non-declining sustained yield of sawlogs and total woodflow for the revised indicative yields are summarised for the period of the new plan in Table 8. The estimated contribution to the total woodflow from forest within each of the Department's three regions is also shown. Because logs sourced from one region can be transported and processed in another, these figures should not be used to infer the availability of logs to industries within a region.

Table 8: Revised indicative sustained yield (cubic metres) for principal timber species

Species	Log grade	Average annual yield (m^3)	Indicative level of woodflow by forest region		
			Swan	South West	Warren
Jarrah	First and second	182,000	52,000	104,000	26,000
	Other bole logs	499,000	154,000	301,000	44,000
	Non-bole logs / residue	Not estimated			
Karri	First and second	42,000			42,000
	Other bole logs	80,000+			80,000+
	Non-bole logs / residue	Not estimated			
Marri	Bole logs	286,000	44,000	150,000	92,000
	Non-bole logs / residue	Not estimated			

Note: 'Non-bole logs' includes crown and branch wood that has historically comprised up to 10 per cent additional volume on mature trees.

The estimates in Table 8 for the non-sawlog categories comprise the average total yield of resource that would be made available through the integrated harvesting and silvicultural treatment programs. A variety of products will be sourced from this material, including commercial firewood and specialty logs (such as burls etc). Where markets do not exist for all of the log sizes or qualities in this category, or minor variations to treatments arise, a

portion of the volume may be retained in the forest. This is anticipated with the retention of mature marri in the karri and jarrah stands following the suspension of the market for mature marri chiplogs. In contrast, the projections for the 'other bole log' category in karri comprise chiplogs sourced mostly from thinnings in young regrowth stands. Variations to the size of the thinning program could occur without impact on the sustained yield of karri sawlogs.

The net area cutover each year during the period of the final forest management plan will vary according to the combination of decisions made from the two scenarios. During the current plan, the average area cut per annum has been between 15,000 to 20,000 hectares.

The quantity of marri generated each year is dependent on the level of harvest for jarrah and karri sawlogs. Reliable estimation of that portion of the future available marri bole volume that may meet sawlog standards is particularly difficult, and will vary both within and between Departmental regions. As recommended by Ferguson *et al.* (2001), a separate calculation of the sustained yield of marri sawlogs has therefore not been attempted, although maximising the recovery of sawlogs remains an objective.

Separate sustained yields have not been computed for those species that constitute a small volume and are produced largely as an adjunct to harvesting operations in the jarrah and karri forests. This includes wandoo, blackbutt and sheoak. The production of sawlogs for these species during the past three years has averaged approximately 540, 1,520 and 2,260 cubic metres per annum respectively. Sawlogs from these species will continue to be available, but at reduced levels of production corresponding to the reduction in the area of the forest cut for timber.

Future variations in the characteristics of logs sold during the life of the new plan

The allowable harvest will be determined for the 10-year period of the new plan. The annual harvest is not constrained to one tenth of the allowable harvest provided that monitoring ensures that the cumulative removals do not exceed the total amount by the end of the 10-year period.

The sustained yields in Table 8 are based on the current size and quality specifications for sawlogs. The projected sawlog supply after 2003 is likely to comprise a much higher proportion of logs in the smaller and intermediate size classes than is presently delivered to industry.

In addition, the Forest Products Commission has indicated its intent to progress toward a log sales system based on whole bole sawlogs (rather than direct log grades) during the period of the new forest management plan. This means that an increased proportion of what is currently lower grade material may be sold for conversion to sawn timber. While this may vary the proportion of logs sold in different categories, the total projected woodflow will be constrained to the equivalent levels of first and second grade sawlog. Ferguson *et al.* (2001) have recommended that if the whole bole sawlog system proceeds, a 'dual-track' (new and old) basis should be used to compare the sustained yields and maintain transparency of the figures. Thus, while the internal combination or structure of the timber industry may change, the total level of removals will be consistent.

Potential threats	1. The forest area available for timber production reduced during the life of the plan. 2. Log utilisation at harvest below the specification used to calculate the yield. 3. Changes to forest structure resulting from harvesting not recorded for future modelling. 4. Regeneration of harvested forest that failed to restore an adequate stocking. 5. Actual growth rates below those used in modelling. 6. Loss of large areas of fire sensitive karri regrowth to wildfire that would reduce the sustained yield. 7. Market for marri timber does not eventuate.
Management actions	1. Prepare and make publicly available, three-year indicative timber harvest plans that have regard to the allowable harvest levels. 2. Monitor the sawlog and total log sales against the allowable harvest level set by the Minister for the Environment and Heritage, on an annualised basis. 3. Audit utilisation. 4. Record and monitor the area harvested each year to each silvicultural objective (e.g. the area harvested to shelterwood). 5. Monitor the level of sawlog/whole bole sawlog equivalent utilisation in harvested areas. 6. In three years of commencement of the plan review the silviculture of marri/jarrah and marri/karri stands if no significant market for marri timber has emerged.

Management strategies

Monitor the removal of other forest produce and respond when required to ensure that its removal occurs in a manner taking account of ecologically sustainable forest management.

Ensure through regulation, monitoring and audit that the use of other forest produce is managed to comply with relevant guidelines.

Research and determine through a public process, ecologically sustainable limits for other forest produce.

Background

Other forest produce includes salvage logs that become available in carrying out an operation under the approved plan, domestic firewood, burls, craftwood, wildflowers, honey and seeds.

Log timber can be generated by management activities carried out under the plan, such as road or recreation site construction, which may occur in a conservation reserve where timber harvesting is not a permitted activity. Logs may also become available due to natural processes such as wind-throw where they impede established access. Section 33(1)(cb) of the CLM Act provides for the salvage and use of such material to make improvements to any land to which the Act applies.

Historically, sustained yields have not been set for such produce. Forest produce supply is regulated through the issuing of licences with conditions to protect the sustainability of the resource and other forest values.

Monitoring of wildflower harvesting is used as one means to identify if a species is being

threatened by commercial operations. Where such a situation is detected, harvesting of the species may be prohibited or restrictions placed on its take. The species *Andersonia caerulea,* known as purple heath or foxtails, was recently prohibited from being harvested from Crown land. Management of wildflower picking is described in Appendix 17.

When the approved plan is released, the supply limits and the production methods for forest produce will need to be reviewed against the plan objectives and any available information. This will be done with public input.

Potential threats	1. Uncontrolled removal of produce that would lead to over exploitation of the produce and damage to other forest values.
Management actions	1. Regulate the supply through licences and conditions on licences to protect the sustainability of the produce and other values. 2. Where possible, monitor supply patterns for signs of non-sustainability. 3. Monitor compliance with licence conditions. 4. Salvage forest produce generated by management actions or natural events where salvage activities can contribute to the rehabilitation, do not significantly increase the level of disturbance or the risk associated with the operation. 5. Continue to investigate appropriate supply limits and production mechanisms that give regard to the principles of ecologically sustainable forest management.

Management strategy
Monitor and ensure that post-timber harvesting regeneration is consistent with targets set.

Background

Sustaining the productive capacity of the forest requires the re-establishment of growing stock on the site following harvesting. In addition, to meet biodiversity conservation objectives regeneration of the tree component should be done in such a way that all other flora species also have the opportunity to regenerate. This generally means regeneration must be accomplished using techniques that copy natural processes.

Most karri timber supply comes from single-storied mature stands or two-tiered stands where regeneration is required following harvesting. Regeneration can be achieved using seed trees, seeding or planting. Clearfelling to a minimum area of two hectares is necessary to ensure a suitable environment for regeneration to develop. The maximum clearfelled area is currently 40 hectares.

Jarrah trees are regrown after harvesting predominantly from the release of advance growth present on the forest floor and coppice from felled stems following removal of the overstorey. This is known as gap treatment. In some instances, small areas that are inadequately stocked with advance growth are hand-planted with seedlings. If adequate advance growth or coppice material is not present the removal of the overstorey will result in understocked stands and the loss of productivity. In this case, advance growth needs to be established before the overstorey is completely removed in what is known as a shelterwood operation.

Similar degradation of the commercial productivity of the stand could occur with a selective or partial cut, where the size of the gap or the level of disturbance was insufficient for a species to adequately regenerate. This leaves the stand dominated by the non-preferred species. The potential for this occurs in jarrah and karri stands mixed with marri now that

marri is no longer saleable in its traditional woodchip market. Amendments to the silvicultural guidelines have been proposed to ameliorate the problem and the Forest Products Commission is actively seeking new markets for marri. The Conservation Commission will monitor the results of harvesting and regeneration in these stands.

The ease with which jarrah regeneration can be accomplished using gap or shelterwood treatment varies according to rainfall zone with drier areas generally more difficult to regenerate than those in the high rainfall areas (more than 1,100 millimetres). In some cases it is necessary to reduce understorey competition to enable seedlings to become established or advance growth to be released. The silvicultural guidelines take this into account and prescribe different treatments. Limits to the amount of soil disturbance during this process are prescribed to prevent excessive loss of soil-stored seed and regenerative propagules of understorey species for biodiversity reasons.

The methodology and standards for pre- and post-harvest regeneration surveys are documented in the silvicultural guidelines. Regeneration adequacy is a performance indicator and will be stratified by site type so that early warning of inadequate regeneration in previously identified sites (e.g. eastern jarrah forest) will be apparent.

Potential threats	1. Loss of productivity should forest harvested with intent to regenerate, fail to regenerate. 2. Decrease in the productive capacity for timber if dieback-affected area expands and is not rehabilitated.
Management actions	1. Set standards for the time between harvest completion and regeneration and the stocking and composition of regeneration. 2. Assess regeneration adequacy and re-establish where necessary. 3. Monitor regeneration adequacy, particularly for identified sites within eastern jarrah and dominant marri areas and review the adequacy of guidelines and practice where standards are not met.

Management strategy

Monitor the forest for impact of weeds, pests and diseases on forest productivity and respond as appropriate.

Background

Insect pests and disease can affect forest ecosystem health and vitality and at certain levels, are a threat to commercial productivity. They do this by adversely affecting the ability of the growing stock to utilise the inherent productive capacity of the ecosystem or by reducing the economic value of the desired product.

The particular insects and pathogens of potential concern are described below:

- Jarrah leafminer (*Perthida glyphopa*) and gumleaf skeletonizer (*Uraba lugens*) cause dramatic reduction in green foliage on jarrah, resulting in decreased wood growth. Possible causes of outbreaks have been studied in detail and broadscale climate factors appear to be the main factor in population variations. Trials have been conducted using fire to attempt control with no success. Chemical control is not considered environmentally acceptable or economically justifiable.
- Bullseye borer *(Phoracantha acanthocera)* damages karri timber by boring around the sapwood then tunnelling into the heartwood. The tunnels degrade the appearance and structural value of the sawn wood. Damage is more prevalent in poor quality karri sites

than in high quality sites. Dry sites, near jarrah forest and in small coupes, are more prone to borer attack. Wood rots associated with borer damage exacerbate the damage.

- Sites infested by *Phytophthora cinnamomi* result in a complex mosaic of disease expression. Impacts from the disease include no apparent symptoms, a destructive epidemic in *Banksia* species woodland and in heathlands, and a more variable impact within the dominant tree component of the jarrah forest.

  The overstorey of many long-affected disease areas has partially regenerated naturally, predominantly with marri that is resistant to the pathogen. The understorey, however, remains impoverished owing to the loss of susceptible species. Rehabilitation of the overstorey of sites disturbed by the disease has been successful on fertile and well-drained sites. However, where conditions have been more difficult owing to caprock and shallow soils, success has been limited. The development of a dieback-resistant jarrah provides some capacity to sustain or re-establish the dominant overstorey component (Stukely 1993).

  Rehabilitation of disturbed land should, as far as is practicable, meet the needs of all land uses. In that respect, high disease-impacted sites are very productive for water run-off because of the reduced vegetative cover. Therefore, planning for rehabilitation in public drinking water source areas needs to consider the impact of tree plantings on water yield.

  The resources available to undertake rehabilitation are such that most high-impact dieback sites will be allowed to restock naturally with tolerant species and rehabilitation conducted by the Department will be confined to small high priority areas.

- Armillaria root disease *(Armillaria luteobubalina)* is widespread in forests, woodlands and the coastal heath of south-western Australia. It is a soil-borne fungus and despite a prolific production of spores, the main mode of spread is by root to root contact between healthy and infected plants. The host list for *A. luteobubalina* is extensive and includes a wide range of plant species from a diverse range of families (Pearce *et al.* 1986; Shearer and Tippett 1988; Shearer *et al.* 1997a, 1997b, 1998).

  The highest impact from the disease is in regrowth forests, as a result of the production of stumps during harvesting and thinning operations (Pearce *et al.* 1986; Robinson in prep). *A. luteobubalina* invades and rapidly colonises the stumps. Regrowth saplings and residual trees become infected when their roots encounter an infected stump root. Infection can result in tree death or predispose trees to windthrow owing to structurally weakened roots. In unharvested stands of native forest, mortality owing to Armillaria root disease is mainly restricted to subdominant or suppressed trees (Pearce *et al.* 1986). Environmental and biotic stress may also predispose trees and other plants to infection.

Weeds can affect productive capacity through competition with desired productive plants and as a physical barrier to production activities. Where a weed, such as blackberry, threatens productive capacity it is addressed as part of the production process.

The impact of weeds on productive capacity is however, small compared to their environmental impact, hence weeds are addressed in the 'Ecosystem health and vitality' chapter.

Potential threats	1. An outbreak of a native pest that would result in a loss of productivity. 2. An introduction of a new pest, disease or weed that resulted in loss of productivity.
Management actions	1. Monitor insect, weed and disease outbreaks and determine appropriate action. 2. Where appropriate, prescribe hygiene measures for operations to minimise the risk of new fungal infections.

Management strategies

Work with industry and government agencies to ensure that areas subject to mineral and petroleum activities and basic raw material extraction are rehabilitated with the objective of restoring as many of the previous ecosystem values as possible, taking account of ecologically sustainable forest management.

Liaise with mining and petroleum companies to ensure that acceptable standards of rehabilitation are met.

Background

Mining and petroleum operations may involve the clearing of forest areas. However, under the conditions of approval, companies are required to rehabilitate affected areas in accordance with standards set by the Department after consultation with companies. Mining has resulted in the clearing of approximately 19,800 hectares of State forest and timber reserves in the draft plan area of which approximately 13,500 hectares have been rehabilitated (Table 9). There has been negligible petroleum activity in the draft plan area.

Some large-scale open cut mining operations in hard rock can result in a final void that is uneconomic to backfill and revegetate.

Table 9: Areas of State forest cleared by ongoing mining operations and rehabilitated at June 2001

Mineral	Area cleared (ha)	Area rehabilitated (ha)*
Bauxite	14,100	11,300
Coal	4,000	1,170
Gold	360	0
Tin	670	570
Sand	570	480
Limestone	60	0
Gravel	35	25
Total	**19,795**	**13,545**

Source: Department of Mineral and Petroleum Resources and Department of Conservation and Land Management

* *The unrehabilitated area comprises mining infrastructure requirements, permanent public infrastructure and current mining.*

Working with mining companies to plan and direct mining to sites with the least impact on forest values reduces the impact of mining on productive capacity. While there is limited flexibility in mining because of ore body location greater flexibility is provided with infrastructure. Impact is also reduced by minimising the time between clearing and rehabilitation and ensuring rehabilitation is carried out to a standard that will restore productive capacity.

The Department is working with companies to develop criteria that define acceptable mine site rehabilitation standards. They include factors such as integrating mining rehabilitation

with adjacent forest management, the resilience and viability of rehabilitation and the sustainability of revegetation in the long-term. The Conservation Commission may ultimately take back full control and management of land from mining companies after mineral extraction, providing all rehabilitation criteria have been met.

Potential threats	1. Rehabilitation requirement on the mining condition inadequate to restore productivity. 2. Rehabilitation following mining not best practice, limiting the recovery of productive capacity of the site.
Management actions	1. Include, wherever possible, a formal requirement for re-establishment of ecosystems in mining approvals. 2. Negotiate rehabilitation standards for mining that seek to restore forest values over time, and that are paid for from the value of the resource extracted. The Department will also seek compensation for the loss of forest values. 3. Department and the Conservation Commission will develop a policy on the management of productive capacity on former mine sites.

4.3 Key performance indicators

Key performance indicators are being used to track the achievement of the approved plan's objectives and its implementation. The background to the development of key performance indicators is described in the 'Plan implementation' chapter under the heading key performance indicators.

Five indicators have been selected to provide a broad cross-section of achievement of the objective related to the maintenance of productive capacity.

Key performance indicator 6	The area of native forest and plantations.
Performance measure	Changes in: • native ecosystems and plantations; • area by land category; • area cleared; and • area rehabilitated.
Performance target(s)	No permanent loss of forest.
Reporting	After five years.
Response to target shortfall	Investigate and report to the Conservation Commission.

Key performance indicator 7	Annual removal of wood products compared to the volume determined to be the sustained yield by the Minister. Area of each forest type harvested annually.
Performance measure	Cumulative removals for native forest by product compared to the straight-line cumulative allowable removal. Annual area harvested by silvicultural objective.
Performance target(s)	To be no more than 10 per cent over the straight-line allowable limit after five years and on or under the total allowable after 10 years.
Reporting	Annual.
Response to target shortfall	Investigate and report to the Conservation Commission.

Key performance indicator 8	The removal of non-sawlog timber.
Performance measure	Total removals of firewood compared to the authorised removal through contract and licence.
Performance target(s)	Authorised removals more than 70 per cent of estimated total removals based on survey information.
Reporting	Five yearly.
Response to target shortfall	Investigate and report to the Conservation Commission.

Key performance indicator 9	Unproductive area.
Performance measure	The time between commencement of native forest harvesting for regeneration and the completion of regeneration operation.
Performance target(s)	More than 50 per cent within one year. More than 75 per cent within two years. More than 100 per cent within three years.
Reporting	Annual.
Response to target shortfall	Investigate and report to the Conservation Commission.

Key performance indicator 10	The area and per cent of harvested forest treated for regeneration (gap and clearfell) that is effectively regenerated.
Performance measure	The proportion of the sampled annual regeneration program that does not met the prescribed standard.
Performance target(s)	No more than five per cent of the regenerated area requiring remedial action.
Reporting	Annual.
Response to target shortfall	Investigate and report to the Conservation Commission.

5 Ecosystem health and vitality

A forest ecosystem is healthy if it retains the ability to sustain its biological diversity, biotic integrity and ecological processes such as nutrient and water cycling over time. The degree of health and vitality may be reduced by chronic factors, such as pollution, nutrient imbalance, climatic stress, or change in the historic frequency or intensity of disturbance. The loss or replacement of key biological components such as decomposers, pollinators, or food chain relationships can also reduce the degree of health and vitality.

An outbreak of disease or pest insects in the forest may be the result of a decline in health caused by a complex interaction of factors affecting ecological processes. For example, jarrah leafminer (*Perthida glyphopa*) was in outbreak from the late 1950s and until the early 1990s resulting in a dramatic reduction in foliage on jarrah for infested areas. Extensive study could not associate the outbreak with any disturbance factor and it is suspected that broadscale climatic factors were responsible (Abbott 1992).

Disturbance is an important and widespread phenomenon in south-west forests functioning at a wide range of temporal and spatial scales. It provides the heterogeneity that drives ecosystem processes and promotes diversity. When disturbances and stress remain at levels within the range of natural variation and the biological components and processes of the forest are sustained, forest health will also be sustained as forest ecosystems are inherently dynamic and adapted to stress. In theory, as it is extremely difficult to manage for all species individually, it is necessary to sustain the processes that species have evolved with and now depend on to sustain health and vitality. Stresses beyond the limits of tolerance (a critical threshold) can adversely affect sustainability.

Major disturbance factors in the south-west forest ecosystems include fire, wind and rain storms, insect attack, fungal disease, invasion by plants and disturbance caused by humans. Fire in particular is fundamental to the health and vitality of the eucalypt forest because it is apparent that not only is the biota tolerant of recurrent fire but it also appears to be highly fire-adapted. The use of fire to create heterogeneity in the understorey, hence promote biodiversity, is a strategy for the maintenance of biodiversity. Control of fire is also fundamental to the health and well being of the people who live in and around the forest or depend on forest resources for their livelihood, making appropriate management a complex matter.

The impacts of forest management activities, such as a significant change in fire patterns, might create conditions in forests beyond the limits of tolerance of species and consequently lead to a loss of health.

At present the tuart forest around Lake Clifton (Bradshaw 2000) and the eastern wandoo forest (Wills *et al.* 2001) are expressing, through significant crown decline, a loss of health and vitality. The tuart crown decline is the result of the tuart borer (*Phorocantha impavida*), however it is uncertain what stresses pre-disposed the trees to attack by the borer. The cause of the wandoo crown decline is uncertain. It is likely that moisture stress from the prolonged decline in rainfall is playing a part in both cases.

The assessment of forest health can only take place against some baseline condition. It is necessary to understand the changing nature of forests, to identify when change is induced by human intervention, and how this change affects sustainability. Monitoring of the health of forests should be designed to detect stresses, including those caused by human activities so

that protective measures can be implemented. The monitoring system FORESTCHECK (see 'Plan implementation' chapter) will achieve this for part of the forest estate.

5.1 Objectives

Whole of forest/Landscape objectives

- To sustain forest ecosystem health and vitality in a manner taking account of the principles of ecologically sustainable forest management.
- To use and respond to fire in a manner that optimises the maintenance of forest ecosystem health and vitality, ecosystem heterogeneity and processes, promotes conservation of biological diversity and adequately protects life and property.
- To ensure that the impact of weeds, pests and disease on forest ecosystem health and vitality is minimised and take action to reduce impacts where appropriate and practical within the context of ecologically sustainable forest management.
- To identify and mitigate external threats to forest ecosystem health and vitality.

Operational objectives

- To use fire in a manner that reflects site specific variations as far as resources permit.
- To prevent as far as is practicable the introduction, spread and impact of weeds, pests and disease that might cause extensive damage in forests.

5.2 Strategies

Management strategies

Develop a comprehensive fire management plan that achieves the forest management objectives.

Refine the fire management plan by active participation in the proposed EPA review of fire management in the forest region and through adaptive management.

Background

For at least nine months of the year parts of the forest and associated ecosystems are dry enough to carry fire and there are natural and anthropogenic sources of fire to ensure that ignition will occur on many occasions. The decision is not whether fire should be part of management but the extent to which its intensity, extent and frequency (the fire regime) is or can be controlled to meet biodiversity objectives and protect life and property.

Despite the complexity of the subject there is a considerable amount known on both the impacts of fire on forest ecosystems (Christensen and Abbott 1989) and its control and management (McCaw *et al.* 2002). Nevertheless there remain other areas where understanding falls short as highlighted at the fire symposium held in April 2002. It appears that a picture is emerging in which fire diversity is seen as one approach to the conservation of biodiversity. It is also acknowledged that there has long been contention in the community as to the appropriate objectives for fire management in the forests.

The current fire management policy (Departmental Policy No. 19) seeks to use planned fire to protect community and environmental values from damage or destruction from wildfires, and to achieve land management objectives, in accordance with designated land use priorities. In

addition the policy commits to the maintenance of a well-trained and equipped suppression force capable of containing several wildfires simultaneously under extreme weather conditions.

Knowledge of the role of fire in sustaining biodiversity provides a dilemma for managers because species respond very differently. Therefore it is only possible to be highly prescriptive with a fire regime to sustain biodiversity if it is being implemented to favour a specific species over others. This will occur, for example when a threatened species requires specific fire management (including total protection) to ensure its survival. In all other cases it is apparent that to optimise the conservation of biodiversity, management should aim for a mosaic of fire intervals, intensities and sizes at the landscape scale. Knowledge of the temporal and spatial scales of fires in relation to the life histories of organisms or communities involved must underpin the planning of the mosaic.

A corollary to the desire to use fire to establish and sustain habitat heterogeneity is that one of the key threats to biodiversity is infrequent, widespread and uniform burning, particularly within a fragmented landscape and under high intensity. Old-growth karri forest, for example, is vulnerable to high intensity fire, and fuel loads in these forests will need to be managed to control the risk to its maintenance.

Fire, as a disturbance that plays a major role in driving ecosystem processes and conserving biodiversity, cannot be separated from the risk it presents to human safety, the protection of property and other economic resources, and the legal structures established to regulate those risks. Fire management policy and implementation must adequately represent community values and concerns for each of these factors.

The ability of the Department to implement the objectives of the current fire policy has been affected by the increasing complexity (hence cost) of the mosaic requiring burning or protection, the associated reduction in size of burn units, and increased restrictions on burning times associated with smoke management. There is now considerable concern among a section of the community that fuel loads exist and will get worse, which may lead to large, intense and damaging wildfires.

The fire management policy is dated and requires review to incorporate the principles at Appendix 18 (that contain within them the heterogeneous mosaic sought for biodiversity conservation) and incorporate community expectations. The Department has conducted an internal review and the Government has announced that the EPA will undertake an independent public review during 2002. The Department and the Conservation Commission will use that review to formulate a new policy and guidelines for fire management in the forests.

Potential threats	1. Fire regimes inappropriate for the maintenance of health and vitality and biodiversity. 2. Fire plan too complex to implement within resources available. 3. Fire plan not able to be implemented due to restrictions on burning. 4. Extensive areas with high fuel loads that present a high risk to life, biodiversity maintenance and property in the event of a wildfire. 5. Fire suppression force inadequate in size and competency to meet community expectations.

Management actions	1. Continue to undertake regular risk assessments that evaluate threats from fire. 2. Develop and maintain rolling look-ahead plans of proposed fire management. 3. Undertake an annual prescribed burning program that implements the fire management plan. 4. Maintain a competent and adequately-resourced capacity to detect and suppress wildfires that meets community expectations. 5. Participate in the planned public review of fire management and implement the outcomes agreed by Government into policies and guidelines.

Management strategy

Continually improve protocols for the management of *Phytophthora cinnamomi* and the disease caused by it.

Background

Disease of the vegetation and fauna is a natural part of ecosystem process and although it impacts on the health and vitality of some components, it is also a disturbance that provides opportunity for other components of biodiversity. When it operates at normal temporal and spatial scales it is not a threat to the health of the ecosystem. However, management may create conditions where a natural pathogen can cause disease on a more extensive scale. An example is the creation of an extensive patch of karri regeneration that becomes infested with *Armillaria luteobubalina* causing disease and subsequent death. In these cases the threat is to productive capacity rather than health and vitality and is addressed in that chapter of the draft plan. Introduced pathogens on the other hand can result in diseases that seriously impact on ecosystem health and vitality.

Phytophthora cinnamomi

In 1964, *Phytophthora cinnamomi* was identified as the pathogen causing a disease known as jarrah dieback. By this time the pathogen had been accidentally spread throughout the south-west forest zone, mainly by the agency of humans moving infested soil, particularly after the introduction of machines into the forest after the Second World War. In 1974 an amendment to the *Forests Act 1918* provided for the control of access in forests declared as Disease Risk Areas. Since then a sophisticated system of aerial photography and interpretation, impact mapping of uninfected sites, and disease hygiene management has significantly reduced the spread of the disease.

Earlier concerns that other species of *Phytophthora* might cause similar extensive problems have proved unfounded. *P. citricola* and *P. drechsleri* are known to cause very minor damage to understorey flora despite their widespread distribution. Several taxa within the species complexes usually assigned to *P. megasperma* or *P. cryptogea* are generally restricted to seasonally inundated sites. Records of *P. nicotianae* are few and confined almost entirely to native plants in cultivation.

Today *Phytophthora* remains a major threat to ecosystem health and vitality in the south-western and southern areas of the State, and threatens some species with extinction. The Commonwealth has listed *P. cinnamomi* as a key threatening process pursuant to the Environment Protection and Biodiversity Conservation Act. Accordingly, Environment Australia has developed a draft *Threat Abatement Plan for dieback caused by the root-rot fungus* (Phytophthora cinnamomi). In 1996 a State Government review of dieback

management (Podger *et al.* 1996) recommended a more focused approach by concentrating effort on those protectable areas that had natural features conducive to keeping them free from infestation in the medium to long term. The Government accepted this recommendation and the Department revised its policy and guidelines in 1998 to reflect it.

Most effort into the management of *Phytophthora* is directed at minimising the possibility of human-induced new infestations associated with the use of natural resources. In areas where threatened flora and ecological communities are susceptible to the disease, short-term immunity can be provided by the use of phosphite, either as a foliar spray or through stem injection.

As a result of a recommendation in the dieback review report (Podger *et al.* 1996), a Dieback Consultative Council (DCC) was established by the State Government to liaise with land managers, planners and research scientists, and to provide advice on research and management needs. The Dieback Consultative Council Report *Phytophthora cinnamomi and disease caused by it – a protocol for identifying protectable areas and their priority for management*, established a draft protocol for identifying and determining management priority areas considered protectable from infestation. The EPA provided advice on the protocol to the Minister for the Environment and Heritage (EPA 2001), and the Minister set the following conditions for its implementation:

- the use of the protocol be confined to specific trial areas;
- that the DCC, the Department, the Conservation Commission and the Department of Environmental Protection determine a process for giving effect to the EPA advice as set out in Section 7 of their report.

An Expert Working Group is reviewing the feasibility of a trial to compare the protocol and the past system of management.

Management of *Phytophthora* is dependent on knowledge of the presence of the pathogen. Mapping *Phytophthora* presence is difficult and expensive and due to natural spread mapped boundaries are unreliable after three years. Because of this mapping is usually only done where there is a specific and immediate operational need. The Department maintains a data base of all mapped occurrences of *Phytophthora*, however, the usefulness of the data for wider applications is limited for the reasons given above.

Dieback has had a high impact on the vegetation diversity and abundance on some sites. Rehabilitation of these sites with species resistant to the pathogen can restore lost productivity. Rehabilitation, however, can be expensive and adversely affect other values such as water production. Therefore, in many cases it may be preferable to allow the site to find a new self-regulatory balance.

Potential threats	1. Human activities cause new infestations of *Phytophthora cinnamomi* that result in further loss of ecosystem health and vitality and biodiversity. 2. New pathogens introduced resulting in a threat to some ecosystems.
Management actions	1. Progressively identify areas uninfested with *Phytophthora* ('protectable' areas) and manage human access to them. 2. Where assessment demonstrates it is likely to be cost effective, protect threatened flora, threatened ecological communities and the habitats of threatened fauna at risk from *Phytophthora cinnamomi*. 3. The Conservation Commission and the Department will review policy on the management of *Phytophthora* taking into account the results of the trials or other evaluation process established following the advice of the Expert Working Group.

	4. When endorsed by the State Government and where appropriate, the Department will incorporate the strategies in the national *Threat Abatement Plan for dieback caused by the root-rot fungus* (Phytophthora cinnamomi) into its management strategies. 5. Review sites where the impact on the vegetation has been high with a view to setting a priority for regeneration/rehabilitation. 6. Progressively improve and make available information on *Phytophthora* presence in the draft plan area to inform planning and operations.

Management strategies

Monitor the impact of weeds, pests and disease on forest ecosystem health and vitality and where necessary and possible control the weed, pest or pathogen.

Protect forest ecosystem health and vitality, biological diversity and other forest values by adopting appropriate hygiene standards, monitoring and where necessary controlling weed, pest and pathogen infestations.

Background

Weeds

Weed invasion is a major threat to natural ecosystems and the native species within them. Weeds threaten biological diversity by disrupting ecosystem processes and functions. The impacts of weeds on ecosystems include: resource competition; prevention of seedling recruitment; altered morphological processes, hydrological cycles and fire regimes; and changes in soil nutrient status, abundance and diversity of native fauna, and the genetics of native flora.

Most Western Australian ecosystems are vulnerable to some extent to invasion by plant species and this is most evident where the natural system is disturbed and there is a source of weeds, such as areas close to farmland or a plantation of trees that will readily spread.

The weed problem requires coordinated and integrated remedial action across land category, administrative and natural boundaries. This requires focused action at national, state and regional levels. Western Australia's State Weed Plan (Department of Agriculture 2001) recommended the establishment of a State Weed Group to coordinate effective weed mitigation. The State Weed Plan provides the framework within which Government, industry and the community can work cooperatively in the application of resources to weed management in Western Australia.

Weeds such as blackberry (*Rubus* spp.) are widespread throughout the river systems of the south-west forests and arum lily (*Zantedeschia aethiopica*) widely infests the tuart forests of the Busselton area. The scale of these infestations on land vested in the Conservation Commission is such that there will never be the resources to address all infestations. Vigilance is necessary to ensure that emerging threats such as exotic grasses, bulbs and creeper species like bridal creeper (*Asparagus asparagoides*) do not become the problem that blackberry or arum lily are today. Plantations of exotic species are also a potential threat where the planted species is an aggressive seeder and is adapted to the environment. Pine species are vulnerable to fire when young and can be controlled, however, some eucalypts such as *E. muellerana*, which was interplanted with karri over a considerable area, have the potential to spread and survive fire and may need to be controlled.

The Department's (draft) Policy Statement No. 14 'Environmental Weed Management' guides the approach and priority setting for the control of environmental weeds in State forest and timber reserves and is consistent with the objectives of the State Weed Plan. The approach is to define the problem in terms of impacts on environmental values, develop a management plan to reduce impacts, implement the plan and monitor results. The starting point is information on weed occurrence and the threats they pose. Departmental district offices have records of weed infestations and electronic databases that are GIS based and compatible with the State inventory, Weedbase, suitable for holding the occurrence information, and subsequent management of the infestation, are to be developed. Priorities for determining action on weeds are:

- any weed impacting on critically endangered flora, fauna or ecological communities;
- any weed impacting on threatened flora, fauna or ecological communities, or areas of high conservation value;
- small infestations of weeds listed in the Environmental Weed Strategy for WA with an Environmental Weed Rating of high or moderate;
- any weed with an Environmental Weed Rating of high or any weed impacting on values or activities managed by the Department (i.e. VLM, recreation, forest operations); and
- any other weed with an Environmental Weed Rating.

Pests

Animals that cause damage to natural values within the draft plan area can be introduced from overseas, introduced from other parts of Australia, or be native animals that for some reason are threatening managed values. For the purposes of this draft plan, all animals, native or introduced, that are a threat to managed values will be referred to as pest animals.

Management of pest animals is viewed as one of the most important strategies by which biodiversity conservation objectives on lands vested in the Conservation Commission can be achieved. Pest animals have the potential to seriously impact natural ecosystems, through direct effects such as grazing and predation, habitat destruction, competition for resources or more generally as a vector of environmental degradation by the spread of diseases (animal or plant pathogens) and weeds.

Knowledge of the extent and impact of pest animals on natural ecosystems varies between species. Historically the focus on pest animal management has been on species such as rabbits, foxes, feral cats and pigs. However, exotic invertebrates, fish, and other terrestrial and avian pests, and their associated threats to ecosystem function and process, are poorly described. The colonisation of tree hollows by feral bees to the exclusion of native fauna is an example that is known to occur but is of unknown significance.

The interrelationships between pest animals are also not well understood. The interaction of rabbits, foxes and cats is an example of a resource-based interaction that is important for the control of any one of these species. For example, management impacts on the rabbit population may result in changes to patterns of fox predation on native wildlife (prey switching); and reductions in fox populations may result in an increase in the feral cat population.

The direct impact of rabbits and foxes on native fauna and flora has been adequately demonstrated, and management intervention strategies developed to address these impacts. The Department's Western Shield program has resulted in significant increases in the extent and population size of many of Western Australia's native fauna by controlling foxes.

Control strategies for rabbits have been primarily focused on localised operations to protect vegetation communities and populations of flora species with high conservation significance.

Management of rabbits at landscape and whole of forest scales has been attempted by the application of biological control agents such as *Myxomatosis* and rabbit Calicivirus disease.

The impact of feral cats on wildlife populations in the south-west of the State is poorly understood. Little objective information is available to guide the management interventions that may be necessary for feral cats and broadscale control technology is still in development.

The situation is similar for feral pigs. Control of pig populations has been localised, sporadic and uncoordinated. Pig numbers are increasing, as is their geographic range across the south-west.

Effective management actions can only be implemented through coordinated pest animal control across land category, administrative and natural boundaries. This will require integrated effort from all land managers, both private and Government, and the involvement of the community to minimise the potential for introduction and spread of new or existing pests.

The Department's (draft) Policy Statement 'Management of Pest Animals' guides the approach and priority setting for reducing the impact of pest animals on land vested in the Conservation Commission. Management action is aimed at protecting threatened flora and fauna and threatened ecological communities, eradicating small or new infestations, containing existing pest populations, progressive eradication of established pest animals and protecting important habitats. These priorities will change in the event of an outbreak of an exotic animal disease.

Other significant diseases or conditions

Currently there are no other introduced pathogens that result in widespread decline in ecosystem health and vitality. However, a potential threat arises from the disease known as Mundulla Yellows that has been identified in the south-west.

Mundulla Yellows is a little-known and only recently-described disease that has the potential to seriously affect a number of native plant species, as well as revegetation plantings on farms and possibly some eucalypt plantations. Mundulla Yellows is a progressive, slow dieback and yellowing disease of many varieties of eucalypts. It has been reported in trees of all ages, and once symptoms appear, the affected trees die within a few years.

The disease has been mainly detected in isolated trees outside the main forest belt and is thought to be caused by a virus-like agent. Research is underway throughout Australia to confirm this. The situation in Western Australia is being monitored.

Tuart (*E. gomphocephala*) and wandoo (*E. wandoo*) woodlands are currently experiencing decline. Decline is a term used to describe a poorly understood but widespread decline in health and vigour. The primary cause appears not to be a single pest or disease but may be related to environmental stress possibly associated with declining rainfall in recent years, leading to secondary attack in stressed trees by borers and fungi. A Tuart Response Group has been formed to address the tuart decline and the Group is considering expanding to address wandoo decline.

Potential threats	1. Uncontrolled weed, pest animal infestations and disease impair ecosystem health and vitality. 2. An unfocused and uncoordinated approach to weed and pest management that would result in ineffective use of resources.
Management actions	1. Develop and maintain a capacity for the early detection, assessment of the risks posed to forest values and reporting of new introductions of weeds, pest animals and diseases. 2. Develop and implement weed, pest animal and disease control programs based on the risks posed to values, and the resources available for implementation. 3. Wherever possible, eradicate localised infestations before they are securely established. 4. Encourage the coordinated involvement of industry, the community and other land managers in addressing their management. 5. Investigate the cause of any significant decline in the health and vitality of vegetation and implement control measures where possible.

Management strategy

Ensure that only locally occurring species propagated from local seed sources are used in rehabilitation/regeneration areas unless there are over-riding considerations that prevent it.

Background

Natural regeneration of indigenous vegetation is the preferred method of regeneration or rehabilitation for disturbed land that is subject to this draft plan. This is a precautionary measure to provide the best opportunity for the regeneration of self-regulating ecosystems that sustain health and vitality and biodiversity.

Where it is not possible to use natural regeneration or natural regeneration needs supplementing, seeding or planting will be used. Only plant species that naturally occur on the site should be used and the seed sown, cutting used or seed used to grow plants should, wherever possible, be collected locally. For these purposes locally means within a range where it could be assumed the genetic base would be similar.

Departmental Policy No. 10 addresses the rehabilitation of disturbed land.

Potential threat	1. Inappropriate species in rehabilitation results in a non-sustaining ecosystem or a weed problem.
Management actions	1. Wherever possible, use natural regeneration to restore disturbed native vegetation. 2. Where this is not possible, wherever possible, use seed collected locally or plants propagated from seed collected locally.

5.3 Key performance indicators

Key performance indicators are being used to track the achievement of the approved plan's objectives and its implementation. The background to the development of key performance indicators is described in the 'Plan implementation' chapter under the heading key performance indicators.

Three key performance indicators have been selected to provide a broad cross-section of achievement of the objective related to the maintenance of ecosystem health and vitality.

Key performance indicator 11	The risk to assets posed by wildfire.
Performance measure	The total area of State forest and timber reserves by fuel age class.
Performance target(s)	Average fuel age stable or declining.
Reporting	Annual.
Response to target shortfall	Investigate cause and report to the Conservation Commission.

Key performance indicator 12	Compliance with measures to control the spread of *Phytophthora*.
Performance measure	The proportion of hygiene operations in compliance with the prescribed standards.
Performance target(s)	More than 95 per cent of operations sampled to be in compliance.
Reporting	Annual.
Response to target shortfall	Investigate cause and report to the Conservation Commission.

Key performance indicator 13	The severity status of weeds and pests as determined by subjective survey.
Performance measure	List of weeds and pests and their severity status that tracks movements of species between severity categories.
Performance target(s)	No weed or pest to increase in severity status.
Reporting	Initially and at the mid-term review.
Response to target shortfall	Investigate cause and report to the Conservation Commission.

6 Soil and water

This chapter encompasses the conservation of soil and water resources, and measures to protect these values. The conservation of soil and water is intimately linked to the conservation of biological diversity and to sustaining the productive capacity and health of forest ecosystems.

The chemical, physical, and biological characteristics of aquatic systems are an excellent indicator of the condition of the forests around them, albeit difficult to measure. In that respect streams within the forest estate are the least disturbed within 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 timber and other uses, when properly undertaken, is a benign land use in terms of its effect on streams compared to the alternative land uses agriculture, horticulture and urbanisation.

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

6.1 Objectives

Whole of forest/Landscape objectives

- To sustain soil and water resources in a manner taking account of the principles of ecologically sustainable forest management.
- To ensure that timber harvesting, silvicultural and other operations do not damage the soil in a manner that could compromise the conservation of biological diversity, maintenance of productive capacity, and forest ecosystem health and vitality.
- To ensure that operations managed by the Department and Forest Products Commission sustain the quality and quantity of water necessary to support intended beneficial uses.

Operational objectives

- To prevent damage to soil that results in a significant loss of stored seeds/regenerative propagules or significant disturbance/damage to its physical or chemical properties.
- To ensure operations managed by the Department and Forest Products Commission do not cause more than localised and temporary deterioration in the ecological integrity and water quality and quantity of flows of streams, wetlands and their associated vegetation.

6.2 Strategies

Management strategies

Preventative

Schedule silvicultural operations that require heavy machinery, including timber harvesting, for times when dry soil conditions prevail, except for specified circumstances.

Design and locate snig tracks to minimise the area of soil disturbance

Control and regulate operations, including the management of hydrocarbons to minimise spills and to ensure that soil conservation objectives are met.

Ensure that impacts on soils that arise from silvicultural treatments to maximise the regeneration of commercial species remain within acceptable limits.

Review and implement guidelines that protect soil structure and the surface seed store, including through limiting operations that require heavy machinery to times when dry soil conditions prevail, except for specified circumstances, and minimising roading requirements.

Rehabilitation

Undertake any soil rehabilitation or vegetation regeneration work on heavily used areas like snig tracks and landings as soon as possible after the completion of the operation to maximise the chance of regeneration from stored seed/propagules.

Background

Soils, and the organic matter they contain, provide the physical, chemical and biological foundation necessary to support plant 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 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, roading, timber harvesting, wildfires and grazing can cause soil erosion and 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 best practice operating standards in codes of practice and guidelines. Significant changes in soil bulk density are broad measures of the soil's physical properties important for fertility and hydrological processes. Soil-bound organic matter and above-ground debris are important to soil fertility in that they contribute to the physical, chemical and biological properties of soil.

The impact of machinery on the physical characteristics of soils is immediate and generally obvious albeit still difficult to quantify. 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. Within the jarrah forest approximately 30 per cent of the area subject to harvesting will show visible signs of disturbance during timber harvesting. However, (Whitford 2001) found that less than 16 per cent of the area exceeded the threshold (20 per cent increase) proposed by (Rab 1999) for the Montreal Indicator of soil compaction. Soil disturbance and consequent compaction in mature karri forest timber harvesting can be considerably higher because of the heavier log loads and the often higher soil moisture conditions.

Physical disturbance of soil during jarrah harvesting operations has been found to significantly reduce the abundance of native plants (Burrows *et al.* 2002). The return to pre-harvest abundance was considered to be unlikely in the medium term. While the ecological significance is uncertain it is clear that minimising soil disturbance to sustain the soil-stored regenerative potential is highly desirable from a biodiversity point of view.

Unlike the physical effects on soil from disturbance, the effect on 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, Hingston *et al.* (1988) could find no conclusive evidence of a deterioration of the jarrah forest ecosystem due to changes in nutrient cycling associated with prescribed burning. While adverse impacts on the physical problems 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.

Controlling disturbance

The physical impact on soils in timber harvesting can be managed through appropriate machinery use, snig-track layout, timing operations to avoid high soil moisture and physically protecting soils with vegetative matting. 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. To achieve dry soil only harvesting it is necessary to establish stockpiles of logs, preferably at the mill but sometimes in the bush.

Guidelines for the protection of soil during timber harvesting operations are contained in the Manual of Management Guidelines for Timber Harvesting in Western Australia. The guidelines also include erosion control measures.

Monitoring soil compaction during operations is required to ensure damage does not exceed limits prescribed in guidelines. Bulk density measurements are time consuming and costly to collect, while visual classification provides a simple and reasonably accurate means of efficiently identifying the intensity and extent of soil disturbance (Whitford 2001).

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 (major snig tracks and landings) guidelines require rehabilitation by ripping to decrease bulk density. Rehabilitation is more effective when undertaken as soon as possible after the damage, is under dry soil conditions and uses appropriate ripping technology.

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.

Potential threats	1. Compaction of soils that led to a loss of biodiversity due to an inhibition of vegetation regeneration and development. 2. Failure to comply with guidelines that resulted in unacceptable soil damage. 3. Disturbance to vegetation and soil that led to accelerated erosion. 4. Damaged soil that was not rehabilitated resulting in a long-term loss of productivity. 5. The nutrient status of soils unknowingly diminished through management activities.
Management actions	1. Evaluate all proposed management activities for the risk they pose to soil physical properties. Prevent or prescribe controls to them that contain damage to levels specified in guidelines. 2. Periodically review and enhance to best practice, guidelines designed to control operations to protect soil values. 3. Ensure soil damaged during operations is appropriately rehabilitated at the cost of the proponent of the operation. 4. Review soil erosion risks following planned and unplanned disturbance to vegetation and soil and mitigate risks where necessary. 5. Investigate the development of a soil hazard assessment system to help planning to sustain soil values.

Management strategy

Ensure stream water quality and flows are protected through appropriate soil conservation prescriptions and stream buffering.

Background

Streams are an important component of the biological diversity of the forest because of the aquatic biota and the fringing vegetation and habitats they provide. They are also important as an economic source of water for domestic, agricultural and industrial uses and as a recreational resource.

Most of the undisturbed freshwater habitats in the south-west are potential refuges for relictual aquatic species many of which have not been surveyed. Therefore, it is considered they should all have management systems that emphasize rigorous protection of biodiversity and maintenance of ecosystem function (Horwitz *et al.* 1997).

The increasing demand for high quality water and the potential for reduced supply resulting from continued declining rainfall will require management to ensure maintenance of water production and of risks to water quality from potentially conflicting activities. The Water and Rivers Commission has published a number of policies, guidelines and water quality protection notes that provide guidance on water quality protection.

Legislative responsibilities

Map 4 shows areas of dual responsibility in State forest and timber reserves between the Conservation Commission and the Department on the one hand, and the Water Corporation or the Water and Rivers Commission on the other. The management of drinking water sources is the responsibility of the Water and Rivers Commission. However, the Department and the

Water Corporation provide the day-to-day management of the metropolitan and some country catchments where dual responsibility occurs.

Legislation administered by the Water and Rivers Commission provides for the control of potentially-polluting activities and regulates land use to ensure that raw water quality is sustained at a high standard. These responsibilities apply to catchment areas and water reserves, and underground water pollution control areas. Catchment areas are established to protect the quality of surface water sources used for public drinking water supply. Water reserves are established to protect the quality of future surface water sources.

Water quality

Degradation of surface and groundwater quality by salinity is a risk for water quality for aquatic ecosystems and for human use, particularly in the intermediate (900-1,100 mm/year) and low (less than 900 mm/year) rainfall zones of the draft plan area. Stream salinity occurs when water tables rise through soil-stored salt, and intersect the ground surface, bringing salt to streams. The major cause of these groundwater rises is reduced water use from transpiration, when native perennial vegetation is cleared and replaced with annual agricultural crops. Where evapotranspiration levels are restored quickly by regenerating native vegetation, the risk of increasing stream salinity is low (Borg *et al.* 1988).

Because the degrading impacts and consequences of salinity on surface and groundwater quality are significant, timber-harvesting activities are conducted with a high degree of sensitivity to salinity management. Recognition of this potential impact was reflected in Ministerial Conditions 12 and 16 on the Forest Management Plan 1994-2003 whereby timber harvesting was to be more precautionary in the intermediate and low rainfall zones and high salt risk areas. Salinity is managed during timber harvesting by the retention of enough vegetation cover to prevent water tables from rising and salt in the soil and groundwater, does not significantly contribute to stream flow. This is achieved by sustaining sufficient basal area on harvested areas and provision of buffers around all streams. The specifications are detailed in Appendix 3.

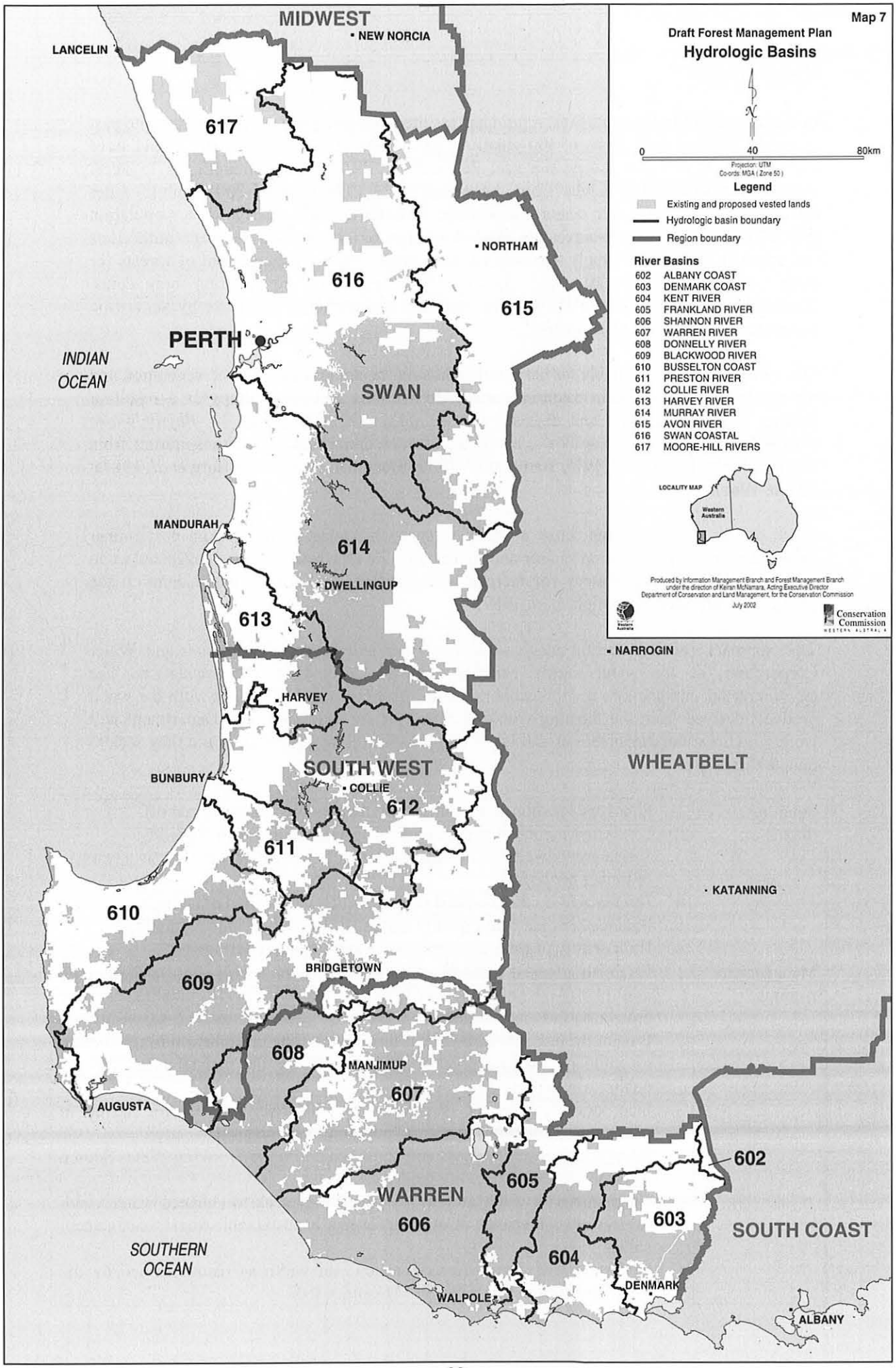
The drying trend experienced in the south-west over the past 30 years continues to shift the location of the isohyet lines that determine the high, intermediate and low rainfall zones used to differentiate management practices for salinity. However, management does not need to reflect the changing isohyet lines as they are only a coarse correlation with the important variables of soil stored salt and depth to water table. Soil-stored salt is insensitive to rainfall fluctuations except over the very long term and depth to water table is declining making the existing boundary of the intermediate rainfall zone more precautionary than it was in the past.

Because salinity management measures are based on past silvicultural practice, research is currently in progress to evaluate the hydrological response to timber harvesting in the intermediate rainfall zone using the current silvicultural practices. Timber harvesting of the trial catchments has taken place but results will not be available until groundwater levels have peaked and subsequently declined. This will be mid-term of the approved plan.

Turbid run-off from roads and other soil-moving operations such as mining and timber harvesting in hardwood and softwood forests and contamination from petroleum products, fertilisers, herbicides, pesticides and human waste have the potential to reduce water quality if adequate controls are not in place. Management systems use a defence in depth approach to protect water quality. This approach entails limiting access by pollution sources to sensitive areas of the catchment, controlling operations to minimise potential problems for water quality, containing contaminants in engineered traps and filtering overland flow through stream side vegetative barriers. The Department works with the Water and Rivers Commission, the Water Corporation and industries active in the forests in the ongoing

improvement of each of the defensive measures. In particular, some softwood forests are established in Public Drinking Water Source Areas with no retained native vegetation on the streamline. Special care is needed in these areas to prevent loss of water quality when harvesting and replanting are undertaken.

In that regard the Water and Rivers Commission has reviewed the efficacy of the current stream and river reserve system, as an appropriate water quality protection strategy (Water and Rivers Commission 2001). Responses and proposed actions to each of the 23 recommendations of the report are provided in Appendix 19. Implementation of the proposed actions will be through the review of existing guidelines within the first year of the approved plan and the undertaking of trials to be completed within the first five years of the plan. The field trials are to evaluate the possibility of zoning streams based on their association with sensitive water values and varying stream buffer width by zone. The outcomes will form part of the mid-term review of the plan and any water quality gains will be assessed in relation to the biodiversity and visual amenity values of the stream buffers.


Map 7
Draft Forest Management Plan
Hydrologic Basins
0
40
80km
Projection: UTM
Co-ords: MGA (Zone 50)
Legend
Existing and proposed vested lands
Hydrologic basin boundary
Region boundary
River Basins
602 ALBANY COAST
603 DENMARK COAST
604 KENT RIVER
605 FRANKLAND RIVER
606 SHANNON RIVER
607 WARREN RIVER
608 DONNELLY RIVER
609 BLACKWOOD RIVER
610 BUSSELTON COAST
611 PRESTON RIVER
612 COLLIE RIVER
613 HARVEY RIVER
614 MURRAY RIVER
615 AVON RIVER
616 SWAN COASTAL
617 MOORE-HILL RIVERS
LOCALITY MAP
Western Australia
Produced by Information Management Branch and Forest Management Branch
under the direction of Kieran McNamara, Acting Executive Director
Department of Conservation and Land Management, for the Conservation Commission
July 2002
Conservation Commission
WESTERN AUSTRALIA
MIDWEST
NEW NORCIA
LANCELIN
617
NORTHAM
616
615
PERTH
INDIAN OCEAN
SWAN
MANDURAH
614
DWELLINGUP
613
NARROGIN
HARVEY
WHEATBELT
SOUTH WEST
BUNBURY
COLLIE
612
611
KATANNING
610
BRIDGETOWN
609
608
MANJIMUP
607
AUGUSTA
602
605
WARREN
606
603
SOUTH COAST
SOUTHERN OCEAN
604
DENMARK
WALPOLE
ALBANY

Water quality

Declining rainfall in the south-west region has resulted in water yield reductions over the past 20 years. Average river flows of 300 gigalitres per annum into Perth dams since 1911 have reduced by 20 per cent during the past 20 years (CSIRO 2001). Streamflows to Perth metropolitan dams have halved from the period 1911-1974 to 1975-2001. While water authorities are reducing per capita water usage through demand management, population growth means more water sources are needed into the future. Options the water authorities can consider to increase supply that will have an impact on the management of forests for other values include increasing the capacity of existing dams, constructing more dams, increasing catchment water yield by forest thinning, and reducing water use by vegetation associated with groundwater sources.

The volume of water available for harvest depends on the amount used by the vegetation and the resultant stream flow in catchment areas. Reductions in forest canopy as a result of mining, timber harvesting and disease such as jarrah dieback caused by *Phytophthora cinnamomi* all increase streamflows, by reducing interception and evapotranspiration from forest canopies (Shea *et al.* 1975; Batini *et al.* 1980; Stoneman *et al.* 1987; Borg *et al.* 1987a, 1987b, 1988).

Much of the northern jarrah forest comprises regrowth stands resulting from past timber harvesting. Jarrah is a high water user and thinning of the regrowth has been suggested as an economically attractive strategy for increasing streamflow into water supply dams in the northern jarrah forest (Schofield *et al.* 1987).

This approach requires careful analysis by the Water and Rivers Commission and Water Corporation, of the water supply benefits against the cost of implementation. The environmental implications and the economic and logistical issues of dealing with the wood products derived from the thinning would also need to be evaluated. The Department will work with the water authorities to assess the implications of any proposal should they seek to pursue this option.

Potential threats	1. Poor road location and maintenance that resulted in turbid run off. 2. Poor erosion control in operations that resulted in stream turbidity. 3. Saline groundwater that contributed significantly to streamflow as a result of timber harvesting. 4. Human activity that resulted in bacterial contamination of streams. 5. Balance between water quality and quantity focused only on quality. 6. High density of trees that restricted water available for harvest.
Management Actions	1. Establish informal reserves on all streams to the standard prescribed in the draft plan (Appendix 3) and code of practice and provide guidelines on their protection and management. 2. Protect the integrity of informal reserves and the catchment through the use of guidelines of best practice management for the maintenance of water quality in all operations. 3. Incorporate appropriate standards for the retention of tree cover in silvicultural guidelines to control potentially saline ground water. 4. Review and manage access and activities on Public Drinking Water Source Areas to meet water quality guidelines. 5. Cooperate with water authorities where they seek to enhance water yield, subject to maintenance of other ecologically sustainable forest management values. 6. Undertake trials on buffer definition and width as recommended by the Water and Rivers Commission (Appendix 19).

6.3 Key performance indicators

Key performance indicators are being used to track the achievement of the approved plan's objectives and its implementation. The background to the development of key performance indicators is described in the 'Plan implementation' chapter under the heading key performance indicators.

Four key indicators have been selected to provide a broad cross-section of achievement of the objective related to the maintenance of soil and water.

Key performance indicator 14	The annual flow weighted mean salinity and the trend for streams in fully-forested catchments.
Performance measure	The annual flow weighted mean salinity and the trends for gauging stations on the following rivers:* Mitchell River (603005) Weld River (606002), (606195) Shannon River (606185) Barlee Brook (608151) Carey Brook (608002) Margaret River North (61008) Harvey River (613002) Tallanalla Creek (613005) Falls Brook (613008) South Dandalup (614043), (614007) Little Dandalup (614017) Wilson Brook (614021) North Dandalup River (614036) * *Some of these gauging stations have been shut down. Reporting on the indicator will be dependent on water authorities maintaining gauging stations and supplying analysed data at appropriate times.*
Performance target(s)	All streams to remain fresh (less than 500mg/litre TSS). Salinity trends to be neutral.
Reporting	Every five years.
Response to target shortfall	Investigate cause in report to Conservation Commission, particularly with respect to climate and disturbance in the catchment.

Key performance indicator 15	The implementation of operational measures designed to protect water and soil.
Performance measure	The extent of compliance with measures in silvicultural and operational guidelines designed to protect soil and water values.
Performance target(s)	85 per cent of sampled areas to be in compliance.
Reporting	Annual.
Response to target shortfall	Investigate cause and report to the Conservation Commission.

Key performance indicator 16	Percent of stream kilometres in catchments in which stream flow and timing has significantly deviated from the historic range of variation.
Performance measure	The length of streams inundated by impoundments or dams. The length of forested streams below impoundments. The length of streams above impoundments.
Performance target(s)	Increase in streams impacted by impoundments limited to public water supply needs.
Reporting	Mid term.
Response to target shortfall	Investigate cause and report to the Conservation Commission.

Key performance indicator 17	Per cent of water bodies (e.g. stream kilometres, lake hectares) with significant variance of biological diversity from the historic range of variability.
Performance measure	The diversity of aquatic macro-invertebrate fauna at a selected number of monitoring sites.
Performance target(s)	No sites with fauna significantly different from the reference condition.
Reporting	Mid term.
Response to target shortfall	Investigate cause and report to Conservation Commission.

7 Global carbon cycles

Living matter has a significant influence on the chemical composition of the atmosphere. Vegetation withdraws carbon dioxide from the atmosphere and then stores it through the process of photosynthesis. Carbon dioxide is returned to the atmosphere by the respiration of vegetation, the decay of organic matter in soils and litter, and through disturbances related to fire and harvesting of the biomass. Methane may also be emitted when organic matter decomposes. The interchange between organic matter and the atmosphere is large; approximately a seventh of the total atmospheric carbon dioxide passes into vegetation each year.

Forests have an important role in global carbon cycles, both as sinks and sources of carbon. Carbon stocks in forests include biomass (litter, woody debris, roots, dry standing stems), soil carbon pools, and forest products. The temperate forests of Australia are estimated to contain 51 gigatonnes of carbon of which 65 per cent (33 gigatonnes) is soil carbon stock (Food and Agriculture Organisation 2001).

Natural disturbances also affect the carbon cycle and these disturbances are the major cause of carbon fluxes in these forests. Wildfire and damage from insects, diseases and storms may play a large role in the carbon cycling in forests. Forest management practices may either increase or decrease these effects.

There are natural fluctuations of carbon stocks in forests over time. However, over the past 150 years atmospheric concentrations of carbon dioxide have increased from about 285 parts per million (ppm) to 386 ppm, about a half of which has resulted from land-use change, predominantly changes from forest ecosystems to agricultural, urban or other land uses (Intergovernmental Panel on Climate Change 2000).

Changes to atmospheric chemistry at this scale are reported to have resulted in small but measurable climate changes already (Intergovernmental Panel on Climate Change 2001). Global climate model simulations of climate regimes under elevated carbon dioxide concentrations[1] suggest that the south-west of Western Australia will experience up to 60 percent less rainfall and up to 5°C higher average ambient temperatures in the coming 70 years (CSIRO 2001). Computer simulations of this type are subject to large degrees of uncertainty, and further and better modelling may reveal more conservative projections. However, the current dry spell corresponds with the climate changes projected in global climate models for the State's southwest. While all or part of the changes experienced in the south-west in the recent past may be due to a number of different climate influences, part of it could be an early expression of climate change resulting from human influence on climate through the enhanced greenhouse effect (Indian Ocean Climate Initiative 2001).

Whatever the cause of the recently-experienced drying trend, it is large enough to require two types of adaptation of forest management objectives and practices:

- to limit the contribution of forest management to higher atmospheric carbon dioxide concentrations; and
- to consider the likely impact of predicted climate change on the components of biodiversity and adopt management strategies that, where possible, ameliorate the impact.

[1] based on a business as usual outcome of a further doubling of carbon dioxide concentrations to 740ppm by 2070

7.1 Objectives

Whole of forest objectives

- To sustain the forest's contribution to global carbon cycles in a manner taking account of the principles of ecologically sustainable forest management.
- To sustain or increase the net carbon sink of the forests.
- To ameliorate where possible, the predicted effects of climate change.

7.2 Strategies

Management strategy
Incorporate carbon management considerations into management planning and guidelines.

Background

Carbon management objectives can be incorporated into forest management guidelines to: increase carbon accumulation in forests or conserve existing forest carbon pools. Promotion of the use of forest products as substitutes for greenhouse-intensive products is another way to sustain forests contribution to global carbon cycles (Kirschbaum 2002). However, such activities are outside the role of the Conservation Commission and the scope of this plan.

Increase carbon accumulation in forests by reforesting cleared land, rehabilitating degraded land and improving the growth rates of standing vegetation.

- Reforestation within the area of the draft plan will be limited, as there is little cleared land vested in the Conservation Commission. The Forest Products Commission is pursuing this strategy on cleared private land that is mainly outside the draft plan area.
- Rehabilitation following disturbance of the forest vegetation through mining or other activities is actively pursued to sustain biodiversity and the production of forest products. The rehabilitation of land degraded by *Phytophthora cinnamomi* presents an opportunity to increase carbon storage in the forest. However, this remains a challenge for biological and financial reasons.
- Forest in the mature and senescent stages of growth is at its maximum carbon storage potential and is no longer accumulating any carbon. Silvicultural management of forests in younger stages of growth, such as thinning, generally redistributes carbon accumulation onto fewer trees rather than increasing overall carbon accumulation. Fertilisation can increase the rate of carbon gain. However, the impacts of fertilisation on biodiversity and on subsequent fluxes of nitrous oxides, which are also greenhouse gases, are unknown.

Conserve the carbon already fixed in existing sinks by avoiding the conversion of forests to other land uses and sustaining the forest's total biomass over time.

- Deforestation causes the major loss of carbon from forest carbon pools. Allowing no further State forest and timber reserves to be alienated and converted to agriculture or other uses will avoid this factor.
- Forest ecosystems and plantations in Australia are currently absorbing more carbon than they are emitting (Australian Greenhouse Office 1999). This is likely to be due both to regrowth in harvested native forest ecosystems and the growth of plantations.

- Where harvested forest materials are used for long-lived products such as housing, and the forest regrows to replace the harvested plants, the total forest and forest product carbon pool with increase over time and may exceed the total stored in a mature forest (Resource Assessment Commission 1992 Appendix K).

Several management factors can affect the amount of carbon that will be maintained in sinks on State forest and timber reserves subject to timber production (Sampson and Scholes 2000):

- *Quantity removed and timing:* carbon stocks can be modified through harvesting practices such as the volume of timber extracted, the rotation length and thinning regimes and the use to which the product is applied.
- *Low-impact practices:* Reducing the disturbance of soil and remaining vegetation during harvesting will conserve soil carbon and the productive capacity and sequestration potential of the site.
- *Regeneration:* effective regeneration of areas where biomass has been removed on a temporary basis, such as through timber harvesting, or on a permanent basis, such as through conversion to other land uses, can sustain the pool of stored carbon.
- *Fire management*: fire is assumed to be carbon-neutral over the growth – harvest cycle of trees (Australian Greenhouse Office 2000). However, while trees absorb carbon dioxide and soils absorb nitrogen gases, carbon dioxide, methane and nitrous oxide are released in planned burning and in wildfires. This gas exchange is likely to yield a net greenhouse impact from fires in south-west forests. Thus, from a forest management perspective, the fact that the south-west forests are predominantly natural systems results in fire management being concerned with the timing, intensity and form of carbon release rather than with the erosion of a long-term natural carbon sink. In addition, because fire is a natural part of the ecosystem in certain conditions, fire is intimately connected to regeneration and forest health, both of which promote the sequestration of carbon from carbon dioxide released by the fire. Fire frequency is related to the amount of stored carbon in the surface soil layer. There is a general increase in carbon content of soil with decreasing fire frequency.
- *Pest and disease management*: since carbon dioxide is absorbed through photosynthesis, it is important to keep pests and pathogens within tolerable levels to sustain vegetative cover. 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 reduced growth and carbon sequestration. The greenhouse implications of these outbreaks have not been quantified and no broadscale environmentally-acceptable control has been found to be effective. The disease caused by *Phytophthora cinnamomi* has undoubtedly resulted in losses from the forest carbon pool and measures are in place to limit its spread for biodiversity conservation reasons.

Summary

Native forest carbon sinks can be increased or sustained by:

- reforesting cleared areas in forest reserves;
- rehabilitating degraded forest areas;
- restricting the conversion of forest areas to agriculture or other uses;
- employing low impact forest harvesting practices to protect vegetation and soil carbon; and
- undertaking research to establish the relative greenhouse emissions from differing fire management options.

Potential threats	1. Soil carbon pools reduced through poor soil management during operations. 2. Regeneration inadequate to replace the carbon removed in timber harvesting over time. 3. Long-term declining forest health that resulted in reduced carbon pool. 4. Poor regeneration following open-cut mining.
Management actions	1. Ensure all harvested forest is regenerated to the standard prescribed in guidelines. 2. Rehabilitate degraded areas of forest where appropriate to a standard that meets the designated long-term land use. 3. Institute measures to control soil disturbance to acceptable levels defined in guidelines (see Soil and water criterion) 4. Develop completion criteria for mining and basic raw material extraction rehabilitation. 5. Institute measures to sustain the health and vitality of the forests (see 'Ecosystem health and vitality' chapter). 6. Include forest issues in the ongoing development of Departmental greenhouse gas position and policy on emissions, sequestration, and bioenergy.

Management strategy

Incorporate the best available scenarios of likely future climate into management planning.

Background

Climate and climate change have been major factors driving the development of Western Australia's high biological diversity, by isolating much of the State from biota originating in other parts of the world and by subjecting the indigenous biota to changing conditions to which they have adapted and evolved.

Climate variability has recently surfaced as a potentially significant effect on productive capacity as south-western Australia experiences a sustained and substantial shift to drier conditions. The change has been marked by an absence of wet winters, less rain days and less rain on extreme rain days. There is now evidence that this shift is not simply a random occurrence but is driven by some changes in atmospheric circulation and climatic relationships.

Any region with increased temperatures and reduced rainfall will experience reductions in soil moisture that will constrain plant growth and increase the likelihood of wildfires. Large outbreaks of fire may lead to losses in vegetative cover and soil carbon. Temperature and rainfall also affect productive capacity through their influence on the photosynthetic ability of plants.

Biodiversity conservation – Changes in species patterns will result from the change in environmental conditions induced by a change in climate. Because some indigenous biota are now restricted to narrow ranges, climate change is an important threatening process affecting their survival. The development of a comprehensive, adequate and representative conservation reserve system provides an important base from which to manage any adverse impacts on the biota from climate change. Sustaining linkages in fragmented landscapes such as the Wheatbelt is another useful strategy that provides opportunities for plants and animals to move as they track their climatic requirements. In a largely intact landscape like the south-west forests, retaining a level of habitat connectivity is an equivalent strategy. This is accomplished through the network of stream zones and retention of mature forest elements.

Productive capacity – There may be rises or falls depending on the species. Increasing carbon dioxide will assist plant growth as will an increase in summer rain in parts. However, a decrease in overall rainfall will shorten the growing season for many plants and lead to reduced biomass production. Declining rainfall and its effect on tree growth will not impact on the sustained yield determined for this plan but will be monitored through periodic inventory and growth plot monitoring.

Ecosystem health and vitality – Climate change presents a very complex situation for forest health. Existing rainfall decline appears to be a factor in the reduced health of tuart and wandoo forest. However, any increase in summer rain would exacerbate the impact of the plant pathogen *Phytophthora cinnamomi*. Increased drought could extend the fire season and see the forest subject to more fires. However, there is evidence now that the fire pattern in most of the forest has significantly decreased from its historical frequency, consequently an increase in frequency may not be deleterious in the long term.

Soil and water – Stream flow in the forest will decline as rainfall declines and this will threaten flora and fauna associated with streams and wetlands. The protection of stream zones, as centres of biological activity will be of increased significance. 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 and fire regimes.

Natural and cultural heritage – Natural heritage, because it is based on the same values as those important for the conservation of biodiversity, has the potential to be similarly affected. Measures to ameliorate the impact on biodiversity will apply to natural heritage.

Socio-economic benefits – Social benefits based on the use of biomass will be affected to the extent that the biomass production is affected.

On current knowledge of the likely magnitude and result of changes to climate from increases in atmospheric levels of greenhouse gases, it is considered the draft plan strategies encompass the broad precautionary actions possible.

While the impact of climate change on biological diversity and productive capacity will not be significant in the 10-year life of the new forest management plan, it is important that it be monitored and its impact on productive capacity, biological diversity, hydrology and ecosystem health be considered in ongoing strategic planning.

Potential threats	1. Climate change that resulted in changes to the standing biomass, species representation, environmental processes and growth rates of forest ecosystems. 2. Climate change scenarios not adequately defined to consider their likely impact on forest values.
Management actions	1. Investigate the likely impacts of climate change scenarios on forest values, including the role of forest ecosystems in the carbon cycle. 2. Maintain contact and, where appropriate, collaborate with external groups undertaking research and modeling with regard to climate change to develop better climate change scenarios. Incorporate climate-modeling results in future planning for the management of State forest and timber reserves.

7.3 Key performance indicators

Key performance indicators are being used to track the achievement of the approved plan's objectives and its implementation. The background to the development of key performance indicators is described in the 'Plan implementation' chapter under the heading key performance indicators.

No key indicators have been selected for this criterion.

8 Natural and cultural heritage

Heritage comprises the things we value and want to keep as a community and as a culture. This concept can be applied to natural and cultural environments. Therefore heritage in forests includes both cultural, i.e. those aspects associated with human association with the forest, and natural values related to the biophysical expression of forests.

Indigenous perceptions of the forest see no separation between natural and cultural values. Our Australian 'bush' heritage and ethos celebrates this traditional cultural perception of Australians. Current trends in community values regarding native vegetation in general and forests in particular are indicative of a reassertion of their cultural heritage value beyond their natural components, scientific attributes and ecological processes. Our cultural heritage embraces the cultural values of all Australian peoples, whether they be indigenous, the early colonists or subsequent migrants.

Western Australian legislation separates the treatment of heritage into Aboriginal (Aboriginal Heritage Act), and places, buildings and sites associated with post-colonisation habitation (Heritage of Western Australia Act), whereas the Commonwealth Australian Heritage Commission Act recognises Aboriginal, non-Aboriginal and natural heritage in the same legislation.

8.1 Objectives

Whole of forest/ Landscape objectives

- To protect natural and cultural heritage values in a manner taking account of the principles of ecologically sustainable forest management.
- To ensure that places on land vested in the Conservation Commission with natural and cultural heritage values are identified, recorded, assessed and managed according to best practice.

Operational objectives

- To develop procedures that ensure that the presence and management of natural and cultural heritage places are considered prior to an operation taking place.
- To work with traditional custodians and other people with special knowledge on the interpretation, protection and management of their cultural heritage.

8.2 Strategies

Management strategies

Protect and manage significant Aboriginal cultural heritage jointly with Aboriginal people.

Work with Aboriginal people and other people with special knowledge to interpret their cultural heritage places and values.

Background

Aboriginal society has existed in various forms in Western Australia for at least 40,000 years (Gibbs 1996). The cultural heritage of the Nyoongar people, who are the traditional inhabitants of the south-west of Western Australia, reflects a society that developed a complex yet subtle relationship with their country. Ethnographic and archaeological evidence attests to the dynamic relationship between the Nyoongar people, the biota and landscapes of their country.

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.

In this era of reconciliation between indigenous and non-indigenous people, it is recognised that the Nyoongars are among the most dispossessed of indigenous people of Australia. Their country has been dramatically altered and vast changes in the biodiversity and the landscapes have occurred to enable the growth and development of contemporary society.

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 Nyoongar heritage is acknowledged and conserved as it provides Nyoongars with an essential emotional and spiritual link to their cultural traditions and practices. Moreover, it is recognised that many heritage places are still used today and provide a means of maintaining their culture. The protection of Aboriginal heritage is therefore a matter of protecting Aboriginal cultural identity, and facilitating access to the land.

The Aboriginal Heritage Act makes provision for the creation and maintenance of an Aboriginal Site Register of places and objects customarily used by Aboriginal people and for the protection of those sites. Furthermore, the Act protects and preserves all Aboriginal heritage regardless of whether the sites or objects are recorded or otherwise known.

The *Native Title Act 1993* also obliges the Department and the Forest Products Commission to notify native title claimants and their State representative body of what the Act defines as 'future acts' (including 'public works', such as roading associated with timber harvesting) proposed in an area under native title claim and provide them with the opportunity to comment on the proposed public work.

The Department and the Forest Products Commission have access to an electronic record of registered sites in the draft plan area and it is used to identify whether operations will impact on known sites. A procedure 'Interim guidelines for Aboriginal Heritage assessment prior to harvesting on State forest' sets out the process. These guidelines are to be reviewed by the Department, the Forest Products Commission, the Department of Indigenous Affairs, the South-West Aboriginal Land and Sea Council and the native title claimants.

The Aboriginal Site Register is not a comprehensive listing of all sites. In order to comply with the Aboriginal Heritage Act, Departmental and Forest Products Commission staff are required, prior to conducting operations, to assess the likelihood of the presence of non-registered sites in consultation with native title claimants and other Nyoongar groups and individuals with rights, interests and knowledge of the area. In close consultation with these groups, archeological and ethnographic field surveys may be undertaken prior to operations in order to identify and avoid sites. In the event that sites cannot be avoided, the Department and/or the Forest Products Commission will make the necessary applications under section 18

of the Aboriginal Heritage Act to seek Ministerial permission to disturb a site with a development.

It is expected that over time, much of the area of State forest will be progressively assessed for archeological and ethnographic importance. The Conservation Commission and the Department will investigate ways of developing this assessment program.

Close consultation with local communities and the Department of Indigenous Affairs will be maintained. Nyoongar people also seek appropriate access to parks, forests and reserves for a full range of spiritual, cultural and recreational purposes. The Department's draft policy statement 'Aboriginal involvement in nature conservation and land management' (2000) sets out the intent in the management of Aboriginal cultural heritage, and provides a policy framework within which native title claims can be negotiated and indigenous land-use agreements developed.

Potential threats	1. Unidentified sites inadvertently damaged. 2. Registered site damaged because of inadequate procedures or inadequate application of procedures. 3. Incorrect interpretation of Aboriginal heritage that resulted from lack of consultation with Aboriginal groups.
Management actions	1. Seek an amendment to the CLM Act and inclusion in the new biodiversity conservation legislation, provision for the undertaking of Aboriginal traditional and cultural activities. 2. Establish an Aboriginal heritage policy approach that: • facilitates timely resolution of native title claims; • enables Aboriginal people to continue to practice Aboriginal law and culture; • enables Aboriginal people to exercise their right to care for lands; • facilitates economic and social justice outcomes for traditional owners; and • provides security of purpose to Aboriginal native title rights. 3. Develop complementary outcomes to the Native Title Act wherever possible to implement Aboriginal heritage programs. 4. Seek to establish a formal Nyoongar consultative working group to advise on issues relating to the Aboriginal cultural heritage in the draft plan area. 5. Acknowledge and identify a network of Nyoongar women and men with authority and knowledge, and provide for or facilitate their involvement in natural resource management and cultural heritage. 6. Facilitate cross-cultural awareness and interpretive activities to inform and educate the wider community regarding Aboriginal culture.

Management strategies

Identify and record heritage places on databases.

Protect natural and cultural heritage places through an appropriate mix of management, and/ or reservation where appropriate.

Background

Cultural heritage

The exploration and colonisation 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 is also a rich folklore, traditions and the ongoing use and care for the land and forests.

The Heritage of Western Australia Act provides for the listing of places of the built environment with heritage value (Register of Heritage Places). A public authority is required to protect a registered place unless there is no prudent or feasible alternative (section 11). The definition of cultural heritage significance in the Heritage 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 State forest and timber reserves, some of which are listed.

The management of cultural heritage sites is set out in the Department's draft policy statement 'Management of non-indigenous cultural heritage on CALM estate'. The approach is in accord with the Australia ICOMOS Charter for Places of Cultural Significance (Burra Charter) that sets the standard of practice for heritage owners or custodians (Australia ICOMOS 1999). The approach incorporates the State Government policy, *The Government Heritage Property Disposal Process*, designed to ensure government departments appropriately address cultural heritage in land acquisition and disposal.

Natural heritage

Natural heritage values include old-growth forest; representative vegetation; natural landscapes; rare, threatened or restricted flora and fauna; forest communities; remnant vegetation; important wetlands; biodiversity; species richness; refugia and centres of endemism; flora at the limit of their range; and geological heritage. The Australian Heritage Commission Act provides a register and process for the identification and listing of these places.

A systematic and extensive identification and assessment of natural heritage values has provided the basis for a regional framework for their protection (Department of Conservation and Land Management and Australian Heritage Commission 1992; Commonwealth of Australia and the State of Western Australia 1998a).

The primary means for protecting and managing natural heritage values is through their incorporation into the conservation reserve system where appropriate. Other off-reserve values may be protected by management prescriptions and through statutory planning processes.

The region has been geologically mapped at a very generalised 1:250,000 scale and more detailed 1:50,000 scale mapping has been completed for the coastal parts. There is a rich heritage of geological information still to be derived from successive geo-scientific investigations.

Potential threats	1. Cultural heritage lost because of inadequate identification and recording. 2. Cultural heritage lost because of inadequate procedures or inadequate application of procedures. 3. Significant natural heritage not captured in the reserve system.

Management actions	1. Progressively undertake systematic surveys and enhance databases of the significance of cultural heritage places and values. 2. Collaborate with Commonwealth and State agencies, local government authorities and non-statutory organisations about cultural heritage conservation. 3. Review existing processes for adequacy and, where necessary, develop new processes that comply with legislative and policy requirements to conserve. 4. Enhance and, where necessary, develop databases to inform operational planning about natural heritage places and values heritage assets and recognised heritage places in State forest and timber reserves.

8.3 Key performance indicators

Background

Key performance indicators are being used to track the achievement of the approved plan's objectives and its implementation. The background to the development of key performance indicators is described in the 'Plan implementation' chapter under the heading key performance indicators.

Three key indicators have been selected to provide a broad cross-section of achievement of the objective related to the maintenance of cultural and natural heritage.

Key performance indicator 18	The identification and protection of cultural heritage.
Performance measure	The number of existing and new heritage sites identified in management planning and the number protected.
Performance target(s)	No disturbance of a registered place without formal approval.
Reporting	Annual.
Response to target shortfall	Investigate and report to the Conservation Commission.

Key performance indicator 19	Consultation and involvement of Aboriginal people in forest management.
Performance measure	Establishment of the Nyoongar working group. Issues addressed by the Nyoongar working group. References with respect to native title rights.
Performance target(s)	Nyoongar working group to be established within one year of draft plan approval. All legal requirements met.
Reporting	Annual.
Response to target shortfall	Investigate and report to the Conservation Commission.

Key performance indicator 20	The protection of heritage places through representation in reserves.
Performance measure	Representation of heritage values in the existing and proposed formal and informal reserve system.
Performance target(s)	See Key performance indicator 1.
Reporting	Biennial.
Response to target shortfall	See Key performance indicator 1.

9 Socio-economic benefits

Forest ecosystems are renewable and, with management regimes that retain their ecological integrity, biological components, and adaptive capacity, can be sustained in perpetuity.

Historically, population growth and development pressures have resulted in the conversion and loss of forest land to other uses and the degradation of forest ecosystems. There has also been a tendency to focus on the extraction of timber and the management of the forest land base to favour timber production. Over the past 20 years the shift in social values has seen that change to where the forest is most highly valued for its biodiversity and aesthetic appearance. As a result management to support that shift has resulted in a decline in the economic benefits from timber and an increase in those generated from the forest's biodiversity or its appearance, such as nature-based recreation.

The ability to deliver multiple social and economic goods and services over the long term depends on the maintenance of the forest land base and of natural forest ecosystem processes. The goods and services from the forests that provide socio-economic benefits include the following:

- minerals, construction materials;
- revenue, direct and indirect employment, incomes, and profits;
- clean and regulated flows of water;
- visual amenity;
- nature-based recreation and its associated equipment, interpretation, campgrounds etc.;
- timber and non-log timber products;
- wildflowers and seeds;
- bee-keeping;
- sequestration of atmospheric carbon; and
- genetic resources for the development of medicines.

The socio-economic aspects of water are addressed under the 'Soil and water' chapter.

The most economically valuable product from the forest comes not from its appearance or biological productivity but from the ground on which it grows. Minerals and gravel, sand and stone that are collectively known as basic raw materials (BRM) had an output value in excess of $4.7 billion in the year 2001. Mineral and petroleum explorers require ongoing access to areas that have economic resource potential if this contribution is to continue.

A socio-economic study is being conducted on the changed social and economic opportunities resulting from implementation of the *Protecting our old-growth forests* policy and the scenarios in this draft plan. The results of this study will be released during the public comment period for the draft plan, and considered in the development of the final plan.

9.1 Objectives

Whole of forest objectives

- To sustain and enhance socio-economic benefits to meet the needs of the public in a manner taking account of the principles of ecologically sustainable forest management.
- To generate social, cultural and economic benefits through the provision of a range of goods and services that are valued by the community and are produced in a manner taking account of the principles of ecologically sustainable forest management.
- To provide for an increase in the socio-economic benefits derived from natural values to mitigate the impact on local communities of the reduced availability of timber supply.

9.2 Strategies

Management strategy
Minimise the impact of mineral and petroleum activities on other forest values.

Background

Mineral extraction from land in the three regions covered by this draft plan in 2001 totalled more than $4.7 billion, of which $4.2 billion came from State forest. Royalty payments to the State Government contributed $94.8 million to the State's economy, and the sector directly employed 9,423 people during the period (Table 10). Other significant community benefits, including company and personal taxes, and flow-on employment for services and goods needed by the industry, are not documented but would be large. The region supplies a significant proportion of the world demand for a number of minerals.

In addition to the mineral resources, the Department obtains gravel resources for its own road construction purposes. Gravel, limestone and other construction materials are extracted from private lands, and can include land in the name of the Executive Director of the Department, on Extractive Industry Licences and Development Approvals authorised by local government. These materials are not included in Table 10. Gravel, sand and limestone extracted for third-party sale are classed as minerals and are shown in the production figures in Table 10.

Table 10: Socio-economic benefits of mineral production in the area covered by the draft plan

Commodity	Departmental administrative region	Output value 2001 ($millions)	Direct employment
Bauxite	Swan, South West	3,766	6,569
Clay	Swan, South West	0.12	7
Coal	South West	258	677
Construction materials; limestone; limesand	Swan	12.4	29
Gold	Swan	119	589
Titanium minerals and zircon	South West, Warren	327	1,017
Limestone; limesand	Swan, South West	8.9	14
Silica; silica sand	Swan	3.8	20
Tantalum-lithium-tin	South West	205	501
Total		**4,700**	**9,423**

Source: Department of Mineral and Petroleum Resources

It is not possible to be sure of the potential mineral or petroleum values within the draft plan area. However, most of the forest is known to be highly prospective for a diverse range of precious, base, specialty and alloying metals and various industrial minerals. Also the forest region west of the Darling Fault contains known gas resources and the prospect of finding further hydrocarbon resources is high. Work done for the RFA, and a subsequent study by the Department of Mineral and Petroleum Resources, in April 2001, shows that south-western Australia contains potential for 13 metaliferous, five industrial and three energy source deposits. Many of these areas are on State forest. Many of these potential resources lie beneath State forest.

The process for the exploration and extraction of minerals and petroleum is described in Appendix 20, and is subject to the present review of mining and petroleum activities in national parks and nature reserves under the Government's environment policy. Map 8 shows the extent of exploration licences that overlap the area of this draft plan. The State often facilitates access by industry to minerals, through State Agreement Acts. In the draft plan area these include the *Alumina Refinery Agreement Act 1961,* the *Alumina Refinery (Pinjarra) Agreement Act 1969* and the *Alumina Refinery (Wagerup) Agreement Act 1978* covering Alcoa bauxite mining operations, the *Alumina Refinery (Worsley) Agreement Act 1973* covering the Worsley bauxite mining operations, the *Collie Coal (Griffin) Agreement Act 1979* and the *Collie Coal (Western Collieries) Agreement Act 1979.* Mineral and petroleum resources can also be accessed through the Mining Act and Petroleum Act subject to meeting approval requirements.

These agreements are Acts of Parliament under which the mining companies are granted both rights and obligations in relation to a particular area and activity. If the Agreement Act post-dates 1971 they are subject to environmental review under the EP Act prior to being granted conditional approval to mine.

These Acts are specific bilateral agreements between the Government and the mining companies, and may not be altered without the concurrence of both parties. While they over-ride the CLM Act, they include requirements to protect forest values and facilitate recovery of harvestable timber from areas cleared for mining. The projects are subject to or have

subjected themselves to environmental assessment by the EPA, and the Department advises the Minister for the Environment and Heritage on appropriate environmental conditions for project implementation. These relate specifically to the protection and conservation of natural values, the recovery of timber harvested from areas cleared for mining, and ensuring the effective rehabilitation of areas after mining.

Potential threats	1. Mineral petroleum and construction materials, resources unavailable as a result of the establishment of new conservation reserves.
Management actions	1. The Conservation Commission and the Department, in consultation with the Department of Mineral and Petroleum Resources, will advise Government and Government agencies on the effects of mining and exploration on forest values, conditions to mitigate impacts, rehabilitation and completion criteria. 2. The Department will consult closely with the Department of Mineral and Petroleum Resources and work with mining companies wherever possible to achieve the best socio-economic benefits commensurate with minimising through management the effects of resource extraction on forest values. 3. The Department will seek reasonable cost recovery for its involvement in regulating exploration and mining activities.

Management strategy

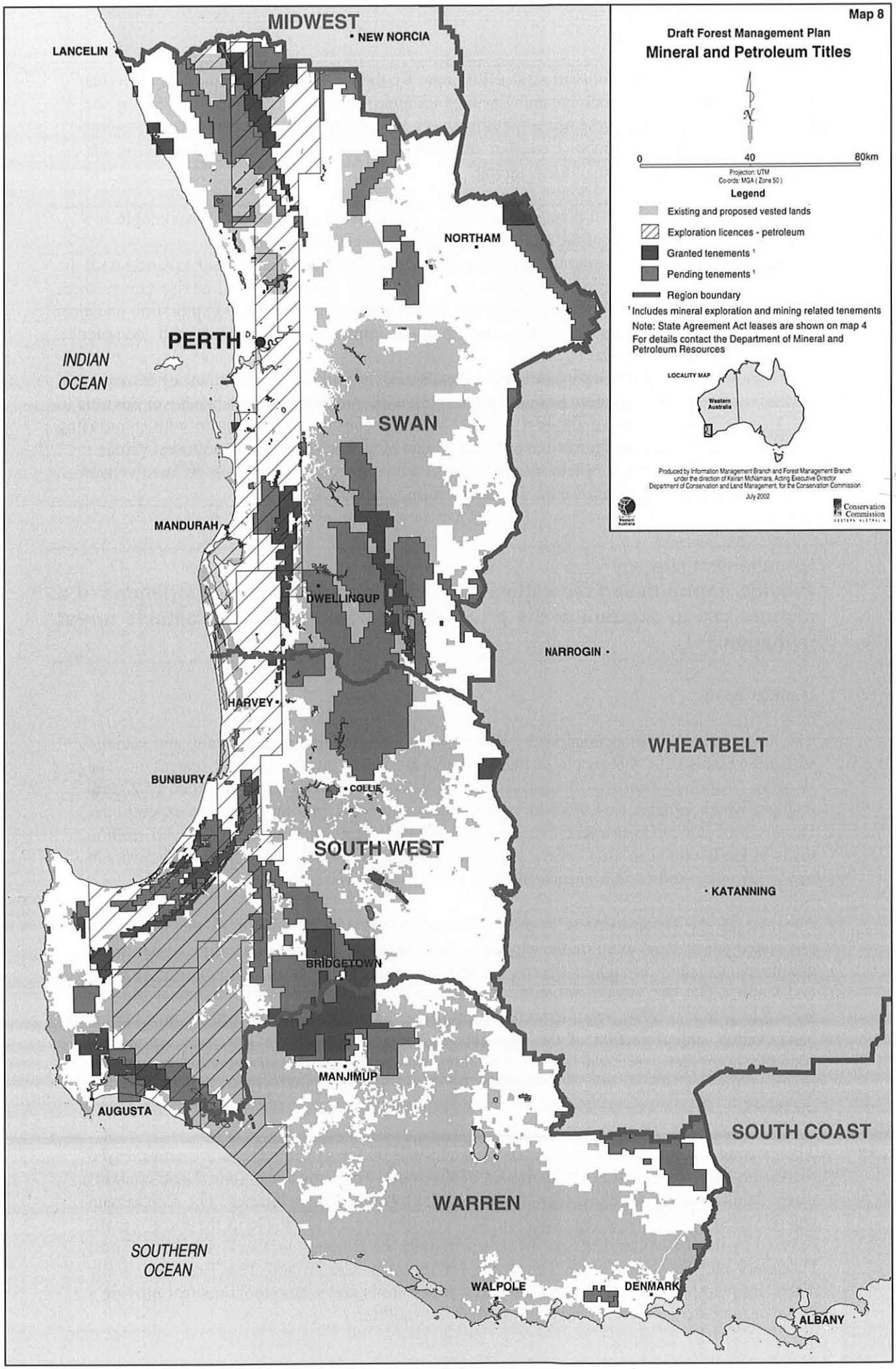
Provide nature-based recreation opportunities and visitor experiences in a manner taking account of the principles of ecologically sustainable forest management.

Background

The forests and their associated landscapes provide a diverse and economically and socially valuable resource for the people of the State to participate in nature-based recreation. The Western Australian Tourism Commission estimates that in 2000 the south-west had 1,528,000 visitors, which equates to 4,963,000 visitor nights and $422 million in visitor expenditure. During 2000/2001, Departmental survey data showed there were an estimated 4.6 million visits to lands vested in the Conservation Commission within the three regions (Department of Conservation and Land Management 2001).

The role of the Department is to provide opportunities for the visitor to the forest and associated ecosystems to enjoy the experience and increase their understanding of the forest and its management through interpretation. Interpretation is a means of communicating ideas and feelings that help people enrich their understanding and appreciation of their world and their role within it. Effective interpretation programs enhance positive attitudes towards the conservation and protection of the physical environment and native flora and fauna, and promote a greater understanding of the inter-relationships between people and nature. Interpretation programs may be provided by Departmental staff, private guides or tour operators.

The existing and proposed formal reserve system will be the primary focus for nature-based recreation and interpretation in the forests of the south-west, however, State forest contains many facilities and contributes significantly to the available opportunities. The Department has 653 recreational assets registered on its recreation facility database in the three regions covered by the draft plan. High profile assets include the Bibbulmun Track, The Hills Forest Discovery and Heritage Centre, Icy Creek Environment Centre and The Tree Top Walk. There are many picnic and camping sites, recreation trails and scenic lookouts that provide a range of tourism and recreational opportunities for visitors.


Map 8
Draft Forest Management Plan
Mineral and Petroleum Titles
0
40
80km
Projection: UTM
Co-ords: MGA (Zone 50)
Legend
Existing and proposed vested lands
Exploration licences - petroleum
Granted tenements [1]
Pending tenements [1]
Region boundary
[1] Includes mineral exploration and mining related tenements
Note: State Agreement Act leases are shown on map 4
For details contact the Department of Mineral and Petroleum Resources
LOCALITY MAP
Western Australia
Produced by Information Management Branch and Forest Management Branch
under the direction of Kieran McNamara, Acting Executive Director
Department of Conservation and Land Management, for the Conservation Commission
July 2002
Conservation Commission
MIDWEST
NEW NORCIA
LANCELIN
NORTHAM
PERTH
INDIAN OCEAN
SWAN
MANDURAH
DWELLINGUP
NARROGIN
HARVEY
WHEATBELT
BUNBURY
COLLIE
SOUTH WEST
KATANNING
BRIDGETOWN
MANJIMUP
AUGUSTA
SOUTH COAST
WARREN
SOUTHERN OCEAN
WALPOLE
DENMARK
ALBANY

The Department earns revenue from visitor services through tour operator concessions located on Conservation Commission vested land, and camping and visitor fees to some areas including guided activity programs. Concession payments and fees contribute to sustaining visitor facilities and park values, and aim to meet the full cost of providing services.

The Government has provided additional impetus to the development of nature-based tourism by establishing an Environmental Tourism Unit within the Western Australian Tourism Commission focusing on the development of sustainable nature-based tourism throughout the State. The unit has an Advisory Council made up of a range of Government and tourism industry representatives. The Advisory Council is assisting with the development and implementation of the new Western Australian Nature-Based Tourism Strategy.

Nature-based tourism has been identified as one possible alternative source of economic activity to offset the decline in the timber industry. The Government has announced a number of initiatives aimed at encouraging investment in tourism facilities and thereby providing potential employment opportunities.

Expanding the range of visitor facilities within the south-west region is anticipated to encourage visitors to stay longer and spend more thereby increasing the economic benefits associated with nature-based tourism. Some of the new facilities being developed include the Karri Tingle Visitor Centre in the proposed Walpole Wilderness Area as well as a number of tourist drives and private sector low impact accommodation developments.

In keeping with the principles of ecologically sustainable forest management the development of sites and facilities needs to be ecologically sustainable. A potential conflict in use of the forest is that of recreation and the maintenance of water quality in Public Drinking Water Source Areas in the northern State forests. The Water and Rivers Commission has the responsibility to manage water quality and is developing policies and protection notes to guide protection actions. The Department is working with the Water and Rivers Commission to develop access policies and practices that will protect water quality.

Other important issues affecting recreation and visitor access to State forest include restricted access for safety reasons as bauxite mining expands in some areas, vehicle restrictions due to dieback hygiene and visitor protection from the potential hazards in the natural environment.

The principles listed in Appendix 21 for the achievement of visitor services objectives, Departmental Policy Statement No. 18 'Recreation, tourism and visitor services' (1991) and operational guidelines prescribe visitor services provided by the Department. Programs are implemented by Departmental regions and districts based on a five-year strategic plan, and two-year business plans. Visitor services are funded through recurrent and capital budget allocations to the three forest regions, and through the retention of park entrance, camping, lease and licence fees.

A framework plan is established in the Warren Region and it is proposed to extend it to the other two regions. The framework plan zones precincts, areas and sites into a spectrum of degrees of development. These zones create nodes for directing audience groups to avoid conflicts with other groups and ensure appropriate service developments are provided.

Potential threats	1. The development or expansion of visitor services limited by conflicts with other forest uses. 2. Visitor services not sustainable leading to degradation of the environment. 3. Visitor services not matched to community demand.
Management actions	1. Integrate the provision of recreation opportunities and visitor services across all forest land categories through the development of a strategic framework plan for the forest.

	2. Rationalise old recreation sites and develop new sites and interpretative programs and projects in accordance with resources available and the strategic framework plan. 3. Manage risks to visitors by taking reasonable measures, relative to hazards, that are consistent with activities undertaken, intensity of use and the inherent character of the site. 4. Undertake research and monitoring of the knowledge, attitudes, skills and actions of visitors to provide for improvement in the quality of visitor services.

Management strategy

Maximise socio-economic benefit derived from the harvesting of timber, taking account of the principles of ecologically sustainable forest management.

Background

State forest and timber reserves within the scope of this draft plan provide both native forest hardwood and plantation-grown softwood timbers. The growing, transport and processing sectors within the timber industry are geographically dispersed across the south-west. Consequently, substantial socio-economic benefits accrue from the industry to the local, regional and State economies.

Work done for the RFA (Commonwealth of Australia and the State of Western Australia, 1998c) estimated that the annual gross value of production of the hardwood and softwood industries to the point of first sale was $400 million. The native forests sector employed 2,400 people directly in harvesting, haulage, milling and timber dressing with an indirect flow-on of an estimated 2,900 people.

At that time the industry provided gross revenue to the State, from harvest and sale of forest products, of approximately $130 million annually. This was comprised of $70-80 million from the native forests sector and $50-60 million from the plantations sector.

Under this draft plan it is predicted that gross revenue from native forest operations will fall to less than $40 million. The actual impact of this contraction on the south-west and State economies will depend on the management scenario chosen and consequent sustained yields, and the development of a newly restructured industry focused on local, employment-rich processing industries that produce high value products such as furniture, joinery and flooring. Initial estimates based on the 2001 indicative yields are that around 1,000 jobs will be lost in the short term.

Revenue from plantation operations will continue to rise in the short term but will level off at approximately $70 million during the life of the plan.

Native forests

Timber harvesting within the jarrah and karri forests has historically generated a wide range of products, including sawlogs, poles, piles, veneer logs and residue logs for chipwood and charcoal. Log products are produced in the forest by contractors to the Forest Products Commission and sold by that Commission to independent private processors. Periodically the Department takes a small quantity of log timber from the Forest Products Commission to be used for improvements to the land as provided for in section 33(1)(cb) of the CLM Act.

The range of sustained timber yields that is proposed in this draft plan is a significant reduction in the total log supply available from State forest and timber reserves in the Forest Management Plan 1994-2003. The reduction largely results from the reduced area of native forest available for timber production.

Accordingly, Government and industry-initiated adjustment programs are underway to realign the native timber industry to a lower log supply. Central this is the goal of restructuring the industry in a manner that will maximise the socio-economic opportunities that can be derived from the available resource. Strategies adopted by the Forest Products Commission to achieve this include:

- Restructuring the industry by requesting proposals for timber allocation based on high value adding and downstream processing.
- Maximising the future sustained yield by assisting industry to step down their intake ahead of contract expiry. The timber saved is to be added to the available yield over the period determined by Government.
- Working to improve the level of utililisation of the resource through measures such as a switch to bole sawlog sales.

Thus, while the total log volume produced may decrease, an increasing proportion will be directed to downstream processing. Value-adding initiatives are focusing on the provision of kiln-dried timber and the emergence of a significant secondary-manufacturing sector that produces outdoor furniture, high-value indoor furniture, joinery and flooring products. Expansion of this industry sector has the potential to generate substantial employment within the south-west. This will require, in part, the development of new market opportunities within Australia and overseas.

While seeking to maximise the production of value-added products, there will continue to be a substantial proportion of wood that, owing to size, defect, or consumer preference, is unsuited to sawlog uses. A further challenge during the period of the draft plan will be to maintain or extend the markets for such non-sawlog components and residue logs. Local industries currently utilise jarrah logs and residues for the production of charcoal for silicon production, and karri residue logs are used in the production of woodchips for paper manufacture. Maintaining these markets, as well as maximising the recovery of higher value products from the total available residue timber resource, is also important to facilitate silvicultural practices that promote the growth of high quality sawlogs in the future.

The increased dependence of the karri yield on regrowth forests makes protection of the large areas of fire sensitive karri regrowth important to sustain the socio-economic benefit of the available resource.

Minor volumes of other species associated with the jarrah and karri forest will continue to be available for specialist markets. These include craftwood products and value-added applications such as furniture and flooring, where they form a valuable complement to the other major species.

Plantations

There are approximately 50,000 hectares of pine plantation in State forest and timber reserves covered by this draft plan. In accordance with section 56(1)(b) of the CLM Act, these areas are managed to achieve the optimum yield in timber production consistent with the satisfaction of long-term social and economic needs.

Potential threats	1. Access to the resource further limited by land use change decisions. 2. Resource allocation and pricing that did not encourage value adding.
Management actions	1. Where appropriate, the Conservation Commission and the Department will work with the Forest Products Commission on industry development issues that will improve the socio-economic benefit from the allowable timber harvest. 2. Assist the Forest Products Commission to operate on State forest and timber reserves planted with exotic species to achieve the optimum yield in production consistent with the satisfaction of long-term social and economic needs. 3. Sustain the productivity of plantations on State forest by replanting suitable areas after harvest and through application of the 'Code of Practice for Timber Production in Western Australia', except where it has been determined by Government that it will be returned to native vegetation, such as in Gnangara and Lane Poole Reserve.

Management strategy

Manage disturbance activities to as far as possible sustain the inherent visual qualities of the landscape in a regional context.

Background

Visual landscape management is based on the premise that the visual quality of a landscape is a resource that can be assessed and managed in much the same way as other values, such as fauna, flora, water and recreation. The intent of visual landscape management is to ensure that all uses and activities are planned and implemented to complement rather than detract from the inherent visual qualities of the landscape. Portions of the landscape resources in the draft plan area are highly valued by the community, and underpin much of the value of the south-west nature-based tourism industry.

Management activities that disturb existing vegetation, such as open cut mining, borrow pits, timber harvesting and regeneration, road construction, public utilities and fire, can impact negatively on the visual landscape. Sensitive visual landscape management, through considered planning, design and implementation is therefore necessary to ensure the socio-economic benefits of the region associated with visitor experiences, such as nature-based recreation and tourism, are sustained.

Implementation guidance is provided by Department Policy Statement No. 34 'Visual Resource Management on Lands and Waters Managed by CALM' (1989). In accordance with the policy, the 'Visual Landscape Management System' (Department of Conservation and Land Management 1989) has been applied to all land management activities and is well established. The system combines characteristics of the physical landscape (visual quality) with socio-cultural considerations such as land use, historic features, access and volume of use. The output is mapped and visual landscape management zones are identified and assigned an objective for management.

Potential threats	1. Landscapes degraded in the long term by poorly planned and implemented activities.
Management actions	1. Maintain a visual landscape classification and management system. 2. Review and where necessary update, the application of visual landscape management principles in land use planning, codes of practice, operational guidelines and other relevant manuals.

Management strategy

Provide for necessary basic raw materials extraction in a manner taking account of the principles of ecologically sustainable forest management.

Background

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 through leases issued under section 97 of the CLM Act. There are currently 31 leases for gravel extraction in the south-west forests. Recent amendments to the CLM Act require leases to be in conformity with the purposes of management of State forest and timber reserves stated in section 55 of the Act. Allowable purposes for BRM extraction under the amended legislation are more restrictive than before and BRM extracted from such leases must be used, for example, on roads whose purpose supports recreation, catchment management, timber production or conservation.

The Department uses BRM for its own purposes in recreation and nature conservation activities and facilitates its supply for timber harvesting undertaken by the Forest Productions Commission.

BRM extraction impacts on the vegetation and degrades biodiversity values if effective follow-up rehabilitation is not undertaken. Consequently the Department does not provide BRM for private use, but will supply local government authorities using a CLM Act lease where the use is deemed to meet the requirements of the Act, service State forest and there are no alternative resources available. Similarly BRM may be made available from the conservation estate for public access roads within the conservation estate through Local Government Act powers subject to environmental assessment and no alternative sources being available. Outside of these circumstances access is restricted to exceptional circumstances following consideration of conservation value impacts, trade-offs and compensation. BRM are not available for resale by local government authorities unless they hold a survey lease, granted under the Mining Act. The Department also uses BRM for its own road-making activities.

Access to BRM for local government will be affected in some areas by the conversion of State forest to conservation reserve land categories. The Department will work with local government and the State Government to address this issue. For the Department to assist it will require Shires to develop long-term plans (20 years) identifying their needs for BRM, where the need is geographically and what alternative public and private resources exist. There is scope for a strategic evaluation of potential gravel source areas under the auspices of the State Gravel Supply Strategy to assist in alleviating future problems that may face local Shires in the assessment of gravel supplies.

Relevant documents for the management of BRM are Department Policy Statement No. 2 'Local Government Authority Access to Basic Raw Materials from State Forest and Timber Reserve', Department Policy Statement No. 10 'Rehabilitation of Disturbed Land', 'Guidelines for Gravel Pit Rehabilitation and Environmental Management of Quarries' (Department of Minerals and Energy 1994).

Potential threats	1. Land use changes that limit access to BRM.
Management actions	1. The Department and the Conservation Commission will limit clearing for BRM on State forest and timber reserves to that considered essential by Government. 2. Seek to ensure that the cost of rehabilitation is borne by the organisation responsible for BRM extraction and that, where necessary, a rehabilitation performance bond is a condition of the lease. 3. Progressively develop plans and works programs for rehabilitation of worked-out excavations. Where it serves management objectives for the site, the Department will issue gravel extraction leases to proponents in situations requiring rehabilitation of abandoned unrehabilitated pits (orphan sites).

Management strategy

Regulate access for the apiculture industry in a manner taking account of the principles of ecologically sustainable forest management.

Background

Under the CLM Act, the Department is responsible for managing beekeeper access to land vested in the Conservation Commission. Although honey-bees are an exotic species, apiary sites occur on all land categories of land vested in the Conservation Commission. There are almost 80 beekeepers who have registered sites in State forest and timber reserves, and around 1,000 apiary sites registered on these lands.

Department Policy Statement No. 41 'Beekeeping on Public Land' (1992) guides the management of apiculture. The activity is controlled by the issue of apiary site permits and conditions under Part 11 of the *Forest Management Regulations 1993* pursuant to the CLM Act. In addition, a code of practice for beekeepers was negotiated with the industry (Department of Conservation and Land Management 1999b). The Beekeepers Consultative Committee provides a formal means of liaison between the Department and the industry. An annual fee is charged for apiary site permits and in general the fee is expected to cover the cost of management.

The apiculture (beekeeping) industry in Western Australia values its production at $7.5 million annually with associated benefits to agriculture and horticulture of around $90 million, through the incidental pollination of commercially-grown crops. Western Australia produces an average of 3,000 tonnes of honey annually. Permits can be issued for up to five years and environmental conditions attached to the permit require compliance with Departmental management requirements, water catchment guidelines, dieback control and fire management.

Ecological principles suggest that introduced honey-bees adversely affect native plant pollinators through competition for pollen and nectar resources. Research is being undertaken to quantify any relevant effects and is expected to be available in the near future. Feral honey-bees are also thought to affect species that breed in tree hollows by competing for that resource. In the meantime, the Government's policy is to maintain existing levels of apiary sites in nature reserves, national parks, and conservation parks, except where their removal has been prescribed in an area management plan. This policy also allows for apiary sites in State forest that are now proposed to become one of the conservation reserve land categories arising from the *Protecting our old-growth forests* policy to remain until such time as an area

management plan is prepared for the reserve. Apiculture is at present considered to be compatible with the land management purposes in State forest and timber reserves. The industry has argued for tradability of sites and a Government Position Paper has been released.

Potential threats	1. Maintenance of biodiversity compromised by bee-keeping. 2. Management practices for other forest uses that limited access to sites or resulted in reduced flowering.
Management actions	1. Support and administer apiculture through the allocation of sites under permit on Crown land subject to land access policy and management conditions. 2. Review apiary industry access policy and guidelines when research results on the impact of honey bees on biodiversity becomes available. 3. Review licence fees so that over time management costs are fully covered.

Management strategy

Regulate the commercial harvesting of protected flora so that the conservation of the species is not jeopardised and in a manner taking account of the principles of ecologically sustainable forest management.

Background

The flora industry includes wildflowers and foliage, seed and craft products such as banksia cones, didgeridoos and tea tree sticks. These products are harvested from Crown land, bush on private property and cultivated crops according to the process described in Appendix 17. The wildflowers and foliage component of the industry alone was estimated to be worth $17.5 million based on Australian Bureau of Statistics export figures (1998/99) and local data.

Departmental policy 13 Commercial Flora Harvesting guides management of flora harvesting. Flora harvesting is not permitted in national parks, conservation parks or nature reserves.

State forest, timber reserves and unallocated Crown land are a major source of native flowers and foliage for the industry with 9.6 million flowering/foliage stems (63 per cent of the total) being harvested from these areas in 1999. These stems are harvested from 48 species. The three main foliage crops are sourced almost entirely from Crown land in the forest areas of Western Australia. The RFA estimated the forest-harvested component of wildflower production to be worth $3.7 million annually. Thirty-eight per cent of seed, or about 19 tonnes, was harvested from south-west forest Crown lands in 1999 from 329 species. The majority of seed harvested is used for minesite rehabilitation.

The expansion of the conservation reserve system under the Government's *Protecting our old-growth forests* policy will transfer considerable areas of State forest in the Warren Region into land categories where wildflower picking is traditionally not permitted. The industry is currently negotiating continued access to parts of those areas through the Walpole Wilderness Area Stakeholder Reference Group set up by Government.

Potential threats	1. Land-use changes restrict access to the flora resource.
Management actions	1. Permit picking and seed collection under licence on State forest and timber reserves subject to land use priorities, conservation needs and management conditions. 2. Incorporate into the proposed biodiversity legislation to replace the Wildlife

	Conservation Act, measures to improve its management effectiveness consistent with the provisions of Policy Statement No. 13 'Commercial Flora Harvesting'. 3. Review cost recovery mechanisms and seek a greater recovery of management costs when the new biodiversity legislation is passed. 4. Assist industry with the horticultural development of the wildflower resource.

Management strategy

Provide leases for facilities and uses where they meet the requirements of the CLM Act and have regard to the principles of ecologically sustainable forest management.

Background

Leases over land that is vested in the Conservation Commission may be granted according to section 97 of the CLM Act for State forest or a timber reserve (referred to as forest leases), and section 100 of the Act for conservation reserves, excluding wilderness areas.

There are approximately 290 leases current in the draft plan area. Revenue from forest leases is approximately $100,000 per year. Leases have been issued for a variety of purposes, including grazing, rural dam sites, prisons, industrial facilities, gravel extraction, tourism, recreation club use and rubbish sites. An annual fee is charged for leases, and the Department seeks full cost recovery as a minimum for all its fees and charges for commercial leases. Where facilities are of a commercial nature, a market-based charge will be derived.

An amendment in 2000 to section 97 of the CLM Act requires the purposes of issued leases to be consistent with the purposes for the management of State forest and timber reserves listed in section 55(1a) of the Act. These are conservation, recreation, timber production on a sustained yield basis, water catchment protection and other purposes prescribed by the regulations.

The purposes for all existing leases have been reviewed for their compliance with the revised CLM Act and divided into four categories. These are:

- The purpose conforms to section 55(1a), such as leases for recreation or tourism activities. These leases will be retained as they are.
- The purpose does not conform to section 55(1a), such as dam sites and telecommunications facilities, but there is a logical connection between the purpose of the lease and one or more of the purposes of State forest, or the lease is considered essential for the Department to meet its duty of care to persons, property, land, waters, flora or fauna. The Department will seek remedies by way of regulations or statutory amendment to formalize such activities.
- The purpose does not conform to section 55(1a), such as prison sites and houses. There is no logical connection between the lease purpose and the objectives for management of State forest and the natural values of the land have been lost. It is proposed to excise the land occupied by these leases from State forest.
- The purpose does not conform to section 55(1a), there is no logical connection but the environmental values of the land can be restored. It is proposed to cancel these leases. The purposes include rubbish tips.

The activities for a proposed lease should also be compatible with important land uses on State forest and timber reserves, particularly the supply of domestic drinking water.

Potential threats	1. Lease purposes that do not conform to the requirements of the CLM Act.
Management actions	1. Seek regulations under sections 55(1a) and 55(1a)(e) to support the ancillary lease purposes described in this section. 2. Where lease purpose does not conform to the CLM Act requirements, cancel or dispose of the land where restoration of forest values is not possible.

Management strategy

Promote, encourage and facilitate the controlled exploration for native flora for scientific, therapeutic and horticultural purposes.

Background

Bioprospecting is the collection and chemical and genetic assay of biological materials for potential chemical or genetic products, generally for use in medicine or agriculture.

It can range from:

- searching for naturally-occurring compounds that can be used as they are;
- searching for genetic materials that can be used to enhance an already existing product, or
- searching for chemical constituents that might be used to augment other chemicals or that may provide insight into certain elements of organic chemistry and thereby enable improved applications to be achieved.

A party wishing to access flora from Crown land requires a licence from the Department. The Department has developed a view as to the conditions under which a party may be permitted to access biota for bioprospecting purposes. These are:

- to give priority to environmental protection,
- to ensure equitable financial and other returns to the State from the activity itself and any commercial success from the activity.

During the 1990s the Department was involved in a number of bioprospecting activities, in response to commercial sector interest and in line with a Departmental view that bioprospecting could be a valuable option for sustainable use of the State's indigenous biota. In 1999 the Department signed a licence agreement with a company seeking to undertake systematic bioprospecting of the State's flora. This licence agreement does not preclude other organisations from bioprospecting.

Potential threats	1. Potential of flora unidentified. 2. The State does not receive an adequate return from commercially exploited compounds.
Management action	1. Meet the requirements of the current agreement.

9.3 Key performance indicators

Key performance indicators are being used to track the achievement of the approved plan's objectives and its implementation. The background to the development of key performance indicators is described in the 'Plan implementation' chapter under the heading key performance indicators.

Three key indicators have been selected for socio-economic benefits that centre on the socio-economic benefits of timber and recreation. These have been selected because timber and recreation are included in the CLM Act as objectives for management of the land and they are addressed specifically in the Government's *Protecting our old-growth forests* policy.

Key performance indicator 21	Number, range and use of recreation/tourism activities available by proposed land category in the draft plan area.
Performance measure	• Type and number of recreation and tourism facilities available in the draft plan areas (e.g. picnic sites, campsites, toilets, visitor centres, walking trails, or major tourism developments), • The number of visits to selected recreation areas. • The satisfaction visitors express with their experience.
Performance target(s)	Visitor satisfaction maintained at high levels.
Reporting	Annual.
Response to target shortfall	Investigate and report to Conservation Commission.

Key performance indicator 22	The value and volume of wood and wood products production, including value added through downstream processing.
Performance measure	Value of timber products at the forest gate.
Performance target(s)	Value to increase in real terms.
Reporting	Biennial (subject to Forest Products Commission supplying data).
Response to target shortfall	Investigate and report to Conservation Commission.

Key performance indicator 23	Direct and indirect employment in the forest sector.
Performance measure	The numbers employed in the forest sector. Forest sector employment as a proportion of total employment.
Performance target(s)	Numbers employed to increase over time.
Reporting	Biennial (subject to Forest Products Commission supplying data).
Response to target shortfall	Investigate and report to Conservation Commission.

10 Plan implementation

10.1 Objective

To ensure that forest management complies with the forest management plan and is continually improved so as to achieve best practice.

10.2 Strategies

Management strategies

Monitor key characteristics of the environment and management operations and review and continually improve forest management both routinely and through adaptive management trials as previously identified.

Undertake adaptive management trials to improve forest management practices in the areas of prescriptions for river and stream buffers and key silvicultural treatments.

Background

Monitoring

The management processes of monitoring and auditing can overlap. However, in this draft plan monitoring is the process by which a check is kept on the state or condition of a subject whereas auditing is a means to check if a process has been undertaken in the manner prescribed or if the intent stated for it was achieved. Auditing is addressed under a separate strategy in this draft plan.

The purpose of monitoring within the draft plan 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 objectives. As a consequence monitoring will provide a major source of information that can be used to adapt management.

Other government agencies also have responsibility for monitoring in the draft plan area. The Water and Rivers Commission and the Water Corporation, for example, monitor water quality and quantity. The Department will use monitoring available from other resources in its monitoring program.

The Department has a number of systems available or planned that it can use to meet the purposes for monitoring. These are: FORESTCHECK, the Montreal process indicators of sustainable forest management and key performance indicators selected for this draft plan.

The details of each of these systems follow:

FORESTCHECK

This is an initiative by the Department to monitor components of the biodiversity in the south-west jarrah forests subject to disturbance. It had its origin in the response to Ministerial Condition 11 on the implementation of the Forest Management Plan 1994-2003, which

requires monitoring of the environmental impacts of jarrah silviculture on a range of sites. While it addresses the first monitoring category, it is aimed at monitoring the response to pressure. FORESTCHECK will sample various silvicultural treatments, and unlogged or lightly logged forests, across a representative range of jarrah forest landscapes. At each grid, all birds, mammals, reptiles and vascular plants will be sampled and a selection of 'indicator' species of invertebrates, fungi and cryptograms. After a year of operation, and following data analysis, a decision will be made as to whether only 'indicator' species need be sampled, allowing a greater number of sites to be monitored. Each site will be assessed in spring and autumn every three to five years. (Department of Conservation and Land Management 2000b). FORESTCHECK has been designed to mesh with the Montreal process criteria and indicators.

The risks to karri forest biodiversity from silvicultural practices were not regarded as significant at the time, nor currently, owing to the large reduction in disturbance from timber harvesting. Monitoring of karri forest will continue through other components of the Department's monitoring and ongoing research programs.

The Montreal Process Indicators of sustainable forest management

The Montreal indicators address monitoring related to the first category. The Montreal Process Working Group consisted of representatives of Australia and 12 other countries covering five continents, which contain 90 per cent of the temperate and boreal forests of the world. In 1995 they agreed to seven criteria and 67 indicators that provide a common understanding of what is meant by sustainable forest management at a whole of forest scale. Western Australia is a part of the Montreal Process Implementation Group for Australia (MIG) and is developing systems to report on the indicators. The first report was published in 1997 (Commonwealth of Australia 1997b). Data on indicators will be used in national State of the Environment reporting as well as a Montreal Process Criteria and Indicators Report.

Key performance indicators

Key performance indicators will be used to assess the effectiveness of the new plan in meeting the objectives for the criteria for sustainability. However, it is not possible, practical or cost effective, to measure all the aspects of management because of technical and resource impediments, hence indicators used will target 'key' objectives of the draft plan.

Protocols have been established for the Montreal indicators and protocols will be developed for key performance indicators that establish definitions, aims, scope, methods, costs, responsibilities and authorities. A staged implementation is proposed for the development and reporting on indicators in the approved plan, to take account of the resources and technologies needed to measure them. See the strategy on key performance indicators.

Detecting changes in the condition of the forest as a consequence of natural or management induced processes will be achieved through FORESTCHECK and the Montreal indicators of sustainability.

Measuring performance in achieving the objectives proposed for each criterion for sustainability will be achieved through the Montreal indicators of sustainability and the key performance indicators set in the draft plan.

Review

Review is an important part of the management process and is essential for the effectiveness of adaptive management. The objective of a review is to assess past performance, identify

causes of problems in performance and consider possible solutions to these problems and make recommendations for corrective action.

Operations and management systems are reviewed on an informal basis in the daily course of events. However, a formal review provides a disciplined and systematic process to gather together the disparate indicators of operational performance routinely collected such as monitoring results, audit reports and incident reports and use them to evaluate the effectiveness of organisational set up, responsibilities, staffing, work programs and performance. From this management procedures and programs are adjusted as necessary.

The Conservation Commission is responsible for auditing the implementation and carrying out of the approved management plan. In addition, key performance indicators will be providing data on achievement of the objectives in the plan. The Conservation Commission will gather all available information from the trials outlined in the following section on adaptive management, results from monitoring, audit and research to conduct a comprehensive mid-term review of the implementation of the plan. This review will be published.

Adaptive management

Adaptive management will be a key component of the management system that implements the approved plan, recognising that there is an incomplete knowledge of the effects of management practices on ecosystems. Adaptive management has a long, albeit informal history in forest management in Western Australia (see Abbott and Whitford 2002 in respect to forest management and tree hollows).

The capability to undertake adaptive management depends on the accumulation of knowledge concerning management practices, their implementation and impact on the environment. Knowledge can be gathered by experimentation (research), formal and informal monitoring programs and compliance checking through supervision and audit.

The research, monitoring and auditing that is proposed in this draft plan and that will be used to provide the knowledge to adapt management is described in later sections. However, it is already known that some areas of management in this draft plan may be adapted during the life of the plan following systematic trials. These are:

- stream buffers – following field trials in cooperation with water authorities (see strategy under the 'Soil and water' chapter and Appendix 19);
- fire – following the public review to be conducted by the EPA (see strategy for fire under the 'Ecosystem health and vitality' chapter);
- *Phytophthora* management – following the advice of the Expert Working Group flowing from the EPA assessment of the revised protocol (see strategy for *Phytophthora* under the 'Ecosystem health and vitality' chapter); and
- silvicultural trials.

Results from these trials are expected to become available at the mid-term review of the plan. Decisions on the implications for management will be made in the second half of the plan period and may be implemented immediately or built into planning for the subsequent plan period. Although changes may take place to management practice as a result of information obtained, the sustained yield approved by the Minister for the Environment and Heritage will be maintained for the life of the plan.

Potential threats	1. Monitoring inadequate to detect when a change to management practice is required. 2. Review of monitoring results inadequate.
Management actions	1. Implement the key performance indicators in the draft plan. 2. Report against key Montreal indicators and develop currently unmeasureable indicators. 3. Implement the first stage of FORESTCHECK subject to adequate funding. 4. Use monitoring, incident reports and auditing of the environmental management systems of the Department and the Forest Products Commission to monitor those operations that can have a significant impact on the environment. 5. Conduct periodic formal reviews of forest management and adjust practice where necessary. 6. The Conservation Commission to undertake a comprehensive mid-term review of the implementation of the plan and publicly report on it. 7. The Conservation Commission will refer any proposed change of significance in forest management to the EPA for their advice on whether it constitutes a variation to the proposal as assessed by them. 8. Undertake formal trials to test the adequacy of management practices, including stream buffers and aspects of silviculture.

Management strategies

Provide opportunities for Government agencies, non-government organisations and the community to participate in policy development and plan implementation.

Provide opportunities for community involvement in voluntary activities and educational and social development programs on ecologically sustainable forest management.

Background

The participation of stakeholders in planning and management is an ongoing process that can involve communication, interaction and joint decision-making between different stakeholders. A good participation process will result in decisions that are more sensitive and responsive to community concerns and values. The breadth and depth of public participation in the planning and management of the forests will increase during the life of the approved plan as public interest in management issues rises and the Department expands the range of issues for which participation takes place on. An example of this is the local community advisory committees established to help with management planning and finalising boundaries for the new reserves proposed in the Government's Protecting our old-growth forests policy.

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 Water and Rivers Commission and the Water Corporation have legislated responsibility for water supply and water quality from forested catchments and the WA Tourism Commission 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.

The public also has a right to have a meaningful role in the management of forests for environmental, economic and social outcomes. There is a statutory role for public

participation in management plan development, however there are many areas of public interest that are not addressed in statutory management plans which the public would like the opportunity to know about and comment on prior to their implementation. These include timber harvesting plans, prescribed burning plans and changes to the codes of practice and management guidelines that set standards for field operations.

The participation process the Department will use will vary depending on the issue, its complexity, level of interest and the responsibilities of the stakeholders. It may be educational, consultation, functional participation, joint planning, joint decision making or facilitating community decision making. In general:

- issue plans that cover geographical areas or issues of high public interest will be advertised and made available for public comment prior to their adoption;
- task plans will be discussed directly with affected stakeholders and made available to the public; and
- codes of practice and management guidelines, such as the silvicultural guidelines, will be developed or amended in consultation with affected stakeholders and advertised and made available for public comment prior to their adoption.

The Department's Policy No. 15 'Community involvement' (2001) and Administrative Instructions 31 'Operational guidelines for public participation in planning and the management of advisory bodies', and 43 'Operational guidelines for volunteer activities', set out in detail community involvement objectives and strategies. Existing Departmental policies relevant to forest ecosystem management are listed in Appendix 22.

Potential threats	1. Significant decisions are made that affect a resource another organisation has a legal interest in without them having a chance to provide comment. 2. No chance for the community to provide input to an activity of high public interest before it occurs.
Management actions	1. Consult and work cooperatively with government agencies and organisations on forest management activities, guidelines and standards whenever they may affect resources or values the agencies or organisations have a responsibility for or an interest in. 2. Develop and implement programs that provide the community with educational opportunities and information on ecologically sustainable forest management. 3. Establish processes, and relationships with community groups, to foster public involvement at both the policy, planning and plan implementation levels for forest management activities that have a high community interest. 4. Provide a range of opportunities for volunteers to be involved in forest management activities.

Management strategy

During the term of the plan to continue to explore opportunities to refine forest management to the understood natural disturbance limits of the ecosystem(s) present, including specifically recognising and allowing for site specific variations.

Background

Forest ecosystems of the south-west have evolved in the presence of disturbance from fire, storms, pests and diseases, although there is now a range of introduced pests and diseases to which there is no co-evolution. A precautionary approach to management that involves disturbance of ecosystems would therefore be to regulate that disturbance to within the limits of what is understood to have been the natural range of that disturbance. In this way a manager could have some confidence that the regenerative mechanisms of the flora and fauna would be effective in recovering from the disturbance.

For example, a study to define and map the development stages of karri forest (Bradshaw and Rayner 1997) identified approximately 4,500 discrete structural patches, the majority (50-60 per cent) of which were less than 10 hectares and more than 75 per cent were below 40 hectares. This information suggests karri clearfell coupes should be in the tens of hectares rather than the hundreds of hectares if disturbance from timber harvesting is to be constrained to the understood natural scale of disturbance.

The heat and smoke derived from fire play a major role in stimulating the germination of seed of a suite of forest understorey plant species. While it might sometimes present operational difficulties, the use of fire in regenerating ecosystems following disturbance, particularly timber harvesting, is therefore a means to seek the highest species diversity in regeneration activities.

This approach does not mean management should slavishly attempt to mimic the natural or pre-European processes even if they could be adequately determined. Management is required that takes account of the current condition, existing constraints and social requirements of the forest. However, within this context an understanding of the scale of natural disturbance regimes gives the manager the opportunity to be precautionary by, wherever possible, working within those limits.

Potential threats	1 The proportions and distribution of forest structures not optimal for forest values. 2 Knowledge on natural ecosystem functioning inadequate to prescribe best practice limits to disturbance. 3 Disturbance well outside natural ecosystem function limits resulting in a loss of biodiversity, health and productivity. 4 Inadequate management practices limit the capacity of natural processes to restore biodiversity and ecosystem health.
Management actions	1. Establish a landscape scale unit and develop structural goals for the three scales of management. 2. Set limits for disturbance (coupe size, soil disturbance, fire intensity, etc.) in guidelines. 3. Consolidate guidelines for human-induced disturbances that allow natural processes to function adequately to enable full functioning of the ecosystem.

Management strategy

Develop, refine and implement a formal ISO 14001 accredited environmental management system.

Background

The effectiveness of the forest management system will ultimately determine the effectiveness of the implementation of the management plan objectives and strategies. A good management system needs to cater systematically for the planning, implementation, monitoring and any amendments to implementation, known as adaptive management, that are identified as necessary through monitoring or other means of identifying deficiencies.

A formal Environmental Management System (EMS) provides a standard, systematic framework for management activities that facilitate a precautionary approach and adaptive management. The most widely accepted standard for an EMS is that of the AS/NZS ISO 14000 series.

The core component of an EMS is the analysis of all management activities to identify environmental 'aspects' that arise in the course of those activities and then to rate them for their significance with respect to risk to the environment. An 'aspect' is an element of an organisations activities, products or services that can interact with the environment. A significant aspect is one that can have a significant environmental impact.

The aspect rating process achieves the requirement of the precautionary principle to be guided by a careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment. The EMS then requires controls on operations (guidelines) to ameliorate the risk of adverse environmental impacts followed by monitoring, auditing and review of the effectiveness of those controls. An effective EMS provides a strong framework for a precautionary approach to management incorporating adaptive management.

The precautionary principle requires an assessment of the risk-weighted consequences of various options. A formal risk management system is a systematic way of identifying risks, evaluating their significance and identifying options to ameliorate them to tolerable levels. Management can then weigh up the implications and make informed decisions.

The Department is in the process of implementing formal risk management systems for its activities. Formal risk management systems have already been developed for particular issues such as public recreation on land categories managed by the Department (Visitor Risk Management System) and the risk to various forest values from wildfire (Wildfire Threat Analysis). The key elements of all of these formal systems are that they have an objective approach to the assessment of risk and they document the process and the outcomes for subsequent audit and review.

An EMS for native forest harvesting and regeneration operations in Western Australia has been developed and is being implemented by the Forest Products Commission. Certification was achieved during 2001. The Department is now developing an EMS to cover its operations and responsibilities in respect of forest management.

Potential threats	1. Management system that does not provide for monitoring of operations or a mechanism for improving deficiencies. 2. Management system that does not systematically cover all elements recognised as important.
Management actions	1. Develop and implement an EMS for forest management to the AS/NZS ISO 14001 standard to complement that developed by the Forest Products Commission, by May 2004.

Management strategy
Develop mechanisms to provide for lower level management actions to be consistent with the objectives and strategies of the approved plan.

Background

The approved plan will contain strategies to achieve outcomes for timber supply, biodiversity conservation, water protection and a range of other issues and values. If individual strategies are implemented in isolation they will not only be inefficient but there is a high likelihood that conflicts in space and time will cause the failure of some strategies. For example, prescribed burning in a particular area also needs to consider the requirement for fire for regeneration following timber harvesting, the need for fuel reduction to protect life and property and the need to retain areas unburnt to enable mapping for dieback symptoms.

This is done through the development of issue plans that integrate the various forest management plan strategies to achieve the best overall outcome for all values on a particular area. Issues plans provide site-specific detail for parts of State forest and timber reserves although they may also include a part or all of a national park provided it is consistent with any relevant area management plan.

The greatest planning effort will be the plan used to integrate planning for the delivery of other strategies. Because of this, the planners developing the three-year timber harvesting plans are usually the ones who integrate the implementation of other plans and strategies on State forest and timber reserves. Following the discussion and negotiation on the integration all issue plans, such as the burning plan, are adjusted to be in harmony. Public involvement at the issue level planning stage will occur (see previous strategies for community involvement).

Once the integration has taken place task plans are drawn up for each activity. Task plans contain a high degree of site-specific detail and operate for the length of time of the operation, which might be a year for a timber harvesting coupe or a month for a prescribed burn plan. At this level public involvement would normally be confined to those immediately affected by the operation, such as the neighbour of the harvesting operation or the apiarist with the site in the burn area.

Task plans are supported by codes of practice and other guidelines that set out the best practice means of achieving the particular task (see strategy for controlling operations). These guidance documents are written so that they integrate the outcomes sought by the various strategies in the plan at the operational scale.

Potential threats	1. Implementation of strategies not integrated resulting in inefficiencies and failure to achieve desirable outcomes.
Management actions	1. Develop issue plans for the implementation of strategies in the draft plan that integrate other forest management plan strategies. 2. Develop detailed task draft plans to implement effectively the issue draft plans and achieve strategy integration at the operational scale.

Management strategy
Identify, document and communicate roles and responsibilities in management.

Background

State forest and timber reserves are vested in the Conservation Commission and the Department manages the land according to management plans prepared under the direction of the Conservation Commission and approved by the Minister for the Environment and Heritage. The Forest Products Commission is responsible for the harvesting and regeneration of the forest and the sale of forest products, and associated industry development issues (see section 2.3 in 'Biological diversity' chapter).

Key roles in the implementation of the strategies in the draft plan need to be identified within the Department and the responsibilities associated with those roles documented. Doing this ensures responsibility for activities that are important for achieving the draft plan's proposals or performance standards is understood.

The EPA has a specific role under the EP Act to assess the new forest management plan and the Department of Environmental Protection the role of monitoring the conditions the Minister for the Environment and Heritage may set in relation to the implementation of the draft plan. On occasions, the EPA may undertake the task of compliance monitoring. The EPA also has a broad informal role to oversee the condition of the environment and will achieve that by informal monitoring of the performance indicators used to measure the implementation of the new plan.

Potential threats	1. Key tasks are not carried out due to confusion as to where responsibilities for them lie.
Management actions	1. Systematically identify and document responsibilities between the Department and the Forest Products Commission on forest management related to timber harvesting and regeneration. 2. Identify key tasks associated with implementation of the approved plan and document the roles and responsibilities associated with them.

Management strategy
Generate and transfer knowledge and develop the necessary skills and competencies in staff.

Background

Knowledge accumulation

Full and effective implementation of many of the actions identified in the new forest management plan will require improvement in knowledge and understanding of the biological diversity of south-west forests at the genetic, species and ecosystems levels.

The Department maintains a research function that seeks to advance the understanding and means of protection of the State's biodiversity and the sustainable utililisation of the State's natural resources. It is common for inquiries and reviews to identify research priorities. Attachment 11 of the RFA (Commonwealth of Australia and State of Western Australia 1999) identified high level priority areas for research on the description and documentation of biodiversity, the protection and conservation of biodiversity and the sustainable use of natural resources. Other recent lists include those from the EPA (1998) and Ferguson *et al.* 2001.

The Department's research function must accommodate the research needs of the biota throughout the State, where for many areas, knowledge is less than for forest areas and the urgency of conservation actions is often greater. Because of this, resources to undertake

research will never be available to address all the issues 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 five-year strategic plan outlining the projects, staff allocation and expected outcomes (Department of Conservation and Land Management 1999a).

Data collection for direct use in improving management systems is also a source of increasing knowledge. The inventory of forest resources and modeling of the growth will be continued during the life of the plan in line with the recommendations in Ferguson *et al.* (2001).

Many of the strategies in the new forest management plan will be implemented immediately it is approved. However, where knowledge is incomplete and the understanding of the impacts is uncertain, strategies are conservative, based on the precautionary approach, and will be adapted as new knowledge becomes available from research and monitoring.

Skills

In order to implement management strategies effectively, the workforce should be appropriately skilled. Formal skills development through training is one element of establishing competence. However, acknowledgement of other sources of skills through experience and education is important. It will be necessary to develop criteria to allow measurement of competence for particular tasks.

The process for identifying competency criteria of key tasks is an element of an EMS and progress was made through the development of the Forest Products Commission's EMS.

Potential threats	1. Inadequate understanding of natural systems that resulted in poor management outcomes. 2. Staff with responsibility for key activities who lacked adequate competencies.
Strategies	1. Develop and implement research and other programs to acquire knowledge that will improve the basis for forest management. 2. Identify the skills and competencies required for the key tasks in delivering ecologically sustainable management, review the skill and competency level of staff and contractors and initiate training and other programs to overcome deficiencies.

Management strategy

Develop, make public and maintain a comprehensive suite of operational guidance documents to control operations that incorporate best practice taking account of the principles of ecologically sustainable forest management.

Background

Control of management outcomes is achieved through stipulating requirements in a hierarchical series of documents (Table 11) and the supervision of implementation and monitoring and auditing the outcomes.

Parliament sets the relationship between the Conservation Commission, the Department and the Forest Products Commission and prescribes the broad management objectives for State forest and timber reserves. Activities that conform to the objectives in the CLM Act, and the

policies that guide those activities, are determined by the Conservation Commission and the Minister for the Environment and Heritage through the development and approval of a forest management plan.

Implementation of the approved plan by the Department occurs within the guiding framework of policies, instructions, codes of practice and management guidelines. Field activities associated with the implementation of the approved plan are managed by the Department, the Forest Products Commission and other bodies, such as mining companies. Issue plans, action plans and operational prescriptions, developed by these bodies, make up the detailed works programs necessary to implement the strategies proposed in this draft plan, and meet the standard or outcome set.

Table 11: Hierarchy of documents that guide management in State forest and timber reserves

Controlling document	Content	Custodian
Acts of Parliament	Generally broad structures and intent for issues	Parliament
Statutory policies	Policies on specific issues relevant to forest management that have a statutory or whole-of-Government backing	Government, Conservation Commission, the Department and various other Government departments
Management plan	Strategies for management utilising CLM Act requirements and relevant policies	Conservation Commission
Management policies	Policies on specific issues relevant to forest management	Conservation Commission and the Department
Codes of practice, silvicultural and other management and operational guidelines	Details on how tasks are to be performed to meet management requirements	Department, Forest Products Commission and other industry bodies depending on the activity

Appendix 23 lists current guideline documents.

The implementation of the strategies and management actions through lower level guidance documents such as the silvicultural guidelines and the Manual of Management Guidelines for Timber Harvesting in Western Australia can determine the success or otherwise of strategies to conserve biodiversity or soil and water. The Conservation Commission and the Department as the custodians, and in the case of the Department also a user, of the forest need to establish standards for implementation and means to check implementation to see that standards are being met. Where performance does not meet the standard some enforceable corrective action needs to be in place.

While 100 per cent compliance with all guidelines is obviously a goal, in practice perfect compliance cannot be achieved in all instances for two reasons. Firstly, many guidelines require interpretation of complex natural resource systems in the field therefore assessment of compliance is in shades of grey rather than black and white. Secondly human behaviour is inconsistent and even well-trained and caring operators will make errors of judgement or observation, or will be affected by unavoidable accidents.

Audits of compliance with provisions in the Manual of Management Guidelines for Timber Harvesting in Western Australia currently attempt to quantify key management activities such as protection of stream zones, implementation of soil conservation measures and protection of crop trees. For example, in the last audit on stream zone protection, 95 per cent of the

boundary sampled had been successfully protected. However, this parameter alone is not adequate to use as a standard as it provides no limits on the type and severity of the breach.

Guiding documents are updated periodically to incorporate new knowledge and when updated will be subject to community consultation procedures.

Evaluation of success in meeting the required standards will be achieved through monitoring, self reporting on compliance, and auditing of operations.

Potential threats	1. Operations that pose a significant threat to the environment do not have appropriate guidelines to mitigate the threat. 2. Guidance documents not maintained and consequently lose currency with respect to best practice.
Management actions	1. Review existing guidelines within the first two years of implementation of the plan to ensure they conform to the requirements of the plan and the principles of ecologically sustainable forest management. 2. Develop a hierarchy of guidance documents, segregate responsibilities between the Department, the Forest Products Commission and the Conservation Commission by the end of the first year of implementation. 3. Wherever appropriate and possible, develop performance targets for compliance with guidelines.

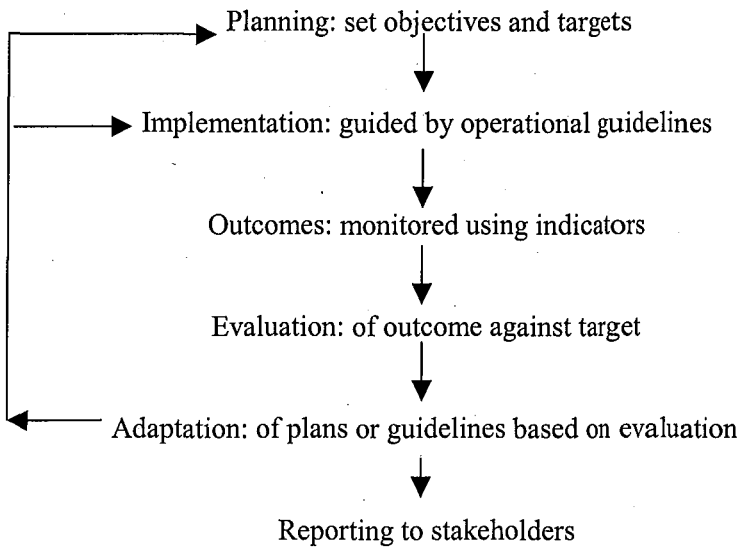
Management strategy

Track the achievement of the objectives of the approved plan and the implementation of the plan's strategies through the key performance indicators and in other ways.

Background

The criteria that form the structure of this draft plan and the objectives and strategies relevant to them are effectively the Conservation Commission's working definition of sustainable management for the forests of the south-west. There is a growing public expectation and it is the Conservation Commission's desire that achievement of or progress toward, sustainable forest management will be demonstrated rather than assumed. Performance indicators are one means of achieving this provided there is agreement on objectives, targets and the indicators used.

Performance indicators are a quantitative or qualitative variable that can be measured or described and which when observed periodically demonstrates trends or achievement of targets. The use of indicators also provides a basis for adaptive management (Raison *et al.* 2001):



The use of indicators in this draft plan is a means to track the effectiveness of the plan in meeting its objectives. However, it is not possible, practical or cost effective, to measure all the aspects of management because of technical and resource impediments, hence indicators used will target 'key' aspects of the draft plan. A key set of indicators is defined by Kanowski *et al.* (2001) when considering the conservation of biodiversity as: *the minimum set, which if properly monitored, provides rigorous data describing the major trends in and impacts on, Australian biodiversity.*

The selection process for indicators used the following criteria. Ideally they should:

- be a robust indicator of change and reflect a highly valued aspect of the draft plan;
- provide an early indication of adverse change;
- be capable of being readily measured and be cost effective to collect the data;
- be easy to understand;
- be relevant to the draft plan's desired outcomes or implementation; and
- contribute to other monitoring requirements such as RFA and Montreal process.

The most fundamental requirement for successful indicators is the establishment of clear objectives for management. Past forest management plans have not clearly articulated objectives for the range of outcomes proposed in plans. The overall goal of the draft plan is for forest management to be in accord with the principles of ecologically sustainable forest management described in the CLM Act.

Indicators can be designed to measure any or all of the three elements of a management issue, namely (i) the condition of the subject under consideration, (ii) the pressure(s) that might be affecting the subject, and (iii) the response to those pressures by management. Indicators can also be applied at the scale of whole of forest, landscape or operational. The selection of indictors will depend on the issue, however in general, indicators that measure an output are more useful than those that measure inputs or workload.

Key performance indicators are placed at the end of each chapter. While indicators that measure outcomes were sought, the difficulty in obtaining meaningful data has meant that in many cases the indicators had to rely on measurement of inputs. An example of this is the indicator that measures compliance with codes of practice established to obtain an outcome

such as soil protection or biodiversity conservation. While it would be preferable, for example, to measure changes in the bulk density of soil or in the levels of biodiversity conserved that the codes are directed at, it is often impractical.

Key performance indicators in this draft plan will have protocols developed for them that, among other things, define the data to be collected, the frequency, who will do the collection and reporting, the targets for compliance and what the response will be to a failure to meet the targets. It is anticipated that protocols will need to be reviewed frequently as experience on data gathering and interpretation is gained.

The review of key performance indicators in this draft plan and the development of new indicators will be maintained throughout the life of the approved plan.

Potential threats	1. Resources available inadequate to measure key performance indicators. 2. Selected key performance indicators that do not adequately illustrate trends in criteria for sustainability.
Management actions	1. Develop protocols that establish definitions, aims, scope, methods, costs, responsibilities and authorities for each key performance indicator. 2. Progressively implement data collection analysis and reporting of the key performance indicators in the draft plan. 3. Continue development of key performance indicators.

Management strategy

Audit implementation of the approved plan and the compliance of operational guidance documents with the plan's objectives and strategies.

Background

A major control in the forest management system is audit that checks compliance with standards and assesses the effectiveness of systems. The Conservation Commission has a statutory responsibility (CLM Act section 19(1)(g)) to audit the implementation and compliance with management plans and has an audit manager to effect that responsibility. The Department and the Forest Products Commission maintain operational internal audit sections to audit the effectiveness and efficiency of their management systems. Auditing of forest operations will be undertaken at four levels:

- The Forest Products Commission will undertake internal audits of the efficiency and effectiveness of its operational systems and compliance audits of its field performance. The results of audits will be reported to the Department and the Conservation Commission.
- The Department's internal audit will review Forest Products Commission audit results, undertake audits of Forest Products Commission compliance, audit Departmental operational systems and the performance of other external operators on State forest and timber reserves. These audits will be reported to the Conservation Commission.
- The Conservation Commission will review the audits of both the Department and Forest Products Commission and undertake its own audits of activities on its land. In addition, the Commission will monitor performance against key performance indicators.
- Third party independent auditors will conduct six-monthly audits of the Department and Forest Products Commission EMSs as part of the certification process. The results of those audits will be reported to the Conservation Commission.

Priority for auditing will be based on an assessment of the risk operations pose to the achievement of management outcomes. Audits of compliance with guidelines and codes of practice will, wherever possible, quantify results so that audit can be one of the means used to check that the required standard is being achieved in the field. Audits of the implementation of provisions in the Manual of Management Guidelines for Timber Harvesting in Western Australia currently quantify some of the compliance and this will be extended to cover the full range of quantifiable compliance requirements.

Potential threats	1. Auditing inadequate to detect significant breakdown in compliance. 2. Audit program that is not focused on the highest priority issues.
Management actions	1. Develop an annual risk-based audit program to check compliance with the implementation of the approved plan in conjunction with the Conservation Commission and Forest Products Commission. 2. The Conservation Commission and the Department will quantify required outcomes and the standards for activities that will facilitate audit as an effective control tool.

10.3 Key performance indicators

Key performance indicators are being used to track the achievement of the approved plan's objectives and its implementation. The background to the development of key performance indicators is described in section 10.2.

Five key performance indicators have been selected to track implementation. The indicators relate to the participation of stakeholders in planning and management, the development of the necessary skills, competencies and knowledge for management, the implementation of the environmental management system and adaptive management.

Key performance indicator 24	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)	Number of registered volunteers working on ecologically sustainable forest management projects.
Reporting	Annual.
Response to target shortfall	Investigate and report to the Conservation Commission.

Key performance indicator 25	Develop and maintain human resource skills across relevant disciplines.
Performance measure	The extent to which the Department demonstrates the capacity and commitment to develop and maintain the essential skills of staff.
Performance target(s)	Capacity and commitment matches prescribed competency levels.
Reporting	Annual.
Response to target shortfall	Investigate and report to the Conservation Commission.

Key performance indicator 26	Development of scientific understanding of ecosystem characteristics and functions.
Performance measure	• Expenditures on research and development related to ecologically sustainable forest management; • Person years of scientific research, by ecosystem or disciplinary area of study, in the field of ecologically sustainable forest management; and/or • Number of peer-reviewed articles published annually on ecologically sustainable forest management.
Reporting	Annual.
Response to target shortfall	Investigate and report to the Conservation Commission.

Key performance indicator 27	Environmental management system.
Performance measure	Development of an environmental management system to a standard suitable for accreditation.
Performance target(s)	May 2004.
Reporting	Annual.
Response to target shortfall	Investigate and report to the Conservation Commission.

Key performance indicator 28	Adaptive management.
Performance measure	The extent to which guidance documents have been reviewed and management modified to improve ecologically sustainable forest management.
Performance target(s)	All guidance documents reviewed by mid-term.
Reporting	Annual.
Response to target shortfall	Investigate and report to the Conservation Commission.

Appendices

APPENDIX 1

Principles for conserving biodiversity

Western Australia is a signatory to the National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996). The National Strategy has adopted nine principles in the development of its objectives and actions, and recommends these be adopted and implemented.

1. *Biological diversity is best conserved in-situ.*

2. *Although all levels of government have clear responsibility, the cooperation of conservation groups, resource users, indigenous peoples, and the community in general is critical to the conservation of biological diversity.*

3. *It is vital to anticipate, prevent and attack at source the causes of significant reduction or loss of biological diversity.*

4. *Processes for and decisions about the allocation and use of Australia's resources should be efficient, equitable and transparent.*

5. *Lack of full knowledge should not be an excuse for postponing action to conserve biological diversity.*

6. *The conservation of Australia's biological diversity is affected by international activities and requires actions extending beyond Australia's national jurisdiction.*

7. *Australians operating beyond our national jurisdiction should respect the principles of conservation and ecologically sustainable use of biological diversity and act in accordance with any relevant national or international laws.*

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

9. *The close, traditional association of Australia's indigenous peoples with components of biological diversity should be recognised, as should the desirability of sharing equitably benefits arising from the innovative use of traditional knowledge of biological diversity.*

APPENDIX 2

Structural goals for jarrah and karri forest overstorey

Stages of development of forests

The generalised stages of development of a patch of trees that develops without intervention can be broadly categorised as follows:

Jarrah (Department of Conservation and Land Management 1992b)

Jarrah establishment stage
The stage of development includes the seedling stage (less than one year, usually with cotyledons present); lignotuberous seedling stage (older than one year, cotyledons absent, one stem with a lignotuberous swelling); seedling coppice stage (obvious lignotuber, multiple shoots); and the ground coppice stage (multiple shoots less than 1.5 metres in height). The establishment stage finishes when the dynamic coppice shoot exceeds two metres. This can occur within five years, but may extend over decades depending on competition from the overstorey and fire regimes.

Jarrah juvenile stage
A crown of small branches, all of which will be shed as the tree gains height, characterises the juvenile stage. Branches are shed from the base of the crown, and the formation of a clear bole is commenced. This juvenile or primary crown usually contains about four years of growth and vigorous crowns are conical in shape. This stage ends when the diameter reaches 15 centimetres at an age of between 15 to 30 years.

Jarrah immature stage
Trees between 15 and 45 centimetres in diameter are described as immature. During this stage, a secondary crown develops while the upper crown resembles that of the juvenile stage. The semi-persistent lower branches form leaf-bearing juvenile crown units which give eucalypt crowns their characteristic appearance. The lateral spread of the crown commences during this stage, which concludes at between 40 to 70 years.

Jarrah mature stage
The mature stage is reached when the diameter reaches 45 centimetres and concludes when it reaches around 100 centimetres.

During this stage, large persistent branches develop. Semi-permanent crown units grow from the main stem and the persistent branches. These persistent branches are also known as the shaping branches. As the primary crown pushes outwards, it may be weighted downwards although this occurs less in jarrah than in other eucalypts. Epicormic shoots may be evident towards the end of the mature stage, and dead branches are common in the crown. This stage of development concludes at between 120 to 250 years.

Jarrah senescent stage
Trees greater than 100 centimetres in diameter are described as senescent. During this stage the branches of the primary crown break, or die, and are replaced by branches that develop from dormant buds on the trunk (epicormic branches).

The epicormic branches are never as efficient as the branches of the primary crown. They may live for a few years or decades and then break and be replaced. This process may be repeated several times before eventual death.

Analysis of the ages of large jarrah trees (Burrows 1991) indicates that relatively few exceed an age of 360 years.

Karri *(Bradshaw and Rayner 1997)*

Karri establishment stage
This is the first and shortest stage. It begins with the germination of seedlings following the removal of the overstorey associated with suitable seed bed conditions. The stage ends with closure of the canopy of the regenerating karri trees, signalling their dominance over the understorey. Stem numbers during this period will be reduced from perhaps a million germinants per hectare to 5,000 saplings. The time varies with site productivity but eight years is used as a general minimum.

Karri juvenile stage
The stage is characterised by increasing competition between trees and their struggle for dominance over their neighbours. Trees grow very rapidly and by the end of the stage have separated into dominant and dominated strata. The understorey species progressively die off, leaving those that do not require fire to regenerate and the very long lived. On a fully stocked stand, stem numbers will decrease from around the 5,000 to 500 per hectare. The juvenile stage ends at about 25 to 30 years of age of the stand.

Karri immature stage
The trees begin to form a semi-permanent crown with the lower branches dying and breaking off. Tree growth is rapid until it is between 50 to 60 years old. Competition continues but at a lesser rate than in the juvenile stage. Neighbouring trees take up small gaps created by mortality.

The stage ends when individual tree crowns have reached the size above which they are no longer capable of expansion regardless of the space available, which is at approximately 120 years old.

Karri mature stage
The physical limitations of each individual are now reached, hence the tree can neither occupy more of the site nor increase its crown dimensions: only diameter now increases.

Crown branches will periodically break, resulting in vigorous replacement through epicormic development without changing crown dimensions. Individuals will slowly decline but the growth rate of the dominant will be largely sustained. Where a tree dies, the surrounding trees cannot take up the space, leaving the opportunity for regeneration to occur. The initiation of hollows probably begins early in this stage as large branches break and branch stubs grow over. The mature stage ends when the stand is about 200 to 250 years old.

Karri senescent stage
During this stage the tree reduces its capacity to sustain growth and control over the site. The process of crown renewal slows and as major branches are lost they are replaced by less vigorous epicormics lower down the branch or on the bole. Damage provides entry points for fungi that further weaken the tree structure. The trees are in decline and will slowly break up, unless the process is exacerbated by disturbance such as fire or storm.

Tree age studies have shown a rapid decline in numbers between 200 and 280 years followed by a more gradual decline with very few individuals exceeding 350 years (Rayner 1992). The death of senescent trees leads to the establishment stage.

The significance of forest structure to management objectives

Forests are dynamic, continuously changing as stands of trees pass through the stages of development from establishment to senescence and death and back to establishment. The proportion of each development stage is important for all forest values.

Different development stages support different suites of biodiversity, so in the absence of detailed knowledge of the requirements of every organism it is desirable to have all developmental stages represented in the forest as a precautionary measure toward sustaining important components of biodiversity.

In forests used for timber production having a continuous representation of each age class (known as a 'normal' forest) was the classical means to achieve a sustained yield of timber. When timber production was based on large-sized sawlogs that came from the mature and senescent trees, the structural objective for the normal forest was not incompatible with that desirable for biodiversity as all stages were well represented. However, with more intensive management using smaller-sized trees, the structure obtained by the achievement of sustained timber yield is not necessarily one suitable for the maintenance of biodiversity.

The mature and senescent stages of development tend to be favoured by users of the forest for nature-based recreation and aesthetics. Similarly flowering, hence honey production, is negligible in the establishment and juvenile stages. Total carbon sequestration is also at its maximum for the stand in the mature and senescent stage of development, although the rate of sequestration is highest in the juvenile and immature stages.

The distribution of developmental stages is significant for all of these values except carbon sequestration. For example, development stages must be relevant to the physical and climatic gradients that affect species distribution and to the scale relevant to fauna. Therefore structural goals for the forest need to be considered at a range of levels. This draft plan has selected three scales to apply structural goals:

- whole of forest – all the forest land subject to the draft plan;
- landscape – an intermediate scale between the whole of forest and operational; and
- operational – at the level of the harvesting coupe or the prescribed burn.

What causes forest structure to change

Forest structure changes through the passage of time as a growth moves young stages progressively through to older ones and when a stand is killed and regeneration takes place. A fire can kill a stand at any developmental stage, although it would most usually be in the very early or senescent stages of development.

In the forests of the south-west stand replacing events take place through:

- timber harvesting and regeneration;
- mining and rehabilitation;
- fire and regeneration through natural or artificial means; and
- disease or pest attack and regeneration.

Changes in forest structure resulting from timber harvesting and mining can be readily predicted and subsequent development modelled. Changes to structure resulting from fire and disease are more problematic, but can be estimated using probability based on the past frequencies assuming future environmental conditions and management remains similar.

Determining appropriate structural goals

Jarrah – whole of forest scale

Unlike karri, the jarrah forest exists as a fine scale uneven aged mosaic. As a consequence it cannot readily be mapped for developmental stages, making the setting of whole of forest goals based on the proportion of each stage impossible.

To overcome this, the Forest Management Plan 1994-2003 adopted goals based on four disturbance categories: minimal disturbance being the formal reserve system; low disturbance being the informal reserve system; moderate disturbance being forest used for timber harvesting and other disturbance uses; and high disturbance being forest subject to mining. The goals were:

- minimal disturbance – at least 25 per cent;
- low disturbance – at least five per cent;
- moderate disturbance – convert no more than an average of one per cent in this category to the establishment stage each year;
- high disturbance – maximise retention of late development stages and regenerate the mined area as soon as possible.

Minimal and low disturbance categories were assumed to contain the range of development stages suitable to sustain biodiversity through time.

Data for 2000 show the following:

- minimal disturbance – 38 per cent;
- low disturbance – 9 per cent; and
- moderate disturbance – 0.25 per cent/annum.

All old-growth forest is now protected and significant additional formal reserves are proposed, consequently the area of forest in the minimal disturbance category will increase substantially. This will also mean a decrease in the area of forest converted annually to the establishment stage.

Jarrah – landscape scale

The earliest attempt to control forest structure at the landscape scale was in the Environmental Impact Statement for the marri wood chip project (Forests Department 1973) where a goal of retaining 20 per cent of each forest block in the licence area free from timber harvesting was set. This was achieved through the creation of informal reserves on roads and streams. The goal was not extended outside the licence area.

This approach adopted the administrative unit 'forest block' (which vary from 3,000-8,000 hectares) as the landscape unit and established a quantifiable retention prescription as a surrogate for aesthetic and biodiversity objectives. The approach highlights the two problems in determining goals for a landscape scale that still exist:

- what is an appropriate unit to select as a landscape scale? (see 'Biological diversity' chapter);
- having selected an appropriate unit, what biodiversity conservation objectives are appropriate for it, and how do forest structures relate to those objectives?

These are complex questions for which there has been limited analysis and discussion.

Jarrah – operational scale

Although not explicit, there has been a long-standing objective to sustain the habitat necessary for the presence of fauna at the operational scale. The strategy to achieve this has been to retain structural diversity during timber harvesting operations, particularly through retention either permanently or temporarily of known useful habitat components.

The measures employed are:

- large formal reserves alongside timber harvesting areas;
- informal reserves among timber harvesting areas;
- seeking a minimum of three age or size classes representing the development stages of the forest in each coupe;
- retention for visual resource management;
- retention of existing and potential habitat (trees with hollows and logs) in coupes;
- retention of cull trees in coupes;
- retention of shelterwood trees during establishment phase;
- temporary retention (15 to 60 years) to limit gap size to 10 hectares (TEAS);
- 30 per cent retention for salinity management in second order catchments; and
- varying gap size according to visual resource zones.

The information on which much of this is based is limited to a small number of species and is static in nature, i.e. limited to the response at the site as a consequence of the action.

Karri – whole of forest scale

The 1994 Forest Management Plan made the assumption that, on average, karri trees live for 200 years, and that the proportions of each development stage to sustain this were:

- establishment 4 per cent
- juvenile 8 per cent
- immature 48 per cent
- mature/senescent 40 per cent

The structural goal for karri was set at a whole of forest scale as:

The minimum proportion of the area of the karri forest dominated by the mature and senescent stages of development will be retained at approximately 40 per cent.

No goal was set at the landscape or operational scale.

The development stages of the karri forest were subsequently mapped (Bradshaw and Rayner 1997). The distribution of development stages at 2000 was:

- establishment 9 per cent
- juvenile 18 per cent
- immature 23 per cent
- mature/senescent 50 per cent

The 1994 whole of forest goal is no longer relevant as a constraint on timber harvesting of karri, however, the goal is still a sensible minimum for the mature and senescent development stages and could be retained. Stand replacing fire is now the biggest threat to the non-achievement of the goal and its retention will provide some guidance to fire protection measures in old-growth forest.

In order to meet the structural goal in the long term, the Forest Management Plan 1994-2003 proposed, instead of clearfelling, to grow on to mature and senescent stages significant proportions of existing and future juvenile and immature stands. This is no longer necessary because of the additional protection of mature and senescent karri, and the inclusion of regrowth in the reservation proposed in this draft plan. Future plans will have to give consideration to the structural stages.

Karri – landscape scale

Setting structural goals at the landscape level has not been attempted previously, but is proposed during the term of the approved plan.

Karri – operational scale

While there have not been explicit structural goals at the operational scale, there have been guidelines for the past 30 years for the retention of structural components during timber harvesting for biodiversity and aesthetic reasons. These have evolved over time and continue to evolve, as information, particularly with respect to biodiversity, becomes available. The diversity in structure achieved by these measures aggregates up to the landscape level, and the whole of forest level, and contribute to the whole of forest goal.

Measures for the retention of structural components are:

- formal reserves alongside logged areas;
- the informal reserve system ;
- mature patches of forest retained to ensure there is no more than 400 metres of regenerating forest;
- potential habitat trees;
- regrowth that can be protected in the regeneration burn; and
- limits on coupe size (40 hectares)

Setting structural goals

The draft plan proposes a landscape management unit be developed and goals for the major forest species be developed during the first half of the term of the approved plan.

APPENDIX 3

Land categories, land classification, management plan zoning and prescriptions

Land categories

The land categories vested in the Conservation Commission and the purposes for their management are set out in Table 12.

Table 12: Land categories vested in the Conservation Commission

Land category	Management purpose(s) CLM Act 56(1)a-e	Management guidelines
Nature reserve	Sustain and restore the 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.	A regional land management plan or relevant area management plan or in its absence the provisions of the CLM Act and other relevant Acts.
National park and conservation park	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 features of archaeological, historic or scientific interest.	A regional land management plan, relevant area management plan or in its absence the provisions of the CLM Act and other relevant Acts.
Other land referred to in the CLM Act section 5(1)(g) or 5(1)(h)	Achieve the purpose for which the land was vested in the controlling body. (Such a purpose cannot include timber production because the reserves do not fall within the meaning of the term 'departmental land' in the FP Act.)	A regional land management plan, a relevant area management plan or in its absence the provisions of the CLM Act and other relevant Acts.
Indigenous State forest or timber reserves	To achieve the purpose or combination of purposes provided for in the proposed management plan under section 55(1a) (conservation, recreation, timber production on a sustained yield basis, water catchment protection or other purpose prescribed by the regulations).	The regional land management plan 'Forest Management Plan'.
State forest or timber reserves planted with exotic species	To achieve the optimum yield in production consistent with the satisfaction of long-term social and economic needs.	A regional land management plan, any specific plantation management plan and the 'Code of Practice for the Management of Timber Plantations'

Land classification

The Minister for the Environment and Heritage may, on the recommendation of the Conservation Commission and, where applicable, any associated body, by notice published in the *Gazette*, classify any land that is vested in the Conservation Commission (CLM Act s62(1)) as:

(a) a wilderness area;

(b) a prohibited area;

(c) a limited access area;

(d) a temporary control area;

(da) a forest conservation area;

(e) a recreation area for a purpose or purposes specified in the notice; or

(f) such other class of area as the Minister, on the recommendation of the Conservation Commission, thinks necessary to give effect to the objects of this Act.

This provision will be used to classify some State forest and timber reserve as forest conservation areas. This classification is proposed because there is an existing impediment, such as high mineral prospectivity, to an immediate change to a formal reserve land category such as nature reserve, national park, or conservation park.

The objective for management of a forest conservation area is primarily biodiversity conservation hence they will not be available for timber production, but may be available for other uses such as wildflower picking, apiculture or minor craftwood. Forest conservation areas contribute to achievement of CAR targets. No forest conservation areas have been established although some are proposed in this draft plan. (see Appendix 7).

Management plan zoning

The draft forest management plan zones areas of State forest and timber reserves for specific purposes, mainly to identify and protect areas during operations at the operational scale for biodiversity conservation and landscape protection. The results of such zoning are known colloquially as 'informal' reserves.

The criteria for an informal reserve are (Commonwealth of Australia 1997b):

- specified by provisions in an approved statutory management plan;
- of a size appropriate to protect the values the zoning seeks to protect;
- opportunity for the public to comment on the criteria for selection and management through the management plan process; and
- capable of being identified on maps.

The informal reserves proposed in this draft management plan are set out in Table 13.

Table 13: Informal reserves proposed in State forest and timber reserves

Informal reserve type	Purpose	Specifications
Old-growth forest	Protect areas of old-growth forest outside the formal reserve system.	Areas greater than two hectares of ecologically mature forest where the effects of disturbance are now negligible.
River and stream zones	Provide forest undisturbed by timber harvesting for biodiversity conservation and ecosystem health and vitality at the operational and landscape scales. Protect water quality for biodiversity and consumptive uses. Protect aesthetic and social values. Protect productive capacity, soil values and carbon pools.	Total 60 metres for first, second and third order[2] streams. Minimum width of 20 metres on any side. Total 150 metres on fourth order streams. Minimum width of 50 metres on one side. Total 400 metres on fifth order and above streams. Minimum width of 100 metres one side.
Travel route zones	Protect aesthetic and social values. Provide forest undisturbed by timber harvesting for biodiversity conservation and ecosystem health and vitality at the operational and landscape scales.	A minimum of 200 metres wide on both sides of Level 1 travel routes[3]. A minimum of 100 metres wide on both sides of Level 2 travel routes. A minimum of 200 metres wide either side of the Bibbulmun Track.
Diverse ecotype zones (DEZ)	Protect sensitive ecosystems for biodiversity conservation and ecosystem health and vitality.	Rock outcrops greater than 0.2 hectares and wetlands, heath, sedge, herb and low density woodland communities. All boundaries to have a buffer of undisturbed vegetation around them of up to 50 metres from the edge of the feature. Ecological characteristics will be used to determine the boundary of these zones. DEZ are defined in the Forest Management Information System by vegetation codes.

Areas set aside by management plan prescriptions

The draft forest management plan also provides a range of protective measures by prescription for certain areas and components of State forest and timber reserves. The prescriptions proposed are detailed in Table 14.

[2] Classification system for width and importance of streams, varying from one for minor streams, to five for major streams or rivers.

[3] 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). Except for the Bibbulmun Track, travel route zones apply only in the Warren Region.

Table 14: Protection by prescription proposed in State forest and timber reserves

Prescription	Purpose	Specifications
Manage saline water tables.	To minimise the risk of them rising and contributing to streamflow following timber harvesting.	All second order catchments in the intermediate rainfall zone (900-1,100 mm/year) and low rainfall zone (less than 900 mm/year) to have 30 per cent of the area retained at a basal area greater than $15m^2$/hectare for a period of 15 years after harvesting the remainder of the catchment. In thinning in the intermediate rainfall zone, keep final basal area to greater than or equal to $15m^2$ per hectare. Retain additional river and stream buffers on streams in 'high salt risk' catchments subject to timber harvesting as defined by agreement between WRC and the Department.
Retain habitat components at the operational management level threatened by timber harvesting in jarrah forest.	To sustain populations of fauna dependent on mature habitat components.	An average of four primary habitat trees per hectare and six to eight potential habitat trees to be retained in harvesting. An average of one ground habitat element per hectare (e.g. hollow logs).
Maintain temporal and spatial distribution of harvested areas.	To provide structural diversity for biodiversity and visual values.	The maximum size of a gap in jarrah harvesting to be approximately 10 hectares and varied downwards according to visual landscape zoning. The width of Temporary Exclusion Areas (TEAS) strips to be varied between 50 metres and 100 metres depending on visual landscape zoning. The maximum size of a clearfell area in karri to be 40 hectares, and 20 hectares in regrowth. Where possible limit the distance between patches of mature karri to no more than 400 metres.

Biodiversity conservation using land categories, land classification and zoning

All land subject to this draft plan contributes to its biodiversity conservation objectives, however land categories, land classification and land zoning are used to establish a three-tiered system for designating priority for the conservation of biological diversity. They are:

The formal reserve system

The formal conservation reserve system is made up of categories of land that meet the following criteria:

- is mapped and its boundaries are identifiable on the ground;
- has conservation as a dominant purpose for reservation; and
- requires Parliament to establish it and change its use.

The CLM Act provides five land categories that are compatible with the criteria for a formal reserve. The three most used are nature reserve, national park and conservation park. These are the preferred land categories for areas identified to become part of the CAR reserve system.

In some cases it is not immediately possible to change State forest or timber reserve selected for inclusion into the CAR reserve system, to one of the above categories, because it may be subject to a State Agreement Act, mining tenement or some other use. These can be made a formal reserve using the 'any other land' categories pursuant to CLM Act sections 5(1)(g) and 5(1)(h) and include conservation as a purpose in the vesting. The formal reserve system is described in Appendix 6.

Informal reserve system

The informal reserve system includes land zoned in the management plan for a conservation purpose (see above). Part of the informal reserve system contributes to the comprehensive adequate and representative reserve system (see Appendix 6).

Multiple use land

Multiple use land is available to produce the goods and services that require moderate to high disturbance of the forest in their production. This includes minerals, timber, wildflowers, basic raw materials and some recreation activities and facilities.

Controlling the physical and temporal scale and intensity of the disturbance, and ensuring rehabilitation of disturbed land provides for biodiversity conservation.

The land categories used are State forest and timber reserve.

APPENDIX 4

Management plans in force or in preparation within the draft plan area

Plan	Plan type	Plan period	Date gazetted
Forest Management Plan 1994-2003	Regional	1994 -2003	22.3.1994
Swan Region			
Northern Forest Region Regional Management Plan	Regional	1987-1997	12.2.1988
Mooradung Nature Reserve	Area	1985-1995	21.2.1986
Moondyne Nature Reserve	Area	1981-1991	Adopted 18.8.1980
Nature Reserves of the Shire of Toodyay	Area	1985-1995	Adopted 10.12.1984
Nature Reserves in the Shires of York and Northam	Area	1987-1997	10.7.1987
John Forrest National Park	Area	1994-2004	19.8.1994
Yanchep National Park (under review)	Area	1989-1999	2.7.1989
Yellagonga Regional Park	Area	in preparation	
Gnangara Regional Park	Area	in preparation	
Beeliar Regional Park	Area	in preparation	
Herdsman Lake Regional Park	Area	in preparation	
Swan Estuary Marine Park and Adjacent Nature Reserves	Area	1999-2009	7.4.2000
Matilda Bay Reserve	Area	1992-2002	
Canning River Regional Park	Area	1997-2007	5.12.1997
Carnac Island	Area	in preparation	
Shoalwater Islands Nature Reserve	Area	1992-2002	20.10.1992
Woodman Point Regional Park	Area	in preparation	
Rockingham Lakes Regional Park	Area	in preparation	
Jandakot Regional Park	Area	in preparation	
Forrestdale Lake Nature Reserve	Area	1987-1992	10.7.1987
Thomsons Lake Nature Reserve	Area	1981-1991	Adopted 18.8.1980
Darling Range Regional Park	Area	in preparation	
Nature Reserves of the Shire of Serpentine-Jarrahdale	Area	1981-1991	Adopted 18.8.1980
Serpentine National Park	Area	2000-2009	3.10.2000

Plan	Plan type	Plan period	Date gazetted
Lane Poole Reserve	Area	1990-2000	14.12.1990
South West Region			
Central Forest Region Regional Management Plan	Regional	1987-1997	12.2.1988
Yalgorup National Park	Area	1995-2005	4.8.1995
Benger Swamp Nature Reserve	Area	1987-1992	12.2.1988
Leschenault Peninsula	Area	1998-2008	8.1.1999
Leeuwin-Naturaliste National Park (under review)	Area	1989-1999	21.4.1989
Logue Brook Reservoir and Catchment Area	Area	1990-2000	16.3.1990
Waroona Reservoir and Catchment Area	Area	1990-2000	16.3.1990
Warren Region			
Southern Forest Region Regional Management Plan	Regional	1987-1997	12.2.1988
Perup Forest, Lake Muir Nature Reserve, Unicup Nature Reserve	Area	in preparation	
Shannon Park and D'Entrecasteaux National Park (under review)	Area	1987-1997	8.1.1988
Walpole-Nornalup National Park	Area	1992-2002	3.7.1992

Notes:
Although the period of the plan may have expired, under section 55(2) of the CLM Act the plan continues until revoked or replaced by a new approved plan. However, provisions of the FP Act mean that a production contract written under a management plan expire with that management plan.

'Date Gazetted' means the date that notification of the Minister's approval of the relevant plan was published in the Government Gazette (except those designated 'Adopted'). This is the date the plan becomes operative unless a later date has been specified in the plan.

Plans gazetted prior to 1985 were prepared by the former Department of Fisheries and Wildlife.

APPENDIX 5

Silviculture in State forest and timber reserves

What is silviculture?

Silviculture is the management of forest vegetation (mainly trees) to achieve specified objectives. It is the theory and practice of controlling forest establishment, composition, structure and growth to achieve those objectives. Silviculture is applied to achieve a wide variety of outcomes including erosion control; wood production and/or fibre production; watershed regulation; sustension of habitat for wildlife; maintenance of aesthetics; provision for recreation; etc.

Objectives may be complementary to, or conflict with one another. The silvicultural system(s) is therefore the mechanism that determines the integration of varied objectives at the operational level.

Silvicultural systems

A silvicultural system defines an overall suite of treatments through the life cycle of the forest to achieve the specified objective.

Silvicultural treatments usually, (but not always), involve felling trees. They can be divided into treatments designed to regenerate forest stands, or intermediate treatments that sustain vigor and desired composition and stand structure. These are summarised below:

Clearfelling

All trees in a stand are harvested at the same time and regeneration is sourced from seeds from surrounding trees, retained seed trees, coppice, or artificial seeding or planting. The size or extent of the clearfell patch will vary, but clearfelling provides an open environment, which is desirable for regenerating shade-intolerant species. Site preparation, which is the removal of woody debris and weed competition, is required for successful regeneration of either naturally seeded or planted trees.

Clearfelling alters wildlife habitat by replacing mature stands of trees with herbaceous plants, shrubs, and seedling trees. Therefore wildlife dependent on mature trees are disadvantaged, while other species may benefit. Clearfelling can be scheduled to create a variety of structural types, including stands of young trees, middle-aged trees, and older trees. Structural goals for the forest may be set to achieve this in a controlled way. There is little or no danger of damaging retained trees in subsequent felling cycles.

Shelterwood

The shelter wood system is applied when the species to be regenerated require some protection from direct sunlight to become established. Depending on the initial condition of the stand, two or three partial harvests of the overstorey are used to regenerate the stand. The objective of the initial harvest is to improve the vigour and seed production of the remaining trees and to prepare the site for new seedlings. The remaining trees provide shade and shelter from extreme conditions. Subsequent harvests remove the shelterwood trees and allow the regeneration to develop as an even-aged stand. The species favoured by the shelterwood system are those that naturally regenerate in the shade.

Group selection

A group selection silvicultural system involves the harvest of small groups rather than individual trees. The openings resemble clearfellings, but since they are small (less than 1 hectare to 10 hectares), the edge trees still provide a protected environment for the developing regeneration in the group opening. This method is similar to single tree selection in that harvests are frequent, but it is easier to avoid damaging the residual stand. The number of roads required, and the frequency with which they are used, is greater for group and single tree selection than for other silvicultural systems to supply a similar total volume of timber over time.

Single tree selection

In single tree selection, each tree in the stand is evaluated. Less productive trees are removed, overly dense areas are thinned, and mature trees are harvested (selecting only the biggest and best trees, known as 'high grading', eventually reduces the quality of the trees that are growing on the site). Seedlings of shade-tolerant trees develop wherever they can find space. Cuttings are more frequent over the forest area than with other silvicultural systems, and damage to the remaining trees is a consideration.

Thinning

Thinnings are prescribed to reduce competition between trees and to accelerate growth on the trees that remain. Thinnings are grouped as commercial or non-commercial, depending on whether the harvested trees can be sold. They might be termed as thinning from above, where dominant and co-dominant trees are removed, or thinning from below where smaller trees with crowns below the dominant trees are removed.

Improvement cuttings

Improvement cuttings are made to remove competing, less productive trees to favour vigorous, commercially valuable ones. The choice of species depends on the objectives for timber, wildlife, aesthetic appeal, or recreation. Many trees that have little to no timber value might be left to favour these other uses.

Salvage cutting

Salvage cuttings are prescribed to remove trees infested with insects or disease, that may pose a threat to the remaining stand, or trees damaged by fire or windstorms.

History of silviculture in Western Australia *(Bradshaw 1999)*

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 system practiced, although this was not a deliberate policy but a result of no forest management and no intention of regenerating the forest. The cut over 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 practiced following the passing of the *Forests Act 1918*. Clearfelling was the system used and seed for regeneration came from cull trees most of which were ring barked following establishment of the regeneration. The Big Brook forest is an example from this period.

1940 to 1967

Around 1940 the silvicultural system changed to a selection system. 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; and
- to create access in the forest, particularly for fire control.

The maximum selection gap size was 120 metres in diameter (the seed dispersal limit) but typically gaps were down to 30 metres in diameter. The system 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 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 exposure; and
- 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 present

Clearfelling was resumed in 1967 to overcome the problems produced by the selection system. 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.

The maximum gap size for a clearfell patch was initially set at 200 hectares, but has subsequently been reduced to 40 hectares.

The thinning of regrowth karri was introduced during this period for karri regrowth around 30 metres high. The age this occurs varies according to site quality but is approximately 20 years of age. The resulting product is usually only suitable for chip. The timing of second and subsequent thinnings depends on growth rate, markets and the intended rotation length for the stand.

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 system was introduced following the passing of the Forest 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 satisfactory regeneration did not develop.

1984 to present
From the mid-1980s, a combination of systems has been used, depending on the structure of the forest and the condition of the existing lignotuber regeneration:

- Cutting to gap (0.2 to 10 hectares) to release existing lignotubers so they can develop into saplings, etc (see Appendix 2 for a description of jarrah development stages).
- Shelter wood cutting and follow up burning treatment to encourage the development of a lignotuber pool. This is practiced where there is currently an inadequate quantity of lignotubers to regenerate the site successfully if all the overstorey was removed.
- Thinning of immature stands that are still actively growing to promote growth on retained stems.
- Single tree selection in low quality stands.

Over the past three years the average annual area cut over was 18,000 hectares. Table 15 shows the proportion of this area cut to the silvicultural objectives.

Table 15: Areas cut to silvicultural objectives since 1998

Silvicultural objective used	Area (ha)	Percentage
Thinning to promote growth	1,440	8
Release of regeneration (cutting to gap)	4,165	23
Establish regeneration (shelterwood)	7,375	41
Single tree selection (selection)	975	5
Selective (selection)	3,050	17
Other	995	6
Total	**18,000**	**100**

Source: Department of Conservation and Land Management Annual Reports

Review of silvicultural systems for the draft plan

The current silvicultural systems 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 silvicultural guidelines has broadened from the maintenance or enhancement of the productive capacity of the forest for timber production to include biodiversity, water and visual objectives. A review of the current guidelines, particularly with respect to ecologically sustainable forest management and the Montreal Criteria and Indicators, is underway to:

- formally update the guidelines in the light of knowledge gained through application of current guidelines or from research findings, e.g. the Kingston study;
- formally update the guidelines with respect to requirements of relevant reviews, e.g. Ministerial Advisory Group on Karri and Tingle Management 1999; and
- update the guidelines with respect to broader ecologically sustainable forest management goals and to ensure the guidelines link to the objectives and strategies of the draft forest management plan.

It was also seen as desirable to amalgamate the current guidelines into one document for each species. The first stage of the review is complete and a number of proposed changes have been put forward. The final guideline will be completed following comment on the draft plan. A description of the basis of the current guidelines, and the proposals for improvement, are summarised in this appendix.

Jarrah

Background

There are four basic characteristics of jarrah that underlie the current silvicultural application:

- it regenerates from seed;
- it develops a pool of lignotuberous regeneration on the forest floor beneath the forest canopy;
- when there is disturbanee to the overstorey canopy, e.g. fire or windstorm, regeneration will be released from the lignotuberous pool and begin development into mature trees; and
- 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 and suppression of individuals.

These points must be considered when planning harvesting operations to ensure the productive capacity of the forest is sustained.

In simple terms, where a lignotuberous pool of regeneration exists and the overstorey is mature, harvesting can be applied to remove the overstorey and allow regeneration to be released. Where regeneration is lacking or non-existent, 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:

- the creation of gaps where regeneration is adequate;
- the retention of a shelterwood where regeneration is inadequate; and
- application of a thinning treatment where a regrowth forest already exists.

It should be noted that the application of shelterwood does not reflect the classic definition of this technique as described in the early part of this appendix. 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 simply a source of seed from which regeneration may establish and provide for the maintenance of forest values during the extended period required for lignotuberous development of regeneration to a stage capable of release.

The jarrah forest is naturally uneven aged and one aim of silvicultural application is to sustain this. However, rather than applying single tree selection which results in the difficulties previously described, group selection methods are applied particularly when applying gap treatments. The minimum size group is two tree heights or about 50 metres in diameter. The largest size group is about 10 hectares with this limit being set to achieve objectives for visual amenity and biodiversity conservation.

Over much of its range, jarrah is the dominant species of the jarrah forest. Marri, (*Corymbia callophyla)*, 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, (*Eucalyptus wandoo*) which occurs mainly on the eastern margins of the forest and blackbutt, (*Eucalyptus patens*) which occurs in the moister more fertile gully sites.

Proposed changes to jarrah silvicultural guideline

The main changes proposed to the existing jarrah guidelines are summarised as follows.

Exclusion of old-growth areas from harvesting
A separate management guideline has been developed for this in Appendix 14.

Revised habitat retention requirements
In the light of the results from the Kingston research project, retention of primary habitat trees is proposed to increase from four to six trees per hectare. The characteristics required for these trees would also change, having the effect of retaining less vigorous more senescent trees than before. This change in number of primary habitat trees would also change the required success criteria for retention from 20 primary per five hectares to 30 primary per five hectares.

An additional requirement to explicitly mark for retention of balga (grass trees) is proposed, to provide greater diversity of retained habitat for, in particular, ring-tail possums. The work that has been completed in Kingston has identified balga as an important refuge site for this species. Where available, four large balga per hectare would be marked for retention.

A requirement to retain all natural hollow logs with a pipe of more than 10 centimetres diameter, and length of more than three metres is also proposed.

It is proposed that a greater emphasis be placed on the protection of retained habitat from fire applied during the regeneration process.

Predator control
A significant addition is the proposed fox baiting to achieve predator control. This complements the greater emphasis on habitat retention at the coupe level and is intended to remove predator pressure on sensitive species during the period of regeneration of the forest when they are most vulnerable.

Planting jarrah in gaps in the southern high rainfall forest
Results of research conducted in the high rainfall southern forests have shown that planted jarrah seedlings can successfully grow into well formed saplings and poles without passing through a prolonged lignotuber phase. One silvicultural issue that has been identified in the high rainfall southern forests is the proliferation of marri regeneration following harvesting, which can preclude adequate jarrah regeneration. The introduction of planting jarrah seedlings would allow for a means of ensuring adequate, successful regeneration of jarrah on these sites.

Refinement to shelterwood retained basal area
Based on the results achieved with the application of the current silvicultural guideline, the retained basal area in shelterwood treatments would be reduced from 15 square metres per hectare, to 8 to 10 square metres per hectare. This would reduce competition from the retained overstorey, allowing more seedlings to establish successfully.

Management of dieback infested areas
The proposal provides for a precautionary approach to the management of dieback on sites where any intensification of the disease is likely to result in high impact to forest values. On these sites it is proposed to retain 15 square metres per hectare of overstorey cover.

On those sites where intensification of the disease is unlikely, as defined by rainfall and vegetation complex, silvicultural application would be the same as dieback-free forest.

Definition of an eastern jarrah type
This is a new approach to define that area of the eastern jarrah forest where the expectations of its capacity to establish regeneration following standard application of silvicultural guideline 1/95 have been over ambitious. The main components of the proposed management of these areas is to accept a lower stocking level of regeneration, a uniform retention of retained tree cover, maximise the use of existing regeneration through coppice treatments and accepting a longer period of recruitment of seedlings through multiple regeneration events.

Eastern jarrah has been defined on the basis of rainfall zone and vegetation complexes.

Application of coppice treatments
Greater emphasis is proposed to be placed on applying coppice treatments in gap application to achieve acceptable stocking levels. Coppice treatments have the advantage that the coppice regeneration already has a very well-developed root system, which means the growth of coppice shoots is rapid.

Jarrah planting
A guideline for jarrah planting is proposed, with two seed collection zones, north and south of the Preston River. This represents a precautionary approach as current data on genetic variability suggest minimal variation within the main jarrah belt.

Landing rehabilitation
Explicit requirements and success criteria for landing rehabilitation are proposed.

Regeneration surveys
A requirement to survey at least a five per cent sample of gap release regeneration in the first year following release burning is put forward, to provide for a formal measure of the success or otherwise of gap regeneration.

A measurement of retained forest structure (thinned forest) or measure of retained basal area is also proposed, particularly for establishment surveys in areas harvested to shelterwood. The requirement for this has been introduced on the basis that if the forest has been subject to a thinning or remains at full stocking of overstorey, establishment of regeneration cannot be expected and is not required. The retained basal area suggested is 12 square metres per hectare.

Management of fire damaged regrowth
Where wildfire has seriously damaged the growth potential of regrowth jarrah forest guidelines for remedial treatments have been proposed. Where damage is serious coppice treatments are suggested.

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 wildfire.

Unlike jarrah, karri seedlings do not have a lignotuberous phase. Following successful establishment they continue rapid growth into saplings and subsequently poles. They are 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 size at maturity, suit the application of a clearfelling system of silviculture. This is similar to other tall forests of the world. The minimum size patch for effective management is approximately two hectares, while the maximum is constrained to 40 hectares for visual and biodiversity reasons.

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, varies in structure from pure karri to mixtures with other species to varying extent. The most frequently occurring species other the 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 karri silvicultural guideline

The main changes proposed to the existing karri guidelines are summarised as follows.

Exclusion of old-growth areas from harvesting
A separate management guideline has been provided for this in Appendix 14.

Management of two tiered stands to conserve growing stock
The proposed management of these stands is to retain as much regrowth growing stock as possible within harvesting constraints. The intent of this is to increase the amount of potential sawlog available in the mid-term. Previously only regrowth patches that met full stocking requirements or minimum patch dimensions, e.g. one to two hectares, have been considered.

Management of mature and two tiered mixed forest
Currently these stands are harvested by clearfelling with the emphasis in regeneration focusing on the karri component. The new guideline proposes to manage these stands within the context of the jarrah silvicultural guideline, i.e. retention of habitat trees and crop trees with a more balanced approach to the maintenance of the mix of species in the regeneration phase. The effect would be that the regenerating forest would have greater structural diversity, and the regeneration a greater component of marri and jarrah relative to karri.

Limitations to clearfell patch size
The recommendation of the Ministerial Advisory Group on Karri Tingle 1999 has been included. This limits the clearfell patch size in mature and two-tiered forest to 40 hectares, and 20 hectares in regrowth forest.

Retained marri chipwood
With the reduced market for marri chipwood, there has been a requirement to manage retained marri in coupe to balance both unnecessary disturbance and the requirement to regenerate the forest following harvesting. Basal area guidelines are proposed to allow for this. In practice it would result in some marri being felled to waste to facilitate regeneration while accepting that a large component of the retained marri would be left to grow on as part of the resulting forest structure.

Retained patches of mature forest
A guideline is proposed to aid coupe planners on implementation of the 400 metre retention rule in karri.

Marking of potential habitat trees
The marking of potential habitat trees in clearfell coupes is proposed for general adoption.

Landing rehabilitation
Explicit requirements and success criteria for landing rehabilitation are proposed.

Thinning with stump removal where Armillaria is present
Research has shown that Armillaria has the potential to be a significant concern for regrowth management. As recommended by research, stump pulling at the time of first thinning is prescribed for those areas where severe damage to regrowth stems from the fungus is evident.

Post-thinning burning
Guidelines prescribing conditions under which post-thinning burning can be carried out are proposed.

Response to fire damage in regrowth
A decision matrix is proposed for management of regrowth stands suffering damage from wildfire. The aim of this matrix is to sustain the productive capacity of the stand.

Wandoo

Background
Wandoo forest generally occurs on the eastern periphery of the jarrah forest, east of the 700 millimetre rainfall isohyet. It occurs as a 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 ash bed, regeneration tends to occur as clumps, which in turn leads towards an uneven aged forest structure.

Wandoo following release from the lignotuber phase of development is very sensitive to damage from fire. Any applied fire needs to ensure that this sensitivity is taken into account.

Proposed changes to wandoo silvicultural guideline

The main changes proposed to the existing wandoo silvicultural guideline are as follows.

Increased emphasis on habitat
A greater emphasis is proposed on retention of habitat. The guideline is similar, but less prescriptive, than the requirements described for jarrah.

Acceptable regeneration standard
There has also been an amendment to the acceptable standard for successful regeneration. This has changed from 10 seedlings on 50 per cent of ashbed, to 10 seedlings on 70 per cent of ashbeds.

APPENDIX 6

Establishment of a comprehensive, adequate and representative (CAR) reserve system

An objective of the draft forest management plan is to establish a conservation reserve system that meets world's best standards in terms of comprehensiveness, adequacy and representativeness.

The National Reserve System (NRS) Program seeks the establishment of a comprehensive, adequate and representative (CAR) reserve system of protected areas that will preserve Australia's native biodiversity. The Guidelines for the 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 it also aims to consider the ecological requirements of rare or threatened species and ecological communities and ecosystems, special groups of organisms such as those with specialized 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 draft plan is in two parts. Inside the RFA area an expanded reserve system was proposed in the RFA, based on NRS principles, and subsequently the Government's *Protecting our old-growth forests* policy has committed to further reservations. Outside the RFA area a different level of vegetation mapping is available and there has not been a rigorous process of application of the NRS principles.

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 1997a) 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; and*
- *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, and*
  - *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; and*

- *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 1979b and 1979c; 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 six 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 1979a), (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) and (vi) the forest ecosystems devised for the RFA (Bradshaw and Mattiske 1997).

IBRA was endorsed by the Australian and New Zealand Environment and Conservation Council (ANZECC) 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 (1979a) 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 National Reserve System 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, 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, land form 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.

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.

Inclusion of high quality habitat

In the RFA process, 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 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 3) 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 (DFA) and the RFA that followed it.

As a part of the DFA process, the Commonwealth established a Commonwealth Scientific Advisory Panel (CSAP), to which it referred a number of issues for advice, including the issue of the conservation role of informal reserves in Western Australia. The issue centred on how much old-growth forest was reserved in formal reserves and informal reserves and what should be the appropriate balance of formal and informal reservation of old-growth. The State and Commonwealth agreed that reservation targets for biodiversity were achieved.

The CSAP recommended, as a precautionary measure for the DFA, that a buffer be added to the outer margins of all linear reserves considered for inclusion in meeting CAR reservation targets, on the basis that edge effects might affect the values of these linear reserves. The position adopted in the DFA was that smaller informal reserves (60-metre wide first, second and third order stream reserves and 200-metre wide road reserves) would not contribute to the achievement of CAR reservation targets, and that a deduction of 25 per cent of the area of 400-metre wide road reserves for karri and 15 per cent for jarrah for internal edge effects was also allowed.

The Western Australian Government established a Scientific Panel to review this issue and provide advice. The Panel concluded that the larger linear reserves clearly provided special significance and representativeness to the total reserve system in the forests of Western Australia. The Panel was of the opinion that the Commonwealth position was vastly overweighed for the Western Australian situation and there was no justification for the buffering or discounting that the Commonwealth sought.

For karri forest at the time of the DFA, some 49 per cent of old growth (as mapped at that time) occurred in proposed and existing formal reserves and for jarrah forest the figure was some 42 per cent.

The report on the DFA process identified the need for the issue of informal reserves to be considered in the preparation of the RFA. During the RFA process, a draft discussion paper on the issue of informal reserves was prepared and this discussed a number of alternative approaches to dealing with the issue.

The public consultation paper for the RFA, *Towards a Regional Forest Agreement for the South-West Forest Region of Western Australia - A Paper to Assist Public Consultation*, described the position taken to that stage of the RFA process, and sought public comment. A large number of submissions was received on this issue and these were considered in the development of the RFA. The position adopted for the RFA was not the same as for the public consultation paper.

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 by the CSAP for the DFA;
- 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; and
- the Bibbulmun Track travel route reserve (400 metres wide).

This draft plan carries forward the position adopted for the RFA 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 Forest Management Plan 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 Forest Management Plan 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 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 Forest Management Plan 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 have been the subject of negotiation with the Agreement Act companies (see Appendix 8).

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 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 blocks north-east of Collie and Helms block on the Blackwood River west of Nannup. These are collectively termed the 'moratorium' blocks. The Government considered the URS report in late 2001, and an additional 14,500 hectares will now be added to reserves around Wellington Dam, bringing the total area protected to more than 17,500 hectares. The areas to be added to the national park are Lennard, Gervasse, most of Davis and part of Lowden.

A review of the high conservation value of more than 100 forest blocks has been undertaken by Ecoscape Australia as part of the Government's *Protecting our old-growth forests* policy. A final report has been published (Ecoscape 2002), and is still being considered by Government.

Outside the RFA area

Forest ecosystem mapping was not undertaken in the area of the draft plan outside the RFA region hence it was not possible to integrate the CAR reserve system development for inside and outside the RFA region.

The break up of land categories vested in the Conservation Commission is shown in Table 16.

Table 16: Area of land categories vested in the Conservation Commission

National park	Nature reserve	Conservation park	5(1)(g) and 5(1)(h)	State forest	Timber reserve	Misc. reserve
26,900 ha	66,300 ha	4,490 ha	10,070 ha	57,900 ha	50 ha	890 ha
16 per cent	40 per cent	3 per cent	6 per cent	35 per cent	Negligible	Negligible

The consequence of this analysis is that the draft plan cannot be the main mechanism for establishing a CAR reserve system outside the RFA area because the land vested in the Conservation Commission is largely already existing or proposed formal reserve.

Establishing a CAR reserve system on the Swan Coastal Plain; has been addressed through a number of programs and planning instruments. The EPA initially sought to identify suitable areas for reservation through the Conservation Through Reserves Committee system reports for System 1 (Department of Conservation and Environment 1976) and System 6 (Department of Conservation and Environment 1983). The Environmental Protection Authority began an update of the system reports for the Swan Coastal Plain in 1994 but in 1996 the program was spent, concentrating on the Perth Metropolitan Region. The result from this was 'Bush Forever' which seeks to establish a conservation reserve system on the Swan Coastal Plain portion of the Perth Metropolitan Region that is, as far as is achievable, comprehensive adequate and representative (Western Australian Planning Commission 2000).

Bush Forever is a 10-year plan that seeks representation of at least 10 per cent of each of 26 vegetation complexes (Heddle *et al.* 1980) that occur within the area. A number of criteria (e.g. areas containing rare or threatened communities or species) have been used to select 287 (51,200 hectares, representing almost 18 per cent of the area) Bush Forever Sites to meet this aim. Protection of the identified areas is being sought through a range of options from purchase and reservation to negotiated planning solutions. This program is particularly complementary to the formal reserves in this draft plan as it is targeting the area where land vested in the Conservation Commission is least represented.

The review of the remainder of the Swan Coastal Plain with an equivalent of Bush Forever, is proposed. There have been a number of studies that have led to recommendations for protection of specific areas using the Beard vegetation association mapping as updated by Hopkins (Hopkins *et al.* 1996) as the basis for assessing priority. In particular the biodiversity audit of IBRA regions undertaken for Environment Australia assessed the representation of vegetation associations by IUCN protection categories. The EPA is also formally assessing the potential environmental impacts of the Greater Bunbury Region Planning Scheme and will review the protection of regionally significant natural areas in the scheme on the Swan Coastal Plain. The EPA has developed a draft strategy for identifying natural areas of regional significance which is expected to be released in the near future.

The vegetation association mapping of Beard is mapped at a broad scale and is a structural system, compared to the vegetation complex mapping of Heddle. Floristic community types have also been surveyed for the area of the Swan Coastal Plain (Gibson *et al.* 1994, Department of Environmental Protection 1996) and the coastal and near coastal areas of the Warren Region on the South Coast (Gibson and Lyons unpublished). A combination of Heddle vegetation complex mapping and floristic community survey information are the primary regional datasets used in Bush Forever and proposed for the System 6 update and EPA review of the Greater Bunbury Region Scheme. These datasets provide a consistent basis for assessment of the CAR reserve system and protected areas of the Swan Coastal Plain.

A proposal is being prepared by the Tuart Response Group (Haswell pers. com.) to update the vegetation complex mapping and produce a Tuart Atlas between the Moore River and Busselton during 2002/03. When completed the mapping will be used to reassess the protection of vegetation complexes.

APPENDIX 7

Origin of reserve proposals

(see page 190 for explanatory notes)

ID	Locality name	Area (ha)	Management plan ID 1987	Management plan ID 1994	RFA ID	*Protecting our old-growth forests* policy: Rein-stated	*Protecting our old-growth forests* policy: New	*Protecting our old-growth forests* policy: New class'n	Proposal type
1	Moore River	22,130	114-118						NR, other, NP to NR
2	Mogumber	130	130,131						Ex Dir freehold to NR
3	Boonanarring	890	99-101						Other to NR
4	Caraban	2,200	108-109	8(a)					SF to s5(1)(h)
5	Caraban	3,330	110, 111	8(b)					SF to CP
6	Yanchep	110	126						SF to NR
7	Wabling	2,170	123-125						SF to NR
8	Lake Muckenburra	70	112						Other to NR
9	Julimar	28,590	75-80, 129		1				SF to CP; Interim FCA
10	Julimar	30	73, 74						s5(1)(g),other to CP
11	Ridges	2,410	121, 122						SF to NP
12	Pinjar	700							SF to NR
13	Pinjar	5,020							SF to s5(1)(h)
14	Neerabup	1,240	119						NP*
15	Yongka (Melaleuca Park)	3,200	113						SF to NR
16	Moondyne	5,170	84, 127						NR, other to NP
17	Avon Valley (Toodyay)	3,580	pt 97						Misc res to NP
18	Avon Valley (Toodyay)	1,710	pt 97		2				Misc res to NP; Interim FCA
19	Morangup	930	128						NR to NP
20	Greenmount	60	71						NP*
21	Gooseberry Hill	30	70						NP*
22	Kalamunda	400	81						NP*
23	Mundaring (Mundaring)	2,220			4				SF to NP
24	Mundaring (Mundaring)	770	85-93, 134		5				SF, other to NP

* Previous proposals to change the category of these areas from national park will not proceed.

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
25	Mundaring (Mundaring)	660					yes		SF to NP
26	Lesmurdie Falls	60	52, 53, 83						NP*
27	Helena (Helena Valley)	5,040			8				SF to NP
28	Flynn (Helena Valley)	3,940			11				WRC freehold to NP
29	Wandoo (Wandoo)	2,240					yes		SF to NP
30	Wandoo (Wandoo)	13,750			12				SF, other to NP
31	Wandoo (Wandoo)	29,390	57, 58, 59, pt 94, 67-69, 72, 96		13				CP to NP
32	Russell	450	pt 94		14				SF to NP
33	Russell	3,360	pt 94, pt 95						SF to CP
34	Russell	340	pt 94		pt 15	yes (pt)		yes	SF, UCL to NP
35	Talbot	60			16, 17				Other to NR
36	Victoria (Pickering Brook)	5,860			6				SF, UCL to NP
37	Illawarra (Canning)	2,520			7				SF, other to NP
38	Dale (Helena Valley)	1,320	66		10				Ex Dir freehold to NP
39	Dale (Helena Valley)	5,780	65		9				CP to NP
40	Monadnocks	300		6	18				s5(1)(g) to s5(1)(h)
41	Monadnocks	15,200	39	5					s5(1)(g) to NP
42	Monadnocks	30		7					s5(1)(g) to s5(1)(h)
43	Monadnocks	7,480			20-23				SF, WRC freehold to NP
44	Monadnocks	1,520					yes		SF to NP
45	Flint	1,980					yes		SF, TR to CP
46	Gibbs	2,280		pt 9	pt 19	yes (pt)			SF to CP
47	Wearne	1,530					yes		TR to CP
48	Bannister	1,150					yes		SF to CP
49	Gyngoorda	1,350	pt 16		pt 26	yes (pt)			SF to CP
50	Monadnocks	4,990	pt 14, 15		24				SF, UCL to NP
51	Monadnocks	690	pt 14		pt 25	yes (pt)		yes	SF to NP

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
52	Wandering	4,360	27-31						Other, TR to CP
53	Serpentine	40	No	previous	ID				Other to NP
54	Serpentine	120			27				NR to NP
55	Darling Scarp	410			28-32				SF to NR
56	North Dandalup	60	13						Other to NR
57	Clifton north	120	pt 32						UCL to NP
58	Clifton south	520	52						SF to NP
59	McLarty	690	61						SF to NP
60	Marrarup	30			33				UCL to NR
61	Lane Poole	230	24						Misc. to s5(1)(h)
62	Lane Poole (Icy Creek)	180	22	12					Ex Dir freehold to s5(1)(h)
63	George	1,180		pt 13	pt 34	yes (pt)			SF to CP
64	George	140					yes		SF to CP
65	George	540		pt 13					SF to CP
66	Myalup	690	60						SF to NP
67	Myalup	220	59						SF to NP
68	Wagerup (Yarloop)	10	64	15					Other to NR
69	Clarke (Falls Brook)	400		pt 22	pt 36				SF to NR; Interim FCA
70	Clarke (Falls Brook)	200		pt 22					SF to NR
71	Clarke	290		pt 22	37	yes			SF to NR
72	Harvey	100			35				UCL to CP
73	Lane Poole**	4,300			38-40				SF, UCL to CP
74	Lane Poole	40					yes		SF to NP
75	Lane Poole	1,490			41, 42				SF to NP
76	Lane Poole	1,120					yes		SF to NP

** The *Protecting our old-growth forests* policy states the Government will 'investigate upgrading Lane Poole Reserve to a national park'.

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
77	Lane Poole	38,090	36-39,40,57,63	23-25					SF, s5(1)(g),TR, WRC freehold, other to NP
78	Lane Poole	2,440					yes		SF to NP
79	Lane Poole	3,820					yes		SF, TR to NP
80	Kemerton	550		17					Ex Dir freehold to s5(1)(h)
81	Kemerton	1,860	55, 56	18, 19					Ex Dir freehold to s5(1)(h)
82	Kemerton	90		20					Ex Dir freehold to s5(1)(h)
83	Leschenault Peninsula	490		pt 21					Freehold to CP
84	Gervasse/Lennard/Davis/ Lowden (Wellington)	8,100					yes		SF to NP
85	Gervasse/Lennard/Davis (Wellington)	5,040	21, 22, 23	pt 26, 27	pt 49			yes	SF to NP
86	Gervasse/Lennard/Davis (Wellington)	760			pt 49			yes	SF to NP
87	Wellington	720			48				SF to NP
88	Westralia (Wellington)	1,130	pt 48		pt 46				SF to CP; Interim FCA
89	Westralia (Wellington)	860	pt 48, 49		pt 46				SF to CP
90	Westralia (Wellington)	310					yes		SF to FCA
91	Batalling	400			43				SF to NR
92	The Angle	920			44				TR to NR
93	Cordering	1,110			45				TR to NR
94	Bennelaking	5,630	26-30						SF, UCL, other to CP
95	Muja	6,370	41-47						UCL, TR to CP
96	Camballan	1,520	75, pt 76, pt 79	pt 36, 38					UCL, other, leasehold to CP

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
97	Camballan	6,680	pt 76, pt 79	pt 36, 37	56	yes			UCL, other, leasehold to CP
98	Camballan	430	77, 78	pt 36					Leasehold to CP
99	Goonac (Greater Preston)	1,680	pt 33, 32 ,35 ,80	pt 29, 30				yes	SF, UCL, leasehold, other to NP
100	Goonac (Greater Preston)	3,610	pt 33	pt 29	55			yes	SF to NP
101	Roseneath (Greater Preston)	1,330		28				yes	SF to NP
102	Noggerup south (Greater Preston)	810			54			yes	SF, UCL, other to NP
103	Noggerup (Greater Preston)	3,310	67	31				yes	SF to NP
104	Hovea (Greater Preston)	1,100		34			yes		SF to NP
105	Preston (Greater Preston)	870	68	32	53			yes	SF to NP
106	Boyanup	30			52				SF to NR
107	Dardanup	120			51				SF to NR
108	Dardanup	570	pt 31						SF to CP
109	Dardanup	70	pt 31		50	yes			SF to CP
110	Nth Boyanup Rd	4	24						Other to NR
111	Tuart Forest	50	11						SF, other to NP
112	Tuart Forest	60	10						SF to NP
113	Leeuwin-Naturaliste	230	No	previous	ID				Ex Dir freehold to NP
114	Leeuwin-Naturaliste	10	6						UCL to NP
115	Leeuwin-Naturaliste	20			85				Other to NP
116	Yelverton (Yelverton)	790			86				TR, other to NP
117	Yelverton	420			87				TR, other to FCA
118	Whicher	290			83				SF to FCA

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
119	Whicher (Whicher)	30	pt 16		84			yes	SF to NP
120	Whicher (Whicher)	3,220	pt 16					yes	SF to NP
121	Whicher (Whicher)	3,220	pt 16		pt 82	yes		yes	SF to NP
122	Ryall	900			75-79				SF, TR, UCL to FCA
123	Ryall	280		33	74				SF to CP; Interim FCA
124	Mullalyup	540			73				SF, UCL to FCA
125	Mullalyup	910	85		72				SF to CP; Interim FCA
126	Harrington	690			71				SF to FCA
127	Mullalyup	1,250	86, 87		70				SF, Ex Dir freehold to CP; Interim FCA
128	Greenbushes	430	82						SF, Ex Dir freehold to NR
129	Greenbushes	330			68				SF to FCA
130	Golden Valley	60	66		69				Ex Dir freehold to FCA. To be reviewed to provide appropriate protection for the values, uses and long-term future of the area.
131	Kerr	130					yes		SF to CP
132	Kulikup	140			57				Other to NR
133	Hester east	780		40					TR to CP
134	Nollajup	670	88						SF to NR
135	Hester south	1,440			59				SF, other to FCA
136	Hester central	1,490					yes		SF to CP
137	Hester west	1,030		42	60				SF, TR to CP; Interim FCA
138	Greenbushes	530	83		61				SF to NR; Interim FCA
139	Nelson	620			62-64				SF to FCA

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
140	Dalgarup	950	99		65				SF to NR; Interim FCA
141	Ellis Creek	140	89		67				SF to CP; Interim FCA
142	Jarrahwood	160			80				Other to CP
143	St John Brook	3,440	101, 102		81	yes			SF to CP
144	Rapids	1,270	pt 14						SF to CP
145	Rapids	1,110	pt 14		92	yes			SF to CP
146	Mowen	840	12		93	yes			SF to NR
147	Bramley (Bramley)	4,010			89				SF, TR, other, UCL to NP
148	Bramley	250			90				TR to FCA
149	Leeuwin-Naturaliste	70			88				Other to NP
150	Whichcliffe	1,550	17, 18						UCL to SF
151	Leeuwin-Naturaliste	310		43					Other to NP
152	Leeuwin-Naturaliste	10	1						NR to NP
153	Forest Grove (Forest Grove)	1,390			91				TR, other to NP
154	Blackwood River (Blackwood River)	2,480	2, 91, 92		97				SF to NP
155	Blackwood River (Blackwood River)	14,130			94-96, 98				SF, TR, other to NP
156	Butler (Butler)	14,860					yes		SF to NP
157	Blackwood River (Blackwood River)	1,000	90, 93-98						SF to NP
158	Blackwood River (Blackwood River)	760					yes		SF to NP
159	Chester	370	5						SF to NR
160	Paget	1,400	13						SF to NR
161	Hilliger	9,080			99				SF, UCL, other to FCA

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management Plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
162	Hilliger (Hilliger)	11,720					yes		SF to NP
163	Milyeannup (Milyeannup)	12,170			102				SF to NP
164	Milyeannup (Milyeannup)	420			100				SF to NP
165	Milyeannup (Milyeannup)	5,680	100		101				SF to NP
166	Beaton	440		44	66				TR to CP; Interim FCA
167	Glenlynn	1,400			106, 107				SF, TR, other to FCA
168	Wournbelup/Chowerup	2,160	70-72		58				UCL, other to NR
169	Wournbelup	660	69						UCL to SF
170	Chowerup	700	103, 104						UCL, other to SF
171	Blackbutt	40	1	45					NR to CP
172	Easter (Easter)	930			103			yes	SF to NP
173	Easter (Easter)	60					yes		SF to NP
174	Easter (Easter)	590	5, 13		104			yes	SF to NP
175	Iffley (Easter)	1,280					yes		SF to NP
176	One Tree Bridge	660	15, 16		105				SF, s5(1)(g), Ex Dir freehold to CP; Interim FCA
177	Lewin	40	7						UCL to SF
178	Solai	20	23						Other to SF
179	King Jarrah	190		49					Misc res to SF
180	Dingup	230		48	113				SF to CP; Interim FCA
181	Strickland (Greater Beedelup)	1,670	24		114			yes	SF to NP
182	Beavis (Greater Beedelup)	14,620					yes		SF, Ex Dir freehold to NP
183	Giblett (Greater Beedelup)	450			115				SF to NP
184	Sir James Mitchell NP	160	21, 22, 111						NP to SF

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
185	Dordagup (Greater Dordagup)	6,680					yes		SF to NP
186	Nairn	60	86						UCL to SF
187	Mickalarup Swamp (Tone-Perup)	80		47					Other to NP
188	Walcott (Greater Kingston)	40					yes		TR to NP
189	Warrup(Greater Kingston)	760			112			yes	SF to NP
190	Kingston(Greater Kingston)	19,340					yes		SF, TR, UCL to NP
191	Mersea(Greater Kingston)	760					yes		SF to NP
192	Keninup (Tone-Perup)	5,770		pt 46	108			yes	SF, TR to NP
193	Keninup (Tone-Perup)	1,080		pt 46				yes	TR to NP
194	Weinup	80			111				Other to NR
195	Yackelup (Tone-Perup)	40,180	17, 18					yes	SF, TR, UCL to NP
196	Talling (Tone-Perup)	5		52				yes	Other to NP
197	Talling (Tone-Perup)	5,500		pt 53	110	yes		yes	SF to NP
198	Talling (Tone-Perup)	830		pt 53				yes	SF to NP
199	Stoate (Tone-Perup)	840					yes		SF to NP
200	Bolbelup	1,500			109				TR, UCL to FCA
201	Bolbelup	40	11	54					Other to SF "to be reviewed"
202	Bokarup	480	2, 3, 10						Other, UCL to NR
203	D'Entrecasteaux	4,480	46						Leasehold, UCL to NP
204	Fly Brook (Greater Hawke)	1,420					yes		SF to NP
205	Charley (Greater Hawke)	2,350	pt 27	pt 56	116	yes			SF to NP
206	Charley (Greater Hawke)	2,020	pt 27	pt 56					SF to NP
207	Hawke	2,870	pt 27		117				SF to NP

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
208	Hawke (Greater Hawke)	220	pt 27	57					SF to NP
209	Dombakup (Greater Hawke)	100	80					yes	SF to NP
210	Crowea (Greater Hawke)	3,460					yes		SF to NP
211	Dombakup (Greater Hawke)	470			118				SF to NP
212	Jane (Jane)	130	83				yes		UCL to NP
213	Jane (Jane)	5,940					yes		SF, Ex Dir freehold to NP
214	Jane (Jane)	520					yes		SF, UCL, Ex Dir freehold to NP
215	Northcliffe (Boorara-Gardner)	1,070	87-90		119,120				UCL, other to NP
216	Northcliffe (Boorara-Gardner)	1,530					yes		TR, UCL to NP
217	Northcliffe (Boorara-Gardner)	270					yes		SF to NP
218	Northcliffe (Boorara-Gardner)	700					yes		UCL to NP
219	Muirillup (Boorara-Gardner)	170	85					yes	SF to NP
220	Boorara (Boorara-Gardner)	660	31					yes	SF to NP
221	Boorara (Boorara-Gardner)	260					yes		SF to NP
222	Babbington (Boorara-Gardner)	270					yes		SF, UCL to NP
223	Gardner (Boorara-Gardner)	6,060	pt 81				yes		SF, UCL to NP
224	Gardner	530	pt 81						UCL to SF
225	D'Entrecasteaux	1,000	103						SF to NP
226	Northcliffe	20	91						UCL to SF
227	D'Entrecasteaux	35	62	58					UCL to SF
228	Northcliffe	60	92						UCL to SF
229	Boyndaminup (Boyndaminup)	4,420					yes		SF to NP
230	Boyndaminup (Boyndaminup)	400					yes		SF to NP

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
231	Mattaband	260		59					SF to NP
232	Wattle east	200					yes		SF to NP
233	Wattle west	510					yes		SF to NP
234	Poorginup (Lake Muir)	9,460					yes		SF to NP
235	Chitelup (Lake Muir)	310					yes		SF to NP
236	Lake Muir NR (Lake Muir)	11,390						yes	NR to NP
237	Weld-Mossop	5,780					yes		SF to NP
238	Long-Rocky (Mt Frankland north)	21,950					yes		SF to NP
239	Deep-Ordnance (Mt Frankland south)	34,250					yes		SF, other to NP
240	Sharpe (Mt Frankland south)	3,430			121				SF to NP
241	Collis (Mt Frankland south)	5,930			122, 126				SF, UCL, other, s5(1)(g) to NP
242	Trent (Mt Frankland south)	3,520					yes		SF, s5(1)(g) to NP
243	Trent (Mt Frankland south)	1,930		pt 66	127, pts 128, 129				SF, TR to NP
244	Bow River (Mt Frankland south)	270		pt 66	pt 128		yes		SF to NP
245	Crown res 14325 (Walpole-Nornalup)	80					yes		Other to NP
246	Walpole Townsite (Walpole-Nornalup)	60					yes		UCL to NP

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
247	Swarbrick (Walpole-Nornalup)	460			123-125				SF to NP
248	Crown res 13045 (Walpole-Nornalup)	430	155						Other to NP
249	Hiker (Mt Roe)	8,620	pt 183	pts 60, 61 & 55	135				SF, UCL to NP
250	Gully (Mt Roe)	5,060	pts 183,128 & 142	pt 61	136				SF, UCL, other to NP
251	Kent River (Mt Roe)	36,910	pts 183 & 142	pts 61 & 67	137				SF, UCL, other to NP
252	Roe-London (Mt Roe)	11,400	pt 142, 143, pts 159 & 183	pts 60, 61, 62	130				SF, UCL to NP
253	Thames-Romance (Mt Roe)	16,720	pts 142, 144, 145	pt 62, 70	pts 130 & 131				SF, UCL, other to NP
254	Thames-Romance (Mt Roe)	1,130	129, 130, 153					yes	NR to NP
255	Trent (Mt Roe)	1,030		pt 66	pt 129				SF to NP
256	Bow River (Mt Roe)	350		pt 66	pt 128		yes		SF to NP
257	Styx (Mt Roe)	2,140		pt 66	134			yes	UCL, other to NP
258	Rate (Mt Roe)	490		pt 66	133		yes		Other to NP
259	Thames (Mt Roe)	250	154	pt 66	132			yes	Other to NP
260	Thames (Mt Roe)	320					yes		TR to NP
261	Styx (Mt Roe)	4,410	pt 142				yes		Other to NP
262	Styx	20	150						Other to SF
263	Thames (Mt Roe)	60	149				yes		Other to NP
264	Kordabup	300	131-136						TR, UCL to NR

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
265	Camballup (Mt Roe)	7,840	pts 142, 148		138			yes	SF, UCL, other to NP
266	Perillup (Mt Roe)	3,520	pts 142, 146, 147	pt 61	139			yes	SF, other to NP
267	Perillup (Mt Roe)	790			140			yes	SF to NP
268	Clear Hills (Mt Roe)	15,810		pt 61	pt 130				SF, other to NP
269	Amarillup (Mt Roe)	290			142				SF, other to NP
270	Pardelup	3,670			141				SF, TR, other to FCA
271	Kwornicup Lake	10	184						Other to NR
272	Denbarker	250			150, 152				Other, leasehold (Aboriginal) to FCA
273	Mt Barker	60			pt 153				UCL, other to FCA
274	Denbarker (Mt Lindesay)	27,240	pts 144, 203, 175-179, 124-126, 127	67	pt 131			yes	SF, UCL, other to NP
275	Harewood (Mt Lindesay)	5,560		pt 66	143			yes	SF, TR, other to NP
276	Denmark River (Mt Lindesay)	300		pt 66	144		yes		SF, other to NP
277	Harewood (Mt Lindesay)	100		pt 66			yes		SF to NP
278	Crown res 15623 (Mt Lindesay)	60					yes		s5(1)(g) to NP
279	Harewood south east (Mt Lindesay)	110					yes		SF to NP
280	Crown res 19242 (Mt Lindesay)	50	137						NR to NP
281	Crown res 35168 (Mt Lindesay)	1,170	221						NR to NP
282	Sheepwash (Mt Lindesay)	1,330	pt 203	pt 68			yes		SF to NP
283	Sheepwash (Mt Lindesay)	4,540	pt 203		146			yes	SF to NP

APPENDIX 7 (cont.)

Origin of reserve proposals

ID	Locality name	Area (ha)	Management plan ID		RFA ID	*Protecting our old-growth forests* policy			Proposal type
			1987	1994		Rein-stated	New	New class'n	
284	Hay (Mt Lindesay)	2,290					yes		SF, UCL to NP
285	Sheepwash (Mt Lindesay)	2,010			145				SF to NP
286	Hay (Mt Lindesay)	910					yes		TR to NP

Notes

CP:	Conservation park
Ex Dir:	Executive Director of the Department of Conservation and Land Management
FCA:	Forest conservation area
Misc:	Land vested in Executive Director or former National Parks and Nature Conservation Authority
New:	New conservation reserve proposal under the *Protecting our old-growth forests* policy
New class'n:	Previous conservation reserve proposal reclassified under the *Protecting our old-growth forests* policy
NP:	National park
NR:	Nature reserve
Other:	Crown reserve not vested in the Conservation Commission
Reinstated:	Previous conservation reserve proposal removed under the RFA, but reinstated by the *Protecting our old-growth forests* policy
s5(1)(g):	CLM Act Section 5(1)(g) – land vested under the *Land Act 1933*
s5(1)(h):	CLM Act Section 5(1)(h) – land vested under the *Land Administration Act 1997*
SF:	State forest
TR:	Timber reserve
UCL:	Unallocated Crown land
WRC:	Water and Rivers Commission

APPENDIX 8

Proposed alternatives to reinstated reserve proposals within State Agreement Act mining leases

The Government's *Protecting our old-growth forests* policy commits to *reinstate the 17 proposed reserves (54,000 hectares) revoked by the Government during the RFA.*

The reinstatement of 11 of these proposed reserves is reflected in Table and Map of the draft plan. The other six previously proposed reserves occur within areas covered by two State Agreement Act leases (ML1SA held by Alcoa of Australia Ltd; and ML258SA held by Worsley Alumina Pty Ltd).

Under an Agreement Act, the Government is not able to change land categories within the mining lease that could prejudice the rights of the Agreement Act company, unless both parties agree. One of the reinstated reserve proposals, a 220-hectare addition to Falls Brook Nature Reserve, is supported by Alcoa. The remaining five previously proposed reserves overlap areas with known bauxite deposits or high levels of mineral prospectivity. These cover some 20,315 hectares, identified by the following forest block names:

- Russell (4,776 hectares);
- Gibbs (5,929 hectares);
- Duncan (3,487 hectares);
- Gyngoorda (3,465 hectares); and
- George (2,658 hectares).

Both Alcoa and Worsley are prepared to relinquish their rights to parts of each of the above areas and to alternative areas within their respective mining leases that will meet the Government's conservation objectives without jeopardising their access to high value mineral resources. Accordingly, the Department of Mineral and Petroleum Resources and the Department of Conservation and Land Management have worked with the companies towards the following objectives:

- maintain access for State Agreement Act companies to areas that contain significant mineral resources;
- achieve at least the same area protected in formal reserves as would be the case if all previously proposed reserves were reinstated;
- achieve at least a similar overall level of protection of the conservation values that occur in these areas as would be the case if all previously proposed reserves were reinstated; and
- increase the protection of old-growth forest in formal reserves by, wherever possible, focusing alternative formal reserves around patches of old-growth forest.

The identification of alternative areas for reservation is now completed to the satisfaction of Alcoa, Worsley, Department of Conservation and Land Management and the Department of Mineral and Petroleum Resources.

The outcomes of the process are included in the map of the reserve system (Map 5), which shows reinstated Forest Management Plan 1994-2003 proposed reserves, reserves proposed as alternatives to

In summary, the outcomes of the process are:

- An increased area of formal reserves (by adding previously unreserved old-growth forest to formal reserves). The five reserve proposals referred to on the previous page cover 20,320 hectares whereas the alternative reserve proposals cover 22, 470 hectares.
- A threefold-increase in the amount of old-growth forest protected in these formal reserves. The five previously proposed reserves included 875 hectares of old-growth forest whereas the alternative reserve proposals include 2,675 hectares of old-growth forest.
- The reservation of important conservation values in part of each of the five previously proposed reserves.
- The same or increased level of protection of each forest ecosystem represented in the previously proposed reserves, with the exception of the Jarrah Woodland ecosystem where some 80 hectares less will occur in formal reserves. The total level of formal and informal reservation of the Jarrah Woodland ecosystem is unchanged.
- An increase in the total area of less well reserved vegetation complexes in formal reserves and at least similar levels of protection for each of those vegetation complexes.
- A twofold-increase in the indicative areas of national estate values for refugia, aggregations of old-growth forest and natural landscapes in formal reserves.

In terms of land categories, the outcomes are:

- a new 650-hectare addition to the proposed Mundaring National Park, in Sawyers block;
- a new 2,240-hectare addition to the proposed Wandoo National Park; in Churchlands and Talbot blocks;
- a 340-hectare addition to the proposed Wandoo National Park (currently a conservation park), in Russell block, being part of a proposed conservation park under the 1994 forest management plan;
- a 4,250-hectare conservation park in Gibbs and Flint blocks, including part of a 1994 proposed conservation park in Gibbs block;
- a new 1,520-hectare addition to the proposed Monadnocks National Park in Gibbs block;
- a new 1,530-hectare addition to the Lupton Conservation Park, in Wearne block;
- a 2,500-hectare conservation park, in Gyngoorda and Bannister blocks, including part of a 1994 proposed conservation park in Gyngoorda block;
- a 690-hectare addition to the proposed Monadnocks National Park in Duncan block, being part of a 1994 proposed conservation park;
- a 1,330-hectare addition to a proposed conservation park in George block, being part of a 1994 proposed conservation park;
- a new 1,120-hectare addition to the proposed Lane Poole National Park (currently CLM Act 5(1)(g) reserve) in Bednall block;
- a new 40-hectare addition to the proposed Lane Poole National Park (currently CLM Act 5(1)(g) reserve) in Surface block;
- a new 2,440-hectare addition to the proposed Lane Poole National Park (currently CLM Act 5(1)(g) reserve) in Stockyard block; and

- a new 3,810-hectare addition to the proposed Lane Poole National Park (currently CLM Act 5(1)(g) reserve) in Godfrey and Hillman blocks.

Further details on reservation levels of ecosystems, old-growth forest, vegetation complexes and other values are provided below showing the outcome if all of the original proposals had been reserved, and that under the current proposed alternatives.

Reservation by percentage

Table 17: Comparison of reservation levels of forest ecosystems between the five previous reserve proposals affected by State Agreement Acts and the alternative areas proposed

Forest ecosystem	Percentage of pre-1750 area reserved					
	Formal		CAR informal		All	
	Original	Alternative	Original	Alternative	Original	Alternative
Jarrah North East	15.7	15.7	17.0	17.0	18.3	18.2
Jarrah North West	14.0	14.0	16.6	16.6	19.4	19.4
Jarrah Sandy	22.9	22.9	24.3	24.3	26.1	26.2
Jarrah Woodland	27.8	27.7	43.4	43.3	52.1	52.1
Western Wandoo forest	16.8	17.1	18.2	18.5	19.3	19.6
Western Wandoo woodland	19.6	20.0	23.0	23.4	24.2	24.5
Rocky Outcrops	30.5	30.7	37.8	37.2	44.8	44.8
Shrub, Herb and Sedgelands	51.9	51.9	56.5	56.5	59.3	59.3

Table. 18: Comparison of reservation levels of old-growth forest between the five previous reserve proposals affected by State Agreement Acts and the alternative areas proposed

Forest ecosystem	Percentage of pre-1750 area reserved					
	Formal		CAR informal		All	
	Original	Alternative	Original	Alternative	Original	Alternative
Jarrah North East	77.0	89.3	81.7	92.4	99.7	99.7
Jarrah North West	91.8	92.2	97.4	97.8	99.9	99.9
Jarrah Sandy	99.9	100.0	99.9	100.0	100.0	100.0
Jarrah Woodland	90.3	90.4	97.2	97.3	99.5	99.5
Western Wandoo forest	89.3	89.6	93.4	93.7	99.9	99.9
Western Wandoo woodland	82.0	86.9	90.3	94.9	99.2	99.2

Table 19: Comparison of reservation levels of selected vegetation complexes between the five previous reserve proposals affected by State Agreement Acts and the alternative areas proposed

Vegetation complex	Percentage of pre-1750 area reserved					
	Formal		CAR informal		All	
	Original	Alternative	Original	Alternative	Original	Alternative
Coolakin	14.1	14.3	15.8	16.0	17.3	17.5
Darkin 1	1.3	1.4	1.3	1.4	1.3	1.4
Darkin 2	0.4	0.4	0.4	0.4	0.4	0.4
Dalmore 2	7.0	8.3	7.0	8.3	7.0	8.3
Lukin 2	4.8	7.4	4.8	7.4	5.2	7.4
Michibin	5.8	5.6	7.2	7.0	7.2	7.1
Wilga	0.5	0.4	0.5	0.4	0.5	0.4

Reservation by area

Table 20: Reservation of forest ecosystems, old-growth forest, selected vegetation complexes and other values, if the five previous reserve proposals affected by State Agreement Acts were fully reserved

Forest ecosystems		Old-growth forest	Vegetation complex		Other values	
Forest ecosystem	**Area (ha)**	**Area (ha)**	**Complex**	**Area (ha)**	**Value**	**Area (ha)**
Jarrah North East	12,560	470	Coolakin	4,010	Refugia	10
Jarrah North West	720	0	Darkin 1	0	Aggregations of old-growth	790
Jarrah Sandy	20	0	Darkin 2	0	Natural landscapes	800
Jarrah Woodland	330	0	Dalmore 2	0		-
Western Wandoo forest	5,250	340	Lukin 2	0		-
Western Wandoo woodland	950	70	Michibin	1,620		-
Rocky Outcrops	360		Wilga	80		-
Shrub, Herb and Sedgeland	110					
Other	20			-		-
Total	**20,320**	**880**		**5,710**		**1,600**

Table 21: Reservation of forest ecosystems, old-growth forest, selected vegetation complexes and other values, as a result of the reservation of the alternative areas as proposed by this draft plan

Forest ecosystem		Old-growth forest	Vegetation complex		Other values	
Forest ecosystem	**Area (ha)**	**Area (ha)**	**Complex**	**Area (ha)**	**Value**	**Area (ha)**
Jarrah North East	12,740	2,030	Coolakin	4,310	Refugia	220
Jarrah North West	940	40	Darkin 1	20	Aggregations of old-growth	1,520
Jarrah Sandy	90	0	Darkin 2	10	Natural landscapes	1,520
Jarrah Woodland	250	20	Dalmore 2	530		
Western Wandoo forest	6,270	360	Lukin 2	620		
Western Wandoo woodland	1,600	230	Michibin	1,420		
Rocky Outcrops	400		Wilga	80		
Shrub, Herb and Sedgeland	180					
Total	**22,470**	**2,680**		**6,990**		**3,260**

APPENDIX 9

Area reservation levels of forest ecosystems

	Total pre-1750 extent (ha)	Present extent on all lands in the three regions (ha)	Present extent on all lands vested in the Conservation Commission in the three regions (ha)	CAR Target (ha)	Formal reserves Area of ecosystem representation (hectares) Existing gazetted as at 30.6.2002 (Additions proposed) NP	NR	CP	5(1)(g),(h)	FCA (ha)	CAR Informal (ha)	CAR Total (ha)	Other Informal (ha)	Available for timber harvesting (ha)
Jarrah dominant													
Jarrah Blackwood	347,200	281,810	266,730	52,080	8,170	220	0	20	0	6,180	14,590	19,210	158,470
					(59,240)	(1,770)	(6,300)	(0)	(7,150)		(74,460)		
Jarrah Leeuwin	56,400	19,550	9,320	8,460	2,510	60	0	0	0	290	2,860	50	760
					(5,120)	(0)	(0)	(0)	(530)		(5,650)		
Jarrah Mt Lindesay	126,600	37,570	22,320	18,990	830	700	0	0	0	0	1,530	10	310
					(17,780)	(0)	(0)	(0)	(2,690)		(20,470)		
Jarrah North East	717,100	350,240	262,000	107,570	23,190	4,500	4,250	0	0	6,290	38,230	7,900	135,180
					(40,590)	(4,570)	(35,310)	(0)	(220)		(80,690)		
Jarrah North West	670,600	499,600	445,990	100,590	29,580	1,170	8,270	12,450	0	17,450	68,920	19,030	315,660
					(30,640)	(1,810)	(6,700)	(230)	(3,000)		(42,380)		
Jarrah Rates's Tingle	1,500	1,250	1,120	1,250	990	0	0	0	0	0	990	0	0
					(130)	(0)	(0)	(0)	(0)		(130)		
Jarrah Red Tingle	350	270	230	270	150	0	0	0	0	0	150	0	0
					(80)	(0)	(0)	(0)	(0)		(80)		
Jarrah Sandy	107,900	71,090	64,470	16,190	8,780	230	0	0	0	1,490	10,500	2,000	36,220
					(7,380)	(0)	(8,140)	(0)	(230)		(15,750)		
Jarrah South	557,300	438,920	420,490	83,600	51,800	270	0	0	0	8,640	60,710	25,870	157,790
					(172,150)	(960)	(1,060)	(10)	(1,940)		(176,120)		
Jarrah Unicup	81,000	29,460	16,240	12,150	1,120	3,910	0	0	0	10	5,040	20	70
					(9,940)	(40)	(0)	(0)	(1,130)		(11,110)		

Area reservation levels of forest ecosystems (cont.)

	Total pre-1750 extent (ha)	Present extent on all lands in the three regions (ha)	Present extent on all lands vested in the Conservation Commission in the three regions (ha)	CAR Target (ha)	Formal reserves Area of ecosystem representation (hectares) Existing gazetted as at 30.6.2002 (Additions proposed) NP	NR	CP	5(1)(g),(h)	FCA (ha)	CAR Informal (ha)	CAR Total (ha)	Other Informal (ha)	Available for timber harvesting (ha)
Jarrah Woodland	106,400	67,220	54,520	15,960	8,850	2,560	240	180	0	15,730	27,560	9,350	0
					(13,670)	(600)	(2,680)	(0)	(660)		(17,610)		
Jarrah Yellow Tingle	11,600	9,670	8,730	1,740	1,780	0	0	0	0	0	1,780	0	0
					(6,950)	(0)	(0)	(0)	(0)		(6,950)		
Sub total	**2,783,950**	**1,806,650**	**1,572,160**	**418,580**	**137,750**	**13,620**	**12,760**	**12,650**	**0**	**56,080**	**232,860**	**83,440**	**804,460**
					(363,670)	**(9,750)**	**(60,190)**	**(240)**	**(17,550)**	**(0)**	**(451,400)**	**(0)**	
Karri dominant													
Karri Main Belt	193,000	163,910	153,880	28,950	36,960	220	10	0	0	8,350	45,540	14,450	60,820
					(32,520)	(110)	(400)	(0)	(40)		(33,070)		
Karri Rate's Tingle	1,100	860	790	860	790	0	0	0	0	0	790	0	0
					(0)	(0)	(0)	(0)	(0)		(0)		
Karri Red Tingle	7,200	5,860	5,220	1,080	4,900	0	0	0	0	0	4,900	0	0
					(320)	(0)	(0)	(0)	(0)		(320)		
Karri West Coast	14,500	6,270	4,590	2,180	3,880	30	0	0	0	0	3,910	10	130
					(490)	(20)	(0)	(0)	(30)		(540)		
Karri Yellow Tingle	15,800	13,260	11,970	2,370	2,390	0	0	0	0	0	2,390	0	60
					(9,520)	(0)	(0)	(0)	(0)		(9,520)		
Sub total	**231,600**	**190,160**	**176,450**	**35,440**	**48,920**	**250**	**10**	**0**	**0**	**8,350**	**57,530**	**14,460**	**61,010**
					(42,850)	**(130)**	**(400)**	**(0)**	**(70)**	**(0)**	**(43,450)**	**(0)**	

Area reservation levels of forest ecosystems (cont.)

	Total pre-1750 extent (ha)	Present extent on all lands in the three regions (ha)	Present extent on all lands vested in the Conservation Commission in the three regions (ha)	CAR Target (ha)	Formal reserves Area of ecosystem representation (hectares) Existing gazetted as at 30.6.2002 (Additions proposed)				FCA (ha)	CAR Informal (ha)	CAR Total (ha)	Other Informal (ha)	Available for timber harvesting (ha)
					NP	NR	CP	5(1)(g),(h)					
Wandoo dominant													
Western Wandoo forest	363,200	146,600	97,170	54,480	14,120	3,560	7,530	0	0	2,020	27,230	4,040	29,110
					(20,940)	(600)	(15,200)	(0)	(50)		(36,790)		
Western Wandoo woodland	163,000	72,080	43,360	24,450	11,170	1,480	780	0	0	970	14,400	1,710	8,090
					(9,960)	(180)	(9,020)	(0)	(0)		(19,160)		
Sub total	**526,200**	**218,680**	**140,530**	**78,930**	**25,290**	**5,040**	**8,310**	**0**	**0**	**2,990**	**41,630**	**5,750**	**37,200**
					(30,900)	**(780)**	**24,220)**	**(0)**	**(50)**	**(0)**	**(55,950)**	**(0)**	
Other													
Bullich and Yate	2,800	2,440	2,170	2,440	1,510	0	0	0	0	0	1,510	0	0
					(660)	(0)	(0)	(0)	(0)		(650)		
Darling Scarp	29,000	9,940	2,460	4,350	1,100	110	0	0	0	30	1,240	20	200
					(430)	(460)	(40)	(0)	(70)		(1,000)		
Peppermint and Coastal Heath	80,100	70,830	58,080	12,020	52,200	1,420	0	10	0	160	53,790	10	0
					(4,280)	(0)	(0)	(0)	(0)		(4,280)		
Rocky Outcrops	26,400	12,440	11,670	3,960	4,220	50	80	40	0	1,560	5,950	2,020	0
					(3,270)	(0)	(430)	(0)	(0)		(3,700)		
Sand Dunes	11,100	11,070	11,060	1,660	10,840	0	0	0	0	0	10,840	0	0
					(220)	(0)	(0)	0)	(0)		(220)		

Area reservation levels of forest ecosystems (cont.)

	Total pre-1750 extent (ha)	Present extent on all lands in the three regions (ha)	Present extent on all lands vested in the Conservation Commission in the three regions (ha)	CAR Target (ha)	Formal reserves Area of ecosystem representation (hectares) Existing gazetted as at 30.6.2002 (Additions proposed) NP	NR	CP	5(1)(g),(h)	FCA (ha)	CAR Informal (ha)	CAR Total (ha)	Other Informal (ha)	Available for timber harvesting (ha)
Shrub, Herb, and Sedgelands	429,900	293,780	254,490	64,490	89,030	5,040	190	450	0	19,280	114,000	12,310	0
					(122,260)	(1,010)	(1,600)	(20)	(3,290)		(128,180)		
Swamps	15,300	8,070	6560	2,300	4,200	970	0	20	0	210	5,400	230	0
					(650)	(70)	(120)	(0)	(90)		(930)		
Sub total	**594,600**	**408,570**	**346,490**	**91,220**	**163,100**	**7,590**	**270**	**520**	**0**	**21,240**	**192,730**	**14,590**	**200**
					(131,770)	**(1,540)**	**(2,190)**	**(20)**	**(3,450)**	**(0)**	**(138,960)**		
Total	**4,136,350**	**2,624,060**	**2,235,630**	**624,170**	**375,060**	**26,500**	**21,350**	**13,170**	**0**	**88,490**	**524,570**	**118,240**	**903,060**
					(569,190)	**(12,200)**	**(87,000)**	**(260)**	**(21,120)**	**(0)**	**(689,760)**	**(0)**	

Notes: 1. *All area figures are confined to the Department's three forest regions (Swan, South West, Warren) where they fall within the RFA boundary.*
2. *Ecosystem and land category datasets have been updated since the RFA.*
3. *Jarrah Mt Lindesay and Shrub, Herb, and Sedgelands reported in the RFA extended into the Department's South Coast region.*
4. *The 60 hectares of karri yellow tingle available for timber harvesting are regrowth forest on land held under title by the Executive Director.*

APPENDIX 10

Percentage reservation levels of forest ecosystems

	Total pre-1750 extent (ha)	Present extent on all lands in the three regions (% pre-1750)	Present extent on all lands vested in the Conservation Commission in the three regions (% pre-1750)	CAR Target (% pre-1750)	Formal reserves Ecosystem representation as a percentage of pre-1750 extent Existing gazetted as at 30.6.2002 (Additions proposed)				FCA (% pre-1750)	CAR Informal (% pre-1750)	CAR Total (%pre-1750)	Other Informal (% pre-1750)	Available for timber harvesting (% pre-1750)
					NP	NR	CP	5(1)(g),(h)					
Jarrah dominant													
Jarrah Blackwood	347,200	81	77	15	2.4	0.1	0.0	0.0	0.0	1.8	4.2	5.5	45.6
					(17.1)	(0.5)	(1.8)	(0.0)	(2.1)	(0.0)	(21.4)		
Jarrah Leeuwin	56,400	35	17	15	4.5	0.1	0.0	0.0	0.0	0.5	5.1	0.1	1.3
					(9.1)	(0.0)	(0.0)	(0.0)	(0.9)	(0.0)	(10.0)		
Jarrah Mt Lindesay	126,600	30	18	15	0.7	0.6	0.0	0.0	0.0	0.0	1.2	0.0	0.2
					(14.0)	(0.0)	(0.0)	(0.0)	(2.1)	(0.0)	(16.2)		
Jarrah North East	717,100	49	37	15	3.2	0.6	0.6	0.0	0.0	0.9	5.3	1.1	18.9
					(5.7)	(0.6)	(4.9)	(0.0)	(0.0)	(0.0)	(11.3)		
Jarrah North West	670,600	75	67	15	4.4	0.2	1.2	1.9	0.0	2.6	10.3	2.8	47.1
					(4.6)	(0.3)	(1.0)	(0.0)	(0.4)	(0.0)	(6.3)		
Jarrah Rates's Tingle	1,500	83	75	100% extant	79.2	0.0	0.0	0.0	0.0	0.0	79.2	0.0	0.0
					(10.4)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(10.4)		
Jarrah Red Tingle	350	77	66	100% extant	55.6	0.0	0.0	0.0	0.0	0.0	55.6	0.0	0.0
					(29.6)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(29.6)		
Jarrah Sandy	107,900	66	60	15	8.1	0.2	0.0	0.0	0.0	1.4	9.7	1.9	33.6
					(6.8)	(0.0)	(7.5)	(0.0)	(0.2)	(0.0)	(14.6)		
Jarrah South	557,300	79	75	15	9.3	0.0	0.0	0.0	0.0	1.6	10.9	4.6	28.3
					(30.9	(0.2)	(0.2)	(0.0)	(0.3)	(0.0)	(31.6)		
Jarrah Unicup	81,000	36	20	15	1.4	4.8	0.0	0.0	0.0	0.0	6.2	0.0	0.1
					(12.3)	(0.0)	(0.0)	(0.0)	(1.4)	(0.0)	(13.7)		

Percentage reservation levels of forest ecosystems (cont.)

	Total pre-1750 extent (ha)	Present extent on all lands in the three regions (% pre-1750)	Present extent on all lands vested in the Conservation Commission in the three regions (% pre-1750)	CAR Target (% pre-1750)	Formal reserves Ecosystem representation as a percentage of pre-1750 extent Existing gazetted as at 30.6.2002 (Additions proposed)				FCA (% pre-1750)	CAR Informal (% pre-1750)	CAR Total (% pre-1750)	Other Informal (% pre-1750)	Available for timber harvesting (% pre-1750)
					NP	NR	CP	5(1)(g),(h)					
Jarrah Woodland	106,400	63	51	15	8.3	2.4	0.2	0.2	0.0	14.8	25.9	8.8	0.0
					(12.8)	(0.6)	(2.5)	(0.0)	(0.6)	(0.0)	(16.6)		
Jarrah Yellow Tingle	11,600	83	75	15	15.3	0.0	0.0	0.0	0.0	0.0	15.3	0.0	0.0
					(59.9)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(59.9)		
Sub total	**2,783,950**	**65**	**56**										
Karri dominant													
Karri Main Belt	193,000	85	80	15	19.2	0.1	0.0	0.0	0.0	4.3	23.6	7.5	31.5
					(16.8)	(0.1)	(0.2)	(0.0)	(0.0)	(0.0)	(17.1)		
Karri Rate's Tingle	1,100	78	72	100% extant	91.9	0.0	0.0	0.0	0.0	0.0	91.9	0.0	0.0
					(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)		
Karri Red Tingle	7,200	81	73	15	68.1	0.0	0.0	0.0	0.0	0.0	68.1	0.0	0.0
					(4.4)	(0.0)	(0.0)	(0.0)	(0.0)	0.0)	(4.4)		
Karri West Coast	14,500	43	32	15	26.8	0.2	0.0	0.0	0.0	0.0	27.0	0.1	0.9
					(3.4)	(0.1)	(0.0)	(0.0)	(0.2)	(0.0)	(3.7)		
Karri Yellow Tingle	15,800	84	76	15	15.1	0.0	0.0	0.0	0.0	0.0	15.1	0.0	0.4
					(60.3)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(60.3)		
Sub total	**231,600**	**82**	**76**										
Wandoo dominant													
Western Wandoo forest	363,200	40	27	15	3.9	1.0	2.1	0.0	0.0	0.6	7.5	1.1	8.0
					(5.8)	(0.2)	(4.2)	(0.0)	(0.0)	(0.0)	(10.1)		
Western Wandoo woodland	163,000	44	27	15	6.9	0.9	0.5	0.0	0.0	0.6	8.8	1.0	5.0
					(6.1)	(0.1)	(5.5)	(0.0)	(0.0)	(0.0)	(11.8)		

Percentage reservation levels of forest ecosystems (cont.)

	Total pre-1750 extent (ha)	Present extent on all lands in the three regions (% pre-1750)	Present extent on all lands vested in the Conservation Commission in the three regions (% pre-1750)	CAR Target (% pre-1750)	Formal reserves Ecosystem representation as a percentage of pre-1750 extent Existing gazetted as at 30.6.2002 (Additions proposed)				FCA (% pre-1750)	CAR Informal (% pre-1750)	CAR Total (% pre-1750)	Other Informal (% pre-1750)	Available for timber harvesting (% pre-1750)
					NP	NR	CP	5(1)(g),(h)					
Sub total	**526,200**	**42**	**27**										
Other													
Bullich and Yate	2,800	87	78	100% extant	61.9	0.0	0.0	0.0	0.0	0.0	61.9	0.0	0.0
					(27.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(27.0)		
Darling Scarp	29,000	34	8	15	3.8	0.4	0.0	0.0	0.0	0.1	4.3	0.1	0.7
					(1.5)	(1.6)	(0.1)	(0.0)	(0.2)	(0.0)	(3.4)		
Peppermint & Coastal Heath	80,100	88	73	15	65.2	1.8	0.0	0.0	0.0	0.2	67.2	0.0	0.0
					(5.3)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(5.3)		
Rocky Outcrops	26,400	47	44	15	16.0	0.2	0.3	0.2	0.0	5.9	22.5	7.7	0.0
					(12.4)	(0.0)	(1.6)	(0.0)	(0.0)	(0.0)	(14.0)		
Sand Dunes	11,100	100	100	15	97.9	0.0	0.0	0.0	0.0	0.0	97.9	0.0	0.0
					(2.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(2.0)		
Shrub, Herb, and Sedgelands	429,900	68	59	15	20.7	1.2	0.0	0.1	0.0	4.5	26.5	2.9	0.0
					(28.4)	(0.2)	(0.4)	(0.0)	(0.8)	(0.0)	(29.8)		
Swamps	15,300	53	43	15	27.5	6.3	0.0	0.1	0.0	1.4	35.3	1.5	0.0
					(4.2)	(0.5)	(0.8)	(0.0)	(0.6)	(0.0)	(6.1)		
Sub total	**594,600**	**69**	**58**										
Total	**4,136,350**	**63**	**54**										

Notes:
1. All area figures are confined to the Department's three forest regions (Swan, South West, Warren) where they fall within the RFA boundary.
2. Ecosystem and land category datasets have been updated since the RFA.
3. Jarrah Mt Lindesay and Shrub, Herb, and Sedgelands reported in the RFA extended into the Department's South Coast region.
4. Totals of rows and columns within the table may not be consistent due to rounding.

APPENDIX 11

Protection of old-growth forest

Definition of old-growth forest

Under the 1992 National Forest Policy Statement (NFPS) the Commonwealth and State Governments agreed to a strategy to conserve and manage areas of old-growth forest across Australia as part of a comprehensive, adequate and representative reserve system. To clarify the NFPS objectives, national criteria have been established for the conservation of old-growth forests in a report known as the JANIS report. These criteria were endorsed by the Australian and New Zealand Environment and Conservation Council (ANZECC) in November 1996, and by the Ministerial Council on Forestry, Fisheries and Aquaculture in early 1997.

The NFPS definition of old-growth is:

> *Forest that is ecologically mature and has been subject to negligible unnatural disturbance such as timber harvesting, roading and clearing. The definition focuses on forest in which the upper stratum or overstorey is in the late mature to over mature growth phases.*

The criteria developed by JANIS provide the following interpretation of the definition:

> *Old-growth forest is ecologically mature forest where the effects of disturbance are now negligible.*

The assessment and mapping of old-growth forest undertaken for the West Australian Regional Forest Agreement (RFA) were based on these definitions. The methods and results of this assessment are described in the Comprehensive Regional Assessment (CRA) (Volume 1) Report (1998). A map of old-growth forest was published in the CRA (Volume 2) Report (1998). Public comment was sought on the CRA report and maps. A further field review, undertaken by Mattiske Consulting Pty Ltd, confirmed the mapping of old-growth forest that was undertaken for the CRA in the 'vast majority of the areas'. CRA databases have subsequently been updated to incorporate the results of this review.

The definition of old-growth forest used by the Government to implement the *Protecting our old-growth forests* policy is as defined and mapped in the RFA.

Present extent and distribution of old-growth forest

As at 30 December 2000, there was a total of 332,941 hectares of old-growth forest on land vested in the Conservation Commission in the draft plan area of which 303,018 hectares is in the existing or proposed formal reserve system and the remainder in informal reserves on State forest or timber reserve (see Map 6). Final decisions on the composition of the reserve system (in relation to the high conservation value forest study) and the boundaries of some of the new national parks proposed (where one aim is to incorporate adjacent patches of old-growth as far as possible) are not yet available.

The interim management guidelines for old-growth forest outside the formal reserve system is described in Appendix 14. The breakdown of old-growth forest by land category and forest ecosystem (inside the RFA region) is shown in Table 22.

Table 22: Reservation of old growth forest (within the RFA area)

Forest ecosystem	Area of old-growth on public land at 31.12.00	CAR Target		Formal reserves				Informal reserves		Total set aside from timber harvesting (confined to land vested in the Conservation Commission)	
				Existing reserves at 30.06.02		Additional proposed reserves at 30.06.02					
	(ha)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Jarrah dominant											
Jarrah Blackwood	45,193	27,116	60	4,862	10.8	33,687	74.5	6,610	14.6	45,159	99.9
Jarrah Leeuwin	639	639	100	481	75.3	120	18.8	0	0.0	601	94.1
Jarrah Mt Lindesay	11,596	6,958	60	345	3.0	11,251	97.0	0	0.0	11,596	100.0
Jarrah North East	12,684	12,684	100	1,959	15.4	9,397	74.1	1,288	10.2	12,643	99.7
Jarrah North West	8,189	8,189	100	5,679	69.3	1,878	22.9	622	7.6	8,179	99.8
Jarrah Rate's Tingle	1,054	1,054	100	927	88.0	127	12.0	0	0.0	1,054	100.0
Jarrah Red Tingle	220	220	100	140	63.6	80	36.4	0	0.0	220	100.0
Jarrah Sandy	2,205	2,205	100	2,133	96.7	71	3.3	1	0.0	2,205	100.0
Jarrah South	151,594	90,956	60	43,676	28.8	96,927	63.9	10,992	7.3	151,594	100.0
Jarrah Unicup	4,203	2,522	60	1,008	24.0	3,194	76.0	0	0.0	4,202	100.0
Jarrah Woodland	12,966	7,780	60	4,376	33.7	7,326	56.5	1,218	9.4	12,920	99.6
Jarrah Yellow Tingle	7,314	4,388	60	1,630	22.3	5,683	77.7	0	0.0	7,314	100.0
Sub total	**257,857**			**67,216**		**169,740**		**20,733**		**257,689**	
Karri dominant											
Karri Main Belt	52,318	31,391	60	25,125	48.0	20,236	38.7	6,956	13.3	52,317	100.0
Karri Rate's Tingle	729	729	100	729	100.0	0	0.0	0	0.0	729	100.0
Karri Red Tingle	3,282	1,969	60	3,073	93.6	209	6.4	0	0.0	3,282	100.0
Karri West Coast	520	520	100	470	90.4	48	9.3	0	0.0	519	99.7
Karri Yellow Tingle	7,087	4,252	60	1,986	28.0	5,101	72.0	0	0.0	7,087	100.0
Sub total	**63,936**			**31,384**		**25,594**		**6,956**		**63,934**	

Forest ecosystem	Area of old-growth on public land at 31.12.00	CAR Target		Formal reserves				Informal reserves		Total set aside from Timber harvesting (confined to land vested in the Conservation Commission)	
				Existing reserves at 30.06.02		Additional proposed reserves at 30.06.02					
	(ha)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Wandoo dominant											
Western Wandoo Forest	8,043	4,826	100	1,598	19.9	5,617	69.8	828	10.3	8,043	100.0
Western Wandoo Woodland	3,277	1,966	100	842	25.7	2,028	61.9	405	12.4	3,275	100.0
Sub total	**11,320**			**2,440**		**7,645**		**1,233**		**11,318**	
Total	**333,113**			**100,039**		**202,979**		**28,922**		**332,941**	

Notes:
1. All area figures are confined to the Department's three forest regions (Swan, South West, Warren) where they fall within the RFA boundary.
2. Ecosystem and land category datasets have been updated since the RFA.
3. Jarrah Mt Lindesay and shrub, herb, and sedgelands reported in the RFA extended into the Department's South Coast region.

APPENDIX 12

Beard-Hopkins vegetation associations within the draft plan area

* Vegetation associations that occur within the draft plan area and have greater than 75 per cent of their occurrence in the draft plan area outside the RFA area

Beard-Hopkins code	Description of vegetation association	Pre-1750 extent of vegetation associations						
		All land					Public land	
		Total within draft plan area (ha)	Within RFA (ha)	% of Total	Outside RFA (ha)	% of Total	Outside RFA (ha)	% of Total
* E18Mi	Medium woodland; river gum (E. rudis)	81	0	0	81	100	66	82
* PLc	Low forest; cypress pine (Callitris preisii)	1,919	0	0	1,919	100	1,389	72
* ASZc	Shrublands; A. scrub-heath unknown spp	4,479	0	0	4,479	100	3,081	69
* M4Zc	Shrublands; melaleuca heath	2,082	0	0	2,082	100	1,238	59
* bli	Low woodland; banksia on limestone	58,020	0	0	58,020	100	31,280	54
* XSZc	Shrublands; scrub-heath	2,926	0	0	2,926	100	1,098	38
* E4Mr	Medium open woodland; tuart (E. gomphocephala)	1,083	0	0	1,083	100	394	36
* bLi/mSc	Mosaic: Low woodland; banksia / Shrublands; teatree thicket	41,144	0	0	41,144	100	14,015	34
* E4Mi	Medium woodland; tuart (E. gomphocephala)	41,033	0	0	41,033	100	12,341	30
* a23,32m 3Sc/a26m	Mosaic: Shrublands; A. rostellifera, A. cyclops (S) & Melaleuca cardiophylla (N) thicket / Shrublands; A. lasiocarpa & Melaleuca a	27,531	0	0	27,531	100	6,615	24
* X14SZc	Shrublands; scrub-heath on the Swan Coastal Plain	9,742	0	0	9,742	100	1,882	19
* A1Lr1Ci	Succulent steppe with open low woodland; mulga (A. aneura) over saltbush	378	0	0	378	100	72	19
* X9SZc	Shrublands; scrub-heath Dryandra-Calothamnus assoc. with B. prionotes on limestone in the northern Swan Region	9,010	0	0	9,010	100	1,588	18
* M5Sc k3Ci	Succulent steppe with thicket; Melaleuca thyoides over samphire	1,339	0	0	1,339	100	232	17
* x14SZc/ dZc	Mosaic: Shrublands; scrub-heath on the Swan Coastal Plain / Shrublands; dryandra heath	14,224	0	0	14,224	100	1,944	14
* e2,3Mi/ bLi/mLc/	Mosaic: Medium forest; jarrah (E. marginata), marri (E. calophylla) / Low woodland; banksia / Low forest; teatree / Low woodland;	14,074	0	0	14,074	100	1,147	8
* X8SZc	Shrublands; scrub-heath on yellow sandplain banksia-xylomelum alliance in the Geraldton Sandplain & Avon-Wheatbelt Regions	17,784	0	0	17,784	100	1,310	7
* K3Ci	Succulent steppe; samphire	1,151	0	0	1,151	100	61	5
* E8,9Mi	Medium woodland; salmon gum (E. salmonophloia) & morrel (E. longicornis)	370	0	0	370	100	4	1

Beard-Hopkins vegetation associations within the draft plan area (cont.)

* Vegetation associations that occur within the draft plan area and have greater than 75 per cent of their occurrence in the draft plan area outside the RFA area

Beard-Hopkins code	Description of vegetation association	Pre-1750 extent of vegetation associations						
		All land					Public land	
		Total within draft plan area (ha)	Within RFA (ha)	% of Total	Outside RFA (ha)	% of Total	Outside RFA (ha)	% of Total
* e5,6,8,9, 34Mi	Medium woodland; wandoo (E. wandoo), York gum (E. loxophleba), salmon gum (E. salmonophloia), morrel (E. longicornis) & gimlet (E.	22,813	0	0	22,813	100	70	0
* e6,8Mi	Medium woodland; York gum (E. loxophleba) & salmon gum (E. salmonophloia)	15,322	0	0	15,322	100	27	0
* bLi/dZc	Mosaic: Low woodland; banksia / Shrublands; dryandra heath	1,525	0	0	1,525	100	0	0
* c3Sc	Shrublands; Allocasuarina campestris thicket	1,408	0	0	1,408	100	0	0
* e3,4Mr	Medium open woodland; marri (E. calophylla) & tuart (E. gomphocephala)	1,212	0	0	1,212	100	0	0
* e4Mr/bLi	Mosaic: Medium open woodland; tuart (E. gomphocephala) / Low woodland; banksia	513	0	0	513	100	0	0
* e3Mr/ mSc	Mosaic: Medium open woodland; marri (E. calophylla) / Shrublands; teatree thicket	465	0	0	465	100	0	0
* e5,6,8Mi	Medium woodland; York gum (E. loxophleba), wandoo (E. wandoo) & salmon gum (E. salmonophloia) (E. salmonophloia)	229	0	0	229	100	0	0
* e64,45Mi	Medium woodland; powderbark & mallet	35	0	0	35	100	0	0
* bli	Low woodland; banksia on low sandhills, swamps in swalles with teatree and paperbark	112,966	276	0	112,690	100	56,817	50
* e4Ti	Tall woodland; tuart (E. gomphocephala) (E. gomphocephala)	3,151	8	0	3,143	100	2,286	73
* e3,18Mr	Medium woodland; marri (E. calophylla) & river gum (E. rudis) (E. camaldulensis)	6,676	24	0	6,652	100	368	6
* e2Mb cbLi	Medium very sparse woodland; jarrah (E. marginata), with low woodland; banksia & casuarina	57,636	222	0	57,415	100	6,649	12
* e3Mr	Medium open woodland; marri (E. calophylla)	4,554	51	1	4,503	99	117	3
* sl	Bare and poorly vegetated areas; salt lakes, lagoons &claypans	6,937	153	2	6,784	98	4,655	67
* e2,3Mi/ bLi/mLc	Mosaic: Medium forest; jarrah (E. marginata), marri (E. calophylla) / Low woodland; banksia / Low forest; teatree (Melaleuca Spp.)	99,150	4,357	4	94,793	96	9,299	9
* b1,2Li	Low woodland; Banksia attenuata & B. menziesii	2,956	144	5	2,811	95	849	29
* e2,4Mi	Medium woodland; tuart (E. gomphocephala) & jarrah (E. marginata)	63,793	3,443	5	60,350	95	16,011	25
* e2,3Mr bLi/e2,3	Mosaic: Medium open woodland; jarrah (E. marginata) & marri (E. calophylla), with low woodland; banksia / Medium sparse woodland;	39,788	6,757	17	33,032	83	8,041	20

Beard-Hopkins vegetation associations within the draft plan area (cont.)

* Vegetation associations that occur within the draft plan area and have greater than 75 per cent of their occurrence in the draft plan area outside the RFA area

Beard-Hopkins code	Description of vegetation association	Pre-1750 extent of vegetation associations						
		All land					Public land	
		Total within draft plan area (ha)	Within RFA (ha)	% of Total	Outside RFA (ha)	% of Total	Outside RFA (ha)	% of Total
* e6Mi	Medium woodland; York gum (E. loxophleba)	228,115	44,074	19	184,041	81	2,511	1
* e3Mi	Medium woodland; marri (E. calophylla)	140,632	27,683	20	112,948	80	2,698	2
* bli	Low woodland; banksia	29,617	6,636	22	22,981	78	2,860	10
* MSc	Shrublands; teatree thicket	17,985	4,177	23	13,808	77	2,409	13
e2,3Mi	Medium woodland; jarrah (E. marginata) & marri (E. calophylla)	2,547	740	29	1,807	71	1,390	55
MLc	Low forest; paperbark (Melaleuca rhaphiophylla)	3,579	1,158	32	2,421	68	232	6
e3Mi (e2,5,18,c	Medium woodland; marri (E. calophylla) with some jarrah (E. marginata), wandoo (E. wandoo), river gum (E. rudis) and casuarina	56,869	20,499	36	36,370	64	1,766	3
XZc	Shrublands; mixed heath	4,357	1,626	37	2,731	63	2,708	62
c5e6Li	Low woodland; Allocasuarina huegeliana & York gum (E. loxophleba)	6,798	3,446	51	3,353	49	0	0
e5Mi	Medium woodland; wandoo (E. wandoo)	8,885	4,569	51	4,317	49	476	5
e18mMi	Medium woodland; E. rudis & Melaleuca rhaphiophylla	23,472	14,622	62	8,850	38	435	2
e2,3,5Mi	Medium woodland; jarrah (E. marginata), marri (E. calophylla) & wandoo (E. wandoo)	90,868	63,546	70	27,322	30	774	1
Fl	Bare and poorly vegetated areas; freshwater lakes	12,819	9,161	71	3,658	29	2,045	16
ChSc	Shrublands; Calothamnus quadrifidis & Hakea trifircata (Cape Naturaliste)	2,589	2,182	84	408	16	318	12
e2,63Mi	Medium woodland, jarrah (E. marginata) & E. haematoxylon (Whicher Ra.)	19,337	16,592	86	2,745	14	1,742	9
AgLc	Low forest: peppermint (Agonis flexuosa)	17,291	14,837	86	2,454	14	467	3
XGc	Sedgeland; reed swamps, occasionally with heath	40,216	35,476	88	4,740	12	1,720	4
Ds	Bare and poorly vegetated areas; sand	11,849	10,547	89	1,301	11	833	7
e2,3Mc/e3, 5Mi	Mosaic: Medium forest; jarrah (E. marginata), marri (E. calophylla) / Medium woodland; marri (E. calophylla)-wandoo (E. wandoo)	5,612	5,150	92	462	8	14	0
e3,5Mi	Medium woodland; marri (E. calophylla) & wandoo (E. wandoo)	489,421	461,080	94	28,341	6	3,277	1
Mli	Low woodland; paperbark (Melaleuca sp.)	123,702	117,716	95	5,986	5	1,979	2
e2,3Mp	Medium sparse woodland; jarrah (E. marginata) & marri (E. calophylla)	791	755	95	36	5	0	0

Beard-Hopkins vegetation associations within the draft plan area (cont.)

* Vegetation associations that occur within the draft plan area and have greater than 75 per cent of their occurrence in the draft plan area outside the RFA area

Beard-Hopkins Code	Description of vegetation association	Pre-1750 extent of vegetation associations						
		All land					Public land	
		Total within draft plan area (ha)	Within RFA (ha)	% of Total	Outside RFA (ha)	% of Total	Outside RFA (ha)	% of Total
e2,3Mr bLi	Medium open woodland; jarrah (E. marginata) & marri (E. calophylla), with low woodland; banksia	17,308	16,527	95	781	5	0	0
McLc	Low forest; paperbark & casuarina	23,297	22,291	96	1,006	4	300	1
e2,3Mc/e2 Lc	Mosaic: Medium forest; jarrah (E. marginata), marri (E. calophylla) / Low forest; jarrah (E. marginata)	17,677	16,929	96	748	4	136	1
e2Lc	Low forest; jarrah (E. marginata)	68,487	65,972	96	2,515	4	335	0
e1Tc	Tall forest; karri (E. diversicolor) (E. diverscolor)	67,826	65,935	97	1,892	3	827	1
R	Bare and poorly vegetated areas; rock outcrops	5,595	5,469	98	126	2	95	2
AgLi	Low woodland; peppermint (Agonis flexuosa)	2,742	2,692	98	50	2	5	0
AgSi	Shrublands; peppermint scrub, Agonis flexuosa	32,841	32,550	99	292	1	176	1
e2bLi	Low woodland; jarrah (E. marginata)-banksia	40,626	40,297	99	328	1	104	0
e2,3Mc	Medium forest; jarrah (E. marginata)-marri (E. calophylla)	2,307,318	2,291,306	99	16,011	1	2,027	0
e5,45Mi	Medium woodland; wandoo (E. wandoo) & powderbark (E. accedens)	6,149	6,110	99	39	1	0	0
e2Mi	Medium woodland; jarrah (E. marginata) (south coast)	38,065	37,934	100	131	0	107	0
e2,5,45Mi	Medium woodland; jarrah (E. marginata), wandoo (E. wandoo) & powderbark	35,942	35,827	100	115	0	109	0
e2Li	Low woodland; jarrah (E. marginata)	4,172	4,160	100	12	0	9	0
JZc	Shrublands; Jacksonia horrida heath	6,953	6,948	100	5	0	4	0

APPENDIX 13

Representation on public land of Beard-Hopkins vegetation associations that occur predominantly outside the RFA region

Beard-Hopkins code	Description	Pre-1750 extent (ha)	Extant (ha)	Exist/prop reserves (ha)	% of pre-1750 extent in existing and proposed reserves	% of Extant	Other Cons. Comm. land (ha)	Other public land (ha)
e2,3Mr bLi/e2,3	Mosaic: Medium open woodland; jarrah (E. marginata) & marri (E. calophylla), with low woodland; banksia / Medium sparse woodland;	8,041	8,027	7,556	94	94	0	471
e4Mr	Medium open woodland; tuart (E. gomphocephala)	394	352	335	85	95	17	0
XSZc	Shrublands; scrub-heath	1,098	1,094	931	85	85	0	164
M4Zc	Shrublands; melaleuca heath	1,238	1,205	1,040	84	86	0	165
MSc	Shrublands; teatree thicket	2,409	2,011	1,831	76	91	30	150
ASZc	Shrublands; A. scrub-heath unknown spp	3,081	3,006	2,170	70	72	0	837
a1Lr k1Ci	Succulent steppe with open low woodland; mulga (A. aneura) over saltbush	72	50	50	70	100	0	0
bLi/mSc	Mosaic: Low woodland; banksia / Shrublands; teatree thicket	14,015	13,573	9,578	68	71	2,458	1,536
e4Ti	Tall woodland; tuart (E. gomphocephala) (E. gomphocephala)	2,286	1,822	1,534	67	84	288	0
Bli	Low woodland; banksia	2,860	2,355	1,671	58	71	0	685
Bli	Low woodland; banksia on low sandhills, swamps in swalles with teatree and paperbark	56,817	41,418	31,983	56	77	4,156	5,279
E4Mi	Medium woodland; tuart (E. gomphocephala)	12,341	7,911	5,651	46	71	41	2,219
E3Mi	Medium woodland; marri (E. calophylla)	2,698	1,698	1,041	39	61	5	653
X14SZc	Shrublands; scrub-heath on the Swan Coastal Plain	1,882	1,070	701	37	66	0	368
E2,3Mi/bLi/mLc	Mosaic: Medium forest; jarrah (E. marginata), marri (E. calophylla) / Low woodland; banksia / Low forest; teatree (Melaleuca Spp.)	9,299	6,379	3,205	34	50	1,320	1,855
Bli	Low woodland; banksia on limestone	31,280	23,560	9,664	31	41	12,456	1,441
Sl	Bare and poorly vegetated areas; salt lakes, lagoons &claypans	4,655	2,000	1,403	30	70	0	597
e2,4Mi	Medium woodland; tuart (E. gomphocephala) & jarrah (E. marginata)	16,011	6,566	3,944	25	60	1,213	1,409
x8SZc	Shrublands; scrub-heath on yellow sandplain banksia-xylomelum alliance in the Geraldton Sandplain & Avon-Wheatbelt Regions	1,310	1,299	293	22	23	14	993

Representation on public land of Beard-Hopkins vegetation associations that occur predominantly outside the RFA region (cont.)

Beard-Hopkins code	Description	Pre-1750 extent (ha)	Extant (ha)	Exist/prop reserves (ha)	% of pre-1750 extent in existing and proposed reserves	% of Extant	Other Cons. Comm. land (ha)	Other public land (ha)
a23,32m3Sc/a 26m	Mosaic: Shrublands; A. rostellifera, A. cyclops (S) & Melaleuca cardiophylla (N) thicket / Shrublands; A. lasiocarpa & Melaleuca a	6,615	5,388	912	14	17	0	4,476
k3Ci	Succulent steppe; samphire	61	12	8	13	64	0	4
e3Mr	Medium open woodland; marri (E. calophylla)	117	67	14	12	21	0	53
e2Mb cbLi	Medium very sparse woodland; jarrah (E. marginata), with low woodland; banksia & casuarina	6,649	2,551	745	11	29	177	1,630
x14SZc/dZc	Mosaic: Shrublands; scrub-heath on the Swan Coastal Plain / Shrublands; dryandra heath	1,944	1,680	149	8	9	0	1,531
e6Mi	Medium woodland; York gum (E. loxophleba)	2,511	1,066	121	5	11	0	946
e2,3Mi/bLi/m Lc/	Mosaic: Medium forest; jarrah (E. marginata), marri (E. calophylla) / Low woodland; banksia / Low forest; teatree / Low woodland;	1,147	848	28	2	3	0	819
e3,18Mr	Medium woodland; marri (E. calophylla) & river gum (E. rudis) (E. camaldulensis)	368	259	2	1	1	122	135
PLc	Low forest; cypress pine (Callitris preisii)	1,389	1,389	0	0	0	0	1,389
e6,8Mi	Medium woodland; York gum (E. loxophleba) & salmon gum (E. salmonophloia)	27	27	0	0	0	0	27
e8,9Mi	Medium woodland; salmon gum (E. salmonophloia) & morrel (E. longicornis)	4	4	0	0	0	0	4
m5Sc k3Ci	Succulent steppe with thicket; Melaleuca thyoides over samphire	232	232	0	0	0	0	232
x9SZc	Shrublands; scrub-heath Dryandra-Calothamnus assoc. with B. prionotes on limestone in the northern Swan Region	1,588	1,492	0	0	0	1,381	111
e18Mi	Medium woodland; river gum (E. rudis)	66	66	0	0	0	0	6
b1,2Li	Low woodland; Banksia attenuata & B. menziesii	849	635	0	0	0	0	635
e5,6,8,9,34Mi	Medium woodland; wandoo (E. wandoo), York gum (E. loxophleba), salmon gum (E. salmonophloia), morrel (E. longicornis) & gimlet (E.	70	70	0	0	0	0	70

APPENDIX 14

Interim guidelines for the management of informal reserves

Background

The draft forest management plan zones areas of State forest and timber reserves for specific purposes, mainly to identify and protect areas during operations at the operational scale for biodiversity conservation and landscape protection. The criteria for these zones, (Commonwealth of Australia 1997b) known as 'informal' reserves, are areas:

- specified by provisions in an approved statutory management plan;
- of a size appropriate to protect the values the zoning seeks to protect;
- opportunity for the public to comment on the criteria for selection and management through the management plan process; and
- capable of being identified on maps.

The informal reserves proposed in this draft management plan are set out in Table 12 in Appendix 3.

The mature habitat zones that are discussed in the 'Biological diversity' chapter are not informal reserves. If adopted in the final plan, separate guidelines for them and other retained patches, will be prepared.

Identification in the field

Pre-planning

During the pre-planning of any disturbing activity base plans of the target area will be produced. These plans are developed directly from the Department's corporate database. The plans show those areas of forest zoned in the approved forest management plan as informal reserves. This will provide the first level of identification of informal reserves for field operations staff.

Field confirmation and demarcation

At the reconnaissance stage of planning operational staff are required to inspect the area to determine whether there are any values or features that have not been identified in pre-planning mapping that require protection by the creation or extension of an informal reserve. Different criteria need to be considered for the various types of informal reserves. These are outlined below.

Stream zones, travel route zones and diverse ecotype zones
Operational staff must inspect the target area to determine the presence of additional first order streams and diverse ecotype zones or the absence of mapped first order streams and diverse ecotype zones.

Old-growth
Field confirmation of old-growth must first consider the dieback occurrence map generated for the operation. Mapped old-growth that is now dieback infested does not meet the definition for old-growth and conversely areas of forest previously excluded as old-growth on the basis of presumed dieback infestation that are found to be free of dieback will be classified as old-growth forest.

As the operational plan is further developed, operational staff must inspect the target area for the presence of old-growth forest. Initially this inspection will focus on the old-growth patches as depicted on the base plan. These areas will be inspected by applying, where possible a systematic grid survey spaced at approximately 100-metre intervals. If the boundaries of the old-growth patch are found to be more extensive than the mapped extent, the survey is to be extended until the true boundaries are determined.

In addition to the mapped old-growth patches, the remainder of the proposed operational target area must be inspected for the presence of old-growth patches that may not have been recorded in the mapping process.

Forest with impeded access
In some forest areas particularly in the southern forests the heavy nature of the understorey make it impossible for a complete survey for the presence of informal reserves to occur during the planning stage. It is important therefore that at all stages of the preparation of a proposed disturbing operation, operational staff remain alert for the potential variation to occur. For example in the case of road construction an opportune time for further inspection to occur is at the time of field verification of road alignments prior to roads being cleared and constructed. In forests with a heavy understorey, verification of proposed new road alignments is achieved through blade up scrub rolling of understorey. This allows for an increased area to be accessible for inspection before permanent disturbance such as road building activity takes place.

Amending mapped boundaries
Field inspection of the target area may result in one or more of the following outcomes:

- confirmation that the mapped informal reserve boundaries are essentially correct; or
- evidence to suggest the mapped informal reserve boundaries requires amendment; or
- previously unmapped informal reserves that meet the relevant criteria.

If the inspection confirms that the mapped informal reserves are correct then no further action is necessary. However, if substantial variation to the mapped extent is observed the 'Variation to Coupe Plan' proforma must be completed and submitted to the relevant Departmental Regional Manager for confirmation and authorisation before work that will disturb the vegetation commences. The confirmed revised occurrence is to be clearly depicted on operational plans and following authorisation of the new boundaries is to be correctly demarcated in the field.

Changes to the boundaries of informal reserves arising from field survey will be routinely incorporated into updates of the corporate data base to facilitate future planning and operations.

Demarcation of boundaries
Demarcation of stream zones, travel route zones and diverse ecotype zones will be as described in the specifications, (as amended from time to time), in the Manual of Management Guidelines for Timber Harvesting in Western Australia. Prescribed distances are to be measured from the stream bank for stream zones, from the road formation for travel route zones and from the boundary of diverse

ecotype zones. All informal reserves are to be identified and demarcation completed before operations commence.

Demarcation of confirmed old-growth patches will be as defined for other informal reserves in the Manual of Management Guidelines for Timber Harvesting in Western Australia. This involves painting white crosses on trees, with the cross facing away from the old-growth patch.

Disturbance of informal reserves

General

The following activities are not permitted in informal reserves:

- timber harvesting, except for conditional thinning of regrowth forest in non-CAR accredited travel route zones, salvage from road clearing and salvage of individual trees removed for safety reasons;
- extraction of basic raw materials;
- craftwood collection; and
- firewood collection.

Road and trail construction

In general, new road construction is prohibited in informal reserves. However, in some cases new roading is necessary, for example where stream crossings are required in timber harvesting operations or when the upgrade of an existing track through an informal reserve may be more environmentally acceptable than other options. Where road construction or upgrading within an informal reserve is contemplated the circumstances require assessment on a case by case basis and approval from the relevant Departmental Regional Manager.

Similarly, the construction of permanent walk or other trails will be considered using a risk-based approach, and require approval from the Departmental Regional Manager.

Roads and trails are significant potential sources for the introduction of *Phytophthora* and the placement of new roading or closure of existing roads is critical to long-term management of protectable areas. The placement of roads upslope from informal reserves other than stream zones, particularly for roads to be used in all weather conditions is to generally be avoided to minimise the risk of infesting the informal reserve.

Roads through informal reserves will be constructed and maintained in a manner that minimises the environmental impact on the conservation and landscape values. Existing well-formed roads through informal reserves may continue to be used.

Timber harvesting

Timber harvesting is excluded from informal reserves and harvesting machinery is prohibited from crossing informal reserve boundaries except for:

- the thinning of regrowth forest in non-CAR travel route zones where visual quality objectives can be met;
- trees resulting from the clearing for an authorised road construction or upgrading; and

- individual trees removed for safety reasons along public access roads, around recreation sites or adjacent to work sites.

The authorised Departmental Regional Manager must approve in writing all intended tree removal under these circumstances.

A tree within the boundary of an informal reserve may be felled if it presents a safety hazard to workers in the area subject to harvesting. An appropriate Departmental officer (nominated through the EMS) can authorise the felling of a dangerous tree. A record of the decision will be retained by the relevant District office. The stumps of trees so felled must be branded and marked with crayon to indicate the reason for felling.

Trees within the harvesting area should not be felled if they will fall substantially into the informal reserves, however, a tree may be felled in the harvesting area when only part of its crown will fall into the informal reserve. In these instances the tree is to be crowned off and the log pulled away from the informal reserve boundary. The crown is to remain undisturbed and under no circumstances is machinery to cross the reserve boundary.

Where a tree accidentally falls largely into an informal reserve it is to be left unless the log can be extracted without compromising the integrity of the reserve.

Fire

The objectives for the prescribed burning of informal reserves will be set taking into account the purpose and values sought to be protected in the informal reserve.

The burn prescription for an area that includes an informal reserve must identify the informal reserve and any special requirements with respect to prescribed burning. The burn objectives must take account of those special requirements. However, the inclusion of informal reserves in areas burnt by low intensity prescribed fire to meet general fuel reduction or biodiversity objectives is generally acceptable with no special precautions to be applied.

The inclusion of informal reserves in both jarrah and karri regeneration burning is to be avoided where possible to increase the short-term biodiversity benefits of retained vegetation undisturbed by harvesting. Where this is not practical due to burn security or the need for excessive disturbance to keep fire out of the informal reserve, prescribed burning of informal reserves is acceptable. This should be clearly defined within the prescribed burn concept plan for approval by the relevant Department Regional Manager.

In the event of wildfire, protection of informal reserves must receive consideration, however, this must be taken in the context of broader environmental values and other values threatened by the fire. For example it is not sensible to protect an informal reserve if this would require track construction with greater long-term environmental consequences or lead to higher value losses elsewhere.

Disturbance of informal reserves during wildfire suppression activities is to be avoided and the identification of informal reserves in wildfire suppression planning must take high priority. Disturbance within informal reserves will be rehabilitated in the post-fire recovery process.

Wildflower harvesting

Management of flora harvesting is through the Departmental District Manager endorsement of the pickers licence for specific species and areas from which harvesting may occur. Informal reserves will generally not be endorsed areas for wildflower harvesting. However, some wildflower species currently sought occur naturally in what would be stream zones or diverse ecotype zones. The Department will prepare a list of such species and District Managers may endorse harvesting in informal reserves for these species, where the harvesting would not compromise the values of the informal reserve.

The authority for approving wildflower harvesting in informal reserves will be retained by the Departmental District Manager or their delegated officer.

Permanent features and infrastructure

The siting of permanent infrastructure associated with such activities as recreation site development or mining and utilities may occasionally be required in or adjacent to informal reserves. Proposals for such disturbance will be assessed on a case-by-case basis.

Records

Informal reserves comprise a number of corporate datasets, and procedures are established for custodianship and update on a routine basis.

Amended boundaries of informal reserves must be captured into the Department's corporate data set. For example, boundaries established during harvesting operations will be updated during the annual harvesting and silvicultural record updates.

Where informal reserve boundaries are established in the course of operations other than timber harvesting, it is the responsibility of the District Manager to obtain a map of the boundary and provide details to the Departmental corporate data custodian to enable the updating of the data set.

APPENDIX 15

Threatened species and ecological communities recovery plans relevant to State forest and timber reserves

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'. A scoring system is used as a guide to allocate taxa to the IUCN (World Conservation Union) Red Book (IUCN 1994) categories of threat. The IUCN has revised its categories of threat and criteria for the year 2000 Red List. All categories remain the same except that 'conservation dependent' has disappeared. The Department will retain this category. The 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;
- *Conservation Dependent* – 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.

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 are allocated research and management resources in priority order.

Full recovery plans

Western Swamp Tortoise Recovery Plan
Woylie Recovery Plan
Orange-bellied and White-bellied Frogs Recovery Plan
Sunset Frog Recovery Plan
Noisy Scrub-bird
Chuditch

Interim recovery plans for flora and fauna

Majestic Spider Orchid	*Caladenia winfieldii*
Swamp Starflower	*Calytrix breviseta*
Western Ringtail Possum	*Pseudocheirus occidentalis*
Abba Bell	*Darwinia* sp. Williamson
Wing-fruited Lasiopetalum	*Lasiopetalum pterocarpum ms*
Western Prickly Honeysuckle	*Lambertia echinata* subsp. *occidentalis*
Scott River Boronia	*Boronia exilis*
Split-leaved Grevillea	*Grevillea althoferorum*

Cinnamon Sun Orchid	*Thelymitra manginii* ms.
Ironstone Grevillea	*Grevillea elongata*
McCutcheon's Grevillea	*Grevillea maccutcheonii*
Dwellingup Synaphea	*Synaphea stenoloba*
Gingin wax	*Chamelaucium* sp. Gingin
Trigwell's Rulingia	*Rulingia* sp. Trigwell Bridge
Dwarf spider orchid	*Caladenia bryceana* subsp. brycena
Narrow curve-leaf Grevillea	*Grevillea curviloba* subsp. *incurva*
Curved leaf Grevillea	*Grevillea curviloba* subsp. *curviloba*
Baby blue orchid	*Epiblema grandiflorum* var. *cyaneum* ms

Interim recovery plans for ecological communities

Shrubland Association on Southern Swan Coastal Plain Ironstone
Aquatic Root Mat Communities numbers 1-4 of caves of the Leeuwin-Naturaliste Ridge
Community of Tumulus Springs (organic mound springs) of the Swan Coastal Plain
Shrublands and Woodlands on Muchea Limestone
Eastern Shrublands and woodlands (Swan Coastal Plain community 20c)
Corymbia calophylla – Kingia australis woodlands on heavy soils
Corymbia calophylla – Xanthorrhoea preissii woodlands and shrublands
Shrublands and woodlands on Perth to Gingin ironstone

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 (Swan) Region – in the process of being updated and amalgamated with the Metropolitan Region (Perth District of the Swan Region) Plan.
Declared rare flora and other plants in need of special protection in the Metropolitan Area (Perth District) Region – in the process of being updated and amalgamated with the Northern Forest (Swan) Region Plan.
Declared rare and poorly known flora in the Central Forest Region.

Priority flora

Because of the State's large flora, there are many species that are known from only a few collections, or a few sites, but which have not been adequately surveyed. Such flora may be rare or threatened, but cannot be considered for declaration as rare flora until such survey has been undertaken. These flora are included on a supplementary conservation list called the Priority Flora List.

There are three categories of priority flora 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 flora is included for those species that have been adequately surveyed and are considered to be rare but not currently threatened. Special consideration is given to the management of these species. Commercial harvesting on Crown land is not permitted under the commercial licence conditions.

APPENDIX 16

The calculation of sustained yield

One of the purposes for which State forest and timber reserves are managed is the production of timber on a sustained yield basis. This means that the level of annual timber harvest during a period is constrained to ensure that the supply can be sustained over very long time periods.

The calculation of a sustained yield involves the bringing-together of a wide range of data and information about the forest areas, their current timber resource and silvicultural practices. This information is used to develop a broad schedule for a future sequence and pattern of harvesting over time that aims to accommodate the varied management objectives for forests. These objectives include the future provision of non-timber values such as fauna habitat, recreation opportunities, water production, and conservation values.

Most of the work involved in calculating a sustained yield is performed using computer-based mapping, inventory and modelling systems. The process begins by defining the areas of forest that are outside formal and informal reserves and potentially available for harvest at some time in the future. This ensures that a sustained yield is based solely on the forest estate outside all the areas set aside from timber harvesting. Each patch of forest is mapped into categories of similar species composition, stand structure and potential productivity.

The next stage in the process involves estimating the timber resource currently standing within each mapped category. This is usually obtained by measuring a sample of trees in each category. Because some harvests will need to be scheduled to occur in the future, it is necessary to be able to project the growth on the present standing volume in each category to any time in the future. A variety of approaches is used, including mathematical models that project the growth of individual trees or stands over time. Such models generate estimates of the future wood yield from a stand according to the type of silviculture that is applied and the timing of harvest operations. For example, the future yield from an area of jarrah forest will vary depending on whether a thinning, shelterwood or gap regeneration treatment is applied.

In addition to the silvicultural practices adopted, other conditions that impact on the timing or location of harvests must be considered. These include the overall structural goals for the forest, or for particular areas, such goals as the need to sustain a special stand structure for fauna, or to ensure a minimum time period between thinnings to maintain the visual amenity of the stands. Economic goals, such as a desire to maintain the supply of a particular mix of timber products over time, might also apply.

The next stage in the process uses computer simulation tools to draw this information together and examine alternative timings and locations of harvest across the forest. The sequence of harvests across the whole forest is projected for periods exceeding 200 years into the future. This simulation process is iterative, and alternative scenarios can be examined as a level of sustained yield is sought which accommodates the various goals. After a sustained yield is determined at the whole of forest level, further analysis is undertaken to check that the harvest sequence is feasible at the local patch scale.

The Minister for the Environment and Heritage makes the final determination of a sustained yield level, which must be consistent with the broader forest management policies. Once a sustainable harvest level for the period of a forest management plan is set, this determines the average annual allowable harvest that can be supplied from the public forests for the 10-year period of the plan.

APPENDIX 17

Wildflower and seed collection industry management

All native flora is protected under the *Wildlife Conservation Act 1950* and licences are required to harvest protected flora on Crown land. There is a fee for licences, and royalties are collected for some species harvested, however, the cost of management exceeds the amount collected. It is not practical to improve cost recovery under the current legislation, however, this will be addressed when the Wildlife Conservation Act is replaced by new biodiversity conservation legislation during the life of the approved forest management plan.

General conditions are placed on harvesting through licences and specific conditions are set for some species to ensure their sustainable harvest. Flora harvesting is monitored in the field and through picker returns. Certain species have specific management programs that entail more intensive control through measures including quotas. Management is guided and controlled through a suite of policies and procedures. These include:

- guidance by Policy No. 13 'Commercial Flora Harvesting';
- a management program, Management of Commercial Harvesting of Protected Flora in Western Australia 1 July 1998 – 30 June 2003, for the industry that has been approved by the Commonwealth Minister for the Environment under the *Wildlife Protection (Regulation of Exports and Imports) Act 1982*;
- the use of three-monthly endorsements for lands managed by the Department to allocate areas to pickers and impose specific conditions on picking;
- an *Operations Manual – Management of the Flora Industry* to guide CALM;
- monitoring the returns pickers are required to submit as a condition of their licence, of the quantities, species of flora harvested and where they were harvested from;
- monitoring of pickers' field conduct by district staff and wildlife officers; and
- liaison with the industry through the WA Flora Industry Advisory Committee (WAFIAC).

Harvesting is not permitted in national parks, nature reserves and conservation parks and is generally not permitted in proposed conservation reserves. The Department endorsements are currently being issued up to December 2003 for the area proposed in the Forest Management Plan 1994-2003 to become the Mt Roe National Park, consistent with a 10-year phase-out program for flora harvesting in that area endorsed by the then Government.

Harvesting in informal reserves will be considered on a case-by-case basis using a risk-based approach to manage the risk to target species conservation, and the threat of dieback and other processes.

APPENDIX 18

Principles for fire management

The following principles are based on the following scientific principles (adapted from Burrows and Friend 1998, and Friend *et al.* 1999).

1. The vegetation and climate of the south-west forest region make it highly prone to bushfire. Fire should be regarded as an environmental factor that has and will continue to influence the nature of south-west landscapes and is integral to land management.
2. Species and communities vary in their adaptations to, and reliance on, fire. Knowledge of the temporal and spatial scales of fires in relation to the life histories of organisms or communities involved underpins the use of fire in natural resource management.
3. Following fire, environmental factors such as landform, topography and species' life history attributes, and random events such as climatic events, often drive ecosystems towards a new transient state with respect to species composition and structure. This may preclude the identification of changes specifically attributable to fire.
4. Fire management is required for two primary reasons, which are not necessarily mutually exclusive: (i) to protect and conserve the biota and (ii) to reduce the occurrence of large, damaging wildfires. The biological impact of a single fire event and the rate of recovery are directly proportional to the intensity and size of the fire.
5. Fire management should be precautionary and consider both ecological and protection objectives in order to optimise outcomes.
6. Fire diversity promotes biodiversity. An interlocking mosaic of patches of vegetation representing a range of fire frequencies, intervals, seasons, intensities and scales need to be incorporated into ecologically-based fire regimes if they are to optimise the conservation of biodiversity.
7. Avoid applying the same fire regime over large areas for long periods of time and avoid serial and structural homogenisation by not treating large areas with extreme regimes such as very frequent or very infrequent fire intervals.
8. The scale, or grain-size, of the mosaic should (i) enable natal dispersal (ii) optimise boundary habitat (interface between two or more seral states) and (iii) optimise connectivity (ability of fauna to cross).
9. All available knowledge, including life histories, vital attributes of the flora and fauna and knowledge of Nyoongar fire regimes should be used to develop ecologically-based fire regimes for a landscape unit or a vegetation complex.
10. Fire history, vegetation complexes and landscape units should be used to develop known and ideal fire age class distributions.
11. Wildfire can damage and destroy both conservation and societal values, hence risk management must be based on a systematic and structured approach to identifying and managing the consequences of such an event.
12. Fire management should adapt to changing community expectations and to new knowledge gained through research, monitoring and experience.

APPENDIX 19

Response to the review of stream buffer adequacy by the Water and Rivers Commission

The Water and Rivers Commission report, *Review of Stream and River Logging Buffers to ensure their adequacy in protecting waterways from salinity, degradation and turbidity 2001*, provided 23 recommendations in relation to the protection of the integrity of streams and rivers. The full report can be found on the Conservation Commission web site. Responses to these recommendations have been developed during consultations between the Water and Rivers Commission, the Department, the Forest Products Commission, Water Corporation and the Conservation Commission. These include proposals for trials to inform an adaptive management process that may result in refinements to prescriptions during the period of the approved plan and areas for guideline development or revision within the first year of the approved plan.

Details of actions or responses to each of the recommendations are provided in this appendix.

R1: Two waterway vulnerability zones are proposed, based on proximity to sensitive waterway values. These zones should be used for determining waterway buffer dimensions in forest areas. This proposal will be considered following analysis of trials to test buffer widths. This trial will involve the key agencies in its design and implementation. Design will be undertaken in the first year of the plan, implementation and reporting of results will be completed for the mid-term review of the plan. The need for, and practicality of applying, different buffers depending on the vulnerability of a particular location will be considered based on these results. A program for any changes to prescriptions will be reported in the mid-term review of the plan.
R2: Waterway buffers should be measured as approximately 90 degree horizontal offsets to the edges of waterways. This replaces the present CALM prescription, i.e. the buffer dimension spanning a waterway that can be adjusted laterally in the field to fit between certain minimum dimensions. For this approach to be implemented a clear definition of the 'edge of waterways' is required. This needs to be readily interpretable in the field. Approaches to this will be considered as part of an interdepartmental review of guidelines to be finalised in the first year of the plan period.
R3: For waterways in Zone 1: Buffers should be measured outward from the high water level of the water body and desirably from the edge of riparian vegetation where present. Where riparian vegetation (RV) near waterways is not evident, the buffer should be measured from the edge of the wet season waterway channel or high water mark. The buffer boundary should be finally defined during ground-truth definition of timber harvest plans, (where practical using a Geographic Positioning System). To be developed as part of the review resulting from Recommendation 2.
R4: For Zone 2 waterways and those without defined banks or riparian vegetation: Buffers may be measured from the centre of the waterway or low point in the landscape. To be developed as part of the review resulting from Recommendation 2.

R5: Recommendations on waterway buffer widths are provided overleaf (of the full report). The water resource management agency may assist in defining the water resource values, in consultation with the forest management agency

These recommendations will be considered following analysis of trials to test buffer widths. This trial will involve the key agencies in its design and implementation. Design will be undertaken in the first year of the plan, implementation and reporting of results will be completed for the mid-term review of the plan. The need for changing buffer dimensions from the current prescriptions will be considered based on these results. A program for any changes will be reported in the mid-term review of the plan.

R6: The application of waterway buffer dimensions should be based on local environmental factors and effective use of environmental management systems as described in Interpretation notes for Table 2. The outcome of these buffer definition decisions should be detailed on publicly available maps depicting waterways, the water values protected, forest features and topographical information, at least 2 months prior to commencement of the current adjacent timber harvest.

These recommendations will be considered following analysis of trials to test buffer widths. Design will be undertaken in the first year of the plan, implementation and reporting of results will be completed for the mid-term review of the plan. The need for variability in buffers according to local conditions and the practicality of applying this operationally will be considered based on these results. These considerations will include a review of the adequacy of consultation mechanisms for harvest plans under circumstances where local environmental factors are used to provide variations in buffer widths. A program for any changes will be reported in the mid-term review of the plan.

R7: Roadways should not be constructed within waterway buffers, except at approved waterway crossings, as access to designated water points for fire control, or other circumstances approved by the water resource management agency.

It is not proposed to vary the current approval mechanisms for road construction, however it is proposed to provide guidelines for circumstances when formal consultation with the water resource management agency must be undertaken including the provision of justification of the approach taken. This will include consultation over measures that are required when harvesting is planned near to reservoir edges. Approaches to these will be considered as part of an interdepartmental review of guidelines to be finalised in the first year of the plan period.

R8: Where roads are presently within recommended buffers and they are required for future access purposes, they should where practical be relocated on a risk priority basis to a position outside the recommended buffer. All roads should be constructed and maintained so as to minimise soil erosion and consequent harm to the buffer or its associated waterway.

A risk-based approach to this recommendation to help define roads that should be relocated if necessary and where practical is required. Approaches to this will be considered as part of an interdepartmental review of guidelines to be finalised in the first year of the plan period.

R9: Waterway crossings should be constructed (as close as possible) at 90 degrees to the waterway alignment. For Zone 1, a 75-metre minimum filter strip of under-storey vegetation should be provided to minimise turbid run-off into the waterway (refer to Figure 1 overleaf, adapted from present CALM guidelines). Stream crossings should be constructed and maintained to minimise loss of riparian vegetation, erosion impacts and provide a safe crossing (under all operational conditions, unless controlled by warning signage).

This recommendation reflects the current CLM guidelines.
R10: Where access roads within or close to buffers are no longer required, they should be closed, surface ripped and revegetated with local native vegetation by the forest management authority, using a risk–based priority system for assessment and remedial action. A risk-based approach to this recommendation is required to help define roads that should be closed and rehabilitated if necessary and where practical. Any review should consider alternative means of ensuring that access to closed roads is effectively restricted. Approaches to this will be considered as part of an interdepartmental review of guidelines to be finalised in the first year of the approved plan period.
R11: The prescription for drainage works associated with roadways is considered satisfactory as described in the "Manual of Management Guidelines for Timber Harvesting in Western Australia" (amended version, prepared in consultation with the water resource management agency). This recommendation reflects the current CLM guidelines.
R12: An effective routine monitoring program for the condition of roads, associated drain-ways and nearby waterway buffers should be developed and implemented by the forest management authority. Currently agencies informally monitor the condition of roads and the associated drainage of roads associated with log haulage and other uses. The development of guidelines for the level of monitoring and response actions would be beneficial. Approaches to this will be considered as part of an interdepartmental review of guidelines to be finalised in the first year of the approved plan period.
R13: Vegetation exotic to the local setting is not considered compatible within waterway buffers on sustainable or ecological integrity grounds. Any plantations in State forests and timber reserves should be separated from the buffers by effective measures to avoid blending of exotic and local plant species e.g. a fire break, roadway and / or grass filter strip. This issue is not specific to streams. Strategies to deal more broadly with the presence of weeds are dealt with in the 'Ecosystem health and vitality' chapter of the draft plan.
R14: Where exotic vegetation, planted or intrusive presently occupies waterway buffers, the exotics should be permanently removed on a priority basis as soon as practical (eg on maturity at plantation harvest, in consideration of nature of ecological risks and technical impediments); any soil damage corrected and local provenance native trees and understorey planted. The replacement vegetation cover should achieve stem densities equivalent to natural vegetation in the sub-catchment. This issue is not specific to streams. Strategies to deal more broadly with the presence of weeds are dealt with in the 'Ecosystem health and vitality' chapter of the draft plan.
R15: Where vegetated waterway buffers are absent or degraded they should be progressively and expeditiously restored by the forest management authority on a scheduled priority basis. Support resources should be contributed by those that may gain a financial benefit from the buffer presence. Exceptions to this recommendation are waterway access /crossings, areas of natural exposed rock and places of recognised social or heritage value, where the absence of the waterway buffer is an integral part of that recognised value.

Guidelines for identifying, prioritising and establishing appropriate funding sources are required. Approaches to this will be considered as part of an interdepartmental review of guidelines to be finalised in the first year of the approved plan period.
R16: The forest management authority should maintain the vegetated waterway buffers to ensure their function, integrity, sustainability and safety are preserved. Support resources should be contributed by those that may gain a financial benefit from the buffer presence. This reflects the overall objectives and strategies detailed in this draft plan.
R17: A rolling program should be initiated and maintained that scientifically evaluates and reports the effectiveness of the waterway buffer configurations for various environmental settings /timber harvest methodologies. This program is proposed to be a shared responsibility between land use beneficiaries i.e. timber harvest managers (presently Forest Products Commission) and water service providers (e.g. Water Corporation). Trials will be established. Design will be undertaken in the first year of the plan, implementation and reporting of results will be completed for the mid-term review of the plan. The need for changing buffer dimensions from the current prescriptions will be considered based on these results. A program for any changes will be reported in the mid-term review of the approved plan.
R18: Interpreted investigation and monitoring data gathered on buffer performance should be publicly available. If practical and complimentary to the Forest Management Plan, such data could be included in a "State of the Forests report" providing a "snapshot" of forest usage, key environmental issues, present management measures, and research programs /outcomes. The report could be prepared and disseminated by the forest manager (at a maximum of 10year intervals). Contributions to such a report should be made by all significant users of forest resources eg timber, water, minerals and recreational. The report along with community feedback, could be taken into in the formulation of future forest management plans. A mid-term review of the approved plan will be undertaken and reported publicly. This will include discussion of progress in relation to the recommendations in the Water and Rivers Commission report.
R19: Where new valid data is obtained on the form or dimensions of buffers, it should be incorporated into an improved prescription for vegetated waterway buffers. The mutual endorsement of an altered prescription by agencies associated with forest management and those managing the environment (including water resources) is a prerequisite. This is part of the adaptive management strategy proposed in the draft plan. The results of trials will form the primary basis for any changes to prescriptions, and a review of relevant data will also be undertaken as part of the trial.

R20: Field decisions on the buffer placement and dimensions should continue to be made by qualified and experienced personnel. These people may vary standard buffer prescriptions in accordance with the approved Environmental Management System on the basis of judgments of the local conditions, but should document their rationale in a field report. These recommendations will be considered following analysis of trials to test buffer widths. Design will be undertaken in the first year of the approved plan, implementation and reporting of results will be completed for the mid-term review of the plan. The need for variability in buffers according to local conditions and the practicality of applying this operationally will be considered based on these results. These considerations will include requirements of documentation of decision making. A program for any changes will be reported in the mid-term review of the plan.
R21: The operational management considerations listed above should be included in inspection, audit and reporting arrangements for waterway buffers by the forest management authority. Details of audit requirements are provided in the 'Plan implementation' chapter of the draft plan. A component of the audit will be an assessment of compliance with buffer prescriptions.
R22: Within 10 years of implementation of any revision to the waterway buffer zones prescription, a further review should be conducted which again looks at the efficacy of the prescription. The review should look at scientific research, monitoring and field data reports gathered during the intervening period and then further adjustments be made to suit the findings. The mid-term review of the approved plan and the reporting of the results of the trial will provide much information in relation to this recommendation. As with all elements of the draft plan, buffer prescriptions will be subject to review in the development of the next plan as required after 10 years.
R23: The final Review document should be circulated within the community to attract constructive comment and to further refine the methodology of waterway buffer definition. This is proposed to occur after the Conservation Commission has had an opportunity to consider the document, and the authors have addressed any of its concerns. This recommendation is now built into the plan development and review process now underway.

APPENDIX 20

Exploration and extraction of minerals and petroleum

Access to State forest, timber reserves and conservation reserves for mineral or petroleum activities is authorised by the Mining Act or the Petroleum Act. These Acts stipulate that the Minister for the Environment and Heritage must be consulted by the Minister for State Development prior to any access being given. Further, the Mining Act requires the Minister for the Environment and Heritage's concurrence before access is given to State forest and timber reserves (within the draft plan area), national parks and A Class nature reserves. In A Class parks and reserves the approval of both houses of Parliament is required before Mining Leases and General Purpose Leases are granted and mining can occur. These processes are subject to the present review of mining and petroleum activities in national parks and nature reserves under the Government's environment policy.

All proposals for operations that may potentially cause a significant environmental impact must be referred for the consideration of the EPA under section 38 of the Environmental Protection Act. To clarify mining procedures, a Memorandum of Understanding (MOU) between the EPA and the Department of Mineral and Petroleum Resources (MPR) defines which mineral activities are to be referred to the EPA. The mechanism is set out in MPR Information Booklet 11 *State Guidelines for Mineral Exploration and Mining Within Conservation Reserves and Other Environmentally Sensitive Lands in Western Australia* (Department of Minerals and Energy 1998).

Mineral exploration is conducted on exploration licences or prospecting licences. These are granted with rigorous conditions to protect the environment, specific to the nature of the land and are designed to ensure that the activities do not cause unacceptable impacts. Exploration Licence boundaries must relate to integral one-minute graticules of latitude and longitude, although within these boundaries the applicant may apply to excise sensitive areas at the time of grant. Activities particularly in the earlier stages, primarily involve limited access and hence minimal environmental impact. As mineral indications are located, the intensity of activities increases on reduced areas. In the later stages of economic assessment, bulk samples of ore may be required but these are limited to 2,000 tonnes from exploration licences and 500 tonnes from prospecting licences.

Mining is allowed on mining leases, and these are always granted with a requirement that prior to any production, a mining proposal must be lodged and approved by the Minister for State Development. Any proposals in areas of conservation interest are referred to the EPA according to the above MOU. Miscellaneous licences and general purpose leases facilitate access to leases, or areas for operating plants, respectively, and the grant of these is normally related to approvals for a mining operation. In the draft plan area a number of titles granted under the *Mining Act 1904* still exist, usually with approved operations proceeding on them. They remain alive either by virtue of the transitional provisions of the Mining Act or the presence of a State Agreement.

Petroleum exploration is conducted on permits. These are granted with appropriate and rigorous conditions designed to protect the environment. These titles are granted on a graticular basis of lines at five minutes of latitude and longitude distances, and the boundaries may include sensitive lands that are excluded from access by the explorer. Access to conservation reserves, State forest and timber reserves is only granted after the Minister for the Environment and Heritage has been consulted by the Minister for State Development and has agreed to the access. Exploratory drilling for oil or gas wells is subject to approval on a case-by-case basis. In sensitive areas proposals are referred for consideration by the EPA. Production Licences must be held prior to production commencing, and

these are only granted after the Minister for the Environment and Heritage has been consulted by the Minister for State Development and has agreed to them.

Currently major developments are usually facilitated through State Agreements that are ratified by Parliament as State Agreement Acts. These Acts relate to bauxite, in the *Alumina Refinery Agreement Act 1961* and the *Alumina Refinery (Worsley) Agreement Act 1973*, and coal extraction, in the *Collie Coal (Griffin) Agreement Act 1979* and the *Collie Coal (Western Collieries) Agreement Act 1979*, in the draft plan area. While these Acts are not subject to the CLM Act, they include requirements to protect forest values and facilitate recovery of harvestable timber prior to mining. The projects are subject to environmental assessment by the EPA and ongoing activities are reviewed by interagency environmental review committees. Rehabilitation of post-mining forest values and re-establishment of sustainable productive timber harvesting is a key goal of these committees. It has been usual for companies to pay compensation to the Department based on areas affected. This is intended to pay for the loss of productive timber from affected areas and to cover the Departmental costs incurred in supervisory or inspection activities by its officers.

Environmental assessments of the State Agreement operations are completed prior to commencement. Three committees, all chaired by the Office of Major Projects in MPR, oversee the operations and include ongoing assessment of the environmental impacts of these activities in the region. The Mining and Management Program Liaison Group oversees Alcoa's mining and comprises the Department, Department of Environmental Protection, MPR, Water and Rivers Commission and the Water Corporation. The Collie Coal Mines Environment Committee has the same representation; and the Environmental Management Liaison Group, which monitors the Worsley Alumina operation, has the same agencies plus Agriculture Western Australia. These committees work with the Department of Conservation and Land Management to ensure rehabilitation after mining will achieve forest management objectives.

At the conclusion of mineral or petroleum resource extraction, the Department must ultimately assume ongoing management of the land. To ensure there is no residual liability, the Department is working with the companies and MPR developing criteria that define acceptable long-term levels of rehabilitation in balance with the shorter term benefits from resource extraction. The criteria will include such factors as the ability to integrate the rehabilitation with forest management, the resilience of the rehabilitation and the sustainability of its growth and development.

APPENDIX 21

Principles for the achievement of recreation objectives

Ensure that all recreational areas, facilities and services are planned, developed and managed so as to maintain in perpetuity or enhance the status of Western Australia's natural environment.

Apply a management ethos that recognises, protects and promotes those inherent qualities and cultural attributes that are distinctive to recreation and tourism areas.

Provide and sustain a range of nature-based recreation and tourism opportunities and experiences that are consistent with conservation and land management objectives.

Provide and maintain nature-based recreation areas, facilities, programs and services to a consistently high standard.

Reduce the potential for personal injury and property damage in a way that does not diminish visitor use or enjoyment of an area.

Provide a range of nature-based recreation and tourism facilities that give equity of opportunity for the recreation-seeking public on areas managed by the Department.

Build partnerships with business and the community to provide recreational facilities, services and programs, and to monitor recreational use.

Undertake research to monitor the appropriate level of use and impacts of recreation and tourism activities.

APPENDIX 22

Departmental policies relevant to forest management

No.	Title	Issued or amended
	Approved policies	
1A	Planning	1986
2	Local Government Authority access to Basic Raw Materials from State forest and timber reserves	1993
3	Management of *Phytophthora* and disease caused by it	1998
9	Conservation of threatened flora in the wild	1992
10	Rehabilitation of disturbed land	1986
13	Commercial flora harvesting	1993
14	Weeds on CALM lands	1986
15	Community involvement	2001
18	Recreation, tourism and visitor services	1991
19	Fire management	1987
22	Taking, keeping and display of live reptiles	1992
25	Community education and interpretation	1988
29	Translocation of threatened flora and fauna	1995
31	Management of reserves for the conservation of nature	1990
33	Conservation of endangered and specially protected fauna in the wild	1991
34	Visual Resource management of lands and waters managed by CALM	1989
40	Road management	1991
41	Beekeeping on public land	1992
44	Wildlife management programs	1992
50	Setting priorities for the conservation of Western Australia's threatened flora and fauna	1994
53	Visitor risk management policy	1997
54	Defence force training on CALM managed lands and waters	1996
55	Commercial filming on CALM managed lands and waters	1998
56	Risk management	2000
	Draft policies	
	Management of pest animals on CALM managed land	1999
	Environmental weed management	1999
	Public Participation Policy	2000
	Aboriginal involvement in nature conservation and land management	2000
	Management of non-indigenous cultural heritage on CALM estate	2001

APPENDIX 23

Departmental guidelines relevant to forest management

Guidelines	Last update
Mining on CALM Lands – Guidelines	2000
Phytophthora cinnamomi and disease caused by it. Volume 1 – Management guidelines	2000
Mining on CALM lands - guidelines	2000
Public participation manual	2000
Manual of management guidelines for timber harvesting in Western Australia	1999
Phytophthora cinnamomi and disease caused by it. Volume 2 – Interpreter's guidelines for detection, diagnosis and mapping	1999
Phytophthora cinnamomi and disease caused by it. Volume 3 – phosphite operations guidelines	1999
Trunk injection of the chemical Phosphite for protection against *Phytophthora* disease.	1999
Visitor information statistics collection guidelines	1999
Apiary site management (Guidelines)	1998
Fire as a silvicultural tool in the jarrah forest	1997
Jarrah regeneration surveys	1997
Karri seed crop assessment and monitoring	1997
Establishment guidelines for karri forest regeneration following harvesting	1997
Visitor interpretation manual	1996
Silvicultural practice in the jarrah forest	1996
Silvicultural practice in the karri forest	1996
Running activity programs, a guide to interpreting the natural and cultural world for visitors	1996
Draft feral animal control policy and control manual (Guidelines)	1995
Draft operations manual management of the flora industry	1995
Guidelines for forest landing and snig track design and management	1995
Beekeepers manual	1995
Fox control manual	1994
Guidelines for integrated forest harvest planning and design	1994
Fire operations manual, volumes 1, 2, 3, 4.	1993
Reading the Remote	1993
A field guide, recreation facilities construction standard.	1991
Small structures and hardware portfolio	1991
Guidelines for the management and rehabilitation of gravel pits	c1990
Chemical users manual	c1990
Regeneration in tuart for conservation	1988

Acronyms

ABS	Australian Bureau of Statistics
AS/NZS	Australian/New Zealand Standard
BRM	Basic Raw Materials
CLM Act	*Conservation and Land Management Act 1984*
CAR	Comprehensive, adequate and representative – as applied to the conservation reserve system
DCC	Dieback Consultative Council
ISO	International Organisation for Standardisation
EMS	Environmental Management System
EPA	Environmental Protection Authority
ESFM	Ecologically Sustainable Forest Management
IBRA	Interim Biogeographic Regionalisation of Australia
ICOMOS	International Council for Monuments and Sites
IUCN	International Union for the Conservation of Nature and Natural Resources (now World Conservation Union)
JANIS	Joint Australian and New Zealand Environment and Conservation Council/ Ministerial Council on Forestry Fisheries and Aquaculture National Forest Policy Statement Implementation Sub-Committee
MIG	Montreal Process Implementation Group for Australia
MOU	Memorandum of Understanding
NRS	National Reserve System
PDWSA	Public Drinking Water Source Area
RFA	Regional Forest Agreement
TSS	Total soluble salt
VLM	Visual Landscape Management
WAFIAC	Western Australian Flora Industry Advisory Committee
WATC	Western Australian Tourism Commission

Glossary

Adaptive management	The systematic process for continually improving management policies and practices by learning from the outcomes of operational programs.
Advance growth	Young trees that have established themselves in openings in the forest, or under the forest cover, before regeneration harvesting is undertaken.
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 CLM 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 CLM Act)	Includes habitats, ecological communities, genes and ecological processes
Block	A named administrative subdivision of the forest, varying in size from about 3,000 to 8,000 hectares.
Bole	The tree trunk from the ground to the major branches supporting the crown.
Buffer strip	A strip of vegetation retained on the edge of a feature such as a stream or rock outcrop. Buffer strips can serve a variety of purposes in the landscape, including protection of the feature from a disturbing activity, and provide flora and fauna habitat and aesthetic values.
Catchment	The surface area from which water runs off to a river or any other collecting reservoir.
Clearfelling	A silvicultural system in which the trees are removed at one time to allow regeneration to establish and develop as an even-aged stand.
Code of practice	A document defining and prescribing practices for economically viable operations and good standards of safe work while protecting the environment.
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.
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 or clearfells or a combination of both.
Critically endangered	A taxon is critically endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
Dieback	In the south-west of Western Australia a disease of plants caused by infection by the soil-borne fungi of the genus *Phytophthora.*
Disturbance	Any range of conditions affecting the condition of a natural area. Disturbance may be natural (e.g. fire) or human induced (e.g. timber harvesting).
Diverse ecotype zone	Areas of the forest, generally but not always with little tree cover, that are identified at the operational management scale to be protected from activities associated with timber harvesting because of their importance for the conservation of biodiversity. They include sedge and herb vegetation, rock outcrops, heath, wetlands, etc.
Ecological community	An integrated assemblage of species that inhabit a particular area.
Ecologically sustainable forest management (ESFM)	Forest management and use in accordance with the principles described in section 19(2) of the CLM Act.
Ecosystem	A community or an assemblage of communities of organisms, interacting with one another and the environment in which they live.
Ecotone	A transition area between 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	A framework for the systematic management of an organisation's environmental obligations and targets. Often conforming to a standard, the most popular being AS/NZS ISO 14001.
Epicormic	Vegetative shoots arising on the bole or branches of a tree as a consequence of damage to its crown.
Evapotranspiration	Loss of water from an area of land through the transpiration of plants and evaporation from the soil.
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 Wildlife Conservation Act, 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.

Feral — An introduced or domestic animal now living in the wild.

Fire regime — The combination of season, intensity, interval, extent and patchiness of fire in a given area over a period of time.

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 Wildlife Conservation Act 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 phytogeographical study of plants and animals.

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 ecosystem — An indigenous ecosystem with an overstorey of trees that are greater 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 operations — Work activities undertaken in the forest to achieve the management objectives for that forest.

Forest produce — For the purposes of the CLM Act 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 1978.

Forest products	For the purposes of the CLM 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 (FP Act) Act.
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.
Gap	A discrete opening in the overstorey canopy created to reduce competition to allow seedlings to become established and or develop.
Guideline	Principles, standards and practices for meeting goals that have been established as desirable outcomes for management. They can be quantitative or qualitative.
Habitat	A component of an ecosystem providing food and shelter to a particular organism.
Heritage	Something inherited from past generations that is valued.
High rainfall zone	Areas where the average annual rainfall exceeds 1100 millimetres per year.
Hygiene – in relation to dieback	Actions that decrease the risk of the pathogen being introduced spread or intensified.
Intermediate rainfall zone	Areas where the average annual rainfall is between 900 and 1100 millimetres per year.
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	The visual elements of both the natural and the built environment and including landforms, vegetation, waterform, land-use and architecture.
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.
Low rainfall zone	Areas where the average annual rainfall is less than 900 millimetres per year.
Monitoring	Regular assessment of a management program and of the resources being managed, checking that desired outcomes are achieved, and adjusting the new plan where necessary.
National estate	Those elements of the natural environment, the Aboriginal environment and the historic environment which are of special value to the Australian community, present and future.

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 mature to senescent growth stage.
Patch	A group of trees resulting from a natural regeneration event or a past management activity such as gap creation and regeneration.
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.
Phytogeographic	The biogeography of plants.
Prescribed burning	The planned application of fire under selected fuel and weather conditions to a defined area to achieve specific management objectives.
Prescription	A detailed specification of the objectives, area, procedures and standards for a task to be undertaken.
Policy	The course of action to be followed to achieve an organisation's objectives.
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.
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 CLM 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.
Riparian	Pertaining to the banks of streams, rivers or lakes.
Rotation	The planned number of years between the establishment of a crop and its felling.

Shelterwood system	A jarrah silvicultural system that involves a partial removal from the overstorey of some mature trees and action to establish regeneration under the remaining mature trees. When the regeneration is sufficiently established most of the remaining mature trees are removed to allow the regeneration to develop.
Silviculture	The theory and practice of managing forest establishment, composition and growth to achieve specified management objectives.
Snig track	A track along which logs are pulled from the felling point to a landing or point of loading. An extraction track used by snigging or skidding equipment while pulling logs from the point of felling to the landing.
Specially protected	Those species declared under the Wildlife Conservation Act to be specially protected because they are deemed 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, condition or other attribute.
Structure	When applied to a forest is the vertical and spatial distribution of the vegetation.
Sustained yield	The yield that a forest can produce continuously at a given intensity of management.
Susceptible taxa	Taxa that are of concern because their range is restricted (typically less than 100 square kilometres) and/or they are found in few locations rendering them prone to the effects of human activities or to introduced plants, animals or diseases.
Taxa (taxon)	A defined unit (for example, species or genus) in the classification of plants and animals.
Thinning	A felling made in an immature stand for the purpose of improving the growth of trees that remain without permanently breaking the canopy and encouraging regeneration.
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.
Threatened ecological community	Ecological communities approved by the Minister for the Environment and Heritage as threatened and listed on the Department's Threatened Ecological Community Database.

Threatened taxa	Taxa that are vulnerable, endangered, critically endangered or presumed extinct. Taxa which are 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.
Timber harvesting	The cutting, felling, and gathering of forest timber undertaken as part of a planned sequence of silvicultural activities including the regeneration of the forest.
Treemarking	The silvicultural system in which trees are marked for retention prior to harvesting in a forest.
Turbidity	Discolouration of water due to suspended silt or organic matter.
Vegetation complex	A combination of distinct site vegetation types, usually associated with a particular geomorphic, climatic, floristic and vegetation structural association.
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 survival or regeneration of indigenous species in natural vegetation communities.
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.

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Map 2

Draft Forest Management Plan
Existing Land Categories

Scale 1:500 000

20 0 20 40km

Projection: UTM
Co-ords: MGA (Zone 50)

Legend

- National park
- Nature reserve
- Conservation park
- Other reserve [1]
- State forest, timber reserve, miscellaneous reserve and land held under title by the Executive Director [2]
- 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.

[2] Only includes land held under title by the Executive Director that contains native vegetation.

LOCALITY MAP

DATA DIRECTORY

THEME	SOURCE	DATE	CUSTODIAN
Tenure	Dept of Cons & Land Mgt	June 2001	Dept of Cons & Land Mgt
Topography	Dept of Cons & Land Mgt / DOLA	2000	Dept of Cons & Land Mgt / DOLA
Management boundaries	Dept of Cons & Land Mgt	2001	Dept of Cons & Land Mgt

Produced by Information Management Branch and Forest Management Branch
under the direction of Keiran McNamara, Acting Executive Director
Department of Conservation and Land Management, for the Conservation Commission
July 2002

Conservation Commission
WESTERN AUSTRALIA

NEW NORCIA
LANCELIN
MIDWEST
CALINGIRI
DOWERIN
BOLGART
GOOMALLING
GINGIN
YANCHEP
MUCHEA
TOODYAY
NORTHAM
WANNEROO
MIDLAND
MUNDARING
YORK
PERTH
Rottnest Island
FREMANTLE
KELMSCOTT
BEVERLEY
INDIAN
OCEAN
Carden Island
SWAN
JARRAHDALE
BROOKTON
MANDURAH
PINGELLY
PINJARRA
WANDERING
DWELLINGUP
BODDINGTON
WICKEPIN
CUBALLING
WAROONA
YARLOOP
NARROGIN
HARRISMITH
WILLIAMS
HIGHBURY
HARVEY
WHEATBELT
WAGIN
DUMBLEYUNG
BUNBURY
COLLIE
DARKAN
ARTHUR RIVER
DARDANUP
DONNYBROOK
BUSSELTON
SOUTH WEST
KIRUP
KATANNING
BALINGUP
BOYUP BROOK
KOJONUP
MARGARET RIVER
NANNUP
BRIDGETOWN
GNOWANGERUP
MANJIMUP
AUGUSTA
SOUTH COAST
PEMBERTON
ROCKY GULLY
WARREN
NORTHCLIFFE
MT BARKER
SOUTHERN
OCEAN
WALPOLE
DENMARK
ALBANY

300 000mE 115°00'00"E
400 000mE 116°00'00"E
500 000mE 117°00'00"E
580 000mE 118°00'00"E
6 110 000mN 35°00'00"S

Map 5

Draft Forest Management Plan
Origin of Reserve Proposals

Scale 1:500 000

20 0 20 40km

Projection: UTM
Co-ords: MGA (Zone 50)

Legend

PROPOSED

- Forest Management Plan (1994-2003) reserve
- "Reinstated" Forest Management Plan (1994-2003) reserve [1]
- Regional Forest Agreement proposed reserve [2]
- New reserve from the *Protecting our old-growth forests* policy [3]
- New reserve, as alternatives to reinstated reserve proposals in State Agreement Act areas
- Other new reserve

EXISTING

- Conservation reserve
- State forest, timber reserve, miscellaneous reserve and land held under title by the Executive Director [4,5]
- Other areas excluded from timber harvesting [6]
- Forest Management Plan (1994-2003) reserve proposals not reinstated in State Agreement Act areas

- Regional Park boundary
- Region boundary
- Regional Forest Agreement boundary

47 **ID numbers refer to Appendix 7 - Origin of reserve proposals**

2000 hectares (area guide)

[1] Areas dropped by the RFA but reinstated to the reserve system by the *Protecting our old-growth forests* policy.

[2] Includes some land not vested in the Conservation Commission.

[3] Boundaries of the new reserves are indicative as at 30 June 2002. The boundaries of individual reserves are being finalised.

[4] Includes Unallocated Crown Land proposed to become State forest.

[5] Only includes land held under title by the Executive Director that contains native vegetation.

[6] Includes larger stream, diverse ecotype and travel route zones set aside specifically for conservation. This map does not show other areas set aside from timber harvesting such as old-growth forest patches and small stream and diverse ecotype zones.

LOCALITY MAP

DATA DIRECTORY

THEME	SOURCE	DATE	CUSTODIAN
New reserves	Dept of Cons & Land Mgt	2002	Dept of Cons & Land Mgt-FMB
RFA proposed reserve	Dept of Cons & Land Mgt	2000	Dept of Cons & Land Mgt-FMB
FMP proposed reserve	Dept of Cons & Land Mgt	2000	Dept of Cons & Land Mgt-FMB
Gazetted reserves	DOLA	2002	Dept of Cons & Land Mgt-IMB
Management boundaries	Dept of Cons & Land Mgt	2001	Dept of Cons & Land Mgt-FMB

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July 2002

Government of Western Australia

Conservation Commission WESTERN AUSTRALIA

MIDWEST
SWAN
WHEATBELT
SOUTH WEST
WARREN
SOUTH COAST

PERTH
LANCELIN
NEW NORCIA
CALINGIRI
BOLGART
GOOMALLING
GINGIN
YANCHEP
MUCHEA
TOODYAY
NORTHAM
WANNEROO
MIDLAND
MUNDARING
YORK
FREMANTLE
Rottnest Island
KWINANA
BEVERLEY
INDIAN OCEAN
Garden Island
JARRAHDALE
BROOKTON N
MANDURAH
PINJARRA
WANDERING
DWELLINGUP
WAROONA
BODDINGTON
YARLOOP
HARVEY
WILLIAMS
BUNBURY
COLLIE
DARKAN
DARDANUP
DONNYBROOK
KATANNING
BUSSELTON
KIRUP
KOJONUP
GNOWANGERUP
HALINGUP
MARGARET RIVER
NANNUP
BRIDGETOWN
MANJIMUP
AUGUSTA
PEMBERTON
OCKY ULLY
MT BARKER
NORTHCLIFFE
SOUTHERN OCEAN
WALPOLE
DENMARK
ALBANY

300 000mE 115°00'00"E
400 000mE 116°00'00"E
500 000mE 117°00'00"E
580 000mE 118°00'00"E
6 570 000mN
6 500 000mN
6 400 000mN
6 300 000mN
6 200 000mN
6 110 000mN
31°00'00"S
32°00'00"S
33°00'00"S
34°00'00"S
35°00'00"S

Map 3

Draft Forest Management Plan
Proposed Land Categories

Scale 1:500 000

20 0 20 40km

Projection: UTM
Co-ords: MGA (Zone 50)

Legend

- National park
- Nature reserve
- Conservation park
- Other reserve [1]
- Forest conservation area [2]
- State forest, timber reserve
- Miscellaneous reserve and land held under title by the Executive Director [3]
- 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.

[2] State forest classified under Section 62 of the Conservation and Land Management Act as a forest conservation area.

[3] Only includes land held under title by the Executive Director that contains native vegetation.

LOCALITY MAP

DATA DIRECTORY

THEME	SOURCE	DATE	CUSTODIAN
Tenure	Dept of Cons & Land Mgt	June 2002	Dept of Cons & Land Mgt
Topography	Dept of Cons & Land Mgt / DOLA	2000	Dept of Cons & Land Mgt / DOLA
Management boundaries	Dept of Cons & Land Mgt	2001	Dept of Cons & Land Mgt

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Department of Conservation and Land Management, for the Conservation Commission
July 2002

Government of Western Australia

Conservation Commission WESTERN AUSTRALIA

MIDWEST
SWAN
WHEATBELT
SOUTH WEST
WARREN
SOUTH COAST

INDIAN OCEAN
SOUTHERN OCEAN

LANCELIN, NEW NORCIA, CALINGIRI, DOWERIN, BOLGART, GOOMALLING, GINGIN, YANCHEP, MUCHEA, TOODYAY, NORTHAM, WANNEROO, MIDLAND, MUNDARING, YORK, PERTH, Rottnest Island, FREMANTLE, KELMSCOTT, BEVERLEY, Garden Island, JARRAHDALE, BROOKTON, MANDURAH, PINJARRA, DWELLINGUP, WANDERING, BODDINGTON, WAROONA, YARLOOP, HARVEY, WICKEPIN, CUBALLING, NARROGIN, HARRISMITH, WILLIAMS, HIGHBURY, BUNBURY, COLLIE, DARDANUP, DONNYBROOK, BUSSELTON, KIRUP, BALINGUP, BOYUP BROOK, MARGARET RIVER, NANNUP, BRIDGETOWN, AUGUSTA, MANJIMUP, PEMBERTON, NORTHCLIFFE, WALPOLE, DENMARK, ALBANY, DARKAN, ARTHUR RIVER, WAGIN, DUMBLEYUNG, KATANNING, KOJONUP, GNOWANGERUP, ROCKY GULLY, MT BARKER

115°00'00"E 300 000mE
116°00'00"E 400 000mE
117°00'00"E 500 000mE
118°00'00"E 580 000mE
31°00'00"S 6 570 000mN
32°00'00"S 6 500 000mN
33°00'00"S 6 400 000mN
34°00'00"S 6 300 000mN
35°00'00"S 6 200 000mN
6 110 000mN

Map 6

Draft Forest Management Plan
Old-growth Forest

Scale 1:500 000

20 0 20 40km

Projection: UTM
Co-ordn: MGA (Zone 50)

Legend

- Existing and proposed conservation reserve
- State forest, timber reserve, miscellaneous reserve, and land held under title by the Executive Director [1]
- Old-growth forest [2]
- Region boundary
- 2000 hectares (area guide)

[1] Only includes land held under title by the Executive Director that contains native vegetation.

[2] Old-growth forest outside existing and proposed conservation reserves is excluded from timber harvesting.

LOCALITY MAP

DATA DIRECTORY

THEME	SOURCE	DATE	CUSTODIAN
Old-growth forest	Dept of Cons & Land Mgt	2000	Forest Management Branch
Management boundaries	Dept of Cons & Land Mgt	2001	Dept of Cons & Land Mgt
Topography	Dept of Cons & Land Mgt / DOLA	2000	Dept of Cons & Land Mgt / DOLA
Existing and proposed conservation reserves	Dept of Cons & Land Mgt	June 2002	Forest Management Branch

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Department of Conservation and Land Management, for the Conservation Commission
July 2002

MIDWEST
SWAN
SOUTH WEST
WARREN
WHEATBELT
SOUTH COAST

INDIAN OCEAN
SOUTHERN OCEAN

LANCELIN, NEW NORCIA, CALINGIRI, DOWERIN, BOLGART, GOOMALLING, GINGIN, YANCHEP, MUCHEA, TOODYAY, NORTHAM, WANNEROO, MIDLAND, MUNDARING, YORK, PERTH, Rottnest Island, FREMANTLE, KELMSCOTT, BEVERLEY, Garden Island, JARRAHDALE, BROOKTON, MANDURAH, PINGELLY, PINJARRA, WANDERING, DWELLINGUP, BODDINGTON, CUBALLING, WICKEPIN, WAROONA, NARROGIN, HARRISMITH, YARLOOP, WILLIAMS, HIGHBURY, HARVEY, BUNBURY, COLLIE, DARKAN, ARTHUR RIVER, WAGIN, DUMBLEYUNG, DARDANUP, DONNYBROOK, BUSSELTON, KIRUP, KATANNING, BALINGUP, YUP BROOK, KOJONUP, MARGARET RIVER, NANNUP, BRIDGETOWN, GNOWANGERUP, MANJIMUP, AUGUSTA, PEMBERTON, NORTHCLIFFE, WALPOLE, DENMARK, ALBANY, MT BARKER

31°00'00"S, 32°00'00"S, 33°00'00"S, 34°00'00"S, 35°00'00"S
6 570 000mN, 6 500 000mN, 6 400 000mN, 6 300 000mN, 6 200 000mN, 6 110 000mN
300 000mE, 400 000mE, 500 000mE, 580 000mE
115°00'00"E, 116°00'00"E, 117°00'00"E, 118°00'00"E