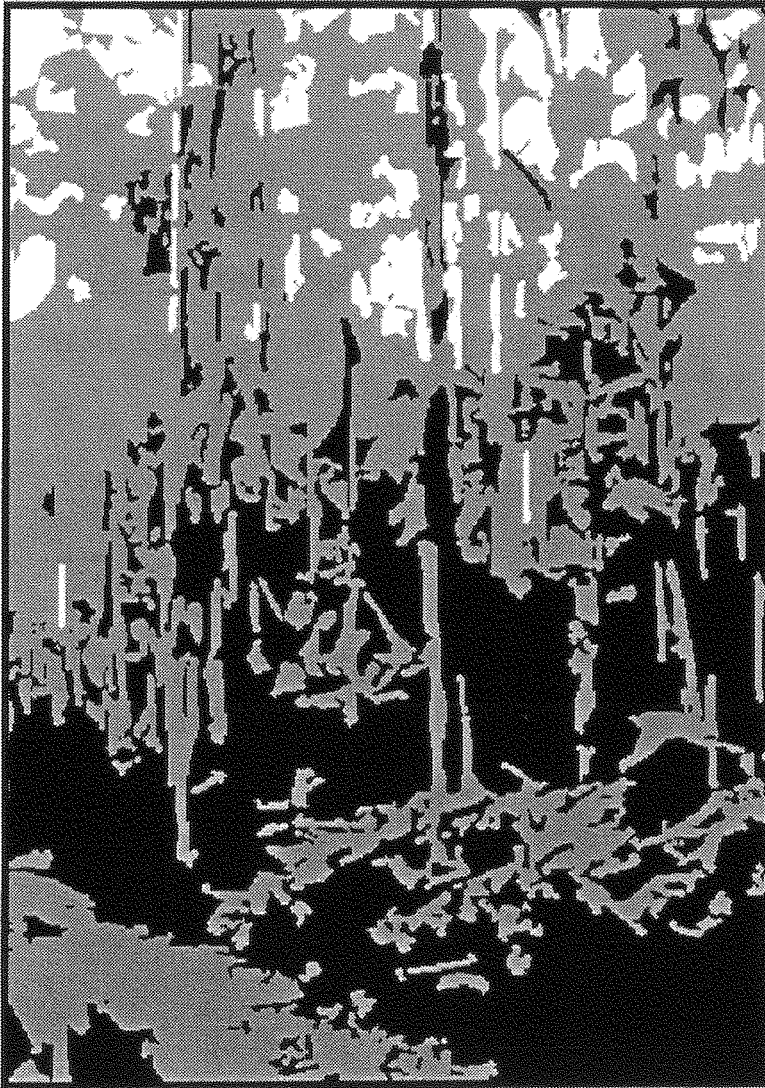


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Calculating Sustained Yield for the Forest Management Plan (2004-2013)



A Preliminary Review

Report for the

Conservation Commission

of Western Australia

by the Independent Panel

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April 2001

EXECUTIVE SUMMARY

1 Introduction

The purpose of this review is to fulfil the requirements of the recommendations by Mr Mike Codd and the related clause in the Regional Forest Agreement, and to facilitate the development of the next Forest Management Plan. The review focuses on the calculation of sustained yields within the context of the principles of Ecologically Sustainable Forest Management. However, only those aspects that directly impinge on the calculation of sustained yield are within the prescribed scope of the review. It is not the purpose of this review to examine the Regional Forest Agreement process and outcomes.

In addressing these issues, the Panel has attempted to ensure that goals and indicators for principles of Ecologically Sustainable Forest Management should be set for the 'whole of forest', not just the State forest. The Panel also considered that the calculation of sustained yield should include individual Regions (Swan, Central and Southern), as well as the entire forest estate, with iteration from one level to the other being necessary.

Recommendation 1.1, Regional Calculations

The underlying inventory and calculation of sustained yield is carried out initially on a regional basis but with provision for aggregation over the CALM-managed native forests. However, iteration from Zone to the Region and back again will be needed to refine the calculation of sustained yield.

2 Stakeholder consultation

Stakeholder involvement in the process commenced in 1999 when a large number of stakeholders had input on the composition and terms of reference of the independent panel. The Minister for the Environment announced the membership and terms of reference of the Panel in July 2000.

The Panel sought public input to the review process by means of written and oral submissions. Organisations and individuals known to have an interest in the subject of the review were invited to make submissions. A total of 42 written submissions was received and 24 stakeholders gave oral presentations at Manjimup, Bunbury and Perth.

Since the process began, a number of significant changes have affected both the organisations responsible for conservation and forest management, and forest policy.

The ALP assumed Government in February 2001. Many of the submissions received by the Panel before the election focused on the issue of 'old-growth' logging, which is no longer relevant in the light of the policies introduced by the new Government. The Government has also indicated its wish to see the development of the next Forest Management Plan fast-tracked. As a result, this report has been completed without the opportunity to provide feedback to stakeholders.¹ However, the Chairman of the Conservation Commission has indicated that feedback will be facilitated in Stage II of the planning process. The newly formed Conservation Commission is the proponent of the next Forest Management Plan.

¹ Following discussions with the Chairman of the Conservation Commission written feedback is to be supplied to people who made submissions. Further information for stakeholders is available on the internet at www.conservation.wa.gov.au.

Recommendation 2.1, Informing the Public

As part of the process involved in preparing the next Forest Management Plan, the Conservation Commission should ensure that recent changes in Government policy, the principles of Ecologically Sustainable Forest Management, and the key elements supporting the planning process and calculation of sustained yield, are widely promulgated and understood.

3 Calculating Sustained Yield

The recommendations of the Panel follow the steps in the calculation of sustained yield are:

- identifying net areas;
- estimating standing sawlog volume;
- predicting future growth or volume;
- modelling potential wood flows to calculate sustained yield.

The term 'net areas' refers to the areas of publicly-owned native forest on which timber production is a permitted activity, i.e. the gross areas **minus** all those areas of reservations and other exclusions in which timber production is not permitted. Net areas can be estimated precisely where boundaries can be clearly identified, either from cadastral data or photo-interpretation. The identification of low volume patches of forest has recently improved and generally no longer presents a risk. Related issues of local and site-specific reservations and temporary exclusions are discussed in a later section.

In jarrah inventory, the application of jarrah silvicultural systems over broad areas of a stratum will vary in places from the planned silvicultural prescriptions for the stratum, and therefore may result in either more or less volume per hectare being removed than was anticipated. The residual risk is low because small continuing biases in the volume per hectare removed principally impact on the cutting cycle and affect the sustained yield very little. Nevertheless, some improvements should be pursued.

Recommendation 3.1, Jarrah Silviculture

Progressive improvement of jarrah stratification for silvicultural and growth prediction purposes should be initiated during the next Plan period. This work needs to be closely integrated with a later recommendation on jarrah growth models.

The dependence on regrowth karri will rapidly accelerate in the light of recent policy changes. This dependence will involve a dramatic increase in the relative supply of small logs after 2003. Utilisation of these is uncertain for sawing, because of size and the greater impact of insect- and fungal-induced defects. A conservative approach to calculating yield should therefore be adopted in the current revision of the Plan.

Recommendation 3.2, Karri Inventory and Utilisation

- (1) The karri inventory should continue to be adapted to handle changing utilisation standards in log recovery, especially with respect to size and quality, during the next Plan period.
- (2) The current revision of the Plan should take a conservative approach in the estimation of karri sustained yield based on current standards of small log utilisation.
- (3) Research on the utilisation of small karri logs should be initiated as soon as possible.

In jarrah, the shift to smaller and/or poorer quality sawlogs will be more gradual reflecting the progressive tightening of supply of larger logs and utilisation of regrowth logs. In addition to continued monitoring, research is needed in the next Plan period on the best forms of utilisation and technologies for processing smaller and lower grade jarrah.

Recommendation 3.3, Jarrah Utilisation

During the next Plan period:

- (1) monitoring of the actual utilisation of jarrah log sizes and grades should be maintained and used in adjusting volumes in coupes to be logged on the simulation of wood flows.
- (2) research on the utilisation and technologies for processing smaller and lower grade jarrah logs should be pursued.

The Panel believes that CALM should complete its responses to the Ministerial Conditions 11, 12 and 16 as soon as possible. The Conservation Commission should then provide, as a matter of urgency, a more integrative review of silvicultural guidelines. The aim of this review should be to inform the public to facilitate the revision of the Plan, including the likely impacts on sustained yield.

Recommendation 3.4, Jarrah Silviculture

- (1) The Conservation Commission should, as a matter of urgency, and following the completion of the CALM reports on the Ministerial Conditions, prepare a review of the silvicultural guidelines with respect to regeneration adequacy, salinity constraints, and habitat considerations to inform decision in the current revision of the Plan.
- (2) The review should also indicate monitoring and research, priorities and funding needed in the next Plan period.

Regeneration on some jarrah-marri sites (especially in the south) often initially favours marri, resulting in the dominance of marri in the earlier stages of stand development, though this balance may shift with age. Silvicultural intervention by way of early 'crown release' and by thinning can be used to alter subsequent stand composition. The economic viability of thinning in marri-dominated stands depends on markets for small marri logs.

Recommendation 3.5, Jarrah-Marri

Calculations of sustained yield for jarrah-marri forest in the current revision of the Plan should determine the sensitivity of the yield to the possible lack of commercial thinning opportunities.

While some marri sawlog will still be available from cut-over southern forests, the Panel believes that this will be negligible in terms of its contribution to the overall sustained yield. The yield of marri sawlogs should not be formally considered in the current revision of the Plan but monitoring of, and research on, the utilisation of marri sawlogs should continue. Blackbutt and wandoo represent similar issues with respect to the calculation of sustained yield – both being in such small volumes that they are negligible in relation to the calculation of sustained yield for individual regions or the whole forest.

Recommendation 3.6, Marri Sawlogs

Calculation of the sustained yield of marri sawlogs should not be formally considered in the current revision of the Plan but monitoring of, and research on, the utilisation of marri and other minor species sawlogs should continue.

Recent reports indicate that new growth models are required for a wider array of silviculture and sites. Research on new growth models reflecting a wider array of silviculture and sites should be initiated in the next Plan period.

Recommendation 3.7, Jarrah Growth

Research on new jarrah growth models reflecting a wider array of silviculture and sites should be initiated in the next Plan period, closely integrating that process with the corresponding recommendation on jarrah inventory, and maintaining transparency of the models used.

In purer karri forest, reliable growth models exist for clear-felling systems and take account of variations in site productivity but further research to improve the growth models in the second half of the period of the Plan will be fruitful.

Recommendation 3.8, Karri Growth

Further research should be pursued to improve the karri growth models in the second half of the period of the Plan.

Karri regrowth forests are fire sensitive and opportunities for salvage from regrowth is less than that from mature forest. The allowance made for losses due to fire in the calculation of sustained yield should be reviewed. Because of the vulnerability of the karri regrowth forest, and in light of the uncertainty in institutional arrangements that prevails, the Government needs to ensure that the institutional arrangements between CALM and the Forest Products Commission provide adequately for continuing fire protection of the regrowth karri estate.

Recommendation 3.9, Regrowth Karri Fire Risk

- (1) A recalibration of the allowance accorded to the risk of fires relating to the karri regrowth resource should be carried out in the current revision of the Plan.
- (2) The Government needs to ensure that the institutional arrangements between CALM and the Forest Products Commission provide adequately for continuing fire protection of the regrowth karri estate as soon as possible.

Timber removals from bauxite and other mining sites are accounted for in yield estimates based on company plans of mining operations over a five-year period and anticipated operations between five and 25 years. Currently, growth rates and rotation lengths for the rehabilitated forest are assumed to be the same as the pre-mined productivity classification. Uncertainty surrounds growth rates of forests on mined sites.

Recommendation 3.10, Rehabilitated Mining Sites

Research should be undertaken comparing growth rates and net area estimates on rehabilitated mining sites with those used in yield calculations during the next period of the Plan.

Rotation length is a fundamental variable in the calculation of sustained yield. Some 85 to 90% of the respective areas of jarrah and karri forest are cut (or scheduled to be cut) under rotations of 200 and 100 years respectively. Very small proportions of high productivity forest are cut (or scheduled to be cut) using rotations as low as 100 and 60 years respectively. While major general changes in rotation lengths would not be desirable, because of their impact on other forest values, the wider application of shorter rotations, up to (but not exceeding) 25 years less than the current predominant rotation lengths for both jarrah and karri may be acceptable to other values.

Recommendation 3.11, Shorter Rotations

The wider use of shorter rotation lengths for jarrah and karri respectively should be explored, and the consequent impacts on yield and Ecologically Sustainable Forest Management evaluated during the current revision of the Plan.

Structural goals are an important element of the current Forest Management Plan. The next step in the development of structural goals is their refinement to the landscape level. Specific structural goals represent a direct approach to maintaining a full suite of age and structurally related values, rather than attempting to achieve them using sustained yield as a mechanism. Structural goals are also useful in balancing the structural attributes between those found in the reserve system and those in production forests.

Recommendation 3.12, Structural Goals

Specific objectives need to be formulated in the current revision of the Plan for appropriate forest structures in terms of the mix of age or size classes and their spatial distribution across the whole forest, together with the structural goals that must then be applied in the calculation of sustained yield.

Future sites of reservations or temporary exclusions in areas not yet harvested cannot always be identified geographically. Allowances therefore have to be made. In some cases, the simulation models incorporate ingenious and realistic simulations of the spatial constraints for areas that are scheduled to be harvested in the future. Other exclusions such as those to protect locally rare and endangered species, or local visual amenity zones are virtually impossible to predict geographically much in advance of pre-logging survey and harvesting. They are therefore addressed by making a reduction in net area or sustained yield, based on past experience.

Recommendation 3.13, Allowances for Local Reservations and Exclusions

Monitoring of logged coupes with respect to the areas of local reservation and temporary exclusions should be maintained to refine allowances in the calculation of sustained yield during the next Plan period.

Existing processes require areas of visual amenity to be identified and managed under protocols defined by professional landscape architects. Trade-offs are inevitably involved in consideration of such areas. The trade-offs have to weigh the social net benefit foregone to the community as a whole from the loss or modification of logging against the social net benefit accruing to the individual and/or local community.

Recommendation 3.14, Local Reservation and Exclusion Trade-offs

Research should be pursued to value the social net benefits and to determine effective processes for making trade-offs in local exclusions and reservations during the next Plan period.

The use of supplementary systems for scheduling wood flows should be pursued during the period of the next Forest Management Plan. This will also require greater effort in the collection of data on non-timber values for use in these models. Embarking on a shift to such an advanced scheduling system, with its attendant workload, would not be practicable within the current revision of the Forest Management Plan.

Recommendation 3.15, Supplementary Scheduling

Supplementary scheduling of wood flows should be examined and pursued, if practicable, though the use of more advanced systems during the next Plan period.

Yield estimates are based on the presumption that silvicultural practices match the prescriptions. Departures do not arise solely from inadequacies in the modelling system. Changes in responsibilities resulting from the creation of the Forest Products Commission and the present limited silvicultural expertise in CALM, represents a potential risk to the appropriate development and application of silviculture. The reduced size of the industry

beyond 2003 may exacerbate this problem through reduced income from sales of wood and consequent possible loss of staffing in the new administrative structures.

Recommendation 3.16, Staff Training and Resources

CALM should commit to the maintenance of staff training and expertise in silviculture through the provision of adequate resources and delineation of responsibilities during the next period of the Plan.

Continuation of a residue market to facilitate karri thinning is of particular importance. Without such an industry, sawlog-thinning yields will be delayed and the total sawlog yield will be dramatically reduced.

Recommendation 3.17, Karri Residue Utilisation

The Government should encourage industries that utilise the residues from thinnings in regrowth forests during the next Plan period.

Consideration should be given to altering the relative royalties of Grades 1 and 2 so that to make sawmillers and loggers indifferent to different grades and to writing contracts in terms of the combined volumes of Grade 1 and 2 sawlogs.

Recommendation 3.18, Sawlog Prices and Contracts

The prices of Grade 1 and 2 sawlogs and corresponding logging contract rates should be examined to remove the present biases that favour the use of Grade 1 logs. Renegotiation of contracts should move toward sale of the combined volumes of Grade 1 and 2 in keeping with the basis for sustained yield.

If a 'whole bole logging' system is introduced for sale and yield regulation, it will be critical to demonstrate that it provides a better approach than the present system. A dual track (new and old) system of calculating sustained yield would need to be used, to provide transparency between the old and new. Collaborative trials with the industry should be continued to 2002, at which time the decision to pursue this system should be taken. If implemented, it should also be subject to a review after some dual track experience has been gained.

Recommendation 3.19, Whole Bole Logging

- (1) Collaborative trials with the industry of 'whole bole' logging should be continued to 2002.
- (2) A decision to pursue this system should be taken as part of the current revision of the Plan.
- (3) If implemented, a dual track basis should be used and reported during the period of the Plan, with a review regarding its exclusive adoption thereafter.

4 Other Issues and Values

Without explicit targets for important whole of forest outputs, no benchmarks exist to adequately evaluate trade-offs between competing values. These are required to better define any prescription variations needed to accommodate non-timber outputs, or to judge progress toward the achievement of Ecologically Sustainable Forest Management. The resulting risk is in setting inefficient yield levels and thus not achieving the inherent potential in terms of social net benefit. Another hazard relates to unresolved expectations held by stakeholders for the level of outputs of other non-timber values. Many of these might be resolved if explicit targets existed.

The Conservation Commission should develop processes to determine and communicate both 'whole of forest' and landscape level targets for as many forest outputs as possible. These targets must be effectively communicated to stakeholders both during the development process for the Forest Management Plan as a basis for informed comment, and at its conclusion as a matter of public record.

Recommendation 4.1, Whole of Forest

The Conservation Commission should develop processes to make explicit both 'whole of forest' and landscape level targets for as many forest outputs as possible. These targets must be effectively communicated to stakeholders both during the development process for the Forest Management Plan as a basis for informed comment, and at its conclusion. The Forest Management Plan must take a whole of forest perspective and not focus solely on the areas available for timber production.

A major shortcoming in the application of fire for vegetation management is the absence of specific management objectives at an appropriate scale. For biodiversity, this is a particular concern in reserved areas that are now a much more significant proportion of the forest estate and where biodiversity values might be expected to have a high priority. Without agreed objectives at this level there is no way of judging whether fire management practices are appropriate or successful.

CALM, in association with the Fire Emergency Services, has initiated a revision of Wildfire Threat Analysis system that gives explicit weightings to a full range of values at risk. This revised system is intended to be used as a decision support tool for both prescribed burning and fire suppression activities across all managed lands and adjacent influence zones and provides a vehicle for implementing fire management based on explicit objectives.

Recommendation 4.2, Fire Management

- (1) In the current revision of the Plan, the development of specific fire management objectives should be initiated for subsequent completion during the period of the Plan. The Plan should incorporate explicit objectives such as species or community priorities, the proportion of the area maintained in a particular post fire seral stage, regrowth protection or the maintenance of diversity at the landscape level versus the site level.
- (2) The revision of the Wildfire Threat Analysis, incorporating consideration of operationally meaningful management objectives and strategies, and communication with the urban electorate and ecological expertise, should be extended to cover all land and ownerships during the next Plan period.

The Panel supports the key recommendations of the EPA in commenting on the recent dieback protocol, as they accord with the precautionary principle.

Dieback areas that have not been logged are credited with the standing volumes involved but are not taken into account in predicting future volume beyond the real or simulated time of logging. The impact of future infection is not currently taken into account. This risk should be taken into account by sensitivity testing in the simulation models, assuming variously (a) no spread and (b) the apparent past spread over the last decade for the various strata, or minor modifications.

Recommendations 4.3, Dieback

- (1) The key points of the EPA advice on the Protocol for the identification and prioritisation for the management of *Phytophthora cinnamomi* 'protectable areas' endorsed by the Minister should be implemented as soon as possible.
- (2) The impact of future infection should be taken into account by sensitivity testing in the simulation models, assuming variously (a) no spread and (b) the apparent past spread over the last decade for the various strata.

The future impact of the honey fungus on regrowth karri is of concern because, like other *Armillaria species*, it can impact on regrowth forests causing mortality of trees retained after thinning. As thinning of regrowth stands proceeds, deaths of retained crop trees should be monitored. This will enable the allowances for the calculation of sustained yield to be refined.

Recommendation 4.4, Honey Fungus

Honey fungus mortality and damage arising from thinning operations, especially in karri regrowth operations, should continue to be monitored during the next Plan period to enable allowances to be developed for the future calculation of sustained yield.

Reports have drawn attention to the high incidence of decay and borer holes in regrowth karri. There is a moderate risk that the proportion of wood recovered from small diameter logs will be lower than expected or that some of the regrowth resource will be downgraded as unacceptable as sawlogs.

Recommendation 4.5, Karri Borers and Rots

An appropriate survey should be conducted across the thinnable karri regrowth estate to assess the potential impact on yield and to develop an appropriate allowance during the next Plan period.

Both leaf miner and skeletonizer are likely to impact on trees in the inventory and growth plots and thus their effects on growth will be integrated into models. The residual risk of chronic infestations of leafminer, causing reduced growth rate, is uncertain. Comparison of growth rates in inventory plots known to be infested with leafminer, and those without, could assist in quantifying impacts of the leafminer.

Recommendation 4.6, Jarrah Pests

Research should be pursued to compare growth rates in inventory plots known to be infested with leafminer and those without, to assist in quantifying impacts of the leafminer during the next Plan period.

The principal hazard to the carbon cycle is associated with the fire regimes and the uncertainty surrounding their impact or changes to soil carbon changes. The likelihood of this hazard having an impact on, and posing a risk to, the global cycle is currently low for the South West Zone, but the Australia-wide or global implications of this issue do merit research.

Recommendation 4.7, Carbon Cycle

Research should be pursued on the impact of fire management and logging regimes on the global carbon cycle during the next period of the Plan.

Greater attention needs to be paid to the trade-offs between new mining sites and biodiversity values. Given the much greater weight the community is according these values, it should no longer be assumed that mining is pre-eminent in the social net benefit it provides from every viable bauxite reserve. Reservation of any areas for biodiversity and other conservation

values would actually lead to a reduction in the cut from areas that would otherwise have been clear-felled prior to mining. The resolution of these trade-offs is important in relation to calculating the sustained yield. It is most unlikely that all such areas could be so reviewed for the current Plan revision but a process should be initiated to deal progressively with these areas, according to the planned schedule of mining operations.

Recommendation 4.8, Bauxite Mining Sites

The Conservation Commission should initiate a formal process for a more detailed examination of areas mooted for bauxite mining with respect to biodiversity conservation and hydrological values and an evaluation of the trade-offs with mining involved.

The calculated sustained yield in the new Forest Management Plan is likely to be substantially lower than that in the Regional Forest Agreement, as a result of the subsequent increases in reservation. Due consideration, analysis and reporting needs to be given to the likely social and economic impacts particularly in rural communities. The Regional Forest Agreement committed the parties to an independent economic and social impact assessment of the draft Forest Management Plan. However, the process to be followed needs to be developed well in advance and needs to be initiated as soon as possible if it is to contribute adequately to the development of the Plan.

Recommendation 4.9, Social Impact Study

An independent and robust social impact study be initiated as soon as possible as part of the current revision of the Plan.

The need for some development of the operational and support aspects of the Visual Management System and some further consideration of geo-heritage issues was identified during the Regional Forest Agreement. The major impacts of heritage values in relation to the estimation of sustained timber yield comes through the exclusion of timber harvesting (reduction in net harvestable area), delay in harvesting, or through the application of modified harvesting prescriptions.

The current databases and approaches appear to provide a generally sound basis for modifying the estimated timber yield for the purposes of preparing the next Forest Management Plan. However, both the concepts of natural heritage and the relative community values of different aspects or examples natural and cultural heritage do change through time.

Recommendation 4.10, Heritage Values

Consultative mechanisms need to be enhanced to ensure that the guidelines for natural and cultural heritage used in forest planning and management are kept in step with changing community values during the next Plan period.

The need for a more effective engagement of indigenous communities in relation to forest management and the impacts of forest management on indigenous communities and their cultural heritage has been identified by several recent forestry enquiries. The results from future engagement with indigenous communities may result in changes to the basis for estimation of sustained yield.

Recommendation 4.11, Indigenous Communities

Specific consultative processes, in addition to those used for general community, should be further developed with the relevant indigenous communities during the development of the next Forest Management Plan to ensure effective input in relation to management proposals that have impacts on indigenous cultural or other interests during the current revision of the Plan.

Databases and modelling of flora and fauna species in the context of planning requires further development. Information from these database help to inform biodiversity goals, targets and performance criteria that can then be translated through to indicators and measurement of Ecologically Sustainable Forest Management outcomes. The risk of not being able to meet biodiversity objectives is reduced through commitments made in the Regional Forest Agreement to improving the knowledge base by appropriate sampling.

Recommendation 4.12, Biodiversity Databases

The Conservation Commission should commit to the maintenance of databases for biodiversity on a 'whole of forest basis' as a pre-requisite for Ecologically Sustainable Forest Management on areas available for timber production and elsewhere.

5 Priorities and Resources

The Panel has provided a summary of the priorities for its recommendations in terms of timing. It has not had time to examine the resources required, other than in a very general manner.

1 INTRODUCTION

1.1 Background

The review has its origins in commitments contained in the report by Mr Mike Codd of January 1999 and the Regional Forest Agreement (RFA) of May 1999. The report by Mr Codd included the following statement:

"it is acknowledged that the RFA process will establish an expert panel to provide independent scientific advice on the provisional sustained yield figure consistent with the principles of ecologically sustainable forest management, and with appropriate provision for potential improvements in utilisation; with such a panel expected to take some 12 months to report"

Clause 50 of the Regional Forest Agreement of May 1999 stated:

"The Commonwealth accredits the process described in An Appraisal of Methods and Data used by CALM to Estimate Wood Resource Yields for the South-West RFA Region of Western Australia (Turner B.J., Department of Forestry, Australian National University, December 1997) and being used by CALM in the calculation of Sustained Yield of wood products from the public native Forest and plantation estate on the understanding that the improvements recommended in that report will be addressed prior to the development of the next Forest Management Plan. Western Australia agrees that the methods and data to be used in the calculation of the Sustained Yield of wood products from the public native Forest and the Sustained Yield figures to be included in the Forest Management Plans will be reviewed by a panel of suitably qualified independent experts as part of the development of each Forest Management Plan under the CALM Act and improvements incorporated during the Forest Management Planning process. Western Australia confirms that its current standard of inventory will be maintained and yield and planning databases and systems, as amended by this Agreement, will be enhanced."

The purpose of this review is to fulfil the above requirements and to facilitate the development of the next Forest Management Plan. The intent of the next Forest Management Plan is to implement the outcomes of the Regional Forest Agreement and subsequent forest policy statements. It is not the purpose of this review to examine the Regional Forest Agreement process and outcomes.

The review focuses on the calculation of sustained yields within the context of the principles of Ecologically Sustainable Forest Management. The agreed principles of Ecologically Sustainable Forest Management set out in the Terms of Reference of the review are:

- (a) *planning and management of forests should maintain the suite of forest values for present and future generations:*
 - *maintain and enhance long-term multiple socio-economic benefits to meet the needs of societies;*
 - *protect and maintain biological diversity;*
 - *protect and maintain natural and cultural heritage;*
 - *maintain the productive capacity and sustainability of forest ecosystems;*
 - *maintain forest ecosystem health and vitality;*
 - *protect soil and water resources;*
 - *maintain forests' contribution to global carbon cycles; and*

- (b) *planning and management of forests should be guided by the precautionary principle;*
(Regional Forest Agreement: Attachment 5)

A discussion of these principles may be found in the Ecologically Sustainable Forest Management report of the Regional Forest Agreement. The precautionary principle is defined² thus:

"Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by

- I. careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment;*
- II. an assessment of the risk-weighted consequences of various options."*

In considering application of the precautionary principle, the Panel was required to pay particular attention to forest management processes and practices dealing with 'risk assessment' and 'risk management' to minimise environmental impacts and avoid serious or irreversible damage to the environment. However, only those aspects of Ecologically Sustainable Forest Management that directly impinge on the calculation of sustained yield are within the prescribed scope of the review.

The principles of Ecologically Sustainable Forest Management state that planning and management should maintain the full suite of forest values for future and present generations through a set of principles relating to the management of various of those values. Sustainability for future generations is clearly a key factor that addresses the equity of resource use between generations. Mention of the long-term multiple socio-economic benefits makes it clear that the review is not confined to commercial net benefits. All values or uses have to be considered in addressing both the equity and efficiency of sustainable resource use.

Neither the Ecologically Sustainable Forest Management principles nor the CALM objectives throw much light on the mix of values or uses to be sought from a particular area of forest. Zoning does exclude some uses and values. It may also guide the priorities to be accorded to various forest uses, where the priorities are explicit in the rationale or basis used for zoning and the prescriptions to be applied in those Zones.

As noted earlier, the review necessarily focuses on the calculation of sustained yields of wood from CALM-managed native forest in the context of Ecologically Sustainable Forest Management. For those areas where wood production is to be permitted, the question remains as to what mix of wood and other values is appropriate. There is no single answer to this question, because the intrinsic worth (or social net benefit) of different uses varies widely within that part of the forest estate available for wood production. In some places, water values may be pre-eminent – in others, landscape aesthetic, wildlife, flora conservation or mineral values may dominate. Yet across an area as vast as the native forests of the South West, there are bound to be areas for which wood production is the dominant value, others in which it provides a significant part of the mix of values, some in which it is a minor component, and many where it is not appropriate.

The role of the Panel is to try to ensure that management practices not only maintain or enhance particular forest values listed in the set of principles for Ecologically Sustainable Forest Management, but that the totality of the social net benefits across the entire forest is as

² Commonwealth of Australia 1992. *National Forest Policy Statement*. Australian Government Publishing Service, Canberra.

high as possible. As is well-known, neither the available data nor analytical techniques are equal to solving this task analytically, and hence the use of a panel of experts, supplementing these endeavours with public input to identify areas of concern and possibly needing further action or change.

1.2 Application of Ecologically Sustainable Forest Management Principles

As with any definition of a process, the principles of Ecologically Sustainable Forest Management are capable of differing interpretations. Numerous bodies, including intergovernmental panels, bodies and processes (IPCC, Montreal Process, Ramsar), major international research centres (e.g. CIFOR), international societies (e.g. IUCN, IUFRO), professional bodies (Ecological Society of America, Ecological Society of Australia, Institute of Foresters of Australia) have sought to help develop their own goals and indicators and to influence those set by government agencies.

The Panel recognises that a single, internationally agreed set of goals or indicators for all forests is unlikely to be achieved. Attempts are in progress to develop goals and indicators for Australia but have not reached a conclusion. Establishment of goals and indicators of Ecologically Sustainable Forest Management in Western Australia is therefore a key priority taking account of the national framework³. In our view, the precautionary principle remains an over-arching guide, and provides for setting of clear goals where good scientific knowledge exists, and for the refinement of goals (adaptive management) as new knowledge is acquired.

Sustainability has been defined⁴ as the capacity for continued productivity where the primary requirement is for site and soil protection and for adequate regeneration and protection) and sustainable yield as the capacity to maintain relatively consistent levels of production or products over an extended period. In the case of Western Australia, the Conservation and Land Management Act refers to 'sustained yield' in exactly the same context as sustainable yield, and the Panel therefore uses the term 'sustained yield' to be consistent with the legislation and terms of reference, but noting that it regards its definition as being identical to that for sustainable yield.

As a starting point, the Conservation and Land Management Act explicitly states several goals for forest management in Western Australia that are broadly compatible with the principles of Ecologically Sustainable Forest Management. These will be refined progressively in relation to the principles of Ecologically Sustainable Forest Management, and the hazards affecting them, in later sections. In addressing these issues, the Panel has attempted to ensure that:

1. Goals and indicators for principles of Ecologically Sustainable Forest Management should be set for the 'whole of forest' (spatial scale).
2. Consideration of 'Sustainability' should involve a time frame longer than that covered by a Forest Management Plan (temporal scale). Some goals will not be achievable within that term but there will be indicators that can be used to assess progress towards those goals.
3. Setting of goals and indicators should recognise the precautionary principle.

³ MIG Secretariat. *A framework of regional (sub-national) level criteria and indicators of sustainable forest management in Australia*. Department of Primary Industry and Energy, Canberra, 108pp.

⁴ Ferguson, I., Gardner, J., Hopper, S. and Young, J., 1999. *Report to Minister for the Environment: Ministerial Advisory Group on Karri and Tingle Management*. Department of Environment, Perth, 67pp

1.3 Risk Assessment and Management

The guiding methodology for risk assessment and management was based on the Standards Australia and Standards New Zealand publication AS/NZS 4360:1999 *Risk Management*. This was adopted because it provides a well-established and systematic approach that is compatible with the Environmental Management System adopted in the Regional Forest Agreement process, having been developed “with the objectives of providing a generic framework for identification, analysis, assessment, treatment and monitoring of risk”.

Some of the key terms are defined as follows:

Hazard: a source of potential harm or a situation with a potential to cause a loss.

Likelihood: used as a quantitative description of probability and frequency.

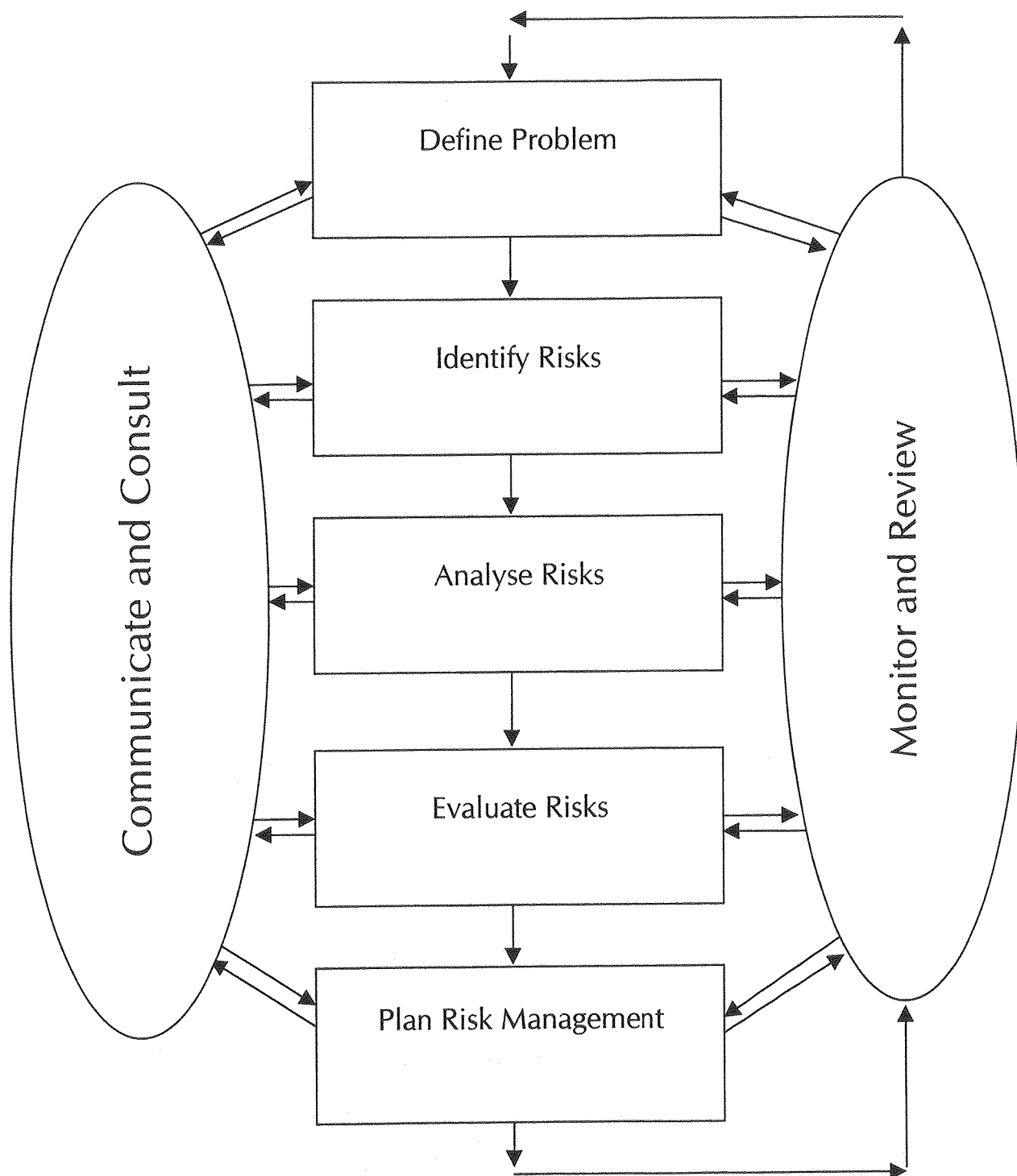
Risk: the chance of something happening that will have an impact on objectives.

Residual risk: the remaining levels of risk after treatment measures have been taken.

Figure 1 (opposite) illustrates the sequence of steps involved in this approach.

These follow a similar pattern to those used in systems analysis and Environmental Management Systems, commencing with the definition of the problem in terms of context and boundaries. Then follows the identification of hazards in terms of what can happen and how it might happen. Analysing hazards then involves determining the existing controls over them. Evaluating risks involved determining their likelihood and magnitude. Risk management then involves evaluating the risks against criteria, deciding on acceptable levels of risk, identifying risk management strategies, selecting the best risk management option, and implementing it. Having done so, the process follows a trial and error ‘dual track’ of communicating and consulting with stakeholders, and establishing processes for monitoring and review. Obviously, the present Stage 1 review cannot complete all these steps but it can initiate the processes and recommend the best initial options.

Figure 1: Steps involved in Risk Assessment and Management



1.4 Terms of Reference and Scope of the Report

The Terms of Reference of the Stage 1 Review define the problem and set the boundaries as follows:

Stage 1 Review

The panel of independent experts will:

1. document and examine the management practices that are used to implement the principles of ecologically sustainable forest management and their integration with the process for establishing sustained yield levels;
2. examine the methods and data used in the calculation of sustained yields in terms of the requirements of clause 50 of the Regional Forest Agreement;
3. examine the timber resource estimates in terms of their consistency with the areas of native forest available for timber harvesting;
4. examine the yield projection system in terms of their consistency with variability in growth rates on varying landforms, soils, climatic zones and forest ecosystems; and
5. examine the yield projection system in terms of consistency with the objectives for management of the CALM-managed estate, as specified in the Forest Management Plan.

The panel will seek technical, industry and community input into these issues.

Scope

The review includes CALM's three forest regions – Swan Region, Central Forest Region and Southern Forest Region.

The scope of the review is to focus on the calculation of sustained yields of wood from CALM-managed native forest in the context of the principles of ecologically sustainable forest management.

While ecologically sustainable forest management deals with the management of all types of forest (native forest, plantations) across all tenures (public, private) and for all values and uses (timber harvesting, mining, conservation, recreation etc) only those aspects of ecologically sustainable forest management that directly impinge on the calculation of sustained yields are within the scope of this review.

Stage 1 Report

The panel will provide a single written report to the Conservation Commission by 30 April, 2001, including:

- Recommendations, as appropriate, for future improvements in matters arising from the terms of reference and indicating –
 - (a) those improvements that may be feasible to implement in the period leading to the next Forest Management Plan; and
 - (b) those improvements that could be implemented in the longer term; and
- Identification of priorities and relative resources required to implement each recommendation within the context of existing priorities for improvements to Western Australia's forest management systems.

Objectives of management

The Terms of Reference note that the objectives for management of CALM-managed lands are as specified in the Forest Management Plan 1994-2003. The overall objective is:

"To manage the native forests of the south-west of Western Australia, in consultation with the community, so that they provide the values required by society while sustaining indefinitely their biological and social diversity."

The conservation objective is:

"To maintain biological diversity at the genetic, species and ecosystem level in the forest, with special emphasis on the protection and conservation of threatened, rare and uncommon taxa and communities."

The management objective is:

"To protect and enhance identified forest values and to employ the best practices in managing forest ecosystems."

The production objective is:

"To manage the forest to produce the range of commercial values approved by Government, in a manner which is ecologically sustainable and provides a fair return to the State."

The tourism and recreation objective is:

"To facilitate the public enjoyment of the forest in a manner that is consistent with the nature conservation and other objectives."

The knowledge objective is:

"To seek a better understanding of the composition and function of forest ecosystems and to promote awareness and appreciation of their values."

The Terms of Reference also note that the practices that are used to provide for ecologically sustainable forest management are as specified in the Forest Management Plan 1994-2003, the Regional Forest Agreement and the previous State Government's forest policy.

Some policy and administrative issues concerning the calculation of sustained yield are somewhat unclear pending the refinement of the working relationships between CALM and the Forest Products Commission in the light of the new legislation defining the respective roles and responsibilities of the regulatory and timber management agencies in the inventory, sustained yield and planning functions. Comment on these matters has therefore been held over until the Stage 2 report.

1.5 South West Zone versus Regional Planning

One question that arises in relation to the long-term multiple socio-economic benefits and the calculation of sustained yield is how well does the stratification and inventory of the forest estate serve the dual purposes of planning the sustained yield and maintaining and enhancing those multiple socio-economic benefits.

Some ambivalence is evident from past experience. Regional plans were prepared for the three forest regions in 1987 (Northern Forest, Central Forest, Southern Forest 1987-1997). Since then, some boundary changes have occurred and these three regional plans were largely replaced by the Forest Management Plan 1994-2003. However, the new Plan does not revoke

the 1987 plans. Where the new Plan and the 1987 plans cover the same issue, the provisions of the 1994 plan simply replace those in the 1987 plans.

Since 1994, it would also seem that regional (in addition to metropolitan) stakeholders and interest groups have taken a much greater interest and involvement in the planning process than was true of the past. Particular rural communities have been closely involved in concerns expressed to the review of karri and tingle management (Ferguson et al. 1999) and have a detailed knowledge of some parts of their particular regional forests. While on occasions, Statewide considerations may need to over-ride; local involvement needs to be fostered.

On the other hand, a Statewide strategy is clearly appropriate for the timber industry as a whole, especially if further processing and value adding are to be fostered. While these issues have largely been settled for the karri and tingle forests as a result of recent Government decisions, the position is more acute for jarrah.

Historically, the system of stratification and inventory was initially based purely on consideration of the productivity of wood. The three forest regions formed logical post-war geographic catchments for the supply of wood, given the centres of population, ports, and main transport routes. The forest was stratified from aerial photography into broad height classes and species mixtures that aided the efficient use of field measurement resources in measuring temporary and permanent plots. Fortunately, that stratification was highly correlated with rainfall, soils, and species richness and (sometimes inversely) diversity and it has therefore been useful for planning other forest uses or mixtures of uses.

Much more detail has been mapped subsequently, including vegetation types, disease (*Phytophthora*) zones, threatened and endangered species habitats, sensitive catchments and wetlands, visual resource management zones, strategic fire management zones, buffer strips and wildlife corridors (the latter two are referred to as road, river and stream zones in the Forest Management Plan). Geographic information systems make these details available to planners and field managers, and to the general public.

A dual system is therefore inevitable, such that the underlying inventory and calculation of sustained yield is carried out initially on a regional basis but with provision for aggregation over the South West Zone. However, iteration from Zone to the Region and back again will be needed to refine the calculation of sustained yield.

Recommendation 1.1, Regional Calculations

The underlying inventory and calculation of sustained yield is carried out initially on a regional basis but with provision for aggregation over the CALM-managed native forests. However, iteration from Zone to the Region and back again will be needed to refine the calculation of sustained yield.

2 PUBLIC CONSULTATION

2.1 Introduction

Stakeholder involvement in this review commenced in 1999 when the Executive Director of CALM wrote asking a large number of stakeholders to have input on the composition and terms of reference of an independent panel to review the processes of establishing the sustained yield from the native forests consistent with Ecologically Sustainable Forest Management.

The Minister for the Environment announced the membership and terms of reference of the Panel in July 2000.

The Panel sought public input to the review process by means of written and oral submissions. Organisations and individuals known to have an interest in the subject of the review were invited to make submissions.

To assist stakeholders in framing their submissions, copies of relevant background documents were made available through public libraries in the metropolitan area and south-west communities. These documents were also accessible through the Internet.

A total of 42 written submissions was received, the main points being tabulated in Section 2.2 and 24 stakeholders gave oral presentations as Manjimup, Bunbury and Perth in the period 1-3 November 2000. Organisations and individuals who made submissions to the Panel are listed in the Appendix.

Since the process began there have been a number of significant changes that have affected both the organisations responsible for conservation and forest management, and forest policy. The newly formed Conservation Commission has taken over responsibility from CALM for this report and is the proponent of the next Forest Management Plan which will ultimately be forwarded to the EPA for consideration for its advice to the Minister for Environment and Heritage, prior to approval of the Plan.

The ALP assumed Government in February 2001. Many of the submissions received by the Panel before the election focused, among other things, on the issue of 'old-growth' logging, which is no longer relevant to this review in the light of the changes in policy introduced by the new Government.

The Government has also indicated its wish to see the development of the next forest management plan fast-tracked. As a result, this report has been completed without the opportunity to give feedback to stakeholders⁵. However, the Chairman of the Conservation Commission has indicated that feedback will be facilitated in Stage II of the planning process (see Terms of Reference, Section 1.4).

⁵ Following discussions with the Chairman of the Conservation Commission written feedback is to be supplied to people who made submissions. Further information for stakeholders is available on the internet at www.conservation.wa.gov.au.

2.2 Summary of topics raised in written submissions

<i>Summary of comments made in submissions</i>	<i>No. of submissions with this comment</i>
1 Ecologically Sustainable Forest Management (ESFM)	
Definitions and interpretation	
The determination to constrain ESFM by considering only 'sustained yield' is unacceptable.	3
The term 'sustainable yield' is more appropriate than 'sustained yield' when discussing ESFM.	2
Consideration should be given to the distinction between 'sustainable ecosystems' and 'sustained timber yield'.	1
Greater clarification of the EGCRA definition of sustainability with respect to time, cost, values and area still required.	1
ESFM means the maintenance of the entire floral, faunal and climatic forest eco-system over the whole of forest.	1
Conflict between commercial and ecological goals is inherent in the definition of ESFM adopted for the review.	1
The definition of ESFM being adopted is 'skewed' to commercial values.	1
ESFM principles cannot be applied universally across conservation and production forest boundaries.	2
ESFM values should be realised in terms of the whole of forest approach.	1
ESFM should involve integrating commercial and non-commercial values of forests so that the welfare of society (both material and non-material) is improved while ensuring intergenerational equity in their values.	2
Adaptive management supported where changes based on sound scientific evidence.	1
<i>Topics suggested for review and comments on approach</i>	
Need for clear documentation as to how ESFM objectives are to be met and evaluated.	1
ESFM principles as outlined in the report from the Independent Expert Advisory Group on ESFM for the RFA should be the basis of current review.	1
Silvicultural techniques and other management practices with regard to ESFM and accreditation of exports should be addressed.	1
The panel should ensure that they stay within their terms of reference.	1
The review should build on RFA and its recommendations for ESFM	2
Yields from the three forest regions should be differentiated within the whole of forest approach.	1

The Panel should give an opinion on where the “maintenance of a steady state diameter distribution to define a desirable ecosystem structure is a useful advance in the definition of sustainability” (Turner and Wood 1993).	1
An opinion should be provided on whether an allowable annual cut in jarrah, equivalent to estimated whole of forest annual growth increment is an acceptable basis for establishing sustainability under ESFM principles.	1
The review should focus on the major issues and not pursue minor details.	1
Sustainable yield should be calculated in a way that all ‘end values’ are accounted for rather than just wood volume or mass.	1
All ESFM values should be accounted for in the determination of sustainable yield.	1
ESFM should be considered in the context of the whole of forest, not with an expectation that the multiple use forest will necessarily provide the same values as the reserves.	1
The yield of species such as blackbutt, marri, casuarinas should be reviewed.	1
The Panel should review timber royalties.	1
Views of independent biologists and ecologists should be sought.	1
The panel should consult with Water and Rivers Commission as part of the process.	1
The panel should make their own on-ground observations.	1
The panel should inspect jarrah regrowth in a range of areas to judge whether it is satisfactory.	1
The Standing Committee on Ecologically Sustainable Development has made a number of recommendations that should be heeded by the panel.	1
There should be a strong emphasis on management requirements for the maintenance of values in forests now in reserves.	1
The panel should also advise on the calculation of an environmentally sustainable yield from the State’s plantation resource.	1
2 Sustained yield Modelling of sustained yield. Factors suggested for consideration:	
Risk assessment of factors affecting sustained yield.	1
Flexible rotation lengths to ensure smooth future wood flows.	1
The very long rotation lengths currently in place offer flexibility in providing for non-timber values.	1
A 200-year rotation length of jarrah should be maintained.	1
A rotation length for karri of less than 100 years should be recommended.	1
New silvicultural practices including those related to changing chipwood demand.	1
Effects of statistical errors on arriving at total available wood.	1

Review the system of allowance for negative and positive uncertainties in determining whether sustainability is verifiable.	1
Review the timing of logging in jarrah temporary exclusion areas.	1
The dieback status of inventory plots may not be readily available or known compromising reliability of estimates of the disease on both growth and mortality.	1
Both quality and quantity of the available sawlogs.	1
Effects of pests and diseases on yield, particularly karri regrowth.	3
Sawlog yields from the areas available for production should be maximised.	1
The deficiencies in yield projection system identified by Turner (1998).	1
Buffer strips and special requests from neighbours may require a contingency allowance in setting sustainable timber yield.	2
Allowance for visual resource management in areas of tourism potential.	1
Provisions for maintaining water quality, not only in catchments for human supply.	1
Climate change and decreasing rainfall.	7
<i>Modelling of sustained yield: concerns</i>	
The quality of inventory data for jarrah.	1
Adequacy of rotation lengths for maintenance of values.	1
Validity of assumptions.	1
Level of sampling and distribution of growth plots.	1
Data and methods used to date are considered inaccurate or inadequate and requiring verification.	3
Positive comments and conclusions reached by previous reviewers of CALM systems should be acknowledged.	3
<i>Timber yields</i>	
Sustained yield should not be discussed in terms of gross bole volumes but sawlogs.	1
Assessment of quality and quantity relationships is apparently difficult.	1
<i>Area available for harvest</i>	
Need for clarifications of area of State forest available for harvesting.	1
Inaccuracies in mapping would suggest inaccurate resource estimates.	1
Various circumstances can impact on CALM's assertion that "areas of low timber productivity which will be too expensive to adequately regenerate should not be harvested".	1
Reservation in the Central forest region was inadequate in the RFA.	1
The RFA/CAR reserve system was adequate.	2
<i>Clarification sought</i>	
Question as to how variability over landscape accounted for in models.	1
Question as to how inevitable diminution of quality of timber is factored	1

into CALM models.	
3 Forest Management Policy	
Lack of stability in government policy and its application results in adverse effects on planning and implementation.	1
CALM's commitment to an EMS and the development of the Australian Forestry Standard should be noted.	1
CALM policies already demonstrate commitment to the application of ESFM.	1
CALM considered the most appropriate agency to consider and implement all ESFM principles.	1
<i>Planning and implementation</i>	
Concerns expressed about current division of responsibilities between departments and commissions and thought likely to impact on delivery of ESFM in the field.	1
Confidence in CALM personnel and systems strongly stated.	1
Application of informed local decision making need attention given the rapid change of biodiversity across south-western landscapes.	1
<i>Monitoring and compliance</i>	
Issue of enforcement procedures for dieback hygiene procedures raised.	1
There are discrepancies between the forest management policies and actual practices with regard to protection of streams, dieback hygiene, soil protection, flora and fauna surveys.	8
<i>Suggestions for improvement</i>	
The current system of log sale contracts should be reviewed so there is a better match with grades available.	1
The case for sale of non-sawlog material to enhance future sawlog availability should be presented. The importance of chip wood markets for ongoing management of regrowth karri.	1
Independent scientists should monitor logging.	1
Ongoing biological survey data ahead of logging required where the knowledge base is deficient.	1
Royalties for sawlogs are set too low and encourage excess consumption of forest products.	1
Contractual agreements should be non-binding under conditions of detected detrimental change.	1
Independent audits of compliance with codes of practise and protocols in the bush advisable.	1
Re-asses the quality of available log resources and issue contracts of sale in the new management plan, which better reflect the apparent lowering of average quality as harvesting moves eastwards.	1
Prohibit sawmill companies from owning logging companies and further investigate a modified version of whole-bole logging.	1
Introduce new harvesting practices suited to improved utilisation of	1

regrowth forests.	
Improve the utilisation of felled trees by lowering stump heights and providing end protection.	1
Change hardwood log specifications from random lengths to order lengths and remove the anomalies between species and between softwoods and hardwoods.	1
Inventory should account for logs stolen and not recorded from logging coupes.	1
The management and priorities of CALM's Timber Technology centre at Harvey should be reviewed.	1
Prior to logging a full appraisal of quantities and grades of timber felled should be made. Quantities and grades sold off coupes should be audited.	1
A licence system was recommended by the parliamentary standing committee on ecologically sustainable development to replace current system of commercial timber contract.	1
4 ESFM	
<i>The precautionary principle</i>	
The precautionary principle should be applied to minimise risks to forest ecosystems.	1
Difficult to use as a criterion of ESFM.	1
Summary of Ehrlich's (1996) criteria for a precautionary approach presented.	1
The precautionary principle can be interpreted in a number of ways and there is potential for it to be misapplied.	1
Should not be interpreted as "when in doubt do nothing".	1
Application of the precautionary principle is important as serious and irreversible damage is occurring.	1
Criteria to be used to measure 'sustainability' needed. Without criteria for assessing outcomes approach adopted is not precautionary.	1
Alcoa has applied the precautionary principle in relation to a range of the company's activities and procedures in the forest.	1
Alcoa has made a commitment that bauxite mining will not take place in the eastern, lower rainfall portion of their mining lease until research shows that mining operations can be conducted without significantly increasing the salinity of water resources.	1
Difficult to interpret.	1
Difficult to apply as a criterion of ESFM.	1
5 ESFM principles	
<i>Conservation of biological diversity</i>	
Strategies appropriate for homogenous forest environments not appropriate in areas of rapid change in biodiversity such as across south-	1

western landscapes.	
There is a paucity of biodiversity data in relation to the eastern margins of the jarrah and wandoo forests.	1
There are yet to be acknowledged values of the diverse range of plants and animals in the South West.	1
Major forest corridor for faunal movements, Nannup-Walpole proposed.	1
Zones free of disturbance should be included in logging plans to provide habitat in the long term.	1
Extent of disturbance in jarrah forest over past ten years of concern.	1
Adequacy of current provisions for fauna habitat questioned.	3
Wildlife conservation requires monitoring with real thresholds for managing change.	1
Fragmentation affects the ecology of forests in various important ways.	1
Clearfelling results in loss of biodiversity.	1
Surveys of flora, fauna and micro-organisms should precede the determination of sustained yield.	1
Logs left to rot on the ground contribute to biodiversity.	1
The mix of species changes as a result of logging. Areas that supported mixed species prior to logging but planted to karri post logging of concern.	4
The CAR reserve system adopted as part of the RFA is adequate.	1
Greater reservation will put increased pressure of logging on regrowth forests.	1
Level of reservation recommended in RFA. In many areas criteria for reservation set by JANIS criteria exceeded.	1
Provision for wildlife corridors should be made in regrowth, to link areas of reserved forest.	1
Care in seed collection and selection of genotypes of seedlings used in regeneration should be taken.	1
Preservation of genetic diversity crucial in the long term.	1
Populations of plants and animals should not be genetically isolated.	2
Current karri regeneration methods compromise biodiversity.	1
Alcoa has made a series of commitments to ensure biodiversity is maintained, including a commitment not to mine in areas of the conservation estate. They participated in the RFA process to establish a CAR system.	1
Alcoa has a number of protocols for the protection of rare species and threatened communities. High value habitats such as swamps are valued.	1
Significant emphasis is placed on re-establishing plant species diversity in rehabilitated bauxite mining areas.	1
Bauxite mining industry has contributed to fox control.	1
An ongoing woodchip industry is of great importance to ensure regeneration and provide an acceptable method of disposing of residues.	1
Areas of State forest which are no longer contributing to sustained yield put enormous pressure on other areas of good stands of trees.	1

Large areas of forest no longer contribute to the sustained yield because of past cutting practices and ways to redress this should be explored, even to the point of planting exotic species.	1
Alcoa maintains extensive research and monitoring plots to assess the growth and development of the new forests.	1
Current mine rehabilitation practices should be reviewed to determine whether future timber production can be enhanced.	1
Waterlogging affects regeneration of jarrah.	1
The ways of maximising growth rates and productivity in different areas should be tested.	1
Diseases such as Armillaria are impacting of regrowth karri.	1
Rates of karri planting suggest overstocking.	1
Greater flexibility should be given to improving productivity in production areas or wood production unlikely to be economically sustainable.	1
There are inadequate provisions for managing regeneration in the reserve system.	1
Productivity of jarrah in areas of bauxite mining rehabilitation has recently been assessed.	1
Some dieback degraded areas of jarrah forest in the vicinity of bauxite mining have been rehabilitated and treated to minimise effects of the disease.	1
Amount of silvicultural, non-commercial thinning considered inadequate.	1
Jarrah regeneration should be reviewed.	1
Regrowth forests should be selectively logged to maintain uneven aged forest that maintains its ecological integrity.	1
Wood chipping and removal of logs for charcoal required to ensure regeneration and minimise waste.	2
Regeneration should be over the total forest, not just in production areas.	1
<i>Maintenance of health and vitality of ecosystems</i>	
Efficacy of disease prevention measured questioned.	1
Protection of the total forest from fire, pests, diseases and unwise human use should be ensured.	1
Management priorities for both regrowth and old-growth forests in reserves should be reviewed.	1
Recent changes to long-term strategic logging plans heighten the risk of major wildfires.	1
The ability to control pests and diseases in the conservation forests limited and will require changes.	1
Almost all forest operations affect site hydrology and jarrah is extremely sensitive to waterlogging.	1
Slowly rising ground water will reduce rooting volume and result in trees being more prone to summer drought.	1
Comment that basic ecosystem processes are compromised by logging.	1

Alcoa aims at restoring a self-sustaining jarrah forest ecosystem.	1
Alcoa is committed to minimise spread and impacts from <i>P. cinnamomi</i> .	1
Species exotic to the jarrah forest but introduced in early rehabilitation trials are being monitored to ensure that any spread is not left uncontrolled.	1
<i>Maintenance and conservation of soil and water</i>	
Additional protection measures are being developed between Water and Rivers Commission and CALM to protect water supply catchments from chemical contamination and from soil erosion and consequent turbidity problems in wetlands and waterways.	1
Water and Rivers Commission and CALM are working to ensure that sustainable ribbons of riparian vegetation are retained along streams. Timber-harvesting contractors are also being trained to understand the stream protection measures developed.	1
The existing stream reserve system is adequate but could be better targeted to priority areas. Protection measures near reservoirs and at road crossings could be improved.	1
Continual logging and burning will affect growth rates of all plants and soil structure will change.	1
Any proposals to thin forest to increase run off for water storage should be the subject of a dedicated inquiry.	1
Bauxite mining into the eastern jarrah forest where saline water tables may be present should be scrutinised.	1
Lack of data on soil health of concern.	1
Effects of clearfelling on soil characteristics and microbial activity raised.	1
Salinity is a major issue and must be adequately addressed with respect to logging and effects on jarrah regeneration.	1
Clearfelling or loss of forest canopy results in less local rainfall.	2
The sensitivity of jarrah to waterlogging and the lack of protocols for managing water within the forest should be considered.	1
Alcoa implements a range of policies and gives high priority to their implementation to ensure that soil and water resources are protected in areas of mining.	1
<i>Maintenance of global carbon cycles</i>	
Alcoa has started to develop a model that predicts that carbon losses from clearing before mining and the consequent sequestration of carbon by the rehabilitation.	1
Mature forests store significant amounts of carbon.	1
Alcoa has tried to develop ways to minimise 'burning to waste' forest products prior to mining.	1
<i>Protection of natural and cultural heritage values</i>	
The heritage values of forests should be protected.	1

Large granite outcrops are left undisturbed along with 50m wide buffers around them in areas of bauxite mining.	1
Alcoa conducts Aboriginal and European heritage surveys on areas proposed for mining.	1
Adequate surveys to ensure CALM does not breach the Aboriginal Heritage Act.	1
<i>Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies</i>	
The impacts of the level of harvesting on the socio-economic structure of communities must be considered.	1
Impacts on timber industry viability of any reduction in size of logs supplied should be considered.	1
Yield regulation on sawlogs likely to maximise the community benefits to be derived.	1
Wood should be valued more highly and used with care.	1
Reduction in volumes of wood available will create unemployment.	1
Restructuring of the timber industry should result in a fewer, better resourced companies with the capacity to invest in greater downstream processing.	1
Different socio-economic circumstances apply to the question of logging in different forest regions. Therefore with respect to some issues whole of forest approach not appropriate.	1
1,313 people are employed directly in the native forest timber industry.	1
The costs, to the people of Western Australia associated with logging of native forests, are not adequately accounted for. Some are quantifiable but many adverse environmental effects are not.	1
The attitude that "you can chop down someone else's forest as long as it's not in my backyard" most strongly objected to.	1
If the sustained yield of logs is set too low the timber industry will not be economically viable.	1
Changing social attitudes to the use of forests and factors affecting use of different products as substitutes for timber.	1
There are substantial costs related to forestry that are not met by CALM but the public of WA.	1
The perceived profits the State makes from logging native forests have resulted in unsustainable logging levels.	1
The economic benefits of logging are questionable and forests may of greater value left standing.	1
Balanced multiple use of our forests is for the benefit of all Australians.	1
Questions raised as to how community values taken into account when logging coupes designed.	1
The community and societal values of the South West timber towns must be considered. Consultation with them essential.	1
Time frames for implementation of ESFM and the calculation of sustained yield and effects on socio-economic structure of communities.	1

Alcoa (bauxite mining) employs 3,800 people in WA and injects \$1.1 billion a year into the State's economy.	1
6 Tourism and recreation	
The benefit of large-scale areas of forest reservation is that they can be promoted internationally.	1
Tourism opportunities within the Northcliffe area have already been compromised by the level of logging in the area.	1
Impacts of timber harvesting must be taken into account in the South West.	1
Tourism and recreation values must be included in any assessment of the forest.	1
The value to communities of the forests for tourism, recreation and water has been undervalued.	1
There is a shifting focus to tourism in areas that have relied on the timber industry for income generation in the past.	1
Forests as a resource for tourism raised.	2
Tourism can ensure long-term economic survival of local communities.	1
7 Specific timber industry issues	
Greater value adding of WA timbers should be encouraged.	1
The timber industry must have security and certainty of log supply.	4
Waste should be minimised.	1
Ways should be identified to foster greater uptake of lower grades of logs.	1
Concerns expressed about declining quality of logs available to industry.	1
Whole bole logging if adopted should be tried to determine the acceptability of the system to industry and to explore issues associated with its regulation within the context of ESFM.	1
Research and development should be undertaken to foster greater industry uptake of smaller regrowth logs.	1
Sustainable level of cut needs to be determined to provide for a secure future for the timber industry in WA in perpetuity.	1
Relevance of the forest industry structural adjustment guidelines should be assessed with respect to outcomes of current review.	1
There should be a greater reliance on plantation timbers.	4
The Whittakers mill in Greenbushes should not be jeopardised by a reduction in the sustainable yield.	1
The timber industry has already suffered major reductions in wood to be supplied and this should be taken into consideration.	1
More flexible silvicultural prescriptions could result in a doubling of wood production.	1
The small and short log, resource offers the best opportunity for a sustainable expansion of the jarrah industry.	1
Industry must try new methods to improve the quantity of each grade of marketable timber recovered from all logs milled.	1

There should be greater uptake of non-sawlog material.	1
Regrowth jarrah logs cut in a trial had a high incidence of defect.	1
The quality of regrowth logs of a rehabilitated bauxite pit were of superior wood quality than 60-year-old natural regrowth logs.	1
It is difficult to eliminate in forest waste totally.	1
Security of available resource for the timber industry is essential for any ongoing investment in the industry.	2
As much of the RFA should be retained as possible.	2
Funds for research and development are essential, as technologies for coping with a small log resource have to be developed.	1
The timber industry has already voluntarily stepped down the timber it will take as part of the RFA, to provide for an ongoing sustainable jarrah timber industry.	1
8 Mining	
Since 1962 Alcoa has mined 12,000 hectares of the jarrah forest and rehabilitated 9,500 hectares. The company has committed to implementing ESFM principles.	1
9 Public consultation and transparency	
Frustration with lack of response to past submissions on forests expressed.	1
Lack of trust expressed in CALM figures on which asked to comment.	1
Time to properly address issues often limited.	1
Public spectators not participants in decision-making.	1
None of the issues raised in submission on draft terms of reference was addressed.	1
10 Next Forest Management Plan (FMP)	
The panel should not become involved in the formulation of the next Forest Management Plan.	1
Local resistance to logging in particular areas should be countered by aiming for a greater appreciation of the values of the overall FMP.	1
Conflict between values should be dealt with during development of next FMP.	1
A wish expressed to see the current review expedite implementation of the new FMP.	1
Review should be finalised before the development of the next FMP.	1
More importance should be given to the social and economic impacts in developing the next FMP.	1
Further planning should be based on the RFA goals and objectives.	1
Responsibility for next FMP should remain with the foresters of CALM and the Forest Products Commission.	1
The RFA agreement should not be 'watered down further' and should be basis of next FMP.	1
The next FMP should embrace a new approach to the management and	1

utilisation of our native forests.	
RFA knowledge base on ecology of both jarrah and karri forest was inadequate.	1
11 Protection of old-growth, two tiered forests and forests of high conservation value	
Old-growth and ancient forests should not be logged.	16
Two-tiered forests should be protected.	9
High conservation value forests should not be logged.	3
12 General comments	
The types of conclusions stated in Meagher (1993) quite unsatisfactory.	1
A Royal Commission or inquiry should be held into forestry in WA.	4
The timber industry is the most sustainable industry in the world.	1
Current logging levels are ecologically unsustainable.	1
Current logging is at unsustainable levels.	5
Further reduction of logging in native forests will affect imports from unsustainably managed forests elsewhere, increase the pressure on farmlands for plantations, see a rise in exploitation of private forests, increase the State's dependence on imported resources, increase the use of steel which is a non-renewable resource.	1
There should be less prescribed burning if management was focused on improved fire suppression capability and the use of new aerial suppression aircraft.	1
If the native forest timbers are under valued just to compete with imports, our economic, social and ecological standards will decrease to those of poorer nations.	1

2.3 Main themes

There was considerable discussion on the definition of Ecologically Sustainable Forest Management and perceptions varied greatly as to the relative weighting of values for different areas including reserves and production forests. There was little consensus as to the scale at which allowance for Ecologically Sustainable Forest Management values should be made.

The main themes, of relevance to the Panel's deliberations were as follows:

- Issues that relate to the maintenance of biodiversity.
- The importance of forests for tourism and recreation.
- The many challenges in managing the reserve systems for the maintenance of Ecologically Sustainable Forest Management values and resources. Resources will be required to tackle a wide range of problems including diseases, feral animal control, weeds, fire and structural diversity.
- Concerns about global warming and trends in rainfall.
- The maintenance and enhancement of productivity over the regrowth estate. Suggestions were various and ranged from sawlog expectations off mining rehabilitation areas in the northern jarrah to silvicultural systems for karri regeneration.
- The importance of monitoring, compliance reporting and audit were also referred to with respect to a number of issues.
- Questions and concerns about the size and quality of regrowth logs. The need to foster greater uptake of lower grade logs from the forest was acknowledged by a number of parties. Many suggestions were made with regard to minimising waste and maximising recovery.
- The importance of security and stability for the timber industry and planners.
- The Forest Management Plan needs to clearly document how Ecologically Sustainable Forest Management objectives are to be met, managed for and evaluated.

The Panel is aware that the implications of the recent major changes in forest policy are not yet widely appreciated. There are major ramifications for the timber industry yet to be grappled with. Some effort will be required during the development of the next Forest Management Plan to increase public understanding of some of the issues associated with the withdrawal of substantial areas of forest from sustained yield calculations.

Recommendation 2.1, Informing the Public

As part of the process involved in preparing the next Forest Management Plan, the Conservation Commission should ensure that recent changes in Government policy, the principles of Ecologically Sustainable Forest Management, and the key elements supporting the planning process and calculation of sustained yield, are widely promulgated and understood.

3 CALCULATING SUSTAINED YIELD

3.1 Introduction

Native forests, totalling approximately 2.42⁶ million hectares, are vested in the Conservation Commission of Western Australia and managed by CALM. The Forest Products Commission manages commercial logging, thinning and associated regeneration and protection activities. Logging is only permitted on that portion identified for multiple use purposes in State Forest and Timber Reserves. About 36% of the public land managed by CALM within the Regional Forest Agreement boundaries (or 45% of the native forest managed by CALM) is available for logging. A sustained yield of sawlogs is derived from these areas.

To preface the more technical review of the calculation of sustained yield, a more general commentary may be useful. In Chapter 1, sustained yield was defined to be the capacity to maintain relatively consistent levels of production or products over an extended period. One way of approaching that would be to measure growth over the entire forest available for wood production and to set the sustained yield at that level. But that presumes that the forest is everywhere in an ideal condition to provide that level of production. In places it carries too few standing trees and in places too many, reflecting the chequered history of human and natural disturbances. Hence it is necessary to take account both of the growth and the current inventory of standing trees.

Various reports in and subsequent to the Regional Forest Agreement process⁷ have provided detailed descriptions of the methods used in calculating sustained yield. They identify the steps in the calculation of sustained yield as:

- identifying net areas;
- estimating standing sawlog volume;
- predicting future growth or volume;
- modelling potential wood flows to calculate sustained yield;

The following sections provide brief abstracts of these steps involved in the calculation of sustained yield updated, where necessary, to reflect more recent changes. These sections focus on what the Panel believes are the key estimates in the calculation of sustained yield, the hazards to them and their likelihood, and the risks and recommended responses to those risks.

⁶ The area of native forest (as at December 2000) within the Regional Forest Agreement and vested in the Conservation Commission of WA was:

Public land within the RFA boundary	2.42 million ha
Public land managed by CALM	2.35 million ha
Native forest managed by CALM	1.91 million ha
Native forest available for timber prodn.	0.856 million ha

⁷ Turner, B.J., 1998. *An Appraisal of Methods and Data used by CALM to Estimate Wood Resource Yields for the South-West RFA Region of Western Australia*. Cwlth & WA RFA Steering Committee. 36pp.; Ferguson et al (1997, Assessment of Ecologically Sustainable Forest Management in the South-West Forest Region of Western Australia: Report of the Independent Expert Advisory Group. Commonwealth and Western Australian Regional Forest Agreement (RFA) Steering Committee, Bentley, 119pp.; Turner, B., Ferguson, I. and Fitzpatrick, N., 1999. *Report By The Expert Panel On The Calculation of a Sustainable Sawlog Yield for the Jarrah and Karri Forests of WA*. Cwlth & WA RFA Steering Committee. 16pp.; Ferguson et al., 1999. *op. cit.*

3.2 Identifying net areas

The term 'net areas' refers to the areas of publicly-owned native forest on which timber production is a permitted activity, i.e. the gross areas **minus** all those areas of reservations and other exclusions in which timber production is not permitted.

The net areas available for wood production represent key variables in the calculation of sustained yield. Using a Geographic Information System, the net areas are derived by superimposing known reserves and exclusions, such as the prescribed buffers on streams, on a map showing roads, rivers, streams and property boundaries. Additional information on forest types is derived from interpretation of aerial photography, followed by field checking, and is of quite high accuracy by world standards.

The interpretation includes detailed delineation of strata by species mixtures (e.g. jarrah, jarrah-marri, karri, karri-marri, karri-marri-jarrah, etc) and broad height classes. The species mixtures are broadly reliable but cannot be expected to be highly accurate locally in the more subtle distinctions (e.g. jarrah vs jarrah-marri, karri-marri, vs karri-marri-jarrah, etc) given the difficulty of identifying these and the variability inherent in these forest types. From the viewpoint of the sustained yield, these finer distinctions between species are of lesser concern if the field inventory system adequately and representatively sample the strata, because the overall species composition is then adequately reflected in the data for the stratum concerned. Some 600 strata are recognised in the jarrah forest, based on tenure, region, rainfall, height, history of cutting, current structure and whether or not mined. Within each stratum, there is further subdivision into six silvicultural classes (called cohorts) – thinned, gap creation, shelterwood, temporary exclusion areas, selective logging and dieback. Some 80 strata are recognised in the karri forest based on species mix and cutting history, together with four silvicultural classes – three site quality levels and a fourth of predominantly senescent forest. Wherever boundaries can be clearly identified, either from cadastral data or photo-interpretation, net areas can be calculated accurately.

Low volume patch identification

The difficulty of identifying patches of forest, generally of less than 1.5 ha in extent, that do not carry sufficient volume to be harvested economically, poses a hazard to the calculation of sustained yield. Considerable progress has been made in recent months to identify patches that are too small to harvest but which in aggregate contain significant volumes of timber. These areas are removed from consideration as volume available for harvest or deferred for later harvest when adjacent larger patches of regrowth or other species are to be logged. Similarly, areas that are artefacts of mismatching databases have been identified and corrected.

There are however relatively large patches of forest in some areas that contain marginal volumes in terms of economic harvest. These are often difficult to determine with precision well into the future because operational and economic constraints may change over time. Estimates of these areas are made on the basis of past harvesting data and applied as percentage reduction in available resources, or mapped by specific surveys and removed from the resource base as a mapped unit. The residual risk to yield estimation is low provided that harvested areas are monitored and adjustment to databases maintained. Related issues of local and site-specific reservations and temporary exclusions are discussed in Section 3.5.

3.3 Estimating standing sawlog volume

Jarrah inventory

In the jarrah forest, initial estimates of standing sawlog volume for a stratum are derived from the product of the net area of a particular stratum times the average volume per hectare derived from periodic field sampling with temporary inventory plots. The estimates of standing volume are by far the most critical data in the calculation of sustained yield because the existing jarrah forest is slow-growing. CALM currently has a well developed system of field inventory in the jarrah forest based on 26,830 photo plots and over 2,900 field plots which is capable of producing resource estimates of standing volumes with a precision adequate for the calculation of sustained yield, assuming current standards of utilisation prevail. A key feature of the inventory system is the complete measurement and description of sample trees to enable reprocessing of the datasets as product or utilisation specifications vary. Changes in utilisation standard can be analysed, if required.

However, the Panel has noted that for a variety of reasons, the application of jarrah silvicultural systems over broad areas of a stratum will vary in places from the planned silvicultural prescriptions for the stratum, and therefore may result in either more or less volume per hectare being removed than was anticipated. While this poses a low likelihood hazard to the inventory, it suggests that attempts should be made to refine the stratification for silvicultural and later growth prediction purposes (see Section 3.3). The residual risk is low because small continuing biases in the volume per hectare removed principally impact on the cutting cycle and affect the sustained yield very little.

Recommendation 3.1, Jarrah Stratification

Progressive improvement of jarrah stratification for silvicultural and growth prediction purposes should be initiated during the next Plan period. This work needs to be closely integrated with a later recommendation on jarrah growth models.

Karri inventory and utilisation standards

In the karri forests, the inventory system used for mature forest is not appropriate to the utilisation of regrowth forest, whose use will rapidly accelerate in the light of recent policy changes introduced by the current Government.

The large increase in reservation of old growth and other forest in Western Australia not only results in a large reduction in yield but also a dramatic increase in the reliance on smaller karri logs after 2003. The result is that a much higher proportion of the sawlog supply will be in logs at the low end of or below the current specification. Not only is there a lower recovery of sawn product from small logs, but they do not produce the same range of products that is possible from larger logs. Size and quality are also strongly associated; more defect being tolerable in a large log than in a small one for the economic recovery of sawn timber.

Unlike jarrah, changes in karri log size and quality will be sudden and substantial. The likelihood of this hazard is therefore high. Because sawlog utilisation standards are to some extent unknown, because of the very different technology and economic conditions pertaining, the inventory needs to be designed to permit continuous review of the changing utilisation standards, especially with respect to size. This highlights that the risk is high.

The marked change in the size of karri sawlogs after 2003 poses an immediate and significant hazard in estimating the proportion of the total future yield of karri that will be accepted as sawlogs. These logs will not only be smaller but a greater proportion may be affected by defect associated with borer activity (see Section 4.2). The new utilisation

standards will not be known in time for the current revision of the Plan. A conservative approach to calculating yield should therefore be adopted in current revision of the Plan, until more experience has been gained with the utilisation of small logs and realistic specifications can be confirmed. The risk to the sustained yield calculation of log volume is not high because the stratification and inventory of the regrowth component can reliably estimate total log volumes and product assortments within them to current specifications. For example, the same log assortment processing routines as used in the jarrah inventory have been adapted for use in estimating regrowth karri log size and quality assortments.

Recommendation 3.2, Karri Inventory and Utilisation

- (1) The karri inventory should continue to be adapted to handle changing utilisation standards in log recovery, especially with respect to size and quality, during the next Plan period.
- (2) The current revision of the Plan should take a conservative approach in the estimation of karri sustained yield based on current standards of small log utilisation.
- (3) Research on the utilisation of small karri logs should be initiated as soon as possible.

Jarrah utilisation standards

In jarrah, the shift to smaller and/or poorer quality sawlogs will be more gradual reflecting the progressive tightening of supply of larger logs and utilisation of regrowth logs following the cessation of logging old growth and the additional reservation of jarrah forest introduced by the current Government. The direction of the risk in jarrah is more favourable in that utilisation standards are more likely to embrace somewhat smaller and poorer grades of logs in the future. This reflects the more diverse markets for jarrah furniture and appearance grades of relatively short length. Thus the residual risk to the calculated sustained yield is low, because the changes are more likely to increase the standing volume and hence the sustained yield.

Monitoring utilisation is a critical step in volume estimation. The feedback from these data is used to adjust estimates and can have a significant impact on the estimated volume available. Monitoring is particularly complex where partial cutting is involved, as in the jarrah forest, because it is not possible to simply compare total volume removed with total volume estimated on a whole coupe. Comparison can only be achieved by detailed post-harvest field sampling. There is a need to ensure that this monitoring is adequately resourced. In addition to continued monitoring, research is needed in the next Plan period on the best forms of utilisation and technologies for processing smaller and lower grade jarrah.

Recommendation 3.3, Jarrah Utilisation

During the next Plan period:

- (1) monitoring of the actual utilisation of jarrah log sizes and grades should be maintained and used in adjusting volumes in coupes to be logged on the simulation of wood flows.
- (2) research on the utilisation and technologies for processing smaller and lower grade jarrah logs should be pursued.

Jarrah silvicultural guidelines

The jarrah silvicultural system currently in use was approved for application by the Minister for Environment in 1992 on a trial basis, subject to review. The guidelines include gap creation, shelterwood and thinning. Following CALM's major Progress and Compliance Report of December 1997, the Environmental Protection Authority (EPA) Bulletin 912 of November 1998 provided advice to the Minister for the Environment in relation to compliance with Ministerial Conditions attached to the Forest Management Plan.

The EPA raised concerns regarding a number of issues in relation to Condition 11 relating to:

- the Kingston forest ecology research not having been carried out on a representative range of sites;
- information on the success of establishment and release of regeneration.

The report by Mr Michael Codd (January 1999) noted that CALM had submitted a report to the Minister recommending approval of requirements for Condition 11. CALM's report focussed on using the proposed Forestcheck monitoring system to provide compliance with this Condition. The EPA was to provide advice to the Minister within three months regarding CALM's proposal. The EPA advised the Minister in August 1999 that a determination should not be made until the issue is referred to the Forest Monitoring and Research Committee. However, this committee has been inactive and the issue remains unresolved.

CALM must report to the Minister for the Environment on the outcomes of the implementation of the silvicultural prescriptions and on monitoring and any modifications required by 2002 as part of the Ministerial Condition 11 in preparation for revision of the Plan.

CALM must also report on Ministerial Condition 12 on phased logging and its impact on salinity and Ministerial Condition 16 on catchments of high salt risk. While it would be unproductive and contrary to the legislation to vary these requirements at this stage, responses to Ministerial Conditions tend to be somewhat arcane and may not be helpful in informing the public. The Panel believes that there is public concern about three key elements of the silvicultural guidelines relating to:

- regeneration adequacy, including methods of assessment;
- salinity constraints for silvicultural prescriptions;
- habitat provision for the maintenance of biodiversity and ecological processes including the outcomes of the forest ecology study in the Kingston area.

The Panel therefore believes that CALM should complete its responses to the Ministerial Conditions as soon as possible. The Conservation Commission should then provide, as a matter of urgency, a more integrative review of silvicultural guidelines with respect to the three key elements listed above. The aim of this review should be to inform the public to facilitate the revision of the Plan, including the likely impacts on sustained yield.

Given the time available and the need for wide circulation, the Panel recognises that this review will require resources beyond those immediately available to the Conservation Commission. However it believes this is one of several critical elements in the current revision of the Plan that the Conservation Commission needs to lead and promote.

A review of this scope and complexity will address a number of hazards that collectively have a moderate to high likelihood, and risk of impacting on the calculation of sustained yield. Given the short period of time available to complete this review, some matters will not be capable of final resolution, and the review should also indicate monitoring and research needs and priorities needing to be implemented in the next Plan period.

Recommendation 3.4, Jarrah Silviculture

- (1) The Conservation Commission should, as a matter of urgency, and following the completion of the CALM reports on the Ministerial Conditions, prepare a review of the silvicultural guidelines with respect to regeneration adequacy, salinity constraints, and habitat considerations to inform decision in the current revision of the Plan.
- (2) The review should also indicate monitoring and research, priorities and funding needed in the next Plan period.

Allowances for habitat trees are factored into the calculation of yield by applying the retention rate specifications in silvicultural guidelines to stand tables used in yield prediction. If retention rates were modified as a result of this review, the specifications and allowances applied to stand tables would need to change.

Regeneration on some jarrah-marri sites (especially in the south) often initially favours marri, resulting in the dominance of marri in the earlier stages of stand development, though this balance may shift with age⁸. The species have different growth rates, and different commercial uses. Silvicultural intervention by way of early 'crown release' and by thinning can be used to alter subsequent stand composition.

Early non-commercial 'crown release' has the potential to improve jarrah dominance in these stands but has yet to be evaluated because there are few stands of suitable age available. This should be done in the next Plan period.

The economic viability of thinning in marri-dominated stands depends on markets for small marri logs. At present chipwood is the only market for these logs. The importance of encouraging the continuation of markets for thinnings from silvicultural operations is discussed elsewhere in this report.

There is a low likelihood of this hazard and a low residual risk that future sawlog availability will be predicted less precisely than is desirable, if some areas of jarrah-marri forest change composition towards more marri. Nevertheless, yield predictions for jarrah-marri forest should consider this possibility, and sensitivity analyses should be conducted in calculating the sustained yield in the current revision of the Plan.

Recommendation 3.5, Jarrah-Marri

Calculations of sustained yield for jarrah-marri forest in the current revision of the Plan should determine the sensitivity of the yield to the possible lack of commercial thinning opportunities.

Marri sawlog utilisation

The changes in reservation in the southern forests have significantly affected the yield for marri sawlogs. The Ministerial Advisory Group Report on karri and tingle management⁹ noted the difficulties in assessing the sawlog volume in standing marri without destructive sampling. By far the greater amount of potential marri sawlog was located in recent reservations in the Southern Region. In the Swan and Central Regions, marri is much more affected by fire and other factors and prolific kino veins and water shakes are much more common in these regions. Only a minute fraction of standing marri from favourable sites in these regions is likely to be suitable for sawlogs. While some marri sawlog will still be available from cut-over southern forests, the Panel believes that this will be negligible in terms of its contribution to the overall sustained yield. It therefore recommends that the yield of marri sawlogs should not be formally considered in the current revision of the Plan but monitoring of, and research on, the utilisation of marri sawlogs should continue.

Blackbutt and wandoo represent similar issues with respect to the calculation of sustained yield – both being in such small volumes that they are negligible in relation to the calculation of sustained yield for individual regions or the whole forest.

⁸ Stoneman, G. L., Rose, P. W. and Borg, H. 1988. Recovery of forest density after intensive logging in the Southern Forest of Western Australia. *Department of Conservation and Land Management Technical Report No 19.*

⁹ Ferguson *et al.*, 1999. *op. cit.*

Recommendation 3.6, Marri Sawlogs

Calculation of the sustained yield of marri sawlogs should not be formally considered in the current revision of the Plan but monitoring of, and research on, the utilisation of marri and other minor species sawlogs should continue.

3.4 Determining future growth or volume

Jarrah growth models

Future volume is based on a model of predicted standing volume over time varied according to the strata and its silvicultural history. The yield at each harvest is based on a nominated silvicultural practice (e.g. thinning, partial harvest, clear fell etc) at a particular time. No growth is attributed to mature jarrah (over 200 years) or karri forest (over 100 years). Jarrah forests are covered by a series of growth plots and the systems of establishment, research and re-measurement are generally appropriate.

The reliability of the wood flow estimates is heavily dependent on the predictions of harvest yields per hectare in terms of timing as well as level. These estimates are derived from a combination of standing inventory, growth plot data, yield models, feedback from harvest records, utilisation monitoring and expert judgement. As noted earlier, there is a need for more growth data to inform this process, especially relating to current jarrah silviculture. However growth plots can never be expected to represent every variant in site and structure and will always lag behind current silvicultural practice. Nor does growth directly equate to yield. For these reasons a combination of data sources will always be necessary to arrive at yield estimates. The transparency of the present system is a valuable feature in this respect.

Predictions of standing volumes and yields for karri have a relatively high degree of precision. Jarrah forest, which has a more complex structure and to which more complex silviculture is applied, has lower precision. Because of its complexity and the more variable site-by-site silviculture that is applied, there are realistic limits to the precision that may be achieved by modelling. Continuous monitoring, maintenance of databases and regular reviews of yield predictions (at least every 10 years) represent an important safeguard.

The hazards, risks and recommendations are similar to those of Section 3.3. The Panel draws attention to similar recommendations in recent reports¹⁰ that new growth models are required for a wider array of silviculture and sites. Research on new growth models reflecting a wider array of silviculture and sites should be initiated in the next Plan period, closely integrating that process with the corresponding recommendation on jarrah inventory, and maintaining transparency of the models used.

Recommendation 3.7, Jarrah Growth

Research on new jarrah growth models reflecting a wider array of silviculture and sites should be initiated in the next Plan period, closely integrating that process with the corresponding recommendation on jarrah inventory, and maintaining transparency of the models used.

Karri growth models

In purer karri forest, reliable growth models exist for clear-felling systems and take account of variations in site productivity. Continued monitoring of and adjustment to growth models will be required to incorporate new data and take account of the effect of initial stocking on

¹⁰ Turner, 1998; Ferguson *et al.* 1997; and Turner *et al* 1999, *op. cit.*

the growth and clear bole development of karri. Although the likelihood of hazard to the karri sustained yield is currently low, the rapid acceleration of harvesting in the regrowth forest after 2003 will increase the hazard to high by the end of the next Plan period, and the risk correspondingly. Further research is needed to improve the growth models in the second half of the period of the Plan.

Recommendation 3.8, Karri Growth

Further research should be pursued to improve the karri growth models in the second half of the period of the Plan.

Fire allowances

Both prescribed fire and wildfire can impact on log quality and sustained yield in a number of ways and represent hazards to future sawlog volume, especially in karri. Planning and fire management operations aim to minimise extent of fires by keeping strategic areas at low fuel levels and by maintaining effective fire detection and suppression capability.

A reduction of 0.1% in the area of jarrah forest harvested per year is made in recognition of the average losses incurred in wildfires. This may seem small, but accords with the historical statistics, remembering that jarrah is a hardy species, which may be damaged but is seldom killed by fire. The risk to jarrah from prescribed fire is generally low, as the immediate dependence on regrowth forest is less, and the period of fire sensitivity is largely confined to the first ten to 15 years after regeneration.

Karri is much more fire sensitive, as regrowth stands are vulnerable to low intensity fires until their age exceeds 20 years, and a reduction of 1% of the area harvested per year has been made in the calculation of sustained yield. In view of the increased risk associated with dependence on a more vulnerable regrowth resource, this allowance should be reviewed. The issue of protection of regrowth also needs to be resolved as it is now critical to the future sustainability of the industry. For example, a loss of 2,000 ha (not a large fire) of 20 to 30 year-old regrowth would create a very serious gap in the later capacity to sustain the sawmilling. Few possibilities for salvage of this material currently exist. As in the jarrah forest, decisions will need to be guided by the precautionary principle – in particular, by the risk-weighted consequences of the options.

Because of the vulnerability of the karri regrowth forest, the Government needs to ensure that the institutional arrangements between CALM and the Forest Products Commission provide adequately for continuing fire protection of the regrowth karri estate.

Recommendation 3.9, Regrowth Karri Fire Risk

- (1) A recalibration of the allowance accorded to the risk of fires relating to the karri regrowth resource should be carried out in the current revision of the Plan.
- (2) The Government needs to ensure that the institutional arrangements between CALM and the Forest Products Commission provide adequately for continuing fire protection of the regrowth karri estate as soon as possible.

Bauxite mining sites

Timber removals from bauxite and other mining sites are accounted for in yield estimates based on company plans of mining operations over a five-year period and anticipated operations between five and 25 years. Such sites are identified as mined sites and are subsequently treated as jarrah-regrowth forests. Growth information from rehabilitating forest is collected by companies. After the standard logging allowances have been made for the loss of area in roads etc, the net areas are carried forward as areas of production forest, with due

allowance for the time lag due to mining and completion of regeneration operations. Growth rates and rotation lengths for the rehabilitated forest are the same as the pre-mined productivity classification. Uncertainty surrounds how well growth rates of forests on mined sites mirror those of regenerating natural forest. The likelihood of hazard to the calculation of sustained yield is high given the annual areas involved and the long-term extent of mining. The recommended response is to institute a program of comparing growth rates and net area estimates on rehabilitated mining sites with those used in yield calculations during the next period of the Plan.

Recommendation 3.10, Rehabilitated Mining Sites

Research should be undertaken comparing growth rates and net area estimates on rehabilitated mining sites with those used in yield calculations during the next period of the Plan.

3.5 Modelling potential wood flows to determine sustained yield

The system used by CALM to predict wood flows into the future is based on a simulation process. The forest is divided up into different strata; a silvicultural and harvest regime is determined for each stratum; and the yield at each simulated harvest is estimated. The summation of these simulated yields over all the strata provides the predicted wood flow over time. Different regimes can be applied to all or part a stratum to generate different wood flows. A major advantage of this system is that the assumptions are transparent and yields are based on silvicultural prescriptions and experience rather than on theoretical growth rates. This reduces the risk of calculating unrealistic yield estimates.

An array of areas is excluded from harvesting within the areas available for timber production, in order to protect other values. They include at the landscape level:

- retention of patches of mature karri forest at least every 400m – *biodiversity conservation*;
- travel route zones – *landscape aesthetics*;
- stream buffer zones – *turbidity, salinity, conservation and aesthetics*.

And at the coupe level:

- maximum specified gap size (jarrah 10 ha, karri 40 ha) reducing in sensitive landscape zones – *landscape aesthetics*;
- reservation of areas to protect rare and endangered species – *flora and fauna conservation*.

In addition to area reservation there are permanent reservation of some individual trees (habitat trees) and temporary reservation that impacts on wood flow over time:

- retention of habitat and potential habitat trees – *fauna conservation* (permanent reservation);
- limitation on intensity and timing of harvest in salt sensitive zones at second order catchment scale – *salinity protection*;
- retention of overwood while regeneration establishes – *landscape aesthetics, timber production, conservation*;
- temporary exclusion zones to protect fire sensitive regeneration – *productivity*;
- retention of temporary buffers where required – *landscape aesthetics*.

These elements are not intended to operate in isolation but to complement each other in protecting non-wood values. Taken together with the conservation reserves (both outside and

within State forest) in which timber production is excluded, they provide a comprehensive and integrated system.

Different simulation models are used for jarrah and karri forests. These have been reviewed in recent reports¹¹. Both models have been substantially upgraded since these reports and the Panel is satisfied that they are appropriate for the purpose and represent a high standard of practice.

Rotations

Rotation length is a fundamental variable in the calculation of sustained yield.

In the current Plan the predominant rotation lengths are 200 and 100 years, although they range from 100 to 220 years and 60 to 250 years for jarrah and karri respectively¹², reflecting the constraints set by the current structural goals. The 200 and 100-year rotations were used or scheduled to be used on about 85 to 90% of the respective areas of jarrah and karri forest.

Increased reservation resulting from new government policies means that structural goals are less constraining at the whole of forest level, though not necessarily at the landscape level, enabling consideration of a wider application of shorter rotation lengths. While major changes in rotation lengths would not be desirable, because of their impact on other forest values, the wider use of shorter rotation, not exceeding 25 years less than the current predominant rotation lengths for both jarrah and karri may be acceptable to other values. The Panel therefore recommends that the current revision of the Plan should explore a greater variation around the present predominant rotation lengths for jarrah and karri, and evaluate the consequent impacts on yield and Ecologically Sustainable Forest Management. This represents another critical element in the revision of the Plan.

Recommendation 3.11, Shorter Rotations

The wider use of shorter rotation lengths for jarrah and karri respectively should be explored, and the consequent impacts on yield and Ecologically Sustainable Forest Management evaluated during the current revision of the Plan.

Structural goals

Structural goals are an important element of the current Forest Management Plan. Consideration of structural goals and how such goals are to be accommodated across the whole forest estate for biodiversity purposes will be an important element of the new Plan. These goals are used to help maintain and ensure appropriate forest structures in terms of the mix of age or size classes. The next step in the development of structural goals is their refinement to the landscape level. Specific structural goals represent a direct approach to maintaining a full suite of age and structurally related values, rather than attempting to achieve them using sustained yield as a mechanism, and are therefore an important means to managing biodiversity (among other values) over a rotation. Structural goals are also useful in balancing the structural attributes between those found in the reserve system and those in production forests. In terms of whole-of-forest structural goals, recent additions to the reserve system have increased the relative proportions of the mature and senescent growth stages.

Examples of values affected by these goals include the mix of habitat and ecosystem attributes associated with maintaining particular flora and fauna populations. At a more

¹¹ Turner, 1998; Turner *et al.*, 1999; and in broader aspects by Ferguson *et al.*, 1998 and 1999. *op. cit.*

¹² Turner *et al.*, 1999. *op. cit.*

detailed level, trees that are important as nest and refuge resources for hollow-dependent fauna provide another example. It is important to plan for a suitable configuration and pattern of hollow-bearing trees across the production forest to help manage biodiversity values and ecosystem processes across the whole forest estate. CALM has the information and systems to predict, manage and plan for hollow-bearing trees in both space and time.

Recommendation 3.12, Structural Goals

Specific objectives need to be formulated in the current revision of the Plan for appropriate forest structures in terms of the mix of age or size classes and their spatial distribution across the whole forest, together with the structural goals that must then be applied in the calculation of sustained yield.

Allowances for local reservations and exclusions

Future sites of reservations or temporary exclusions in areas not yet harvested cannot always be identified geographically. Allowances therefore have to be made. In some cases, the simulation models incorporate ingenious and realistic simulations of the spatial constraints for areas that are scheduled to be harvested in the future. Examples include recognition of stream buffers, maximum gap size, temporary exclusion zones to protect karri regeneration, and reservation of patches of mature karri and linking corridors. The Panel commends this work which, by any standard, is state-of-the-art.

Exclusions for dieback are discussed in Chapter 4. Other exclusions such as those to protect locally rare and endangered species, or local visual amenity zones¹³ are virtually impossible to predict geographically much in advance of pre-logging survey and harvesting. They are therefore addressed by making a reduction in net area or sustained yield, based on past experience. These are hazards of relatively low likelihood, and widespread but low risk. The allowances can only be improved by monitoring of experience on logged coupes of similar character and applying that experience to make similar allowances for future reductions in yield, as is currently done. Monitoring of logged coupes with respect to the areas of local reservation and temporary exclusions should be maintained to refine allowances.

Recommendation 3.13, Allowances for Local Reservations and Exclusions

Monitoring of logged coupes with respect to the areas of local reservation and temporary exclusions should be maintained to refine allowances in the calculation of sustained yield during the next Plan period.

Local reservation and exclusion trade-offs

When considering harvesting of a particular coupe, local interests are often affected. For example, existing processes require areas of visual amenity to be identified and managed under protocols defined by professional landscape architects. Trade-offs are inevitably involved in consideration of such areas. The trade-offs have to weigh the social net benefit foregone to the community as a whole from the loss or modification of logging against the social net benefit accruing to the individual and/or local community. Often the precautionary principle will apply, since there may be no clear answer in the weighing of benefits but the logging can be deferred, perhaps for many years, without major immediate impact. However, deferral may involve some impact on the calculation of sustained yield. The problem is then what allowance to make for the likelihood that the area may be available for harvesting at a much later date or alternatively may not be available at all. The assumption of equal probabilities would seem appropriate, so the allowance would then be based on the future availability of half the area or future volume concerned. The recommended response is

¹³ Ferguson *et al.*, 1999, *op. cit.*

contingent on the previous item and involves, in the case of local visual management exclusions, making an allowance equivalent to half of the expected area being available for harvesting at a later cutting cycle.

Research should also be undertaken to develop suitably controlled variations to the rules concerning other exclusions and reservations. These are areas in which trade-offs between values can be exercised, given transparency and suitable safeguards, to the benefit of all values. The residual risks are low. The recommended response requires research to value the social net benefits and the effective processes to be used in making trade-offs during the next Plan period.

Recommendation 3.14, Local Reservation and Exclusion Trade-offs

Research should be pursued to value the social net benefits and to determine effective processes for making trade-offs in local exclusions and reservations during the next Plan period.

Supplementary scheduling models

Earlier reports¹⁴ recommended the adoption of the linear programming SPECTRUM model as a supplement to the existing simulation models. The reports pointed out the benefits in being able to test other alternatives more rapidly and to 'smooth' the yield outputs but acknowledged its hazards in terms of reduced transparency that increases the difficulties of understanding the underlying assumptions.

The present Panel agrees that the use of supplementary systems for scheduling wood flows should be pursued during the period of the next Forest Management Plan. This will also require greater effort in the collection of data on non-timber values for use in these models (see also discussion of whole-of-forest issues in Chapter 4). Embarking on a shift to such an advanced scheduling system, with its attendant workload, would not be practicable within the current revision of the Forest Management Plan.

Recommendation 3.15, Supplementary Scheduling

Supplementary scheduling of wood flows should be examined and pursued, if practicable, though the use of more advanced systems during the next Plan period.

3.6 Overview

While there are no components of this process that the Panel perceives to have significant hazards beyond those elements already alluded to, each component discussed in previous sections lends itself to continued refinement and improvement. The priorities for the further development of these different components should be gauged by the contribution they make to yield at critical times in the future, as informed by sensitivity analysis.

These priorities will change from time to time. For example the recommendation to revise the mature karri inventory¹⁵ is no longer relevant because of recent changes to Government policy. The almost total dependence on regrowth beyond 2003 has now shifted the emphasis to regrowth yield models for karri. Sufficient new growth data has accumulated to justify a further revision of these models, as earlier recommended.

The intimate link between silviculture and yield is often overlooked when policy changes to silviculture or yield are proposed. Yield estimates should be re-calculated whenever changes

¹⁴ Turner, 1998; Turner *et al.*, 1999. *op. cit.*

¹⁵ Turner, 1998; *op. cit.*

to silviculture are proposed so that changes to the yield are included in the evaluation of the proposal.

Staff training and resources

The success of these systems depends on maintaining the necessary monitoring and databases, and enhancing the models for each of the components. The resources and staff to develop and maintain these systems are more or less independent of the level of harvest.

As noted earlier, yield estimates are based on the presumption that silvicultural practices match the prescriptions. However, such departures do not arise solely from inadequacies in the modelling system. Changes in responsibilities resulting from the creation of the Forest Products Commission and the present limited silvicultural expertise in CALM, represents a potential risk to the appropriate development and application of silviculture. The reduced size of the industry beyond 2003 may exacerbate this problem. The greatest hazard to continued improvement in these areas is the likelihood of reduced income from sales of wood and consequent possible loss of the funding and staffing in the new administrative structures. The risk is high. CALM should commit to the maintenance of staff training and expertise in silviculture through the provision of adequate resources. This is a project requiring additional resources.

Recommendation 3.16, Staff Training and Resources

CALM should commit to the maintenance of staff training and expertise in silviculture through the provision of adequate resources and delineation of responsibilities during the next period of the Plan.

Residue-utilisation in karri

Current sawlog yield estimates for karri assume that a market for woodchip or other non-sawlog residue will exist to facilitate regeneration of two-tiered stands and thinning of regrowth stands. The continuation of a residue market to facilitate karri thinning is of particular importance and the likelihood of hazard is high. Without such an industry, sawlog-thinning yields will be delayed and the total sawlog yield will be dramatically reduced. If the Government wishes to maintain a karri sawlog industry, then it needs to actively develop residue-using industries if it wishes to avoid a high risk of failure of the sawn karri industry. The Government should encourage industries to utilise the residues from thinnings in regrowth karri forests during the next Plan period.

Recommendation 3.17, Karri Residue Utilisation

The Government should encourage industries that utilise the residues from thinnings in regrowth forests during the next Plan period.

Log grades

Sustained yield is currently expressed as the combined yield of Grade 1 and 2 sawlogs. However, log sales are based on separate contracts for each grade. If the ratio of Grade 1 to Grade 2 in log sales is more than that calculated in the estimated long-term yield flows, there is a risk that the harvest will exceed that which was intended, while still appearing to be within the permitted level. Similar results will occur if the harvested areas contain a lower than average proportion of Grade 1 logs.

Consideration should be given to altering the relative royalties of Grades 1 and 2 so that to make sawmillers and loggers indifferent to different grades and to writing contracts in terms of the combined volumes of Grade 1 and 2 sawlogs.

The volumes of lower grade material are capable of prediction by the current system of scheduling wood flows with the same precision and rigour as higher grades. However, such estimates are potentially valuable for policy makers in the light of the reduction in the cut of Grade 1 and 2 sawlogs. If there are unwanted impacts from the amount of material removed under such a system, these should be controlled through the silvicultural guidelines.

Recommendation 3.18, Sawlog Prices and Contracts

During the next Plan period, the prices of Grade 1 and 2 sawlogs and corresponding logging contract rates should be examined to remove the present biases that favour the use of Grade 1 logs. Renegotiation of contracts should move toward sale of the combined volumes of Grade 1 and 2 in keeping with the basis for sustained yield.

Whole bole logging

As mooted in clause 77 of the Regional Forest Agreement, the Forest Products Commission is examining a possible change to log sales based on a 'whole bole' system, in which the entire bole is sold and transported to a central log yard or the sawmill, where the purchaser should be in a better position to make the best use of that bole. Recent trials of a modified system seem promising and place less of the risk on the purchaser, by allowing some docking in the forest. The system has the potential to reduce forest residues and reduce log-grading costs. Trials so far have involved the removal of the whole bole of trees that contain sawlogs.

Whatever the virtues of using such a system for improving the utilisation of the resource, very careful consideration would be required before it could be used as a basis for yield regulation. Should the Forest Products Commission wish to proceed with using the system for yield regulation, it will be critical to demonstrate that it provides a better approach than the present system that is based on product yield. If introduced, a dual track (new and old) system of calculating sustained yield would need to be used, so that transparency between the old and new outcomes can be maintained. Collaborative trials with the industry should be continued to 2002, at which time the decision to pursue this system should be taken. If implemented, a dual-track basis should be used and reported during the period of the Plan, with a review regarding its exclusive adoption thereafter.

Recommendation 3.19, Whole Bole Logging

- (1) Collaborative trials with the industry of 'whole bole' logging should be continued to 2002.
- (2) A decision to pursue this system should be taken as part of the current revision of the Plan.
- (3) If implemented, a dual track basis should be used and reported during the period of the Plan, with a review regarding its exclusive adoption thereafter.

4 OTHER ISSUES AND VALUES

A number of diverse issues and hazards, as well as other forest values, potentially affect the calculation of sustained yield. They include:

- 'Whole of forest' issues
- Fire
- Diseases and pests
- Climate change
- Mining
- Socio-economic values
- Water values
- Heritage values
- Biodiversity values

In preparing the preceding chapter, the Panel found itself repeatedly referring to the need for a 'whole of forest' approach in relation to the hazards, especially with respect to the impact on associated non-wood values and hence this chapter commences with this issue. The direct impact of hazards such as fire and diseases and pests on site productivity, timber quality and the like has generally been addressed through the processes described in the previous chapter to estimate the net areas available for timber production, the product volumes, the future growth and product volumes, and the predicted wood flows to determine sustained yield. But timber values are neither the sole nor necessarily the pre-eminent values that these forests supply, even on those areas designated as being available for timber production. Finally, there are indirect impacts on sustained yield stemming from biodiversity, water, heritage, greenhouse or socio-economic values. Trade-offs between timber production and these other values, in some places, may take the form of additional local constraints on timber production. These additional constraints may also lead to further reductions in sustained yield of timber. In some cases, the trade-offs may work in favour of timber production but not in others.

4.1 'Whole of forest' issues

Under Ecologically Sustainable Forest Management, timber production is recognised as only one of a wide range of forest outputs. Sustained yield of timber can only be estimated as part of a system that also considers requirements for other forest functions and outputs. While determination of sustained yield is conventionally founded on an estimate of the net area of productive forests available for timber production, management toward Ecologically Sustainable Forest Management requires closer consideration of the 'yields' of all forest outputs (e.g. biodiversity protection, water yield, recreation and visual amenity) and these relate to the whole of forest.

Some outputs are compatible with timber production while others are not. Yet others are capable of mixture but at some sacrifice to one, or the other, or both uses. So forests are partitioned into reserved (timber harvesting excluded) and production (harvesting permitted) forest for simplicity. Even within the production forest, many important non-timber forest values need to be considered (e.g. biodiversity protection, water yield, recreation, visual amenity). Most of these values (excluding timber) are produced in both the reserved and the production forest. Goals and objectives for the various forest outputs and uses must be set first at a 'whole of forest' level to estimate the different requirements for the reserved and production forest. Explicit setting of these 'whole of forest' goals must be an integral part of the Forest Management Plan development process; it will be important to determine the

respective roles of the reserve system and production forest estate and their interrelationship in meeting non-timber goals and objectives.

A major shortcoming of the present planning system is the lack of specific non-timber objectives, at either the landscape or 'catchment' level in which each of the above elements may be differentially represented, or at the whole of forest level. Landscape level goals inform, for example, the local prescriptions to be applied, possibly differentially, to coupes within the block of local landscape unit. 'Whole of forest goals' inform choices and decisions between different landscape (or catchment) elements. Biodiversity management provides a good example of such a requirement; particularly how populations or communities are preserved locally within the landscape, and how representative reservation is addressed across the whole forest.

In the absence of specific landscape or 'whole of forest' objectives, there are no benchmarks against which to measure success, or to adequately evaluate the trade-offs between conflicting or complementary values. These conflicts may occur not only between wood and non-wood values but between the various non-wood values as well. The development of prescriptions requires specificity in objectives. Tacit assumptions about objectives held by different people are a potential source of on-going conflict. Processes to develop measurable objectives are seen to be an important task of the forthcoming Forest Management Plan.

Two important hazards arise in relation to the calculation of sustained yield. The first is that without explicit targets for important forest outputs, there are no benchmarks to adequately evaluate or seek the most efficient trade-offs between competing values. This would be required to better define any prescription variations needed to accommodate non-timber outputs, or to judge progress toward the achievement of Ecologically Sustainable Forest Management. The resulting risk is in setting inefficient yield levels and thus not achieving the inherent potential in terms of social net benefit. The second hazard relates to unresolved expectations held by stakeholders for the level of outputs of other non-timber values. These lead to risks of future loss of production area during the planning period as new demands are made resulting in changes in timber production priority or reservation.

As a critical part of the development of its sustained timber yield estimate for the 2004 Forest Management Plan, the Conservation Commission should develop processes to determine and communicate both 'whole of forest' and landscape level targets for as many forest outputs as possible. These targets must be effectively communicated to stakeholders both during the development process for the Forest Management Plan as a basis for informed comment, and at its conclusion as a matter of public record.

Arriving at the appropriate integration of objectives will be a fundamental consideration in management planning. The strategic issue of integrating forest use in meeting social, environmental and economic values and services so as to deliver Ecologically Sustainable Forest Management is important. To help guide and inform its delivery, a more comprehensive modelling framework is required to help integrate forest values and goals, as noted earlier.

Recommendation 4.1, Whole of Forest

The Conservation Commission should develop processes to make explicit both 'whole of forest' and landscape level targets for as many forest outputs as possible. These targets must be effectively communicated to stakeholders both during the development process for the Forest Management Plan as a basis for informed comment, and at its conclusion. The Forest Management Plan must take a whole of forest perspective and not focus solely on the areas available for timber production.

4.2 Fire

In Western Australia's Mediterranean climate, fire plays a significant role in the natural process of development and maintenance of forest flora and fauna, and their characteristics. Balancing the often-conflicting requirements of protecting human life and property, wildfire protection, regeneration, wildlife and vegetation management, and air quality control is a demanding issue for forest managers. There are potentially significant risks to all values (including biodiversity, heritage, landscape aesthetic, timber production, water, greenhouse and socio-economic values) from the application of inappropriate fire regimes.

In recent years there has been increasing attention and concern about the impact of fire on biodiversity values. Concerns have been expressed about the scale, intensity, frequency and season of prescribed fire regimes. Concerns have also been expressed (especially by fire brigade members) about fire regimes that result in very long periods between fires, which is the other side of the coin. There is however no dispute that different fire regimes impact on vegetation composition and structure in different ways. Whether these impacts are positive or negative depends on the degree to which they support the management objectives for the area.

The inhabitants of urban areas (most specifically of Perth) have become increasingly intolerant of occasional and short duration bush fire smoke which, when added to industrial and vehicle emissions in these areas, result in highly visible air pollution and hazards to socio-economic values. Despite agreement that may be reached among stakeholders on the need and application of fire for a variety of purposes, the ability to manage fire appropriately is likely to be severely curtailed in the future as a result of continued complaints about its perceived contribution to air pollution, and the reduced resources for fire management stemming from changes in Government policy¹⁶. This may have an adverse impact on the management for biodiversity as well as for other values.

The net effect of the growing number of constraints on the application of prescribed fire has been a decrease in the areas that are burnt by prescribed fire each year and an increase in the area containing heavier fuel loads throughout the forest area. A continuation of this trend will result in more severe wildfires impacting on the forest over the longer term. This may advantage some values (some elements of biodiversity) but disadvantage others (socio-economic values, in terms of possible losses of life and property, and some other biodiversity values).

The diversity of fire history is relatively high throughout the forest as a whole. The jarrah and mature karri forest each have more than 20% of their area that has not been burnt for 20 years or more, while 40% of other vegetation is in the same category. However, this variation is not necessarily best located for biodiversity values in a site specific or spatial sense.

CALM has given increasing recognition to the importance of developing fire regimes to suit elements of biodiversity and has attempted to incorporate these into its burning programs taking account of its other fire obligations. The results have not satisfied all sections of the community. In response to this, CALM, in association with the Fire Emergency Services, has initiated a revision of Wildfire Threat Analysis system that gives explicit weightings to a full range of values at risk. This revised system is intended to be used as a decision support tool for both prescribed burning and fire suppression activities across all managed lands and adjacent influence zones.

¹⁶ See Ferguson *et al*, 1999, *op. cit.*

A major shortcoming in the application of fire for vegetation management is the absence of specific management objectives at an appropriate scale. For biodiversity, this is a particular concern in reserved areas that are now a much more significant proportion of the forest estate and where biodiversity values might be expected to have a high priority. Till now there has been a tendency to prescribe a fire regime but without explicit and measurable objectives – for example, without an explicit statement of species or community priorities, the proportion of the area to be maintained in a particular post fire seral stage, or the maintenance of diversity at the landscape level versus the site level. Without agreed objectives at this level there is no way of judging whether fire management practices are appropriate or successful.

Fire is no respecter of lines on maps and it is therefore essential to view these management issues across all forests. Steps should be taken in the development of the new Forest Management Plan to begin addressing the question of explicit management objectives and strategies for all forests at a level that provides meaningful guidance for managers and auditable outcomes. This is a project requiring additional resources during the next Plan period.

Recommendation 4.2, Fire Management

- (1) In the current revision of the Plan, the development of specific fire management objectives should be initiated for subsequent completion during the period of the Plan. The Plan should incorporate explicit objectives such as species or community priorities, the proportion of the area maintained in a particular post fire seral stage, regrowth protection or the maintenance of diversity at the landscape level versus the site level.
- (2) The revision of the Wildfire Threat Analysis, incorporating consideration of operationally meaningful management objectives and strategies, and communication with the urban electorate and ecological expertise, should be extended to cover all land and ownerships during the next Plan period.

4.2 Diseases and pests

Dieback

Dieback caused by *Phytophthora cinnamomi* represents one of the greatest hazards to ongoing productivity of the jarrah forest in certain areas and to the maintenance of biodiversity. Impact from *P. cinnamomi* varies greatly with soil and hydrological status of sites. Epidemics are also most commonly associated with major summer rainfall events. Disease expression in jarrah tends to be episodic, in some years jarrah mortalities occur at low frequencies in other years mortalities are significant across quite large areas.

As *P. cinnamomi* has the potential to impact over a large area of the forest it is important that adequate allowance is made for its affects on both growth and mortality of jarrah. It may be true that the epidemic has largely run its course in the northern jarrah forest with most high impact sites already degraded by the disease but changes and more long-term insidious effects on growth in the cooler southern forests could occur.

Further review and monitoring of the impacts of *P. cinnamomi* is needed. The extent to which roading and logging and general access is spreading the fungus in different ecosystems should be known. There are areas that have been comprehensively mapped before and after logging, and the results of such mapping should be analysed. The extent and role of waterlogging in jarrah mortality should also be pursued further¹⁷. If generally applicable, it raises issues for the management of logging with respect to hydrological flows.

¹⁷ Davison, E. M. 1997. Are jarrah (*Eucalyptus marginata*) trees killed by *Phytophthora cinnamomi* or waterlogging. *Australian Forestry* 60 (2): 116-124.

Recent changes in dieback policies¹⁸, first initiated in 1996, and related to logging have led to changes in hygiene prescriptions under some circumstances. Logging in areas deemed to be 'unprotectable' and in buffers around 'protectable' areas may proceed under conditions known to be conducive to spread of the fungus. Seasonal constraints on operations in areas most secure from the fungus and referred to as 'protectable' will not be mandatory, relying on the requirement that operators be clean on entry.

The Environment Protection Authority (EPA), in commenting on the revised policy, has highlighted the need to hasten action on the development and assessment of dieback management strategies. The key points of the Environment Protection Authority (EPA) advice¹⁹ that impinges on the calculation of sustained yield are:

- The EPA endorses the Dieback Review Panel (1996)²⁰ protocol for identifying 'protectable' areas and their priority for management, on a trial basis for three years.
- That industry, institutions and government agencies jointly address the extent to which operational schedules can be modified to ensure that activity on the protectable areas is focussed on minimising access during conditions which are conducive to dispersal of the pathogen and its establishment.
- A system should be developed to ensure adequate protection is given to high conservation areas. Criteria to define high conservation status areas should be developed as a matter of urgency.
- Losses caused by *Phytophthora cinnamomi* should be estimated in terms of industries affected, the implications of their sustainability be reported on, together with the assumptions underlying the estimates.

The Minister is expected to consider these recommendations shortly.

Currently with regard to the calculation of sustained yield, dieback areas that have not been logged are credited with the standing volumes involved but are not taken into account in predicting future volume beyond the real or simulated time of logging. The impact of future infection is not currently taken into account. The Panel believes this hazard of high likelihood and risk should be taken into account by sensitivity testing in the simulation models, assuming variously (a) no spread and (b) the apparent past spread over the last decade for the various strata, or minor modifications thereof. This is a project requiring relatively few additional resources.

Recommendations 4.3, Dieback

- (1) The key points of the EPA advice on the Protocol for the identification and prioritisation for the management of *Phytophthora cinnamomi* 'protectable areas' endorsed by the Minister should be implemented as soon as possible.
- (2) The impact of future infection should be taken into account by sensitivity testing in the simulation models, assuming variously (a) no spread and (b) the apparent past spread over the last decade for the various strata.

¹⁸ Initiated by Podger, F. D., James, S. H. and Mulcahy, M. J., 1996. *Review of Dieback in Western Australia. Volume 1. Report and Recommendations*. Report by the Western Australian dieback Review Panel to the Hon. Minister for the Environment. Minister for the Environment, Perth.

¹⁹ Environment Protection Authority (2001) Protocol for the identification and prioritisation for management of *Phytophthora cinnamomi* 'protectable areas'. Dieback Consultative Council. *EPA Bulletin* 1010.

²⁰ Podger, *et al.*, 1996. *op cit.*

Honey fungus

Allowance is currently made in simulation models for known areas of induced mortality due to the honey fungus. Patches of mortality are removed from the net area. Areas with scattered mortality are mapped and predicted separately. Areas with widely dispersed mortality are covered by sampling by growth plots. Allowance for the impact on log quality is incorporated in the general reduction made to initial calculated yield for all minor hazards posed by various insects and diseases, including honey fungus, borers, and brown rot.

Armillaria luteobubalina is a naturally occurring organism widespread in jarrah, karri and wandoo forests. This fungal disease primarily infects root systems and stumps and experience in other forests suggests that it may take on greater significance in regrowth forest or areas with a history of repeated selection harvests.

The future impact of *A. luteobubalina* on regrowth karri is of concern because, like other *Armillaria* species, it can impact on regrowth forests causing mortality of trees retained after thinning. A database on incidence and areas of different forest types affected by this pathogen is required. Disease interpreters mapping dieback have collected some records. The control strategy being considered by CALM is to thin using stump-pulling techniques rather than leave a large food base of root and stump material in ground which would favour a build up in inoculum of this straw rotting fungus.

As thinning of regrowth stands proceeds, deaths of retained crop trees should be monitored to enable the allowances for the calculation of sustained yield to be refined. The likelihood of some impact from this fungus after thinning is high but incidence is localised and therefore risk to and impact on timber yield is likely to be low.

Recommendation 4.4, Honey Fungus

Honey fungus mortality and damage arising from thinning operations, especially in karri regrowth operations, should continue to be monitored during the next Plan period to enable allowances to be developed for the future calculation of sustained yield.

Bullseye borer, Cossid moth and brown wood

Reports²¹ have drawn attention to the high incidence of decay and borer holes in regrowth karri. The likelihood of significant impact by these agents is moderate and possibly localised in terms of site and climatic conditions. Nevertheless, there is a moderate risk that the proportion of wood recovered from small diameter logs will be lower than expected or that some of the regrowth resource will be downgraded as unacceptable as sawlogs. An appropriate survey should be conducted across the thinnable karri regrowth estate to assess the potential impact on yield and to develop an appropriate allowance during the next Plan period.

Recommendation 4.5, Karri Borers and Rots

An appropriate survey should be conducted across the thinnable karri regrowth estate to assess the potential impact on yield and to develop an appropriate allowance during the next Plan period.

²¹ Abbott, I., Smith, R., Williams, M., Voutier, R., 1991. Infestation of regenerated stands of karri (*Eucalyptus diversicolor*) by bullseye borer (*Tryphocaria acanthocera*, *Cerambycidae*) in Western Australia. *Australian Forestry* 54 pp64-74
and Farr J. D., Dick S. D., Williams M. R., and Wheeler J. B., 2000. Incidence of bullseye borer (*Phoracantha acanthocera*, (Macleay) *Cerambycidae*) in 20-35 year old regrowth karri in the south west of Western Australia. *Australian Forestry* 63 No 2 107-123

Jarrah leafminer and gumleaf skeletonizer

Abbott²² mapped the extent of jarrah leafminer and gumleaf skeletonizer in the jarrah forest and woodlands of the South West. Currently the jarrah leafminer impacts on forests from the South Coast to the north near Collie. Gumleaf skeletonizer was most prevalent between 1983-89, a major outbreak has not been recorded since and recent work suggests a correlation between below average rainfall and outbreaks. Future outbreaks are to be expected. In the case of jarrah leafminer recent impact also has been less obvious than that observed in the past. Research on factors associated with major infestations is continuing.

It is assumed that both leaf miner and skeletonizer, have and will impact, on trees in the inventory and growth plots and thus their effects on growth will be integrated into models. The residual risk of chronic infestations of leafminer causing reduced growth rate is uncertain but comparison of growth rates in inventory plots known to be infested with leafminer and those without, could assist in quantifying impacts of the leafminer.

Recommendation 4.6, Jarrah Pests

Research should be pursued to compare growth rates in inventory plots known to be infested with leafminer and those without, to assist in quantifying impacts of the leafminer during the next Plan period.

4.4 Climate change and carbon cycle

Maintaining the forest's contribution to the global carbon cycle is the only one of the principles of Ecologically Sustainable Forest Management that has a global context; all others being either explicitly or implicitly applicable at the coupe, region or 'whole of forest' scale. The wording of this principle reflects the desire to protect the world from, or at least reduce the impact of, the Greenhouse Effect caused by increasing concentrations of carbon dioxide, methane and other gases in the upper atmosphere and manifested by climate change, notably but not only by way of increasing ground-level temperatures.

Stakeholder input suggested that the calculation of sustained yield itself should factor in the effects of, or risks of climate change. Their concerns were associated with changes in species densities and distribution, and forest productivity, health and vitality attributed to changing climate. Such change is a very slow process. The growth data used in the simulation models already reflect the effects of past climate change and continued monitoring of growth through remeasurement of permanent plots in jarrah, or stem-analysis in the case of karri, provides an adequate means of ensuring that the impact of climate change is accounted for and that yield is adjusted.

The principal hazard to the carbon cycle is associated with the fire regimes and the uncertainty surrounding their impact or changes to soil carbon changes. The likelihood of this hazard having an impact on, and posing a risk to, the global cycle is currently low for the South West Zone, but the Australia-wide or global implications of this issue do merit research. Research should be pursued on the impact of fire management and logging regimes on the global carbon cycle during the next period of the Plan.

Recommendation 4.7, Carbon Cycle

Research should be pursued on the impact of fire management and logging regimes on the global carbon cycle during the next period of the Plan.

²² Abbott, I, 1992. Ecological implications of insect pests in jarrah and karri forests. In: Research on the Impact of Forest Management in South West Western Australia. *CALM Occasional Paper* No 2/92 pp 77-97.

4.5 Mining

Of all the future changes to the native forests of the South West Zone, mining constitutes one of the biggest potential hazard because it results in a reduction of the forest area for a long period, and an uncertain future role for the rehabilitated areas following mining, especially for bauxite. Mining for coal is far more restricted in area and impact. This is not to denigrate mining itself, because it clearly contributes to socio-economic values in other ways.

Furthermore, bauxite-mining companies are to be applauded for their efforts in rehabilitation, and appear to have succeeded in regenerating jarrah and associated tree and understorey species on former bauxite mining sites. Nevertheless, if Ecologically Sustainable Forest Management is to be taken seriously, there are values associated with productive capacity, biodiversity, and hydrology of rehabilitated sites that warrant attention, as the recommendations of the Ecologically Sustainable Forest Management Panel²³ show.

Greater attention also needs to be paid to the trade-offs between new mining sites and biodiversity values. Notwithstanding the excellent planning, research and rehabilitation that the bauxite mining companies have done, the growing concerns of stakeholders with respect to biodiversity and other conservation values need to be recognised. Given the much greater weight the community is according these values, it should no longer be assumed that mining is pre-eminent in the social net benefit it provides from every viable bauxite reserve. In raising this issue, the Panel is aware that reservation of any areas for biodiversity and other conservation values would actually lead to a reduction in the cut from areas that would otherwise have been clear-felled prior to mining. Thus, in terms of this review, the resolution of these trade-offs is important in relation to calculating the sustained yield. It is most unlikely that all such areas could be so reviewed for the current Plan revision but a process should be initiated to deal progressively with these areas, according to the planned schedule of mining operations. The possibility of more intensive timber management on former bauxite pits should also be examined.

Recommendation 4.8, Bauxite Mining Sites

The Conservation Commission should initiate a formal process for a more detailed examination of areas mooted for bauxite mining with respect to biodiversity conservation and hydrological values and an evaluation of the trade-offs with mining involved.

4.6 Socio-economic values

The Regional Forest Agreement process, through economic and social analysis, established baselines for resource, industry and rural community issues. These analyses explored the contribution of commercially valuable forest ecosystems to regional and State industries, and opportunities to enhance production and the value in using resources. The main approach for analysing social and economic implications was through measuring employment levels, economic value of wood and changes in rural communities associated with forecasted wood supply (sustained yield).

Wood supply levels will be considerably reduced from those presented in the Regional Forest Agreement following implementation of State Government forest policies. The calculated sustained yield in the new Forest Management Plan is likely to be substantially lower than that in the Regional Forest Agreement, as a result of the subsequent increases in reservation. Due consideration, analysis and reporting needs to be given to the likely social and economic impacts particularly in rural communities. To meet the intent of Ecologically Sustainable Forest Management, it is recommended that the Conservation Commission ensure that an independent and robust social impact study be undertaken as part of the current revision of

²³ Ferguson *et al.*, 1998.

the Plan. The Regional Forest Agreement committed the parties to an independent economic and social impact assessment of the draft Forest Management Plan. However, the process to be followed needs to be developed well in advance and it needs to be initiated as soon as possible if it is to contribute adequately to the development of the Plan. This type of study is also needed to provide advice on impacts to State and local government and the public, as reflected in the Conservation and Land Management Act.

Recommendation 4.9, Social Impact Study

An independent and robust social impact study be initiated as soon as possible as part of the current revision of the Plan.

4.7 Water values

Most of the present planning of forest management and silvicultural practices for water quality (mainly salinity) and quantity rests properly on detailed research programs completed in the last 20 years. Equally, most of the on-going efforts in water monitoring in forested catchments are directed towards those catchments where detailed measurements were conducted for many years. Water monitoring by the Water and Rivers Commission in many of these catchments has been suspended or placed on long time reviews because responses to disturbance have slowed.

As a consequence of this work, prescriptions have been developed and progressively modified over a number of years. Essentially forest harvesting and regeneration does not appear to present a problem for water values provided that the following is done:

- buffers of varying width are retained on all streams;
- thinning intensity in the intermediate and low rainfall zones is reduced relative to the high rainfall zone that is comparatively salt free;
- the extent and timing of gap harvesting is limited on the second order catchments;
- phased logging is conducted throughout the intermediate and low rainfall zones;
- additional constraints to harvesting are applied in specifically identified high salt risk sub-catchments.

The Water and Rivers Commission is currently engaged in a review of guidelines and constraints on logging with respect to its possible impact on water quality. It is expected that the results of this will be incorporated in the Forest Management Plan and that monitoring programs be restored in the Swan and Central Regions in consequence of the mining operations in the next ten years.

4.8 Heritage values

There has been increased activity in the identification and classification of natural and many aspects of cultural heritage value during the last decade, with the most recent comprehensive assessment being undertaken as part the Regional Forest Agreement process. The need for some development of the operational and support aspects of the Visual Management System and some further consideration of geo-heritage issues was identified during the Regional Forest Agreement. The major impacts of heritage values in relation to the estimation of sustained timber yield comes through the exclusion of timber harvesting (reduction in net harvestable area), delay in harvesting, or through the application of modified harvesting prescriptions.

The current databases and approaches appear to provide a generally sound basis for modifying the estimated timber yield for the purposes of preparing the next Forest Management Plan. However, both the concepts of natural heritage and the relative

community values of different aspects or examples natural and cultural heritage do change through time.

Recommendation 4.10, Heritage Values

Consultative mechanisms need to be enhanced to ensure that the guidelines for natural and cultural heritage used in forest planning and management are kept in step with changing community values during the next Plan period.

The need for a more effective engagement of indigenous communities in relation to forest management and the impacts of forest management on indigenous communities and their cultural heritage has been identified by several recent forestry enquiries. This is also in line with evolving community attitudes. The results from future engagement with indigenous communities may result in changes to the basis for estimation of sustained yield.

Recommendation 4.11, Indigenous Communities

Specific consultative processes, in addition to those used for general community, should be further developed with the relevant indigenous communities during the development of the next Forest Management Plan to ensure effective input in relation to management proposals that have impacts on indigenous cultural or other interests during the current revision of the Plan.

4.9 Biodiversity values

Maintenance of biodiversity is a fundamental goal of conservation management and is one of the prerequisites for achieving Ecologically Sustainable Forest Management. Biodiversity means the variety of all life-forms, the genes they contain, and the ecosystems of which they are a part. Biodiversity has regard to genetic diversity, species diversity and ecosystem diversity. Biodiversity is provided for through a Comprehensive Adequate and Representative (CAR) Reserve System that includes Formal Reserves, CAR Informal Reserves, areas on public land protected through prescriptions and CAR Values protected under secure management arrangements by agreement with private landholders.

Together, the Expert Advisory Group²⁴ report and Regional Forest Agreement²⁵ document the Forest Management System applying to the biodiversity principle. The following commitments in the Regional Forest Agreement directly or indirectly affect consideration of biodiversity in the context of sustained yield:

- management and recovery of threatened fauna and flora;
- implementation of plant disease, weed and feral animal control strategies, including monitoring and evaluation procedures;
- maintenance and enhancement of fauna and flora databases;
- developing and implementing a system of pre-logging fauna assessment to predict fauna on forest blocks and document habitat requirements of threatened and sensitive fauna;
- prioritise collection of fauna data and develop a consolidated database;
- appraise and consider data requirements to support assessment of risks to biodiversity.

The Conservation and Land Management Act recognises the conservation of biodiversity (flora and fauna) as a key objective. The biodiversity principle is factored into the calculation of sustained yield through managing planning goals such as structural goals, netting down of

²⁴ *Assessment of Ecologically Sustainable Forest Management in the South-West Forest Region of Western Australia*, Report of the Expert Advisory Group chaired by Professor Ian Ferguson, Commonwealth of Australia and Western Australian Government, 1997.

²⁵ *Regional Forest Agreement for the South-West Forest Region of Western Australia between the Commonwealth of Australia and the State of Western Australia*, May 1999.

area removed through biodiversity prescriptions, applying a reduction to yield to accommodate the retention of habitat trees and conservation through the informal and formal reservation system.

Biodiversity exemplifies the characteristic of many non-wood values, which demand a whole-of-forest approach to data collection. As with a number of the other forest values, biodiversity management and protection is addressed primarily through prescriptions and guidelines applied at the coupe level. The risk is that this will fail to take account of whole of forest issues or, worse still, lead to a neglect of data collection on areas other than those available for timber production.

Databases and modelling of flora and fauna species in the context of planning requires further development. Information from these database help to inform biodiversity goals, targets and performance criteria that can then be translated through to indicators and measurement of Ecologically Sustainable Forest Management outcomes. The risk in terms of not being able to meet biodiversity objectives is reduced through commitments made in the Regional Forest Agreement to improving the knowledge base by appropriate sampling.

Recommendation 4.11, Biodiversity Databases

The Conservation Commission should commit to the maintenance of databases for biodiversity on a 'whole of forest basis' as a pre-requisite for Ecologically Sustainable Forest Management on areas available for timber production and elsewhere.

5 PRIORITIES AND RESOURCES

In framing its recommendations the Panel has attempted to make clear the timing involved. To assist review of the priorities and resources, the following list summarises the recommendations in this report according to their timing.

Timing, and Number and Title of Recommendation

Initiate and complete as soon as possible

- 3.2 (3) Karri Inventory and Utilisation
- 3.4 Jarrah Silviculture
- 3.9 (2) Regrowth Karri Fire Risk
- 4.3 (1) Dieback
- 4.9 Social Impact Study

During current revision of Plan

- 1.1 Regional Calculations
- 2.1 Informing the Public
- 3.2 (2) Karri Inventory and Utilisation
- 3.5 Jarrah-Marri
- 3.9 (1) Regrowth Karri Fire Risk
- 3.11 Shorter Rotations
- 3.12 Structural Goals
- 3.19 (1) & (2) Whole Bole Logging
- 4.1 Whole of Forest
- 4.2 Fire Management
- 4.3 (2) Dieback
- 4.11 Indigenous Communities

During next Plan period (2004-2013)

- 3.1 Jarrah Stratification
- 3.2 (1) Karri Inventory and Utilisation
- 3.3 Jarrah Utilisation
- 3.6 Marri sawlogs
- 3.7 Jarrah Growth
- 3.10 Rehabilitated Mining Sites
- 3.13 Allowances for Local Reservations and Exclusions
- 3.14 Local Reservation and Exclusion Trade-offs
- 3.15 Supplementary Scheduling
- 3.16 Staff Training and Resources
- 3.17 Karri Residue Utilisation
- 3.18 Sawlog Prices and Contracts
- 3.19 (3) Whole Bole Logging
- 4.4 Honey Fungus
- 4.5 Karri Borers and Rot
- 4.6 Jarrah Pests
- 4.7 Carbon Cycle
- 4.8 Bauxite Mining Sites
- 4.10 Heritage Values
- 4.12 Biodiversity Databases

During the second half of the next Plan period (2009-2013)

- 3.8 Karri Growth

At the conclusion of the Plan (2013)

- 4.1 Whole of Forest

In the time at our disposal, the Panel was unable to provide estimates of the resources required for these recommendations. As a broad generalisation, those to be completed as soon as possible will require additional resources because of the urgency. Those to be undertaken during the revision of the Plan generally do not require substantial additional resources, although collectively they may pose a problem, as in the case of the multiplicity that fall on the Forest Management Scheduling Team. The recommendations to be carried out during the next Plan period vary greatly in resources from very few to substantial additional resources, the latter being associated with major new research or monitoring projects.

APPENDIX: LIST OF SUBMITTORS

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