REPORT

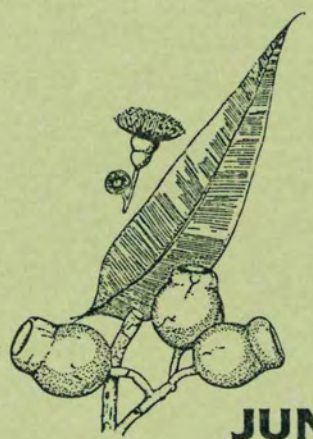
of the Scientific and Administrative Committee

inquiring into aspects of

Conditions Set Pursuant to the
Environmental Protection Act 1986

for the proposed

Amendments to the 1987 Forest Management Plans
and Timber Strategy and Proposals to Meet
Environmental Conditions on the Regional Plans
and the WACAP ERMP Proponent



JUNE 1993

A Report to the Hon. Kevin J Minson, MLA Minister for the Environment

by the

Scientific and Administrative Committee

inquiring into

Conditions Set Pursuant to the Environmental Protection Act 1986

for the proposed

Amendments to the 1987 Forest Management Plans and Timber Strategy, and Proposals to Meet Environmental Conditons on the Regional Plans and the WACAP ERMP Proponent, Department of Conservation and Land Management

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June 1993

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EXECUTIVE SUMMARY

Terms of Reference

The Committee had considerable difficulty with ambiguity in the terms of reference, contained in the Statement of Ministerial Conditions, issued on 24 December 1992. It was resolved that the major responsibility of the Committee was to evaluate the long-term yield of jarrah sawlogs, together with an appropriate level of harvest of sawlogs for the next 10 years and the adequacy of conservation reserves associated with the jarrah/marri forest. The same process was applied to the karri/marri forest.

Jarrah Harvest

On the basis of present utilisation standards of felled timber and inventory data supplied by CALM, the Committee estimates that the sustainable yield of jarrah sawlog is 450,000 cubic metres per year. An alternate calculation based on conservative parameters provided by CALM indicates a sustainable yield of 300,000 cubic metres of sawlogs per year. 450,000 is considered to be the more reliable of the two estimates.

In 1992 CALM proposed a jarrah sawlog harvest of 675,000 cubic metres per year for the next 10 years. This proposal was supported by EPA recommendations to the Minister.

The Committee recommends that 490,000 cubic metres per year be the maximum harvest level of jarrah for the next 10 years. The actual level of harvest can be varied from year to year around that mean, without effecting the outcome. The 10% over-harvest for ten years will not have a significant effect on the long-term sustainable yield.

Approximately one third of the volume of jarrah sawlog contracts are due for renewal within a year. If all contracts are renewed as they fall due, there will be a requirement to provide 530,000 cubic metres per year.

However, the timber industry has been purchasing 460,000 cubic metres of jarrah over the past few years. Thus the recommended maximum of an average 490,000 cubic metres will not disrupt the industry. It will enable timber companies to enter into longer-term contracts. Contract renewals should be structured to encourage the shift from green-sawn timber for structural use, toward dried product for decorative and furniture use. The shift toward these value-added jarrah products will be reinforced by the increasing competitiveness and availability of Western Australian grown pine, for structural use.

Karri and Marri Harvest

The recommended karri harvest is consistent with the estimated annual sustainable yield of 417,000 cubic metres, comprising 214,000 cubic metres of first grade sawlog, 103,000 cubic metres of other sawlog and 100,000 cubic metres of thinning. The entire harvest is used commercially as either sawn timber or woodchip.

The sustainable yield of marri is close to the actual harvest of 70,000 cubic metres of sawlog and 445,000 cubic metres of woodchip. Marri continues to be harvested as a by-product of the jarrah and karri sawlog harvest. As long as there is a jarrah and karri sawlog harvest, it is prudent to maintain the marri sawlog and chiplog harvest.

Conservation Estate

Following implementation of the 1992 CALM proposals, approximately 25% of the jarrah forest and 30% of the karri forest will have been set aside in conservation reserves. In addition to these, a further 8% of the jarrah forest and 16% of the karri forest will be included in areas where timber harvesting is excluded. They are effectively reserves for conservation.

Thus the total proportions of the jarrah and karri forests excluded from harvesting, are 33% and 46% respectively. Both these extensive areas also provide a very broad representation of habitat type, in both forests.

Overall, 35% of the land area of our south-west forests is fully protected. The sustainable harvest is taken from the remaining 65% multi-purpose forest.

Biological continuity within the forest is provided by the system of conservation reserves, road reserves, riparian reserves and the intervening forest areas. The mosaic of different-aged harvest coupes in the multi-purpose forest areas also provides habitat continuity.

Additional Linkage Reserves

The establishment of additional linkage reserves in the jarrah forest, as suggested by the Appeals Committee would require a further 2.5% to 8% of otherwise productive timber area without any demonstrable ecological benefit. However, the effect on sawlog production would have been commercially significant. It is recommended that they not be adopted.

Plantation Opportunities

Western Australia does have substantial capability to produce significant commercial quantities of plantation hardwood chiplog. Plantation hardwood timber is unlikely to replace Western Australia's native hardwood timber within the next 50 years, regardless of market changes or technological improvements in the short-term. Plantation hardwood timber is a different product in terms of, structure, colour, strength, hardness and milling characteristics. It is being grown to produce a high quality pulpwood.

The potential to on-grow a portion of plantation chiplog for sawlog does exist. The lead-time for research, development and cultivation is beyond 20 years. Sawlogs from hardwood plantations may begin to supplement the native hardwood harvest in about 25-50 years.

Resource Security

Contracts for sawlog and chiplog supply should be of sufficient duration to support investment and enable restructuring of the sawlog industry. Absolute resource security cannot be provided without complementary Commonwealth legislation. However, State legislation in support of longer-term contracts covering the 10 year period, is recommended.

Implementation of Conditions

The Committee reviewed the Ministerial Statement of 24 December 1992. Some Conditions were found to be ineffective or confusing. Most of the Conditions can not be substantially modified to accommodate improvements, without a lengthy environmental review process, through Section 46 of the Environmental Protection Act.

The Committee provides advice to assist the interpretation and implementation of relevant Conditions in the Statement.

DEFINITIONS

A number of significant documents with unwieldy titles will be referred to regularly in this report. To make reading easier, abbreviated titles for these documents will be used:

- Proposals to Amend the 1987 Forest Management Plans and Timber Strategy and Proposals to Meet Ministerial Conditions on the Regional Plans and the WACAP ERMP Proponent-Formal Assessment Under Part IV of the EPA Act, Department of Conservation and Land Management, February 1992.

  - *Will be referred to as the 1992 CALM proposals*

- Management Strategies for the South-West Forests of Western Australia, A review, Draft for Public Comment, Department of Conservation and Land Management, February 1992.

  - *Will be referred to as the CALM 1992 Forest Strategy.*

- Report and Recommendations of the Environmental Protection Authority on Proposals to Amend the 1987 Forest Management Plans and Timber Strategy and Proposals to Meet Environmental Conditions on the Regional Management Plans and the WACAP ERMP, December 1992. Bulletin 652.

  - *Will be referred to as the EPA report or the EPA recommendations*

- Report to the Hon. Jim McGinty MLA, Minister for the Environment by Tos Barnett as Appeals Committee examining Appeals Submitted in Relation to the Report and Recommendations of the Environmental Protection Authority on Proposals to Amend the 1987 Forest Management Plans and Timber Strategy and Proposals to Meet Environmental Conditions on the Regional Management Plans and the WACAP ERMP, December 1992.

  - *Will be referred to as the Barnett Report or Appeals Committee Report.*

- Statement that a proposal may be implemented pursuant to the provisions of the Environmental Protection Act 1986 Amendments to the 1987 Forest Management Plans and Timber Strategy and Proposals to Meet Environmental Conditions on the Regional Plans, WACAP, ERMP - December 1992

  - *Will be referred to as the Ministerial Conditions or Ministerial statement.*

INTRODUCTION

Scope of the Report

On 24 December 1992 the previous Minister for the Environment issued a statement under Section 45 of the Environmental Protection Act 1986, that the 1992 CALM proposal could be implemented subject to 18 itemised Conditions (Ministerial Conditions - Appendix 1). Condition 2-1 of that statement was as follows:

> *"2-1 An Expert Scientific and Administrative Committee will be established by the Minister for the Environment to review and report on the implementation of this proposal by 30 June, 1993. The terms of reference of the Committee will be to consider:*
>
> - *reserve recommendations within multiple-use forests involving those proposals related to temporary exclusion from timber production and potential reserves to act as wildlife corridors;*
> - *the environmental, economic and social implications of such proposals for:*
>   - *nature conservation within WA's native forest,*
>   - *the maximum sustainable timber supply, and*
>   - *the existing and future timber industry;*
> - *the potential to increase the plantation estate on cleared agricultural land to contribute to the production of timber products."*

The present Minister convened this Committee in accordance with Condition 2-1. From the outset the Committee had considerable difficulty with the apparent ambiguity in the terms of reference. Condition 2-1 could be read broadly to mean that the Minister required the Committee to redo much of the work done by the EPA in its evaluation and recommendation process, and the Appeals Committee.

Advice from the Environmental Protection Authority suggested that a broad interpretation would be contrary to the Environmental Protection Act. Significant or major changes to any Conditions in the December 1992 Ministerial Statement proposed by the present Minister on the recommendation of this Committee would require that alterations be referred for re-assessment by the EPA under Section 46 of the Environmental Protection Act. This is partially signalled by Condition 2-2, as follows:

> *"2-2 Subject to these Conditions, the manner of detailed implementation of the proposal shall conform in substance with that set out in any designs, specifications, plans or other technical material submitted by the proponent to the Environmental Protection Authority with the proposal.*

Where, in the course of that detailed implementation, the proponent seeks to change those designs, specifications, plans or other technical material in any way that the Minister for the Environment determines on the advice of the Environmental Protection Authority, is not substantial, those changes may be effected."

The terms of reference for this Committee are further elaborated by Conditions 8-1 and 8-2.

> ***"8-1 The allocated timber resource for the period ending 30 June, 1993 prior to the consideration by the Minister for the Environment of the report of the Committee referred to in Condition 1 will not exceed the 1993 level described in the 1987 Timber Strategy together with an additional amount of the timber resource that was approved in the 1987 Timber Strategy but remained uncut. This additional amount may be allocated by the proponent with the approval of the Minister for the Environment on a needs basis up to a total level not exceeding that proposed by the proponent in its 1992 proposals.***
>
> ***8-2 Following consideration of the report of the Committee referred to in Condition 2, the Minister for the Environment shall determine the annual sustainable timber resource available for allocation."***

Condition 8-1 effectively states that the level of the harvest for karri, marri and jarrah until 30 June 1993 must not exceed that put forward by the proponent (CALM) in its February 1992 proposals.

Condition 8-2 requires the Committee convened under Condition 2-1, to provide advice to the Minister to help him determine the annual sustainable timber resource available for allocation. When read in context with other Conditions in the Ministerial Statement, the most reasonable interpretation of 8-2 is that the Committee should advise the Minister of the most appropriate allocation for the coming 10 year period. However, it also implies that the Committee should consider the "long-term sustainable yield".

The Committee concluded that the essential components of the advice required by the Minister were:

1. The maximum sustainable timber resources available for allocation in the immediate 10 year period, and the consequences of harvesting in this period for the long-term sustainable yield.
2. The effect of the CALM proposal and EPA recommendations for level of harvest for the next 10 years on both the existing and future timber industry.
3. The efficacy of the "wildlife corridor reserves" proposed by the Appeals Committee.
4. The potential to increase plantations to contribute to timber production.

Emphasis On The Jarrah Harvest

The Committee found after reviewing the available documents that both the inventory and proposed harvest levels of the karri forest were generally accepted. However, the inventory and level of harvest in the jarrah forest was of concern to the Appeals Committee. Consequently, this Committee has focussed on the proposed management of the jarrah forest.

The inventory and annual sustainable yields put forward by CALM in February 1992 are summarised on Tables 12, 13 and 14 of the CALM 1992 proposal and given below. There are important footnotes to each table published by CALM, which explain details related to a number of values presented. Table 12 provides a summary of the resource base on which the yield proposals depend.

Table 12 CALM 1992(a)

INVENTORY OF TIMBER RESOURCE ON NATIVE FORESTS DESIGNATED FOR MULTIPLE USE IN REGIONAL MANAGEMENT PLANS

FOREST TYPE	STANDING TIMBER VOLUME					STAND INCREMENTS $m^3/ha/an$
	Area (ha)	Gross Bole Volume (10^6m^3)	Sawlogs (10^6m^3)	Other Logs (10^6m^3)	Forest Residue (10^6m^3)	
karri and karri/marri	121,700	25.4	10.2	15.2	4.0	1.5 to 10.0
jarrah/marri	1,239,000	144.0	57.2	86.8	78.7	1.65

Table 13 CALM 1992(a)

CALCULATED ANNUAL SUSTAINABLE YIELD FROM JARRAH FORESTS AVAILABLE FOR TIMBER HARVESTING

JARRAH					MARRI			
SUSTAINABLE YIELD		LOG PRODUCT YIELDS (current specifications)			SUSTAINABLE YIELD	LOG PRODUCT YIELD (current specifications)		
Year	Gross Bole Volume m^3/an	First Grade Sawlogs m^3/an	Other Sawlogs m^3/an	Other logs m^3/an	Gross Bole Volume m^3/an	Sawlogs m^3/an	Other Logs m^3/an	Forest Residue m^3/an
1992-2001	1,360,000	459,000	216,000	685,000	469,000	57,000	412,000	300,000
2002-2036	1,360,000	To be allocated in future strategies			469,000	To be allocated in future strategies		

Table 14 CALM 1992(a)

CALCULATED ANNUAL SUSTAINABLE YIELD FROM KARRI FORESTS AVAILABLE FOR TIMBER HARVESTING (CALM 1992)

KARRI					MARRI			
SUSTAINABLE YIELD		LOG PRODUCT YIELDS (current specifications)			SUSTAINABLE YIELD	LOG PRODUCT YIELD (current specifications)		
Year	Gross Bole Volume m^3/an	First Grade Sawlogs m^3/an	Other Sawlogs m^3/an	Other logs m^3/an	Gross Bole Volume m^3/an	Sawlogs m^3/an	Other Logs m^3/an	Forest Residue m^3/an
1992-2001	417,000	214,000	103,000	100,000	90,000	13,000	77,000	75,000
2002-2036	417,000	To be allocated in future strategies			90,000	To be allocated in future strategies		

In summary, the potential jarrah forest yield identified on Table 13 comprised 459,000m^3 of first grade jarrah sawlog, 216,000m^3 of second grade, short and small-diameter sawlog based on a sustainable yield of 1,360,000m^3 in gross bole volume. Table 14 shows that 214,000m^3 of first grade karri sawlog could be taken, plus 103,000m^3 of other karri sawlogs together with 100,000m^3 of thinning. This was based on a sustainable yield of 417,000m^3 in gross bole volume per annum. Figures are also given for the yield of marri from both the jarrah forest and the karri forest[1].

The EPA Recommendations 6 and 7 of its October 1992, Bulletin 652 indicated that CALM's proposed sustained yields could be accepted over the 10 year period from 1992 to the year 2002 inclusive, albeit with caution.

EPA Recommendation 6

"The Environmental Protection Authority has noted that CALM's silvicultural prescriptions for the jarrah forest have been developed with incomplete knowledge of their long term consequences; and therefore concludes that the proposals to amend the 1987 Timber Strategy should be implemented cautiously. The Authority recommends that the annual sustainable yield estimates in the Timber Strategy should only be applied for the life of the Strategy (ie. until 2002)."

EPA Recommendation 7

"The Environmental Protection Authority recommends that the letting of wood supply contracts from the jarrah forest under the CALM Act;

- *not commit all of the volumes in any class of log defined in the Timber Strategy for a term exceeding 10 years from 1992; and,*

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1. *Throughout this report "jarrah" refers to CALM's overall published proposals for jarrah, marri, wandoo and blackbutt found in the "jarrah forest".*

- *not exceed the annual levels of supply in any class of log or wood (residue) nominated in the 1992 Timber Strategy).*

- *recognise the possibility of the necessity to reduce wood supply beyond 2002 as a result of monitoring and adaptive management following the trial implementation of the jarrah silvicultural prescription."*

Appeals Committee Recommendations

Mr Tos Barnett in considering Appeals against the EPA recommendations of Bulletin 652, departed significantly from both the CALM proposal and the EPA recommendations in regard to modified levels of timber harvest. Barnett recommended adhering to the CALM 1987 Timber Strategy levels of harvest.

The Barnett Appeals Committee recommendations in the executive summary of the report were as follows:

- *Caution in the implementation of the proposals for harvesting and regeneration of the jarrah-marri forests.*

- *No increase in the level of cut beyond the rate approved in the 1987 strategy.*

- *The creation of an extensive system of wildlife habitat corridors linking all streams across the saddles.*

- *A review of forest management policies to present and cost other options - including an option to gradually phase out large-scale timber operations from native forests and to base it on tree plantations on degraded farmlands with a long lead time and no loss of profit or jobs.*

- *Approval of the EPA recommendations and CALM's proposal for the conservation estate with some modification.*

- *A public review of policy and practice regarding the effect and control of dieback.*

- *Provision for undisturbed areas in the high salt-risk areas.*

- *A public review of fire management.*

- *The establishment of an independent Forest Monitoring and Review Committee.*

- *CALM's public accountability and relationship between the public, CALM and the EPA be examined.*

The principal difference between the CALM 1987 and 1992 proposals was in the level of harvest for jarrah. The 1992 proposal meant that 50% more jarrah sawlogs would be harvested over the 10 year period. The 1987 Strategy proposed a significant continuing decline in the availability of jarrah sawlogs from 1993. There was not a marked difference between the two strategies in the level of marri or karri harvest.

The Barnett Appeals Committee recommendation was effectively an outright rejection of CALM's revised inventory of the jarrah forest and potential yield for jarrah.

Evaluation Of Inventory And Yield

The Appeals Committee commissioned specialist forestry advice to review the technical basis of CALM's estimates of jarrah inventory and sustainable yield. Dr Brian Turner and Dr Geoff Wood, of the Department of Forestry at the Australian National University in Canberra were requested to provide this advice by a fax from Mr Barnett to Professor Bachelard of the Australian National University on the 11 December, 1992. At the time Mr Barnett reported (23 December 1992) and Mr McGinty, (the previous Minister) set Conditions on the 24 December, 1992, Dr Turner and Dr Wood had not offered any advice on the outcome of their review. Their report is dated 8 January, 1993 and was received more than two weeks after the Barnett Appeals Committee reported. The complete Turner and Wood report entitled, "The Review of the New Jarrah Inventory System and Associated Timber Estimation Procedures", is attached as Appendix 2.

The Ministerial Conditions for the 1992 CALM proposals were issued before the specialist advice on inventory, growth rate and allowable cut, from Drs Turner and Wood was received and considered. The Committee understands that no significant advice was provided on the matter prior to setting the Conditions.

The Turner and Wood report strongly supported CALM's calculations and methodology. It praised CALM's ability and in the Committee's view would likely have had considerable bearing on the recommendation given by Mr Barnett about timber harvest levels from the jarrah forest.

We recommend that the Turner and Wood report (Appendix 2) be considered an integral background document to our present advice because it comprised new information that should have been considered by both Mr Barnett and the previous Minister before he issued the Statement of Conditions.

The Conditions do not reflect the Appeals Committee's proposed diminution in harvest levels for jarrah to those of the 1987 Strategy. The Conditions do not incorporate the proposal for undisturbed areas in the "high-salt risk areas", the proposal for extensive additional reserves linking streams across saddles between hills, and do not require a review to consider phasing-out large scale timber operations from native forests.

Information provided in commercial confidence to the Committee by CALM confirmed that substantial allocations of jarrah sawlogs are committed in existing 5 to 15 year contracts. Consequently, the State is committed to substantial levels of ongoing jarrah sawlog supply over the immediate 10 year period under existing contracts. Some contracts were due to expire toward the end of 1992, but were renewed on a short-term basis. These comprise mainly contracts with a large number of smaller mills and allocations for one or two older mills operated by the bigger companies. Contracts covering about 30 per cent of the proposed jarrah allocation are due for renewal by the end of 1993.

After considering both Conditions 2 and 8 of the Statement, the Committee agreed that it should concentrate on evaluating the best available estimates of sustainable yield in the longer term, after applying varying levels of harvest in the jarrah forest over the 10 year period 1993 - 2002.

There were three possible outcomes from such an evaluation:

1. The resource allocated for harvest over the 1993 - 2002 period as proposed by the Statement for the 1992 - 1993 year will have an insignificant effect on sustainable yield in the long term. In this case the Committee could simply advise that the Minister proceed with the prescription for harvest that was inherent in 24 December 1992 Statement.

2. If the allocated harvest for the 10 year period either increased significantly or reduced significantly the long term sustainable yield, then the Committee could recommend that the 1993 - 2002 harvest allocation be altered to accommodate the sustainable yield.

3. If the sustainable yield is substantially below the contracted levels of supply, then the Committee could consider the ecological, commercial and social consequences of harvest levels that are ultimately recommended.

Report Structure And Committee Composition

Because of the minor errors and ambiguity in the Ministerial Conditions of 24 December 1992 we first review the environmental assessment process which led to its publication.

The major component of our report then follows. It is an assessment of the annual sustainable timber resource as required by Condition 8-2. Some particular aspects of forestry practice and ecological consequences associated with these procedures have been confused in past arguments and are clarified. The Committee then offers its comments and advice on a number of the Conditions in the Ministerial Statement that are pertinent to the Committee's terms of reference.

The Committee comprised:

Dr Tim Meagher, BSc. (Hons), PhD. - *Biologist (Chairman), Environmental Consultant*

Mr Frank Campbell, Dip. For. (Canberra), BSc. For. (UWA) - *former Assistant Conservator of Forests, former Western Australian Public Service Commissioner.*

Dr Ken Shepherd, Dip. For; BSc. (For.) PhD; FIFA. - *former Reader in Forestry, Australian National University, Canberra, Manager Forestry and Environment, ANUTECH Pty Ltd.*

Dr Darrell Kitchener, BSc. (Hons), PhD. - *Zoologist, Senior Curator, terrestrial vertebrates, Western Australian Museum*

THE APPROVALS PROCESS TO DATE

Both the Ministerial Statement of Conditions under which the 1992 CALM proposals could be implemented and the report of the Barnett Appeals Committee, caused considerable controversy when released at the end of December 1992. The Ministerial Conditions were released on 24 December 1992 and the Barnett report was released several days later.

The Ministerial Statement is meant to be the end point in the environmental approvals process. However the Statement issued by the Minister on the 24 December, 1992 was not and the finalisation of the major issues was effectively deferred for six months. The formation of this "Expert Committee" was one of the significant outcomes of the Conditions.

The EPA evaluation and appeals process to be followed by CALM was outlined in Appendix "C" of CALM's 1992 Proposals document. The letter from the Chairman of the EPA dated the 19 September 1991, together with a flow diagram showing the procedure to be adopted, is attached to this report as Appendix 3. That correspondence showed that the EPA was mainly concerned with environmental conditions within the multi-use forest rather than the amount of timber it could yield. The EPA evidently considered that evaluation and documentation of the sustainable yield from the forest quite properly reside within CALM's area of technical expertise. However, the sustainable yield from the jarrah forest became a significant public concern during the evaluation process and appeals. The yield from the karri forest, although opposed by some quarters, was generally accepted as being *"sustainable"*.

Conservation groups mostly did not accept that CALM's proposed harvest levels conformed with the principles of sustainable development. However no alternate calculation of what sustainable levels might be, appear to have been made. Correspondence received by this Committee clearly indicates that some sections of the conservation community do not support any logging of native hardwood forest.

The 1992 CALM Forest Management Strategies proposed the transfer of substantial additional components of both karri and jarrah forest to reserves. CALM was particularly attentive to provision of additional road, river and stream reserves, which were the EPA's main concern in its advice to CALM of 19 September 1991, (Appendix 3). CALM's final proposals addressed all EPA concerns.

As required by the EPA process the CALM document "Proposals to amend the 1987 Forest Management Plans and Timber Strategy and proposals to meet Ministerial Conditions on the regional plans and the WACAP ERMP" was submitted for public review to the EPA in February 1992.

The 1992 proposals were supported in detail by three further documents:

- Management Strategies for the South-West Forests of Western Australia; A Review - draft for public comment.

- A Nature Conservation Strategy for Western Australia - a draft for public comment.

- National Estate Values in the Southern Forest Region, south-west Western Australia.

The intense interest in the proposal was indicated clearly by the EPA in its Bulletin 652 published in October 1992 which stated that more than 1,000 submissions from the public and other organisations were received during the public review process.

It is understood that CALM expected that the EPA would have completed the submissions process and made its recommendations by the end of July 1992 - a period of six months. Allowing for appeals and the determination of appeals, the approval process would be completed well before the end of 1992. CALM could then formally conclude contracts with a range of sawmillers so that plans for a restructured timber industry could be adopted.

However, the EPA did not complete its report and recommendations until October 1992.

In mid-October 1992 the Hon. R J Pearce resigned as Minister for the Environment and Mr James McGinty was appointed. The incoming Minister decided to appoint an Appeals Committee comprising Mr Barnett to report to him on appeals received against the EPA recommendations. The finalisation of the Statement of Ministerial Conditions was dependent on determination of the appeals.

This delay raised significant administrative difficulties for CALM because approximately 30% of the jarrah sawlog contracts were due for renewal between 1 January, 1993 and 31 December, 1993, with many in the first six months. Without final EPA approval, contracts with some mills could not be finalised, thus causing CALM to initiate contract reductions consistent with the 1987 strategy.

The Barnett Appeals Committee reported to the Minister on 23 December 1992 (in the absence of information it had requested from Dr Turner and Dr Wood regarding the validity of inventory and yield). It advised the Minister not to accept CALM's 1992 proposals but to limit the timber harvest to that prescribed by the 1987 Timber Strategy. This would have meant a substantial reduction in timber harvest between 1993 and 2002 and the inability to maintain supply of timber to a significant number of sawmills.

The Barnett Appeals Committee recognised the difficulty of arriving at a reliable estimate of the appropriate level of jarrah harvest within the time period available (Barnett pp15-18) and suggested that EPA and CALM provide the Minister with an agreed statement on the issue.

On 24 December 1992 the Minister issued a Statement of Conditions which, in Item 8-1, gave approval for a six month extension of contracts for those affected. The wording of Condition 8-1 effectively enabled the industry to continue to harvest at the levels in the CALM 1992 proposal to 30 June 1993. In the interim period the matter of sustainable yield and other items raised by Mr Barnett could be further investigated. This led to the formation of the present Committee.

DETERMINATION OF THE SUSTAINABLE TIMBER RESOURCE AVAILABLE FOR ALLOCATION

Introduction

The "annual sustainable timber resource" referred to in Condition 8-2 available from the forest is implicitly a measurable quantity, However it can be varied. It is dependent on:

- Area available for harvest.
- Prescribed forest uses that are precedent to timber harvesting. These include the ecological standards set for multi-purpose forest use, which in turn limit the size, number and location of trees which can be harvested.
- The inventory of commercially harvestable timber.
- Increment in gross bole volume of harvestable timber and the adequacy of silvicultural information on the gross bole increment of trees across a spectrum of edaphic and climatic zones.
- The age/size class distribution of trees in the existing forest.
- The log quality chosen to make up the harvest.
- The time for which a short-term "annual" harvest at a predetermined level that is different to the long-term "sustainable yield" occurs.
- The economics of harvesting and commercial return obtained on selling the product.

As a consequence of these considerations there is a wide range of possible "annual sustainable timber resources available for allocation".

In Western Australia the sustainable yield is primarily limited by conservation, recreation and other values that the forest must provide in addition to timber production. CALM is not free to simply optimise timber production in the State forests. It must first meet a range of ecological and environmental conditions.

The Committee accepted this reality and has considered the physical, biological and political constraints put on the multi-purpose forest that limit its optimisation for timber production. The task is to determine what the residual forest, available for harvest, can produce safely.

Gross Area Of Forest Available For Harvest

The first task is to clearly establish the area from which production can occur. The Committee adopted data published by CALM in making its calculations[2]. In the case of the karri forest this is straight-forward, but the jarrah/marri forest case is complicated.

The CALM advice on the areas (hectares) of forested land in the south-west can be summarised as follows:

Area of karri/marri forest (hectares):

	Karri/marri Forest
Total area of karri/marri forest:	175,100
Less areas of conservation reserves:	53,100
Gross area of "multiple purpose" karri/marri forest:	122,000

Area of jarrah/marri and wandoo forested land (hectares):

	Jarrah/marri Forest	Wandoo Forest	Total Area
Total area of forested land:	1,572,800	107,100	1,679,900
Less area of conservation reserves:	388,200	53,200	441,400
Gross area of "multiple-purpose" forest:	1,184,600	53,900	1,238,500

Net Area Of Forest Available For Harvest

Those portions of State forest where harvesting may be conducted, have other uses. These include conservation of biodiversity, maintenance of catchment for water supplies, provision of recreational, educational and research opportunities, the maintenance of aesthetic and landscape values, and the conservation of heritage and cultural values. Not all these uses are mutually compatible and some can only be achieved by the separation of activities either in spatially or temporarily. By way of example, a recently harvested area is usually not suitable for recreational purposes for some years until regeneration has progressed. Some heritage or conservation values can only be maintained by the exclusion of harvesting activities.

CALM has taken these various forest values into consideration in its management procedures and designated special areas of the forest which will not be harvested. These areas include:

a) Riparian borders maintained in an undisturbed state to conserve biodiversity and to minimise turbidity in streamflows;

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2. *A number of minor adjustments have been made to the published areas figures by CALM using current GIS data, to bring the areas of forest up to date.*

b) Undisturbed roadside verges on major travel routes for the conservation of biodiversity and for aesthetic/landscape appeal [Visual Resource Management System (VRMS)];

c) Diverse Ecotype Zones, such as heath, sedge and herb vegetation, rock outcrops, swamps, lakes, wetlands and woodland formations.

In summary the area available for harvest after excising the additional "reserved" areas is as follows:

	KARRI FOREST (hectares) karri & karri/marri	JARRAH FOREST (hectares) jarrah/marri/wandoo
Gross area of forest land available for harvesting	122,000	1,238,500
Less designated areas excluded from harvesting[3]	27,890	127,555
Gross residual area available for harvesting	-	1,110,945
Less the estimated area of non-productive jarrah forest[4]	-	100,000
Notional residual area available for harvesting	94,110	1,010,945

As a result of exhaustive inquiry the Committee has concluded that 94,110 ha of karri forest and 1,010,945 ha of jarrah forest are the appropriate areas over which calculations of "sustainable yield" should be made. In the case of the jarrah forest the 100,000ha needs to be realistically included in some calculations and excluded from others. For example, the area over which the 1991 Inventory was conducted includes this area and it is incorporated into the overall weighted index of increment in gross bole volume.

Inventory

Knowing the volume of timber in the forest, the growth increment and the sawlog yield from felled timber is fundamental to setting sustainable harvest levels. These parameters are adequately known for the karri forest but determination of correct values is far more complicated in the jarrah/marri forest. A tree bole is simply the main trunk. Gross bole volume is the volume of trunk available from each tree. However not all the trunk is suitable for sawlog. Karri has a far more conventional sawlog yield from bole, than both jarrah and marri.

CALM completed an inventory of the jarrah forests in 1991.

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3. *CALM(a). The area was obtained from Table 5.*

4. *This adjustment has been made following discussions with inventory personnel within CALM. Uneconomic and woodland areas are unavailable for logging. Noted in CALM briefing paper, 6 May 1993, we have the following "The nature of what constitutes a sawlog also changes over time in response to changes in milling technology, markets and the opportunity to sell mill residues." (pp 5) and, relating to modelling of the 1992 strategy, "low quality forest was selectively cut where it carried above 10 m^3ha^1 and anything below that was excluded from the calculations." (pp 8).*

This provided new estimates of gross bole volume in the south-west forests for individual species (jarrah, marri, wandoo and blackbutt). These data are stored using Geographic Information System (GIS) technology and can be retrieved and analysed in a variety of ways. The methods used in compiling the inventory together with much additional useful information on the way trees vary in sawlog yield, plus illustrations of how logs are derived from felled trees is given in the CALM January 1992 publication "Application of Modern Inventory Techniques in the Forests of Western Australia."

The recent CALM inventory, and subsequent computer modelling of growth and yield for the jarrah forests, broke new ground in terms of both the methodology and the technology employed. These matters were the subject of a review by Drs Wood and Turner of the Department of Forestry, Australian National University, acknowledged world experts in the fields of inventory and yield determination. These reviewers reported to the Barnett Appeals Committee and in their concluding remarks stated *inter alia*:

> *" We note that the proposed sustainable yield of gross bole volume is substantially higher than the previous accepted projected supply. The latter (CALM 1987, pp 42, 49) projected a generally decreasing supply of sawlogs from the jarrah forests, from 523,000m^3 in 1992-1995 to 239,000m^3 in about 2030. The proposed sustainable yield is a constant 1,360,000m^3 of jarrah and 469,000m^3 of marri (CALM 1992a. pp 29). These latter figures however include significant volumes of non-sawlog material. More comparable figures are 675,000m^3 of jarrah and 57,000m^3 of marri sawlogs (1992-2001). Further differences are due to somewhat different definitions of sawlogs and increased utilisation of bole volume resulting in significant increases in the quantity of lower grade logs. (We note that estimated supply of first grade logs for 1992-1995 was previously 400,000m^3 and the proposed sustainable yield of first grade logs is 459,000m^3).*
>
> *The differences noted above reflect the substantially higher sawlog volumes estimated in the recent inventory (57.2 million m^3) (CALM 1992a, pp 27) compared with the 18.25 million m^3 estimated in the previous inventory (CALM 1987, pp 17). The annual sawlog harvest for the 1992-1995 period would be 2.9% of the sawlog resource according to the 1987 Strategy as compared with 1.3% of the sawlog resource using the recent inventory and the proposed sustainable yield. Thus, the proposed increase in potential sawlog harvest would come from a significant increase in utilisation, not from an increase in proportion of the forest harvested.*
>
> *In summary, we are very impressed with the care with which the jarrah inventory has been designed and, as indicated by the results, executed. We have suggested a correction to the sampling intensity calculation (which has negligible impact on the results) and possible increases in the second phase sampling intensity to improve precision if the inventory is to be used at the operational, as opposed to the strategic level. The significant impact of product out-turn estimates on the sustainable yield calculations is noted and this highlights the importance of gaining high precision in these estimates.*
>
> *The approach being used by CALM seems a much needed advance, but is innovative and thus needs careful monitoring. Precise estimation of land areas is also important to the overall inventory.*

Frequent updating of the area statistics to account for changes in the production forest base is essential. Fortunately, CALM's extensive experience with GIS means that the ability to make these rapid updates is available, but care is needed to ensure that all current and anticipated future changes are made.

Successful yield regulation depends on a precise inventory (which we believe now exists, at least at the strategic level) and good growth information. Existing growth information has been extensively reviewed, so we have no doubt that the best possible data set has been used for growth projections. However, this data set has some deficiencies which are not easy to overcome in the short term. For example, little information is available on species other than jarrah. The diameter growth data used in projections, although consistent with other evidence, seem to have been derived from sources (perhaps non-empirical) additional to the data set indicated as the source, and this should be carefully documented. The method of yield projection used by CALM is appropriate to the type of growth data available but more advanced tree growth models should be developed as better data are acquired. The concept of using a steady-state diameter distribution to define a desirable ecosystem structure is an interesting and useful advance in the definition of sustainability, and provides a useful platform for yield regulation. Our spot checks of these calculations indicate that the methodology has been applied correctly.

Assuming the acceptability of the assumptions underlying the sustainable yield approach, we believe that the methodology used by CALM is appropriate and essentially correct. The methodology specifies not only the volume to be removed to achieve sustainability but also the size distribution of removals. This has implications for utilisation, marketing and silviculture which have been mentioned in part but are beyond the scope of this report. However, the success of the yield regulation system depends on its correct implementation. Careful and continuous monitoring of the relationship between predicted and actual distributions and yields will be essential.

Some criticism has been levelled at the accuracy limits of the CALM inventory estimates, suggesting they are unacceptably low. However these criticisms reveal a lack of understanding of accepted sampling techniques and statistical procedures. Taken at the strategic level of planning for the whole forest, as noted in the Wood and Turner report, the statistical variations in the estimates are quite low, and very acceptable by world standards. These matters have been discussed with Drs Wood and Turner who advised the Committee that their report has been misunderstood and misquoted in this regard.

The Committee asked CALM to check a number of field parameters as suggested by Wood and Turner. These have made a substantial difference to sustainable yield estimates and are considered later in the report.

The yield estimates for the karri forest have been developed over time using more routine forestry procedure.

They were refined for the purposes of the 1992 review, but essentially were changed only marginally from earlier estimates provided in 1987.

There is no concern regarding the karri inventory and yield but some understandable confusion remains in regard to jarrah. The marri inventory and yield position is similar to jarrah. Difficulty arises in regard to the residual areas actually available for harvest. These items are now reviewed.

The Timber present in the south-west forests has been estimated by CALM as follows[5]:

> Gross bole volume in the karri and karri/marri forests = 25.4 x $10^6 m^3$
> (karri 19 x $10^6 m^3$, marri 6.4 x $10^6 m^3$)
>
> Gross bole volume in the jarrah/marri forests = 144.0 x $10^6 m^3$
> (jarrah 104.9 x $10^6 m^3$, marri 39.1 x $10^6 m^3$)[4]

However these volumes related to "multiple-use" areas of 122,000ha of karri and 1,239,000ha of jarrah. (They include the proposed road and river reserves.) When these non-harvestable areas are taken into account, the actual areas available for harvest are the notional net figures given for the karri forest (94,110) and jarrah forest (1,010,945). In the case of the jarrah forest the 100,000ha of "non-productive" forest should also be added back in, to give a value of 1,110,945 ha. (It was part of the area on which timber was measured in the 1991 inventory and was included in compiling the area weighted average increment index of 1.65.)

On the basis of these corrections to the area that is available for harvest the adjusted gross bole volume of the karri/marri forest is 19.6 x $10^6 m^3$ and the gross bole of the jarrah/marri forest is 129.2 x $10^6 m^3$.

In karri trees approximately 50% of the gross bole volume is utilised as sawlog. The remainder is utilised as chiplog. (Proposals to amend the 1987 Forest Management Plans and Timber Strategy - Table 14).

In jarrah trees felled for sawlog, approximately 33% of the gross bole volume of the felled tree is retrieved as sawlog material. (CALM's "best estimate" of sawlog retrieval from widespread field trials is 32.4%.) Marri is unpredictable in terms of sawlog yield because a high proportion of the log is usually defective due to gum pockets, cracks and shakes. Marri trees are felled for chiplog and sawlog retrieval is presently a value-added by-product.

Annual Growth Increment And The Concept Of Sustained Yield

The concept of "*sustained yield*" has been fundamental to forestry practice for many years. The standard text by Clawson (1975) states:

> *" Sustained yield connotes maintenance of productive capacity indefinitely, but without commitment as to variations in harvest within a rotation: even flow is a more specialised version of sustained yield, where the requirement of an almost exactly equal annual harvest is added.*

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5. *CALM 1992(a), pp 27.*

It is application of either of these ideas to mature old growth forests which produce the problems. Instead of the idealised managed forest of the forester, imagine an old growth forest, all the land of equal productive capacity, all completely stocked with old trees, all of which are 150 years old, all of which are ripe for cutting.

An area of 1/150 of the whole area could be cut each year. In 150 years the cutting cycle would be complete and the cutting could begin again on the first tract,..... Throughout that 150 year period, volume of timber cut each year would have exceeded volume of timber grown, although management would be fully on a "sustained yield" basis.

"In the long run wood harvest cannot exceed wood growth; in the short run, harvest may exceed growth by drawing down on standing inventory. Less generally appreciated is the fact that in the long run, growth cannot exceed harvest - if we are to grow trees, we must harvest the stands making no growth so that new trees can become established and grow relatively rapidly. The vast primeval forests when white man first saw them may have been wonderful to behold but their net growth was close to zero."

Additionally, the classic forestry text by *Davis* as far back as 1954 stated:

" That cut should equal growth is a perfectly sound general forest truism,; it must be in the long run, and it is in a fully regulated forest. But most forest properties are not fully regulated, and management aims, in working toward better regularity frequently dictate a cut in considerable variance with the growth of the forest. Current increment is often of limited significance, being overshadowed by pressing needs to bring about such things as a better distribution of size and age classes, needed reproduction, removal of unproductive trees, and solution of financial problems. In a forest dominantly of old-growth timber, increment is low and obviously a poor indicator of what should be cut."

The Committee agrees with the Clawson (1975) concept of sustainable development given earlier. While the objective is to provide advice as to optimal harvest levels over the next 10 years these yields should not be considered to be "even-flow" values for the entire rotation period.

Forests that are managed for multiple-purposes are by definition unlikely to be managed for maximum sustained yield and, as a consequence, the yield is set at some lower level. This Committee acknowledges and endorses the reality that the forests of the south-west of Western Australia are required to meet alternate ecological/environmental objectives and are managed in this context. The function of the Committee is to consider the sustained yield available subject to those constraints.

CALM in its 1992 proposal, estimated the gross bole increment in residual areas of the south-west forests available for harvest to be as follows:

Karri and karri/marri forests:

Annual gross bole volume increment of karri:	417,000m^3/year (82.2%)
Annual gross bole volume increment of marri:	90,000m^3/year (17.8%)
TOTAL	507,000m^3/year (100%)

Jarrah/marri forests:

Annual gross bole volume increment of jarrah:	1,360,000m^3/year (74.3%)
Annual gross bole volume increment of marri:	469,000m^3/year (25.7%)
TOTAL	1,829,000m^3/year (100%)

Those estimates also indicated the allocation into sawlogs, and residue. The relevant tables published by CALM (Tables 12, 13, 14 CALM 1992) have been included in the introduction to this report. The Committee considered the compilation and validity of those estimates and outlines its findings below.

The Age/Size Class Distribution Of Trees In The Existing Forest

The relevance of the current annual increment for the annual sustainable harvest depends on the present state of the forest. As indicated in the earlier quote from Clawson (1975), annual increment is of limited relevance to the permissible cut in a substantially "old growth forest". However it becomes far more relevant as the forest approaches a "normal" age configuration in which there is a fairly even distribution of juvenile, mature and senescent trees. It is therefore important, in the jarrah forest, to know how far the forest has developed towards a 'normal' forest in terms of size-age[6] distribution.

As noted above, the "ideal forest" is one in which all of the age/size classes are present. As the older trees are removed by harvest, they will be regularly replaced by an equal number of trees of the next smaller class. There needs to be larger numbers of smaller trees for this replacement process because some will be lost to competition, fire or other natural causes. This replacement process takes place right down to the smallest seedlings. However, this ideal is rarely achieved and one or other age/size class will be found to be in excess or deficient in numbers.

The age/size distribution in the, so-called, "old growth forests" present in Western Australia at the time of European settlement was weighted heavily towards larger sized trees. When the karri and jarrah forests were first subjected to harvesting the large trees were preferentially removed. This process has continued for more than a hundred years. If harvesting is to continue in perpetuity, a gradual change has to be made to harvesting those trees that have regenerated since settlement. The transition situation is fundamental to the yield-scheduling difficulties that are being addressed by CALM.

The karri components of forests are relatively even-aged, having regenerated following major fires in the past. They have been harvested using clearcutting and regeneration techniques such that the age/size distribution in the regrowth forest is directly related to the prior harvest sequence.

Part of the original karri forest not in conservation reserves has yet to be harvested and regenerated.

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6. *Size/age is used advisedly here because it is usually not possible to accurately determine the age of eucalypt trees and size has to be used as an indication of age even though size rate is markedly affected by the mix of edaphic and rainfall characteristics of individual locations.*

However, once the first cut of the forests that are available for harvesting has been completed, the oldest regenerated areas will be available for cutting in a second harvesting cycle. Karri approximates the conventional silviculture model and there are generally accepted values for its yield. The jarrah forest however is not as simple.

The jarrah forests were never composed of individual cohorts, but always had a range of age/size classes present. Harvest has taken place for more than a hundred years, selectively removing larger, older trees. In the period before Forest Department controls first became effective in 1930, extensive areas were heavily cut (most regenerated very successfully).

After 1930 silvicultural methods were initially aimed at creating sufficient sized gaps to ensure regeneration, in the 1950's there was a change to selection of single trees which inhibited regeneration. Thus there is a substantial portion of jarrah forest harvested from about 1950 to 1970 in which regeneration has been poor and future yield will be lower than might otherwise be expected. Current practice has returned to the creation of gaps of a favourable size to ensure adequate regeneration in coupes of up to 10 hectares in area.

The age/size distribution is being gradually changed within the commercial jarrah forest such that it will eventually provide a sustained yield in perpetuity. This will not be without some perturbations that reflect the changes in forest husbandry over the past 100 years.

It is difficult to determine whether the jarrah forest is currently approaching the maximum annual increment in gross bole volume. On the available evidence it is likely that the productivity of the forest will increase beyond the current annual increment of 1,360,000 cubic metres/year given for jarrah by CALM. The published information given by CALM 1992 (b) page 171 supports this view. It demonstrates that using the same data for productivity figures that arrives at an increment of 1.65 on existing forest structure, gives an increment of 1.94 on a "normalised" forest structure. Therefore growth increment can be expected to improve gradually over time with the correct siliviculture.

Calculation Of Sustainable Yield Based On Gross Bole Increment

The increment figures proposed by CALM in 1992 and the sawlog yield from the gross bole volume when applied, provide an estimate of sustainable sawlog yield. That yield is in turn dependent on utilisation percentage.

The 1992 CALM Forest Strategy on page 172 gave the results of growth increment for different size classes in three categories of jarrah forest productivity. The conclusion reached was that the average overall volume increment was 1.65 cubic metres/ha/annum. Wood and Turner endorsed the statistical methodology by which the increment of 1.65 was reached.

The 1992 jarrah gross bole volume increment on the harvestable area of jarrah is 1.36 million cubic metres per year [CALM 1992 (b) pp175]. Using CALM's estimate that 33% $\pm$3% of jarrah gross bole cut is converted to saleable jarrah sawlogs, of which 80% will be first grade and 20% will be second grade.

The following table can then be constructed to indicate the range in sustainable yield from this calculation method.

SUSTAINABLE YIELD OF JARRAH IN CUBIC METRES			
	30% (Lower Limit)	33% (Mean)	36% (High Limit)
1ST GRADE	326,000	359,000	392,000
2ND GRADE	82,000	90,000	98,000
TOTAL	408,000	449,000	490,000

CALM's measurements of jarrah sawlog yield indicate that 32.4% is the most reliable figure when field trials are averaged and weighted. On that basis the 33% is a reasonable figure, and leads to a calculation of 450,000m^3, as shown above. The calculation can be made in another way from the same data.

On average 74.4% of the forest is jarrah and 32.4% will become logs. Thus notional area (1,110,945 ha) times increment (1.65) times jarrah component (74.4%) times sawlog yield 32.4% also arrives at a sustainable yield of 442,000 cubic metres. The agreement in calculation is expected because the input parameters are of the same origin.

Subsequent to the 1992 proposals, CALM re-analysed the growth plots used in the above calculations to take account of low productivity areas, die-back and other considerations. The re-assessment arrived at a whole of forest increment of 1.2 $\pm$ 0.2 cubic metres per hectare. The calculation suggested a mean sustainable yield of 298,000 $\pm$ 50,000 cubic metres per year.

It would thus appear that estimates of the sustainable yield derived from the data and methods available, are between 300,000 and 450,000 cubic metres a year. It is evident from the disparity in the calculations given above, that improved methods of estimating sawlog yield and validating all estimations with field data, should be conducted as a matter of urgency. The relationship between sawlog yield and gross bole volume should be substantially refined.

Forecast Effect Of Harvest Strategies On Long-term Yield

CALM has been active in developing simulation models, particularly for the jarrah forests of the south-west, in recognition of the fact that these forests present many difficulties in predicting long-term yield. For the purposes of the present exercise CALM utilised the FORSCHED computer model.

CALM provided the Committee with a series of predictions for long-term jarrah yield of sawlogs based on estimates of both gross bole volume and annual gross bole volume increment.

The first of these FORSCHED scenarios was based on what the model derived as sustainable yield in perpetuity. FORSCHED indicated that a harvest of somewhere close to 250,000 m^3 yr^{-1} of sawlogs would be sustainable in perpetuity.

This is at substantial odds with the earlier calculations based on CALM's 1992 (b) data which indicates a sustainable yield of 450,000 m^3/year. The Review Committee specifically requested that CALM explain the basis and capability of its modelling technique and run appropriate scenarios. A major concern was, that while the FORSCHED model is recognised as being mathematically reliable, it uses conservative input parameters (such as the 1.2 $\pm$ 0.2 growth increment figure). The model also incorporates an allowance for dieback that reduces computed growth to two thirds of that actually measured. So it is conservative when these inputs are compounded.

The Committee requested examples of the FORSCHED model that adopted a variety of initial 10 year harvest scenarios and then forecast subsequent sustainable yield to the year 2150. It is clear from these outputs that while FORSCHED is conservative in its baseline estimate of sustainable yield, it is useful in comparing consequences of alternative harvest scenarios.

FORSCHED is concluded to be a valuable tool in assessing the consequences of a 10 year short-term over-harvest on the subsequent long-term sustainable yield. FORSCHED can give a useful indication of the proportionate effect of different levels of overharvest on the theoretical sustainable yield.

CALM was requested to prepare FORSCHED simulations of 600,000, 450,000 and 300,000 cubic metres a year for 10 years followed by the consequent long-term sustainable yield.

The results were, that 600,000m^3/year caused a 20,000 reduction, over the subsequent 40 years. A 450,000 m^3/year harvest caused 10,000 reduction and 300,000m^3/year had negligible effect. In the period 40-80 years after the 10 year period of overharvest the effect was more pronounced. 600,000m^3 caused a 70,000 reduction, 450,000m^3 caused 40,000, but 300,000m^3 was negligible.

The Committee then considered the effect of "over-harvest" of the jarrah for 10 years based on harvest of standing volume of timber. The standing volume of 34 x $10^6 m^3$ was derived as follows:

> The volume of sawlogs shown on Table 12 of CALM 1992 (a), measured by the 1991 inventory was 57.2 million cubic metres based on 1,239,000 hectares. Footnotes to the table indicate that 4.4 million cubic metres of marri sawlog were included in that estimate.. So there was actually 52.8 million cubic metres of jarrah sawlogs (derived from 57.2 less 4.4) available from 1,239,000 hectares.
>
> Making an allowance for stream and road reserves, reduces the amount of jarrah sawlogs available to industry to 47.3 million cubic metres (52.8 x 1.111 ÷ 1.239).

In response to the Turner and Wood Recommendation, CALM made a field study to test the 1991 Inventory accuracy in predicting what portion of the total tree bole is, on average, suitable for sawlogs. This allows for fungal infection, insect attack and physical deformity. Trees were cut down and sawn into logs after having made predictions of the expected sawlog suitability.

The study found that of the sawlogs identified by inventory 12½% were in trees left standing for various purposes including animal habitat. Of the remainder 82½% were currently acceptable to sawmills. This indicates that the earlier estimates of the 1992 proposal were high. Applying corrections to the inventory forecast for jarrah sawlogs on forest available for harvesting indicates that about 34 million cubic metres of first and second grade sawlogs would be available to industry if today's standards of tree bole utilisation remained unchanged. (47.3 x 87.5% x 82.5% = 34.14).

Having arrived at a standing volume of 34 x $10^6 m^3$ of jarrah the Committee then considered the effect of over harvest based on adopting the conservative lower 300,000m^3/year estimate of sustainable yield.

CALM was requested to make calculations of the effect of harvesting at 450,000m^3/year for 10 years on the assumed long-term "sustainable yield" of 300,000m^3/year. The result is a depression of 20,000m^3/year in the long-term yield after 10 years. Thus even if the "real" long-term yield is 300,000m^3/year, an over-harvest level of 450,000 for 10 years will reduce the "real" long-term yield from 300,000m^3 to 280,000m^3 per year thereafter. This is due to the dilution effect of the long rotation time, ie. the over-harvest is occurring for only 10 years out of rotation that will be in the order of 150 years.

Therefore the level of harvest proposed by this Committee is adequately "precautionary". If the true "sustainable yield" is in the order of 450,000m^3 then the effect will be negligible.

Present Contractual Commitments

The Committee requested a detailed schedule of CALM's present and proposed contractual commitments for jarrah sawlogs. This was provided and reviewed. The Committee considers the information to be commercial-in-confidence. Approximately one-third of existing contracts fall due for renewal in the 1993 year. Most of the small mills are in the group requiring renewal in the current year. Some substantial allocations to the larger operators also fall due later in 1993.

If all contracts are renewed then the annual volume of jarrah sawlogs required is 532,000 cubic metres a year. However the industry has only been taking 462,000 a year for the past few years. This is in part due to the down turn in the economy and some companies utilising their inventory of stack-dried timber, as they shift to kiln drying.

The Committee having considered the likely range of sustainable yield, the effect of varying levels of short-term overharvest on long-term yield and the industry demand for product considered that a yield in the range of 440,000 to 490,000 with some flexibility would be acceptable over the next 10 years.

The Committee accepts the content of the CALM submission in general terms but is of the view that the original assumption in the 1992 proposal that 50% of gross bole volume will become sawlogs is not supported by data. The Committee accepts that it may be a possible scenario in the long-term, when regrowth forest is the main source of sawlogs.

The Committee's position was put to CALM who in turn restated a preference for 490,000 and offered to support that case. The CALM position is in part a desire to meet reasonable demand without industry disruption. The CALM submission in response to the Committee's request is given as Appendix 4.

One member of the Committee, Dr Shepherd, is firmly of the view that a yield of 470,000m³ for the next 10 years is preferable. Dr Shepherd's advice is that this level can be achieved and maintain industry stability while restructuring from low value green sawn product to dried and dressed product.

An alternate proposal would be for a phased reduction over the next 10 years in which contracts are reduced by 25% as they fall due. A once-only reduction in the cut, from 532,000m³ to either 490,000 or 470,000, must take place almost immediately and must, therefore impact severely on contracts expiring in 1993. Most of the small mills hold such contracts. Other contracts expiring later than 1993 would escape unscathed which would be inequitable. A phased reduction in all contracts would be fairer.

Year	Current Contract at Expiration	75% Renewal	Sum of Current Contracts
Present	0	0	532,000
1993	175,008	132,000	488,405
1994	13,900	11,000	485,455
1995	9,200	7,000	483,255
1996	1,800	1,400	482,855
1998	77,305	58,000	463,550
2003	240,000	180,000	403,400
2006	14,150	11,000	400,480
TOTAL CONTRACTS	**531,413**	**400,000**	**400,000**

Given that the industry is currently utilising approximately 460,000m³ this strategy is achievable.

If the revision of inventory and yield toward the end of the current 10 year period shows a need to reduce harvest levels toward the lower estimate of 300,000m³ then contract renewals should enable this to occur equitably. Renewals over the next 10 years should all be rationalised to fall due again at the end of the 10 year period. These comprise approximately 50% of the contracted supply. The other half is contained in contracts due for renewal in 2003.

Conclusions

The focus of this report has been to resolve the outstanding query in regard to the sustainable yield of the jarrah forest resource.

The Review Committee's investigations lead to the following conclusions in regard to sustained yield and appropriate harvest levels for the next 10 years:

- The forests of the south-west are generously provided with conservation areas which will not be harvested. Conservation values are not at risk from continued timber harvest.

- The karri forest timber resource is being harvested at a sustainable rate. The Committee is satisfied that the present harvest is in reasonable balance with the resource increment and can be maintained in perpetuity.

  The marri forest resource is also being harvested at levels that are within agreed levels of sustainable yield.

- The jarrah forest timber resource is not in a steady state. Average growth increment is likely to increase in the long term as the area of regrowth increases. Dieback will continue to have an effect on jarrah, but if managed adequately, it is most unlikely to be catastrophic.

- On balance, it is wise to be cautious with estimates of jarrah yield. On the basis of conservative forecast (300,000m^3/year) the present sawlog harvesting commitments for the jarrah forest are more than the resource can sustain in perpetuity.

  However a harvest close to 450,000m^3/year for 10 years will not irrevocably damage the long-term yield even if the conservative 300,000m^3/year is subsequently proven to be more appropriate.

- CALM presently has contracts to provide approximately 530,000m^3/year of jarrah sawlog. The industry are presently purchasing approximately 460,000m^3/year. One third of the purchase contracts are due for renewal in the current year.

- The State should obviously honour its contracts as far as possible. If CALM does not renew contracts that fall due this year the ongoing level of harvest would approximate the conservative estimate of long-term sustainable yield (300,000m^3).

- CALM was advised of the Committee's findings in regard to sustainable yield and asked to provide a case in support of the level of harvest for the next 10 years that it considered, would enable industry to restructure and provide stability. That figure is 490,000m^3/year. The CALM case in support of that request is appended.

- The CALM proposal to harvest 490,000m^3/year is in the order of 40,000m^3 more than the most likely estimate long-term sustainable yield. The 10 year period is a minor component of the 150 - 200 years harvest period (rotation). The over-harvest can be accommodated for 10 years without irrevocably altering the long-term sustainable yield. The justification for over-harvest is therefore dependent upon the social and commercial benefits that can occur as a consequence.

- The alternate proposition of reducing contracts by 75% on renewal over the next ten years and arriving at an ongoing 400,000m^3 (or lesser) figure at the next review in 10 years time, should also be considered.

Western Australia's native hardwood forests are some of the very few in the world that are actually being managed for sustainability. While other countries talk about it, Western Australia is actually a world-wide model for doing it properly. This fact should not be overlooked in the public debate in regard to forest management.

Addendum

Since presenting the report on 30 June 1993, information that is relevant to the acceptance of sustainable forestry was published in "New Scientist", on 26 June and 3 July 1993. The items are given as Appendix 5.

The articles indicate:

1. Australia and the United States of America, are probably the only two countries in the world, realistically endeavouring to achieve sustainable forest management by the year 2000.

2. Europeans want tropical producers to be sustainable, but refuse to make their own forests sustainable. As a result the "International Tropical Timber Agreement", has collapsed.

3. International definitions of "sustainability" are still vague and vexatious.

4. Environmentalists are now opposing plantations of eucalypt and pine in Europe on the basis that they reduce diversity.

RESTRUCTURING THE NATIVE HARDWOOD TIMBER INDUSTRY

Historical Use Of Forest Hardwood

Jarrah has been mainly used as a structural timber. In the early years of sawmilling in the Western Australian forests, products were marketed mainly for housing construction, railway sleepers, underlay for road pavement and wharf construction. Green timber was used for house-framing and cladding, roofing construction and fencing.

Sawn green timber has for many years been the mainstay of the timber industry. It was taken straight from the mill to end-use projects, predominantly structural timber in the housing industry. Although nailing jarrah was difficult it could be done while the wood was green. Drills and nail guns were not a common feature at building sites until recently. Once nailed into position, the natural tendency to warp and twist was prevented. However, cracks in plaster walls were evidence of the shrinkage that followed.

While karri has similar structural and textural qualities to jarrah it is not as termite resistant and consequently was not as widely used in the housing industry. The development of termite treatments has almost overcome this problem in recent years. Karri will become increasingly important where long-length structural hardwood is required. Karri will continue to improve as a dressed decorative hardwood.

As the decorative attractiveness of our hardwoods has been recognised, their value has increased. Efforts have been made to dry the best of the mill product for later planing and shaping for use as architraves, flooring and furniture making. The processing was slow, expensive and wasteful. Squared timber was placed in open stacks so air could move through. Heavy weights were placed on top to minimise warping and twisting. The stacks were left in the open for about two years until the drying process was sufficiently advanced for the "dressing" treatment of surface planing and shaping to be effective, once the shrinkage, twisting and warping forces had stabilised. On average, about 40% of each dried stack was immediately useable. The rest would have bends and twists or end and side splits which required further cutting. About 70% of all timber in a stack might eventually be sold as higher value products.

Changing Technology And Product

Kiln drying has revolutionised this value adding process, reducing the time taken to dry timber from at least two years, to about 50 days. In addition, the percentage of each stack of timber dried, which is immediately useable for high value products, rises from 70% to about 95%.

Technology is now available for kiln facilities to be installed by all sections of the sawmilling industry. CALM has also developed low-cost, solar- based drying kilns suitable for the smaller sawmills.

Availability and transport costs from the eastern states has inhibited widespread use of pine until recently. Extensive areas of pine were planted in the 1960's to provide for shortfalls expected after 1990 in the supply of hardwood sawlogs from Western Australian forests. These products are now becoming increasingly available.

The move to high quality use of jarrah and other Western Australian hardwoods has been at least partly driven by increasing supplies of locally grown pine coming onto the market. This will gather market momentum as larger quantities of pine come on stream as plantations mature.

Pine is now becoming the preferred structural timber in the building industry. Within the next few years major modern sawmill and associated drying and dressing facilities at Dardanup will supply large quantities of pine to local markets. Pine is more cheaply sawn, dried and dressed than hardwood and is lighter and more easily worked and nailed. Although it does not compete with the appearance characteristics of jarrah and similar hardwoods it will most certainly compete with green, rough-sawn hardwoods in the construction market. The price differential to pine is likely to make sawmilling of jarrah, for sale as green sawn product, uneconomic within a few years. Jarrah will need to be used as a high-value product for decorative uses or for specialised purposes where hardness and appearance are desirable to retain any place in the market.

There are important physical differences between jarrah and karri timber. Jarrah has greater hardness and durability when exposed to the elements, whereas karri has greater structural strength. Jarrah hardness means it is better for furniture and exposed flooring. The superior termite resistance of jarrah is less important because timber can be treated to resist termite damage.

The move to produce predominantly high-value products from the jarrah, karri and marri forests will cause the sawlog price to increase and as a consequence, encourage markedly better utilisation of felled bole volume. It is anticipated that increased price will largely offset reduced demand.

Forecast Jarrah Yields And Contracts

There have been marked changes in the long-term forecasts for the sustainability of the jarrah harvest. During the 1960's it was generally accepted that jarrah availability would fall significantly. As a result extensive pine plantations were put in place to provide a strategic alternative. By 1982 it was envisaged that the jarrah harvest would have to drop dramatically by 2010 and cease by 2040. Revisions of the inventory in 1987 extended the possible continued availability of jarrah by approximately 20 years and forecast sustainable yield of approximately 140,000 cubic metres per year. That forecast has been revised upwards again by the 1991 inventory. Thus a long-term jarrah harvest is to some degree a relatively recent windfall due to improved inventory and management procedures. It is therefore appropriate to begin the restructuring of the industry consistent with the long-term sustainable harvests.

In advocating an average jarrah sawlog allocation to industry that is in excess of the long-term sustainable yield over the next 10 years, CALM recognises a need for a minimum period of about 10 years for amortisation of capital spent by industry to complete restructuring. The investment associated with the restructuring of the jarrah sawmilling industry is important to the economy of Western Australia (see Table 1).

Table 1 - Investment associated with the restructuring of the jarrah sawmilling industry.

(Source: CALM - figures indicative of commitments to date.)

RECENT MAJOR INVESTMENTS BY INDUSTRY ON SAWMILL TECHNOLOGY PREDRYERS, KILNS AND OTHER PROCESSING FACILITIES	$$ MILLIONS
Companies with annual contracts for sawlogs exceeding 20,000 cubic metres	115.8
Companies with annual contracts for sawlogs between 10,000 & 20,000 cubic metres	4.3
Companies with annual contracts for sawlogs below 10,000 cubic metres	3.5
TOTAL	**123.6**

In examining the option of an immediate reduction of sawlog allocations it is necessary to examine the term of existing contracts. This is summarised in Table 2.

Table 2 - Summary of current and proposed contracts of sale for jarrah sawlogs m^3

	CURRENT CONTRACTS M^3 - EXPIRY YEAR						Total Contract 1993-2006	CALM Proposed Contract
	1993	1994	1995/96	1998	2003	2006		
Large Companies	109,910		5,000	55,105	240,000		410,015	371,300
Medium Companies	23,778	6,200	2,000	20,200		14,150	66,328	42,200
Small Companies	41,320	7,750	4,950	2,000			56,020	48,520
Totals	175,008	13,950	11,950	77,305	240,000	14,150	532,363	462,020

Large Companies: *Having annual intakes of sawlogs exceeding 20,000 cubic metres.*

Medium Companies: *Having annual intakes of sawlogs between 10,000 and 20,000 cubic metres.*

Small Companies: *Having annual intakes of sawlogs below 10,000 cubic metres.*

In 1987 small sawmillers were given security of resource for five years. This was, in most cases, the first time these millers were given any security. Their low overheads also made it possible to use logs of lower quality.

The larger mills were given security for periods of 10 or 15 years. It is in this group that major capital investments have occurred.

The contracts of most of the small sawmillers are due for renewal. If a general reduction in sawlog allocation were enforced, it is this group which would be most affected. As they are seen as providing an important contribution to maximising tree bole utilisation their closure would be undesirable. They are also a very important contributor to employment in the south-west because of decentralised mill locations and labour intensive methods. However, if this group is to continue operations it is important for them to be given both the opportunity and incentive to add value (such as using kiln drying).

The proposal for an annual jarrah sawlog allocation up to 490,000m^3 is recommended on the proviso, that when contracts are reviewed, any first grade jarrah allocation which is forfeited as a result of failing to meet contractual obligations should be withheld, so as to reduce the total annual jarrah sawlog cut.

Resource Security Legislation

The Committee noted that both the Premier and the Minister have given commitments to providing Resources Security Legislation for the timber industry. This aspect was briefly reviewed by the Committee with regard to the objectives of restructuring the industry. The resource security proposition was raised by the Commonwealth in early 1991 but has since lapsed. The subject was reviewed in detail by Fisher (1991) in the Australian Law Journal. Fisher outlined the background as follows:

> *"Commercial decisions concerning the use and development of natural resources frequently contemplate a long time-frame. Industrial and commercial developments often require continuity of access to the resource upon which they are based. On the other hand, political decisions are more often than not prompted by considerations of more immediate and short-term consequences. In other words, politicians may seek to keep their options open while entrepreneurs would wish stability and security of access to their sources of supply. Both points of view are perfectly understandable and it is a matter of overall circumstance where the balance lies in any particular case.*
>
> *It is usual for government to have effective control of the legislative process and it is the risk inherent in this that may cause disquiet or concern for the entrepreneurial section of the community. Many attempts have been made over the years to create a degree of certainty and stability within these arrangements. Much depends in practice upon the relative strengths and weaknesses of the parties.*

The proposed Commonwealth legislation was intended to both assist and regulate the development of major new forest projects rather than be used to restructure well-established forestry operations. Nonetheless Fisher (1991) notes the following interactions that are universally relevant to ongoing use of natural resources and resource security legislation in this State.

> *"The proposed legislative scheme for creating forest resource security is novel in several respects. It deserves scrutiny even though a Bill has not yet been published. At first glance it seems to depend upon a number of assumptions about the relative powers of the Commonwealth and the States and about certain other constitutional limitations. These are:*
>
> - *an acknowledgment that the Commonwealth has no power directly to control the use of land for forestry purposes in a State;*
> - *an acknowledgment that the power of the Commonwealth in respect of trade and commerce with other countries and among the States, external affairs or the acquisition of land for Commonwealth purposes may enable the Commonwealth in appropriate circumstances to regulate the use of land for forestry purposes in a State;*
> - *a recognition by the Commonwealth that existing Commonwealth legislation relating to the environment or aspects of it may apply to projects to be covered by this proposed legislation (for example, the Environment Protection (Impact of Proposals) Act 1974, the Australian Heritage Commission Act 1975, the World Heritage Properties Conservation Act 1983 and legislation affecting Aboriginals or Torres Strait Islanders);*
> - *an acknowledgment that the Commonwealth and a State acting together can invest this scheme with constitutional authority that it might otherwise lack;*
> - *a recognition that, in the absence of a legislative framework, undertakings by the Commonwealth and the State not to exercise powers otherwise available might be unenforceable.*

It is not possible to rule out potential intervention by the Commonwealth into forestry matters. The World Heritage Listing of the wet tropics (Daintree Forest) in Queensland and subsequent widespread closure of logging operations is a matter of record.

In Western Australia security for the industry will be primarily conferred by the structure and longevity of contracts between CALM and individual timber companies. It will be further supported by ensuring that timber harvest complies with the objectives of treaties and conventions entered into by the Commonwealth (eg. "Sustainable Development").

The State Government can legislate to ensure that contracts made with timber companies prevail regardless of changes in government over the next ten year period.

The present Ministerial Statement of Conditions envisages that there will be some harvest of the timber resource after the present 10 year period but also specifies that the level of that harvest will be subject to review. Thus the long-term harvest of the south-west forests, whilst justifiable on present information is by no means guaranteed.

Approximately a third of the contracts for the jarrah resource fall due in the current 12 month period. A review of the terms and conditions of those renewals provide a major opportunity for the government to guide the industry. The next opportunity for government to influence the direction of industry is in 1998 when 15% of the contracts fall due. The government may wish to renew the opportunity of rationalising all contracts to the same 10 year review period or leaving the renewal of contracts staggered as they presently are.

The content of existing and proposed contracts between CALM and individual timber companies were not reviewed. That detail was considered to be outside the scope of this Committee's term of reference.

It is recommended that the Minister take an appropriate period of time to consider not only the overall level of harvest of the jarrah resource for the 10 year period, but also the content and structure of individual contracts due for renewal.

Conclusions

Karri harvesting and use is an efficient, low-waste industry. Residue is chipped and exported for pulp. Encouragement must be given to shift more karri from structural to dried and dressed use. Marri is predominantly a woodchip by-product of jarrah sawlog harvest. Regrowth marri will produce better sawlog yield in the longer term.

There are two opportunities to improve the commercial return from the jarrah harvest. The first is by kiln drying and the consequent move to decorative and dressed timber. The second is by using more of the felled bole volume. Unfortunately jarrah is not a commercial woodchip product.

The jarrah harvest is currently regulated by the retrieval of first grade logs. A large amount of additional low grade jarrah and marri timber is felled on each coupe to accommodate regeneration. The present price structure is not adequately encouraging utilisation of lower-grade logs generated as a by-product of logging operations to retrieve some sawn timber. This, together with greater utilisation of marri sawlogs should be encouraged by a combination of revised pricing and developing of special markets such as parquetry flooring and short pieces for furniture.

Consideration should be given to allowing field inspection for sawmillers to purchase "other" grade logs after coupes have been harvested and cleared of first and second grade logs. These logs can then be removed as is, or trimmed by on-site spot mills before removal.

Price-mechanisms which improve utilisation should be discussed with industry. An industry comprising a mix of small sawmillers with larger companies is consistent with proposals by CALM and endorsed by the Committee. The bigger mill-companies are expected to add value because their commercial structure naturally facilitates this. However, the smaller mills are likely to have quite different market strategies. Their tendency is to take lower quality logs and provide green sawn timber to the building trade to sustain cash-flow.

If they have to pay CALM within 30 days for the log and bear milling costs, they will not want to kiln dry for 50 days to compete in the dressed timber market. Cash flow, added costs in capital equipment and competition from bigger companies are disincentives to invest in value-adding facilities.

It is recommended that the following concept be explored with both the bigger and smaller sawmill companies. It recognises the respective advantages of the commercial and administrative flexibility of smaller privately owner sawmills; compared to the bigger executive-driven public companies which can more readily provide capital investment, market development, product research and promotion.

1) Set a price structure for first grade jarrah logs that favours their use for sawn and dressed timber rather than green-sawn, structural timber.

2) Set the price structure for second and "other" grade logs so that there is an incentive to obtain the maximum amount of sawn timber from each log.

3) The price structure for second and other grade logs should ensure;

   - there is an immediate incentive to retrieve more of the logs which are routinely felled in a coupe but presently left behind.

   - price is revenue neutral to first grade jarrah in terms of royalties received by the State. Neutrality should incorporate not only sawn plank retrieval but haulage, handling and waste disposal.

   - greater use of marri as sawlog is encouraged.

4) Provide incentive terms so that small millers who retrieve high quality sawn timber from second and other grade logs, are encouraged to offer these to co-operative kilns, or kilns of the bigger companies for drying (on consignment).

5) Initiate and subsequently facilitate discussions between small and large sawmillers to rationalise, or time-share the use of some of the under-used mill capacity of the bigger companies to achieve economies of scale.

6) Encourage the use of in-field, pre-milling of "other" grade logs to help in transport cost rationalisation and greater use of felled bole volume.

The approach to restructuring the use of the sawn-timber from the native hardwood forest should be a mix of prescription and inducement. It should incorporate much, if not all, that industry considers is essential to enable product optimisation and profitability. In turn the prescription component should ensure sustainability, satisfaction of environmental pre-requisites, and an appropriate royalty return for access to the State's timber resource.

The objective of CALM's 1992 Management Strategy for the native forests is to achieve better utilisation of the sawlog resource through assisting the restructuring of the timber industry. CALM aims to encourage a sustainable value-added wood processing industry which converts the wood resource to the highest value end product with minimum waste.

CALM's objectives are stated:

> *"Value adding includes any activity that economically converts an available resource into products of higher value which reflect or use the natural features or qualities of the resource. Value adding includes optimising the recovery of saleable products including the use of previously wasted residues.*
>
> *Value adding aims to:*
>
> - *optimise high value, higher quality products, (eg. Kiln dried and dressed timber in preference to green sawn timber);*
> - *expand the quantity of harvestable resource, while increasing its value, (eg. ensure that much higher levels of bole volume become sawn timber);*
> - *maintain or increase employment in resource utilisation, (ie. recognise that timber is not only a commercial product, it is a strategic renewable resource).*

CALM proposes to foster this industry restructuring through the following mechanisms:

1. Contracts for high-quality, general purpose sawlogs will require evidence of;

   a) sawmilling facilities with appropriate technology to process sawlogs efficiently with maximum recovery;

   b) kiln drying facilities, including co-operative use of kilns, to produce an increased proportion of kiln dried product.

2. All new contracts relating to premium grade logs will contain conditions such that, no later than 31 December 1996, at least 60% of the output of the sawmill will be further processed by kiln drying into value-added products.

3. Contracts to purchase premium grade sawlogs will require evidence by 31 December 1996, that at least 80% of the initial output will be further processed into higher value end-products.

4. Contracts will be offered for the purchase of "optional" logs (marri, and third grade jarrah). Milling of lower quality logs which would otherwise be chipped or wasted, achieves the principle of value adding. However, conditions of these contracts will require that processing facilities will need to be provided to maximise the recovery of high-value products and minimise a sawmill waste even for this grade of log.

5. It will be a condition of all contracts, that no later than 31 December 1998, at least 95% of the original quantity of log resource delivered to a mill will be recovered as saleable products.

THE POTENTIAL TO INCREASE PLANTATION ESTATE ON CLEARED AGRICULTURAL LAND

Introduction

The Committee received submissions advocating a cessation of logging native hardwood forests and replacement with plantations on cleared agricultural land. This is laudable and in part will occur naturally. But it is also impracticable for some timber products.

As we shall review in this section, plantation pinewood will gradually replace green-sawn native hardwood as a structural timber, for commercial reasons. Bluegum plantations for paper pulp production are becoming commercially attractive. However, plantation hardwood (bluegum) has no chance of replacing native hardwood as either a decorative timber or structural timber in the foreseeable future. They are different products. It is possible, although improbable, that bluegum could be on-grown from pulpwood plantations for sawlog production. However, whilst it might provide some market share it is simply not a replacement product for pine, jarrah, karri or marri at this time.

Added to this, Western Australia is one of the few places in the World where a sustainable native hardwood industry with a high quality product, has been developed. We have a global responsibility to continue that development. (Refer Appendix 5)

These aspects are reviewed below.

Previous Strategies

Past strategic planning by Government for timber products in Western Australia was based on ensuring an adequate degree of self sufficiency. It was based on the concept that the native hardwood forests would be exhausted, that the building industry would continue to require timber, and that Western Australia would always suffer a transport penalty in imports. This was consistent with a broader strategy adopted by the commonwealth Government in which all States participated. As far back as the 1960's Federal funds were loaned to States to encourage their involvement in creating softwood plantations. Yields from all Australian hardwood forests at that time were considered to be inadequate to meet the expected demand. In the case of Western Australia, hardwood yields were expected to fall dramatically in the early decades of the twenty first century. The resilience of the south-west forests has been consistently under-estimated.

The primary motivation for the 1960's planning was the anticipated large negative balance of trade in forest products, and the associated contribution to international debt. Most states continue to develop plantations, although the federal incentive has now gone. Establishment of softwood plantations by the state governments, using borrowings, is now commercially hazardous.

Present Plantations

The extensive softwood plantations from past Government strategies are now the basis for local industries. The Dardanup sawmill owned by Wespine Industries Pty Ltd (joint venture between Bunnings Ltd and Westralian Forest Industries Ltd) is currently using about 70,000 cubic metres per annum. It will steadily increase its throughput to about 400,000 cubic metres per annum by 2002. Wespine will operate at that volume of sawlogs mainly from state owned plantations. The Dardanup complex is a large sawmill by Australian standards and able to produce and sell timber at world competitive prices. The associated facilities for drying and dressing the mill output are also of international standard.

However it must be recognised that the Dardanup plant will be consuming timber grown on Commonwealth and State funds that have shown a mediocre return for the State, at best. Although projected financial returns to the State, from softwood plantations suggest that further investment is not attractive, it is apparent that some companies which own the newly established industries are prepared to support themselves by continuing plantation development. On this basis, the State's strategic lead in setting up an alternate timber industry has been very successful. The foresight of previous governments is to be complimented.

The products marketed from the Dardanup complex are anticipated to remain competitive with imports. They will also become increasingly competitive with rough sawn building and construction materials drawn from our natural hardwood forests. They should substantially out-compete native hardwood by the end of the 10 year period.

One of the major reasons for emergence of the industries in Western Australia is that all the residue can be utilised, particularly as fibre-board. In this regard, increased market use of medium diversity fibre-board from jarrah residue should be encouraged.

Of more significance is the prognosis that fast-grown hardwoods may provide good financial returns for short rotation pulpwood products. It is quite likely that industry will see some benefit in using these pulpwood plantations as a future source of sawlogs by growing a small selection of trees for a longer rotation (after harvesting the main crop for pulpwood). The rotation for hardwood pulp would be about twelve years and for sawlogs about 25 - 30 years to reach sawlog size. However practical experience around Australia indicates that 40 - 60 years are required to obtain adequate quality sawlogs from blue-gum. This is mainly due to growth stresses in the younger trees.

The hardwood sawlog growing cycle is likely to be similar to current softwood plantations. Any increase in present plantation areas will not therefore produce additional sawlog contributions for about 30 years. However, plantation hardwood will be a very different and inferior end-product compared with native forest hardwoods. It will be different in colour, texture, density and drying quality. In general terms, fast-grown hardwoods provide poor timber products.

The Committee noted that approximately 18,000ha of hardwood plantations (mainly *Eucalyptus globulus*) have already been established in Western Australia. Both CALM and the private sector have extensive plantation programs planned which should result in a hardwood plantation estate in excess of 75,000ha by the end of the 10 year period.

Regardless of plantation production there will be a growing demand for the specialty products of our native hardwood forests.

Current Supply And Demand

With private companies tending to take over future plantation development from the State, supply and demand forecasts will tend to control levels of investment.

The total value of Australian forest product imports in 1991-92 was $2.208 billion. The principal components of imports were sawn wood ($410 million) and paper and paperboard ($1.066 billion).

The total value of forest product exports in 1991-92 was $701 million, including woodchips ($417 million).

The negative balance of trade in forest products for that year was accordingly $1.508 billion - more or less typical for Australia in recent years.

Western Australia was a net importer of sawn timber in 1991 and 1992, representing 9% and 7% of local production respectively. Some imports are specialty timbers and will remain.

Accordingly there is a compelling argument for timber and paper products to be generated from farm plantations, especially if the tree planting has been integrated into farm plans so farmers reap the benefits as revenue from the timber crop.

Wood and paper products from farm trees will need to be competitive with both existing production and imports.

Availability Of Land

According to CALM:

> *"The region suitable for commercial tree plantation extends from south of Perth (near Rockingham) to east of Albany.*
>
> *Rainfall is the principal determinant of tree growth and survival. The 600mm rainfall isohyet has been assumed to be the limit for commercial tree planting.*
>
> *Tree growth is related to rainfall, but within the region growth varies markedly according to soil type. The principal soil factors affecting growth are soil depth, texture and fertility.*

Of the 1.8 million hectares of freehold land in the region 25% is uncleared. As it is not proposed to clear native vegetation to establish plantations, 1.45 million hectares of this area is potentially available for tree planting. It is estimated that approximately one-third of this area - 500,000 hectares - could grow E. globulus at rates which are competitive with agriculture.

It is estimated that the land base available for P. radiata is approximately one-fifth of the E. globulus land base."

CSIRO has provided a cornerstone for establishing land capability in the Great Southern Region. This work has been used in conjunction with Department of Agriculture information and research by CALM to assess tree growth capability by area. CALM has assessed land within various working radii of Albany and Bunbury for *E. globulus* and *P. radiata* productivity.

Results show that adequate land capable of growing these trees is available.

Cost Of Land

Considerable work has been done on the cost of land for plantations.

Maps giving broad indications of land values (isovals), are readily available for the south-west. There are wide variations depending on existing uses, rainfall, soil types and distance from particular towns. To evaluate land for plantations it is necessary also to take into account location and plantation productivity. Given economic prudence on the part of plantation developers, land suitable for plantations should be available at an acceptable cost.

Determining Factors

There are a number of factors which influence the potential to increase the tree plantation estate on cleared agricultural land. Principal factors have already been covered. In summary they are:

1. The value of native hardwood increasing sufficiently in price to ensure replacement by plantation softwood in the structural timber market.

2. Expected demand relative to the supply of timber products in WA.

3. Anticipated or pre-negotiated price for plantation products at the time of harvest.

4. New plantation estates being large enough to under-pin, new or expanded processing plants.

5. A demonstrated or adequately perceived excess of revenue over costs, sufficient to attract the necessary investment funds.

6. Availability of agricultural land capable of growing marketable wood at suitable growth rates (not all agricultural land in the appropriate climatic zone is capable of production).

7. Cost of land relative to its location and productivity.

8. Proximity of suitable and available land to markets and/or ports.

9. Plantation estates being staged at suitable age/size classes to enable continuity of harvest.

10. The existence of relevant community infrastructure.

11. Australia's maintenance of its export woodchip market share.

12. Farming community acceptance of an increased plantation estate. (Value and use of land after timber harvest, is a significant consideration).

Conclusion

Although softwood plantations are now contributing to the production of timber products and the potential for increase in plantation timber and this is favourable, it must be recognised that there is a delay of many years after planting occurs before trees can be harvested. It is also important to realise that most of the products from hardwood plantations will complement those from jarrah and karri forests rather than replace them. This applies particularly to sawlog resources.

Plantation grown sawlogs will provide building materials and lower value products which will replace rough sawn undried timber now supplied from natural forests. But they will not compete with high value furniture quality products for attractiveness or surface features.

The State's best strategy is to utilise the sustainable hardwood yield and encourage maximum development of both hardwood and softwood plantations. Plantation sawlog production will be a natural and logical development from this strategy.

REVIEW OF RELEVANT CONDITIONS IN THE 24 DECEMBER 1992 MINISTERIAL STATEMENT

The Committee received written advice from the Chairman of the Environmental Protection Authority to the effect that the present Minister could not make substantial alternations to the Conditions without revisiting the Environmental Protection Act process defined by Section 46. This view was also taken by the Western Australian Forest Alliance (WAFA) in a submission to us.

The Minister may wish to obtain further procedural advice in relation to alterations or acceptance of other Conditions in the Ministerial Statement of 24 December 1993.

Some of the Conditions have direct relevance to Conditions 2 and 8 which are the main focus of the deliberations of this Committee. The Committee has therefore agreed that it should provide additional advice on a number of the Conditions, to ensure that all possible items have been addressed.

CONDITION 4.1 - *Amendments to Conservation Estate*

> *The proponent shall initiate the Government process required to implement the proposed amendment to the conservation reserve estate as agreed to by the Minister for the Environment and defined in the approved Forest Management Plans.*

A written submission by WAFA to the Committee advised that only 26 of the 166 recommendations for additional Conservation Reserves made by CALM in its 1987 Regional Management Plan had been implemented.

It is difficult to define an exact number of conservation reserve proposals in the 1987 Regional Plans because in many cases individual proposals were made up of an aggregation of a number of areas, eg, the proposed Mt Frankland National Park was made up of Wattle, Johnston, O'Donnell and Soho forest blocks. Nevertheless, the estimate of 26 completed out of 166 is a reasonable reflection of the current situation.

The Committee has been advised by CALM that the reasons for the apparently slow implementation are:

- The category "Conservation Park" had to be created by amendment of the CALM Act - this only occurred in August 1991 and covers 45 of the proposals.

- Proposed land tenure changes must go through statutory approval processes. In some cases, such as the revocation of state forest, this requires the approval of Parliament. Other Government Departments and Shire Councils also need to be consulted and approvals sought. In many cases the process can be bogged down because departments, such as Mineral and Energy, cannot easily agree to a change in land tenure which might quarantine an area from mining before the prospectivity of the area has been properly assessed and demonstrated to be low. Objections from other Government departments and shires also quite commonly result in protracted negotiation over issues such as boundaries.

Most of the implementation to date has been in the Southern Forest Region where the conflict with mineral leases is low.

These issues were dealt with on page 23 (Part 3) of CALM's 1987 Regional Management Plans which stated *inter alia* in regard to "Changes in Tenure, Vesting or Purpose."

> *Although the majority of the areas which are proposed for reservation already have been designated in one form or another as conservation or recreation reserves, some are subject to existing mineral leases and others may contain mineral resources. It is proposed that these mineral claims be progressively evaluated by an appropriately constituted committee. The Reserves Review Committee will continue to progressively evaluate areas within the EPA System 6 area.*
>
> *All proposals to change land tenure or to reserve vacant Crown land will be referred to the Lands and Forest Commission and the National Parks and Nature Conservation Authority, and will be subject to the normal review processes by the Department of Land Administration. This will involve consultation with affected Government and Local Government authorities. Furthermore, it will be necessary for both Houses of Parliament to agree to any changes involving A class Reserves or State forest.*
>
> *The boundaries of the proposed parks and reserves and additional State forest areas shown on Map 8 are not final and may be adjusted during the consultation and legislative processes described above. In addition, boundary modifications may be recommended in future area management plans.*

CALM currently manages all vested and proposed additions to the forest conservation estate in accordance with the intended purpose specified in the management plans.

The Committee is satisfied that CALM has no reluctance to implement its proposals. **Nevertheless, the Committee recommends that the Minister seek a report from CALM detailing the status of implementation of each reserve proposal and request that action be expedited.**

The Conservation Reserve Estate

The Committee was of the opinion that some additional comments about the amendments to the conservation estate might be useful, given that the amendments will take time to complete. These comments relate to both size and representative quality of the estate.

The nature conservation reserve system in the South-West forests has been selected with great care on the basis of the best available data and methodology at the time of selection. The amendments proposed to the reserve system improve the integration of the existing system and provide for reservation of certain biota and geomorphological features that currently occur within the multiple use forest but lie outside the reserve system.

Existing and proposed nature conservation reserves and national parks occupy 26.7% of the total area of the south west forest under crown tenure. The karri forest has a higher proportion of its area in existing and proposed reserves (30.3%) than does the jarrah forest (24.7%). As previously discussed, CALM manages "proposed conservation reserves" as if they were already formally established.

The total area of riparian and road reserves and other areas excluded from logging is a considerable addition to the reserved estate. These areas represent 8.2% of the total south-west forests; again the karri forests will have proportionately more of their area as riparian and other reserves (14.1%) than will the jarrah forest (8.1%).

The combined area of nature conservation reserves, national parks and the proposed riparian reserves will now total 649,945ha or 35% of the combined jarrah, marri, wandoo and karri forests (Table 1).

Table 1 - Area of Crown Land Jarrah, Karri and Wandoo Forest Excluded from Logging

Forest Type	Area of Crown Land	Area in Conservation Reserves			Area in Road & Stream Reserves	Area in Other Zones	Total Excluded From Logging	Area Available for Logging
		Existing	Proposed	Total				
Jarrah*	1,572,800	147,100	241,100	388,200	127,555	-	515,755	1,057,045
jarrah%	*100.0%*	*9.4%*	*15.3%*	*24.7%*	*8.1%*		*32.8%*	*67.2%*
Karri#	175,100	41,600	11,500	53,100	24,690	3,200	80,990	94,110
karri%	*100.0%*	*23.8%*	*6.6%*	*30.3%*	*14.1%*	*1.8%*	*46.3%*	*53.7%*
Wandoo	107,100	11,900	41,300	53,200	-	-	53,200	53,900
	100.0%	*11.1%*	*38.6%*	*49.7%*			*49.7%*	*50.3%*
TOTAL	1,855,000	200,600	293,900	494,500	152,245	3,200	649,945	1,205,055
Total%	*100.0%*	*10.8%*	*15.8%*	*26.7%*	*8.2%*	*0.2%*	*35%*	*65.0%*

* = includes jarrah/marri forest.
\# = includes karri/marri forest.
~ = not possible to quantify the area of jarrah type in diverse ecotype zones.
% = figures expressed as a percentage of the total Crown land forest area for that species.

Source: Based on CALM 1992 Forest Strategy

The Committee considers this reserve system to be excellent, both on a proportional basis and compared to forest reserves in other regions. A directly comparable situation in terms of community concern, is the Eden region of New South Wales. In the Eden region there are 781,000ha of forest of which 40% is private property (leasehold) 19.6% is in reserves and 4.8% is for "modified harvesting". This is the reserve equivalent of our non-harvested "riparian reserves". Thus the percentage in reserves at Eden is 25.4%. This is a smaller percentage of reserved forest than in Western Australia, where the actual area excluded from logging is 35%.

Despite the extensive network of reserves throughout the south-west forests, it remains a possibility that there may still be biotic and habitat types that are not adequately represented for ecological purposes in reserved land. This is because the nature conservation reserves in the area were selected primarily on the basis of a "land unit" approach using landforms, soils, vegetation structure, floristics and selected environmental data. The proponent stated in its 1992 Management Strategy (CALM 1992:138) that "Current methods of assessing representativeness require standardised, site-based data sets that encompass a wide variety of organisms". CALM further stated that while such data sets are available in some parts of the forest "they are too localised, and/or limited to a particular sort of organism" (such as endangered plants, birds or ants).

Havel (1989) reviewed his earlier work which had been the basis for establishment of the nature conservation reserve system in the northern jarrah forest (Havel 1975). He concluded that sampling had concentrated on uplands and was confined to a selection of perennial plants. Granite outcrops, alluvial flats and heathland communities were under-represented. Annuals and some perennials such as orchids, together with both vertebrates and invertebrates were also not taken into account.

The Committee recommends that the Minister instruct CALM to initiate a technical reassessment of the biological adequacy of both the existing and proposed conservation reserve system. This reassessment would require the use of more current methods of biological survey based on standardised, site-based, data sets that encompass an adequately wide variety of organisms. These sites should also be selected to serve a monitoring function as baseline data against which future changes to the forest ecosystem can be assessed. If the addition of these "high value" areas to the conservation estate causes a significant reduction in the commercial utilisation of the multi-purpose forest, consideration should be given to exchanging areas of well represented forest habitat currently in reserves for any such additions. The design and implementation of this ecosystem survey should be referred to the Forest Monitoring and Research Committee that is to be established under Condition 17.

CONDITION 5 - *Revised Travel Route, River and Streams Reserves*

5.1 The proponent shall implement the revised system of travel route (road), river and stream reserves consistent with Condition 15. It is noted that the minimum combined width (both sides of first, second and third order streams) of the proposed zones is 60 metres.

5.2 The proponent shall ensure that the travel route (road), river and stream reserves remain unharvested in perpetuity, except for those portions of regrowth forest within road zones where thinning can be undertaken in a manner consistent with, and so as to enhance in the longer term, the defined visual quality objectives.

5.3 The proponent shall monitor the effectiveness of the travel route (road), river and stream reserves for nature conservation and protection of water quality to the requirements of the Minister for the Environment.

To monitor the effectiveness of the road, river and stream reserves for the protection of water quality the proponent should prepare a research strategy, in consultation with the Water Authority, that details sampling methodology, number of representative sampling sites, intensity and cost. This strategy should be considered prior to implementation by the Forest Monitoring and Research Committee proposed in Condition 17.

Monitoring the effectiveness of the road, river and stream reserves for nature conservation is complicated by the fact that these reserves might only be used by fauna as movement corridors during long-term periods of environmental change, or when populations expand or contract. Time scales may therefore be in decades rather than months. As a consequence of this, studies to elucidate utilisation of corridors by fauna may not demonstrate a possible process in the short-term.

Most biologists acknowledge the possibility that narrow reserves may link larger areas and function as corridors for the movement of selected components of the biota between larger reserves. However, there is little, if any, reliable data to support the view that such corridors are ecologically effective. This is partly because data supportive of their effectiveness is very difficult to collect. Even in a situation such as the Western Australian wheatbelt, where corridors of natural vegetation exist within extremely disturbed environments (wheatfields), it has been difficult to document the effectiveness of corridors for fauna.

Riparian vegetation reserves in the multi-purpose South West forests will provide a pivotal function in maintaining this essential forest ecosystem and consequently have immediate environmental value. However, their value as corridors to facilitate movement between larger reserves is less clear. It assumes that such movement will:

(a) increase migration rates, and thus raise the equilibrium number of species in larger conservation reserves;

(b) facilitate movement of species that range widely;

(c) reduce inbreeding; and,

(d) alleviate demographic stochasticity.

Simberloff *et al.* (1992) critically review the value of corridors to achieve these objectives and report that the objectives themselves are ecologically contentious. They conclude that there are few, if any, studies that demonstrate that biota actually use such corridors (see also Hobbs 1992) and state that "there are still few data, and many widely cited reports are unconvincing", (particularly a number of Australian studies on this subject). Uncertainty arises partly because many of the reported studies lack an adequate experimental design and because of statistical difficulties involved in obtaining adequate sample sizes (Nichols and Margules 1991, Simberloff 1992).

The road, river and stream zones considered in the south-west forests differ further from the analogy of linking isolated reserves in the wheatbelt of Western Australia because the adjacent multiple-purpose forest is managed to preserve much of the extant fauna and flora (Christensen and Abbott 1989, Christensen 1992).

Populations of some species do appear to be affected in the short-term by certain silvicultural practices (see Wardell-Johnson and Christensen 1992).

In the long-term, the habitat of the south-west forest will vary for some biota as a consequence of harvesting operations of long interval (± 40 years), burning regimes, reduction in the density of very old and senescent trees and perhaps different *Phytophthora* outcomes. Despite this, it is the Committee's view that these multiple-purpose forests will retain a wide spectrum of the current biota, including those which utilise the riparian zones.

CONDITION 6 - *Diverse Ecotype Conservation Areas*

6.1 Diverse ecotype areas shall be identified by the proponent and those greater than five hectares shall be identified on publicly available maps.

6.2 The proponent shall ensure that the diverse ecotype conservation areas remain protected from timber harvesting and associated activities in perpetuity.

As EPA Bulletin 652 - Recommendation 4 notes, this objective was proposed by CALM in order to manage areas of heathland, rock outcrop, swamp, lake and other non-forest vegetation. Diverse ecotype conservation areas are thus not multiple-purpose forest areas.

The wording of Condition 6.2 may prove difficult to interpret, in so far as some activities associated with timber harvesting may or may not have a substantial effect on these areas. Obviously, trees will not be harvested but whether the areas should be quarantined from fire or traversed by roads needs some consideration. The Committee found that since CALM proposed the concept and wished to implement it effectively, the wording of the Condition was perhaps unnecessarily severe. CALM has advised the Committee that harvesting and silvicultural treatment of some parts of the production forest may require use of parts of some diverse ecotype conservation areas.

We recommend that where the proponent requires use of a significant part of a diverse ecotype conservation area, the request be referred to the Monitoring and Scientific Committee. This Committee will advise the Minister for the Environment as to whether the request should be approved or sent to the EPA to determine whether it is a substantial alteration pursuant to Condition 2.2 of the Ministerial Statement. Minor alterations or uses and decisions regarding "protection" (eg fire regime) should remain CALM's responsibility and be based on biological advice.

CONDITION 13 - *Habitat Trees*

13 The proponent shall ensure that the number, condition and age of trees retained on sites subject to gap treatment is sufficient, as determined by the Minister for the Environment, to adequately provide the habitat function throughout the cutting cycle of the forest.

This Condition originated in response to EPA Recommendation 11 which in turn had considered the proposal for the jarrah forest on page 14 of CALM's 1992 Proposals document.

> "Three large trees will be retained on every hectare to provide habitat for hollow nesting species; suitable ground habitat (eg, hollow logs) will be retained and protected as far as possible, at a rate of at least one per hectare."

EPA Bulletin 652 considered this item on page 41. On the basis of advice from its own "Technical Advisory Panel" it concluded that three trees per hectare was probably insufficient. The matter appeared to be confused as a result of insufficient data. On the one hand it was noted that possums appear to need three trees per hectare and that there are still many other species that require hollows. On the other hand, it was also acknowledged that by no means are all hollows utilised by animals.

EPA Recommendation 11 does not specify any number or spatial distribution for trees with hollows, nor is it realistically possibly to do this now, because the matter is fundamental to ecological theory and population dynamics - food, shelter, predation or disease may limit the population size of a particular species at any given time of survey. The answer requires exhaustive study. The cost-benefit of such a study will remain a community value judgement.

The Barnett Committee concluded that the habitat trees (with hollows) be those located in corridor reserves. However, this Recommendation was apparently not accepted by the Minister in setting the Ministerial Conditions.

Condition 13 requires the Minister for the Environment to determine the "sufficient" number, condition and age of trees to be retained to adequately provide the habitat function throughout the cutting cycle of the forest. The Minister currently has no additional evidence to that available to the EPA or CALM in the 1992 Forest Management Strategy to do this. The Committee therefore considered the available information and offers the following advice.

Christensen (1988) stated that in forests "Hollows are probably the single most important factor determining the localised persistence of many animal species". In the south west of Western Australia 20%, or 33 species, of the forest-dwelling birds use hollows. Observations of the birds using these hollows showed that 34% used them as nest sites (Wardell-Johnson and Nichols 1991). Approximately 18 species of mammals, including possums, antechinus and bats, use tree hollows in the south west forest. This includes five species that have an obligatory requirement for hollows (Christensen 1988).

Hollow formation in trees depends on a combination of the age of a tree and other natural processes. In eucalypts, hollows are often initiated by wood fungi with termites contributing later, but they may also be directly created by hot fires or initiated by disease, wind damage or lightning strike. Once hollows are formed they may be enlarged physically by parrots and cockatoos or by high intensity fires (Mawson and Long 1993).

Discussion with CALM specialists indicated that size is not necessarily related to age in the trees of the jarrah forest. Growth rate is highly variable between locations and between individual trees at the same location. A direct consequence of this is a commensurate variability assigned to the age of trees by individual authors.

For these reasons we suggest some caution in interpreting the relationships between age of trees and hole or hollow formation given below. Hollow formation is variable, it is first observed when karri trees are about 60 years old (P. Christensen. pers. comm.) and a little later in jarrah and marri trees. The number and dimensions of holes in trees will increase as trees age to senescence.

Inions *et al* (1989) stated that for Brush-tailed Possums "suitable hollows first develop in jarrah trees at about 300 years of age and in marri trees aged about 200 years. The average age of trees inhabited by these possums was about 400 years and 500 years for marri and jarrah respectively." Inions (pers. comm.) considers Brush-tailed Possums utilise hollows in younger trees following a fire event. He noted, for example (Inions 1985), that in forests burnt by hot fires Brush-tailed Possums were recorded in jarrah and marri trees aged 85-600 years and 100-530 years, respectively. Recently Mawson and Long (1993) investigated the utilisation of hollows in eucalypt trees in south west Western Australia by four species of parrot and one species of Cockatoo. They observed that the "lowest average estimated age of nest trees recorded for any one of the parrot species was 275 years and 446 years for the cockatoo species". In the Long-billed Corella, the age of such trees averaged 1061 (680-1333) years and 446 (167-931) in jarrah and marri respectively; and in the other parrots (Port Lincoln Ringneck, Western Rosella and Red-capped Parrot) it was 520-1435 years in jarrah. Suitable holes for these parrots and the Regent Parrot were found in wandoo trees aged between 73-1935 years.

Estimates of the ages of habitat trees in the studies of Inions *et al* (1989) and Mawson and Long (1993) greatly exceed values presented in Burrows (1991) who aged 107 veteran jarrah and marri trees. Burrows (op. cit.) stated that jarrah trees seldom lived longer than 300 years with the oldest tree he sampled aged 377 years; the average age was 208 years. The situation with karri trees appears similar, with few trees known to live beyond 350 years and a major reduction in numbers of karri trees beyond 250 years (Rayner 1992).

The apparent reduced age of old jarrah trees estimated by Burrows (1991), compared to the estimates of Inions *et al* (1989) and Mawson and Long (1993) may result from his sample of veteran trees being taken from a relatively younger forest. It may, however, be influenced by the method used to estimate age. Burrows (1991) directly counted growth rings. Other authors have used growth increment plots based on historical growth data to age their trees. Burrows correlated growth rings with the meteorological record and thereby allowed for multiple annual growth rings. Burrows estimates are likely to be far more accurate.

Reduction in numbers of available nest holes will not necessarily have an immediate impact on the hole dwelling fauna in the short-term for several reasons. First, the parrots are long-lived species so they need only a few successful nestings over their lifecycle (Mawson and Long 1993), and secondly, a reduction of hollows may occur without limiting sites for nesting. For example, Christensen (1988) noted that only 4% of the holes he examined in forests had been used by vertebrate animals.

The Committee is also aware that not all "hollows" are the same. Some species for example, require internal chimneys and build platforms in them.

The implied concern is that multiple purpose forest has, or will have following a complete harvesting cycle, a disproportionately low number of trees with hollows in their branches and trunks and an associated deficiency in providing habitat for those species dependent on hollows. These hollows provide shelter, rest and nest sites, rather than food. Research should therefore focus in two areas. First, whether a 200-250 year rotation cycle provides for adequate tree hollows in jarrah, marri and karri forest, and secondly whether the requirement of fauna for tree hollows can or should be artificially supplemented by the provision of nesting boxes.

Until the results of the proposed research suggest otherwise, it is recommended that the Minister adopt the advice of the proponent that in general three mature habitat trees should be retained per hectare but that flexibility should be exercised in this request. Trees should be grouped where appropriate, associated with regrowth and positioned adjacent to reserved vegetation. It may prove ecologically more advantageous in some situations to provide a group of more than three mature trees at some sites to take advantage of favourable habitat and offset this with reduced density of mature trees at other nearby locations. However, over any 100ha block an average of three trees per hectare should apply.

It is implicit in any management process that priorities be recognised. In the south west forests about 35% of the area has been set aside exclusively for conservation purposes. The multiple-purpose forest by definition must accommodate timber production and cannot be managed exclusively for its conservation values. A consequence of that management will be a reduction in the density of some species at some periods of the silviculture cycle.

It is recommended that the proponent be instructed to establish monitoring processes. First to evaluate the long-term effect of a reduction of tree hollows in the multi-purpose forest on populations of animals that use hollows. Secondly, to monitor the effectiveness of the remnant habitat trees for fauna and determine the density and distribution of trees required to sustain populations of the fauna.

CONDITION 14 - *Banksia Grandis Reduction*

14.1 The proponent shall concentrate the proposed reduction of the population of Banksia grandis in specific areas where the environmental circumstances suggest that treatment will have the greatest impact on reducing the spread and intensification of Phytophthora cinnamomi in the jarrah forest and where required to establish jarrah and marri.

Control of *Phytophthora cinnamomi* is widely recognised as one of the most important silvicultural problems in the jarrah forest. Shearer and Tippet (1989:XV) state that it is the "major factor effecting the ecology and management of the jarrah (*Eucalyptus marginata*) forests." Those authors (op cit) highlight a number of much needed areas for research on *Phytophthora cinnamomi* in the jarrah forest. Particularly, they note that the absence of such research "makes it difficult to predict the effects climatic change will have on disease expression in the future, especially since most of the research has been conducted during a decade of below average rainfall".

Further they note that most of the information relating the environment to disease development comes from research in the high rainfall zone of the northern jarrah forest. They consider that "Emphasis must be given to studies on host susceptibility and pathogen dynamics in intermediate-low rainfall jarrah forest and southern jarrah forest". They state that this information is essential for minimising the spread and intensification of *Phytophthora cinnamomi* and other *Phytophthora* species in these areas. Further, they note that the "effects of different levels of infection on the growth of jarrah requires clarification."

Given the breadth of the above stated need for future research (Shearer is a senior CALM Scientist) it is most surprising to the Committee that the only reference to *Phytophthora* in the Ministerial Conditions relates to the proposed reduction of specific populations of *Banksia grandis* to determine the consequences on the spread of *Phytophthora cinnamomi.*

CALM advised the Committee that jarrah trees are not uniformly susceptible to *Phytophthora* disease. Some jarrah trees die fairly soon after infection, others do not express effects even though inoculated. The Committee considers that there is a case to be confident that research and management can mitigate the disastrous scenario drawn by the Barnett Appeals Committee for the jarrah/marri forests as a consequence of *Phytophthora* infection.

CALM advised the Committee that much of their recent research thrust in understanding the ecology of *Phytophthora* has focussed on the heathland areas of the South-West which have suffered seriously from *Phytophthora* infection. The Committee was further advised that CALM had in place a strategic review of *Phytophthora* research requirements in the entire jarrah/marri forest in response to a Government policy initiative and recommendations from the EPA and the Barnett Appeals Committee. To facilitate this process, CALM at the request of the Minister, recently convened a specialist Dieback Review Panel. The terms of reference of The Panel as set by the Minister are as follows:

- Provide an objective assessment of the importance and nature of problems which *Phytophthora cinnamomi* poses in Western Australia for the conservation of nature and the maintenance of sustainable natural plant productivity.

- Assess the current status of research and identify those lines of investigation which show particular promise and warrant increased support.

- Report on the preferred structure and funding requirements and arrangements for dieback research within Western Australia, in particular the development of novel approaches for disease control and management.

- Evaluate the scientific basis and efficacy of existing management strategies and practices and identify any need for modification.

- Identify opportunities and constraints in the transfer to land management practice of recent and future advances in science and technology and any necessary structures to help maximise opportunities and minimise impediments.

- Suggest organisational structures which might oversee the retention of intellectual rigour in research and maintenance of standards in land management practice.

- Examine the findings of the Parliamentary Select Committee into dieback chaired by the Hon. W Stretch, MLC and provide advice on the implementation of its findings.

The Committee has also noted the recent advances in the ability to use the chemical "phosphonate" as an operational tool to control the spread and impact of dieback. The chemical has been shown in research trials to stimulate biochemical mechanisms that enable dieback-sensitive plants to resist invasion by the fungus. Use of the chemical has now progressed to field operations where it can be applied either by direct injection into plant stems or sprayed from the ground or the air. CALM have advised the Committee that the chemical does not represent a "cure" for dieback but can be used strategically to protect populations of rare and threatened plants and areas of special scientific, scenic or community interest. It is not implied that use of this chemical will currently have any implication for the long-term sustainable jarrah harvest.

The Committee recommends that the recently convened Dieback Review Panel should formally liaise with the Monitoring and Research Committee proposed in Condition 17.

CONDITION 15 - *Fire Management*

15.1 The proponent shall ensure that the fire management objectives related to the jarrah forest silvicultural prescription include the minimisation of air pollution in urban areas, to the requirements of the Minister for the Environment.

The silvicultural burning practice ("tops" burning and removal of fuel) is a minor contribution to urban pollution arising from CALM's prescribed burning practices in the jarrah forest. A far greater contributor to possible air quality impairment would arise from fuel hazard reduction by prescribed burning. For example, in 1991-1992 approximately 7,500ha of jarrah forest experienced silvicultural fire prescription, whereas 296,950ha was subject to hazard reduction burning. Consequently, the Minister is advised that this Condition should apply equally to **hazard reduction** as well as **silvicultural** prescribed burning practices.

15.2 The proponent shall inform the public about its fire management on a regional basis each year in its annual report. This shall include but not be limited to the following:

(1) occurrences and causes of wildfires;

(2) purposes of burns;

(3) areas burnt under different regimes of season and periodicity;

(4) escapes; and,

(5) the contribution of prescribed burning to reducing wildfire hazard.

15.3 Within 12 months of this proposal being given authority to be implemented the proponent shall initiate a public review of its prescribed burning policy and practices and the wildfire threat analysis. This should be done with the close involvement of the Research and Monitoring Committee. If possible, it should be linked with a review of the provisions of the Bush Fires Act.

The public review of "prescribed burning policy and practices and the wildfire threat analysis", should be facilitated by a formal Committee appointed by the Minister. It is recommended that the Committee be comprised of specialists with relevant expertise rather than representatives of interested parties. The Minister could call for expressions of interest for nominations to fill the following Committee specialists:

- fire behaviour;
- effect of fire on forest ecology;
- forest biodiversity;
- socio-economic consequences of fire;
- forestry production

This matter is a specialised technical area in which the principal objective should be public safety. Secondary emphasis should then be applied according to the alternate priorities of the conservation estate forests and the multiple-purpose forests. In the conservation forest estate, a fire regime to maximise biodiversity should predominate the strategy. In the multiple-use forests, protection of timber values should predominate.

The Fire Management Committee should proceed with its work as generally outlined in Condition 15-3. We advise against the Committee being constrained or directed by the other Committee that is proposed under Condition 17. It is CALM's responsibility to assemble relevant specialists, obtain specialist advice and public input, then report publicly. The Committee convened under Condition 17 should remain in a position to provide independent advice to the Minister on the outcome of the Condition 15 inquiry.

CONDITION 16 - *High Salt Risk Catchments*

Conditions 12 and 16 could have been integrated as they both address the same issue. In this section, Condition 16 is considered and advice is also given in regard to Condition 12.

16.1 Within three years, or such other period as the Minister for the Environment shall nominate, the proponent, on advice from the Water Authority of Western Australia, shall identify second order catchments with a high salt risk.

16.2 Within each catchment identified according to the requirements of Condition 16.1, the proponent shall retain additional river and stream buffers and locate areas temporarily reserved during phased logging operations to the requirements of the Water Authority of Western Australia."

This Condition followed from EPA Recommendation 10 which was as follows:

"Recommendation 10

The Environmental Protection Authority recommends that in the intermediate and low rainfall zones at least 30 percent of second-order catchments in the multiple-use jarrah forest should be left untreated (ie, undisturbed from harvesting, thinning etc) for a period of 15 years after harvesting or treatment of the remainder of the catchment. This untreated proportion should:

- *include areas of multi-aged forest (including unlogged sites);*
- *be selected to emphasise wildlife, water resource and visual objectives;*
- *comprise sites with a minimum dimension of 100m; and,*
- *be in addition to protected river and stream reserves and diverse ecotype conservation areas.*

The status and effectiveness of this measure should be evaluated at the time of the next review of the Forest Regions Management Plans and Timber Strategy, by 2002 (see Recommendation 14)."

This EPA Recommendation was the only one on which there was substantial variation between the CALM proposals and the EPA recommendations. The EPA clarified its position in February 1993 when it commented on its earlier Bulletin 652 by way of a paper to the Forest Industries Federation (WA) and the Forest Protection Society. In regard to its earlier Recommendation 10, the EPA wrote in February 1993 as follows:

*"**Recommendation 10** means:*

The EPA accepts CALM's proposals, provided:

- *jarrah forest management plans in the drier areas identify second-order catchments with a high salt risk and permanent 50-metre wide buffers are left on both sides of streams within these catchments;*
- *30 per cent of second-order, high salt-risk catchments in drier areas are not logged for at least 15 years after the balance has been logged;*
- *this 30 per cent includes multi-aged forest, including unlogged sites; is selected to protect wildlife, water resources and visual amenity; includes areas with a dimension of at least 100 metres; and is in addition to areas already protected;*
- *these measures are reviewed in 2002 and monitored until then."*

This further advice is essentially consistent with CALM's proposal. The fundamental purpose of the temporary reserves is to ensure that the water table does not rise, bringing salt stored in the soil profile to the surface. This could impair catchment quality for reservoir use, or produce a period of high salinity in streams that could be detrimental to aquatic organisms.

The Barnett Appeals Committee also reviewed this matter. In commenting on EPA Recommendation 10 The Appeals Committee stated:

> *"The proposals contained in this Recommendation should be modified as follows: In second order catchments in the intermediate and low rainfall areas in the jarrah and jarrah-marri forests at least 30% of the catchment area must be permanently included in habitat corridors, stream reserves and diverse ecotype areas and not be subjected to logging, thinning or other forms of treatment other than fire management appropriate for wildlife habitat if this is necessary"*

On page 23 of his report, Barnett additionally recommended:

> *"I have accordingly recommended the establishment of such permanent habitat corridors approximately 70-100m in width to cross the saddles in order to link streams and other habitat reserves. A network of such corridors, if carefully designed as wildlife habitats would also give rise to other possibilities:*
>
> > *They would do away with the need to retain 30% of second order catchments in the low to medium rainfall areas of the jarrah forest (exclusive of stream reserves and diverse ecosystem areas) as recommended in EPA Recommendation 10. As the proposed wildlife habitat corridors would be designed to link with the stream reserves in such catchments those two areas combined would in most cases total up to 30% of the catchment as a permanent reserve which would be adequate for both habitat and salinity protection purposes. This would make it unnecessary to stagger harvesting as proposed in EPA Recommendation 10.*
> >
> > *Should the Committee's recommendation about the establishment of the habitat corridors not be accepted however, then I consider and recommend that EPA Recommendation 10 should be accepted by the Minister and implemented by the imposition of an appropriate Condition.*

As already discussed, the purpose of the CALM proposal and the intent of the EPA Recommendation 10 was to ensure that timber harvest did not lead to stream salinisation as a result of a water table rise. The Committee found this to be an important and sensible consideration both in regard to the protection of aquatic plants and animals in the streams, plus the vegetation changes that could occur as a consequence of rise in the water table.

The Barnett Appeals Committee apparently intended to expand the water table maintenance measures for the intermediate and low rainfall zones into extended wildlife reserves. However, it is the Committee's understanding that the saddle reserves envisaged by Barnett may not have adequately maintained water quality. The location of areas of retained vegetation in order to maintain stream quality must be the subject of field research.

In addition CALM have provided the Committee with estimates of the additional percentage of the forest that would be removed from production forest as a consequence of the wildlife reserves proposed by the Barnett Appeals Committee. The estimates range from 4.0-8.7% in the high rainfall zone to 2.2-5.6% in the low and intermediate rainfall zones and would represent a significant reduction in the area of multi-purpose forest available for timber harvesting.

CONDITION 12 - *Phased Logging*

12-1 The proponent shall ensure that, in all second order catchments in the intermediate and low rainfall zones of the multiple use jarrah forest subject to logging, at least 30 per cent of each second order catchment has a retained basal area of greater than 15 m^2/ha for a period of at least 15 years after harvesting of the remainder of the catchment.

12-2 This retained forest shall be selected to enhance wildlife, water resource and visual objectives.

12-3 The proponent shall monitor, to the requirements of the Minister for the Environment, and report by 2002 on the status and effectiveness of these measures to protect nature conservation values and water quality at the time of the next review of the Forest Management Plans and Timber Strategy."

The Committee recommends that both Conditions 12 and 16 be implemented in a way that does not unreasonably restrict CALM's management and utilisation of the area but which will achieve the water quality objectives. The pre-requisite research may show the existing specifications in the Conditions to be inappropriate. If this becomes the case, the specifications in regard to both the 30% of catchment area and the 15 m^2/ha basal area should then be re-examined and modified as required.

CONDITION 17 - *Forest Monitoring and Research Committee*

17.1 The Minister for the Environment will set up a Committee having objectives which include:

(1) identification, prioritisation and approval of monitoring and research programs and projects on environmental impacts of forestry management;

(2) the granting of funds towards such monitoring and research;

(3) receival of progress reports;

(4) reporting to the Minister for the Environment; and

(5) publication of results.

17.2 The Committee shall include the heads or nominees of the Department of Conservation and Land Management, the Environmental Protection Authority, the Forest Industries Federation (WA) Inc, the Conservation Council and the Water Authority of Western Australia, and the Chairpersons of the Lands and Forests Commission and the National Parks and Nature Conservation Authority.

17.3 The Committee shall appoint working groups of scientists to recommend and report to the Committee on the design and funding of research projects, the identification, prioritisation and review of monitoring and research programs and projects relating to the environmental impacts of forest management.

17.4 The Committee shall provide brief annual progress reports to the Minister for the Environment, with major reports in 1997 and 2002, at the time of the next review of the Forest Management Plans and Timber Strategy.

This Condition is an amalgam of EPA Recommendation 14 together with comments and recommendations of the Barnett Appeals Committee. These are reviewed prior to comment. The EPA recommendations were as follows:

EPA Recommendation 14

"The Environmental Protection Authority recommends that a Forest Monitoring and Research Committee be established. The Committee should:

- *have objectives which include the identification and approval of monitoring and research programs and projects on environmental impacts of forestry management, granting of funds towards such research, receival of progress reports, reporting to the Environmental Protection Authority and publication of results;*
- *be established within 12 months;*
- *be funded principally from the proceeds of native forest product sales; and*
- *give brief annual progress reports to the Authority, with major reports in 1997 and 2002, at the time of the next review of Forest Management Plans and the Timber Strategy. The Authority shall report to the Minister for the Environment following the receipt of each major report."*

Barnett recommended that this Committee be modified as follows:

"The concept is approved but should be modified to ensure that:

i) The Committee is autonomous (preferably created by Statute);

ii) It reports (publicly) to the Minister (or Ministers) responsible for CALM and for the Environment;

iii) The Committee's Executive Committee should include the heads (or representatives) of CALM, EPA, Forest Industries Federation (WA) Inc, Conservation Council, Water Authority and appropriate research institutions;

iv) The Committee should include working groups of 'hands-on' scientists such as soil scientists and silviculturalists, etc, to recommend on the advertising funding and design of research projects; and,

v) The former Dieback foundation should be considered as a possible model."

Further to this item Barnett also stated on page 31 of his report:

> *"Several appeals raise the question of gaps or lack of balance in the direction of CALM's research efforts and of inadequate monitoring of the effect of logging operations, of prescribed burning, of salinity levels and of the interaction between dieback and CALM's various types of operations. It seems clear that CALM is underfunded for its monitoring and research tasks and that when allocating the available resources it has favoured research efforts into matters immediately relevant for production forestry rather than on matters merely relevant to conservation and non-commercial environmental concern.*
>
> *I have agreed with the EPA's recommendation than an independent Forest Monitoring and Research Committee (FMRC) should be established and have proposed the former Dieback Foundation (funded largely by ALCOA) as a possible model.*
>
> *The FMRC should preferably be established under Statute so that it can control and allocate funds as well as establish research priorities and approve and supervise projects. Its upper levels should include representation of the major interested parties including CALM, EPA, Forest Industries Federation (WA) Inc and the Conservation Council. It should also include representatives of appropriate research institutions. At the lower level there should be working groups of research scientists and the research should be field orientated.*
>
> *Funding should be from a percentage of royalties (and not be an additional charge on industry)."*

However, it is our view that Barnett's proposition is administratively difficult, and that both the formation and work of the Committee should proceed as follows:

The Committee referred to in Clause 17 of the Statement should simply have the status of a Committee established by the Minister. For practical purposes Section 25 of the Environmental Protection Act should be employed in respect of the appointment of the Committee and its operations. Any expenditures incurred in respect of or on behalf of the Committee will have to come from such sources of funding as the Minister properly has at his disposal under the Environmental Protection Act. In our view the Committee could not itself appropriately engage in expenditures, but would be confined to making relevant proposals for the Minister to determine and put into effect through the proper accounting processes.

The Committee can not of itself make appointments. It will simply propose such appointments for the Minister's consideration. Sections 23 and 24 of the Environmental Protection Act are available to the Minister to deal with such matters.

The Committee should be "funded" in the way provided for in S.25 of the Environmental Protection Act.

It is the Committee's firm view that a "watch-dog" Committee to formulate and direct CALM research is unnecessary and counter productive.

CALM accountability is, and must remain, the responsibility of the Minister. It should continue to be the case that the Minister sets CALM's research and administrative priorities. It is also both practical and sensible that the Minister convenes a specialist committee to provide him with independent, technically competent advice. To that end we recommend that Condition 17 either be read or altered to ensure that the Committee is **advisory** to the Minister rather than be an independent decision making body. The composition of the Committee should remain at the discretion of the Minister. It will, for practical reasons, no doubt be similar in composition to that prescribed by Condition 17.

Public Accountability

There has been protracted conflict over forest management issues between the forest industry, conservationists, EPA and CALM. Barnett acknowledged this and gave the following comment on page 33 of his report:

> *"Several appellants complained that they were frustrated in their endeavours to obtain factual information from CALM in order to understand and possibly to comment on CALM's proposals and operations. At meetings and in interviews the view was expressed that these difficulties were deliberately manufactured by CALM officers to prevent them from assessing CALM's activities. There were many complaints from appellants who thought that CALM (and the EPA) had ignored their submissions and that documents put out for public comment were unnecessarily complex and confusing. There were particular concerns at the difficulties in obtaining information about or from the inventory database.*
>
> *From the other side, CALM officers complained that some members of the public (particularly those from the conservation movement) sought and then misquoted information only in order to aim it back at CALM by way of hostile and unreasonable criticism.*
>
> *There is a very high level of suspicion and mistrust between CALM and some sections of the "forest-minded" public and also, unfortunately, between CALM and the EPA.*
>
> *On the other hand, there have been excellent examples of public consultation between CALM and various interest groups by way of published materials and workshops. There has also been extremely effective and willing co-operation between various individual officers of CALM and EPA at middle and senior staff level.*
>
> *The level of suspicion, mistrust and hostility however, is, I believe, beyond reasonable proportions and is quite counter-productive. I have therefore recommended that there be an inquiry into CALM's public accountability to see what can be done to make CALM's vast reservoir of knowledge more open to the public. I have further recommended that the process of achieving a greater degree of accord between all parties interested in forest management be given greater emphasis.*

I consider that there is much residual goodwill and valuable knowledge and experience amongst the groups and organisations involved and that the management of the forests would greatly benefit from more co-operation and less hostility. A professional facilitator should be employed in order to build up a level of well founded trust."

These observations by Barnett were subsequently widely reported in the media and to some extent exacerbated the situation. The Committee accepts much of Barnett's observation as given above to be objective criticism and essentially correct. The Committee has additional comment to offer in this area.

It must be recalled that the prime reason for CALM putting forward the 1992 proposal to modify the 1987 Timber Strategy was that CALM considered that it had new information on inventory and growth increment in gross bole volume, sufficient to warrant the changes.

The Committee considers that the relevant information was not adequately presented or explained in the 1992 CALM proposal documents. However, in assessing the 1992 proposal the EPA accepted CALM's production estimates and did not check the CALM inventory and yield figures to any significant degree, even though they are available in the various CALM documents. The EPA report focussed mainly on those environmental aspects of the proposal that it was more conversant with.

The Barnett Appeals Committee subsequently sought specialist advice on forest inventory and yield from Drs Turner and Wood of the Australian National University. However it was required to report prior to the advice being available. This Committee has also gone into the matter of inventory and yield in considerable detail and our analysis has been presented in this report.

The Committee found CALM staff to be technically competent, scientifically honest and making their best endeavours to optimise the public interest. This Committee asked a number of new and difficult questions of CALM in regard to inventory and sustainable yield of the jarrah forest. Obtaining satisfactory answers often took considerable time and effort.

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Appendix 1

"Ministerial Conditions"

as published by

Hon. James McGinty, MLA
Minister for the Environment

24 December 1992

WESTERN AUSTRALIA

MINISTER FOR THE ENVIRONMENT

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

AMENDMENTS TO THE 1987 FOREST MANAGEMENT PLANS AND TIMBER STRATEGY AND PROPOSALS TO MEET ENVIRONMENTAL CONDITIONS ON THE REGIONAL PLANS AND THE WACAP ERMP

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT (CALM)

This proposal may be implemented subject to the following conditions:

1 **Proponent commitments**

The proponent has made a number of environmental management commitments in order to protect the environment.

1-1 In implementing the proposal, the proponent shall fulfil the commitments (which are not inconsistent with the conditions or procedures contained in this statement) made in the proposal and in response to issues raised following public submissions.

2 **Implementation**

Changes to the proposal which are not substantial may be carried out with the approval of the Minister for the Environment.

2-1 An expert scientific and administrative committee will be established by the Minister for the Environment to review and report on the implementation of this proposal by 30 June 1993. The terms of reference of the committee will be to consider:

- reserve recommendations within multiple use forest involving those proposals related to temporary exclusion from timber production and potential reserves to act as wildlife corridors;
- the environmental, economic and social implications of such proposals for:
  - nature conservation within WA's native forests,
  - the maximum sustainable timber supply, and
  - the existing and future timber industry;
- the potential to increase the plantation estate on cleared agricultural land to contribute to the production of timber products.

2-2 Subject to these conditions, the manner of detailed implementation of the proposal shall conform in substance with that set out in any designs, specifications, plans or other technical material submitted by the proponent to the Environmental Protection Authority with the proposal. Where, in the course of that detailed implementation, the proponent seeks to change those designs, specifications, plans or other technical material in any way that the Minister for the Environment determines on the advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

Published on
24 December 1992

3 Precautionary approach and adaptive management

3-1 The proponent shall manage karri and karri-marri forest in accordance with a precautionary approach. This approach requires that where there is a significant risk that a particular forest management measure could lead to an irreversible consequence appropriate monitoring and subsequent adjustments to management within an acceptable timeframe be carried out.

3-2 The proponent shall manage the jarrah forest in accordance with the following general principles:

(1) a precautionary approach;

(2) adaptive and flexible management practices based on research and monitoring of environmental monitoring of operations (see condition 17);

(3) implementation as a trial, with a reassessment by the Environmental Protection Authority after ten years - the period of the Management Plans and the Timber Strategy (see condition 11); and

(4) no commitment of all of the wood resource in the long term (see conditions 9 & 10).

4 Amendments to conservation estate

4-1 The proponent shall initiate the Government processes required to implement the proposed amendments to the conservation reserve estate as agreed to by the Minister for the Environment and defined in the approved Forest Management Plans.

5 Revised travel route, river and stream reserves

5-1 The proponent shall implement the revised system of travel route (road), river and stream reserves consistent with condition 15. It is noted that the minimum combined width (both sides of a first, second or third order stream) of the proposed zones is 60 metres.

5-2 The proponent shall ensure that the travel route (road), river and stream reserves remain unharvested in perpetuity, except for those portions of regrowth forest within road zones where thinning can be undertaken in a manner consistent with, and so as to enhance in the longer term, the defined visual quality objectives.

5-3 The proponent shall monitor the effectiveness of the travel route (road) river and stream reserves for nature conservation and protection of water quality to the requirements of the Minister for the Environment.

6 Diverse ecotype conservation areas

6-1 Diverse Ecotype Conservation areas shall be identified by the proponent and those greater than five hectares shall be identified on publicly available maps.

6-2 The proponent shall ensure that the Diverse Ecotype Conservation areas remain protected from timber harvesting and associated activities in perpetuity.

7 Old growth karri areas of high social or environmental value

7-1 The proponent shall identify and protect areas of old growth karri (up to 3200 hectares) with a high aesthetic, social or environmental value. This is to be implemented on a regional basis and with the benefit of public involvement. These areas shall:

(1) include those trees in Beavis, Carey and Giblett forest blocks protected from clearfelling by environmental conditions related to the Manjimup-Beenup power line proposal (EPA Bulletin 603);

(2) be identified publicly and progressively from the adoption of the Management Plans, with the proponent reporting to the Minister on progress towards implementation within three years; and

(3) shall not be harvested, and shall be managed to retain their values (other than timber production).

7-2 The proponent shall report on the implementation and management of these special areas at the next Forest Management Review.

8 Sustainable yield estimates

8-1 The allocated timber resource for the period ending 30 June 1993, prior to the consideration by the Minister for the Environment of the report of the committee referred to in condition 1 will not exceed the 1993 level described in the 1987 Timber Strategy together with an additional amount of the timber resource that was approved in the 1987 Timber Styrategy but remained uncut. This additional amount may be allocated by the proponent with the approval of the Minister for the Environment on a needs basis up to a total level not exceeding that proposed by the proponent in its 1992 proposals.

8-2 Following consideration of the report of the committee referred to in condition 2, the Minister for the Environment shall determine the annual sustainable timber resource available for allocation.

9 Commitment of wood

9-1 Subject to condition 8, in the letting of contracts for wood supply from the jarrah forest, the proponent shall;

(1) not exceed the annual levels of timber supply defined in condition 8 above; and

(2) recognise the possibility of the necessity to reduce wood supply beyond 2002 as a result of monitoring and adaptive management following the trial implementation of the jarrah forest silvicultural prescription.

10 Commitment of new resource to be referred

10-1 Notwithstanding Section 38 of the Environmental Protection Act, the proponent shall refer to the Environmental Protection Authority any proposal to enter into a contract for a substantial portion (as determined by the Minister for the Environment) of forest produce identified as other logs (jarrah) or forest residue (marri) in the revised Timber Strategy (Table 13 of the proposals document).

11 Jarrah silviculture trial

11-1 The proponent shall implement the jarrah silvicultural prescription so that monitoring of the environmental impacts on a representative range of treated sites and localities in the forest can be carried out to the requirements of the Minister for the Environment. This shall include long term monitoring which quantifies the impacts of silvicultural practices on environmental elements and values in the forest and provides bases to adjust management.

11-2 The proponent shall give all necessary assistance to the Monitoring and Research Committee (condition 16) to enable it to have an active and fully informed role in the planning and oversight of the scientific monitoring of this trial period.

11-3 The proponent shall report to the Minister for the Environment on outcomes of this implementation and monitoring and on any modifications to the prescriptions by 2002 as part of the next review of the Forest Management Plans and Timber Strategy.

12 Phased logging

12-1 The proponent shall ensure that, in all second order catchments in the intermediate and low rainfall zones of the multiple use jarrah forest subject to logging, at least 30 per cent of each second order catchment has a retained basal area of greater than 15 m^2/ha for a period of at least 15 years after harvesting of the remainder of the catchment.

12-2 This retained forest shall be selected to enhance wildlife, water resource and visual objectives.

12-3 The proponent shall monitor, to the requirements of the Minister for the Environment, and report by 2002 on the status and effectiveness of these measures to protect nature conservation values and water quality at the time of the next review of the Forest Management Plans and Timber Strategy.

13 Habitat trees

13-1 The proponent shall ensure that the number, condition and age of trees retained on sites subject to gap treatment is sufficient, as determined by the Minister for the Environment, to adequately provide the habitat function throughout the cutting cycle of the forest.

14 *Banksia grandis* reduction

14-1 The proponent shall concentrate the proposed reduction of the population of *Banksia grandis* in specific areas where the environmental circumstances suggest that treatment will have the greatest impact on reducing the spread and intensification of *Phytophthora cinnamomi* in the jarrah forest and where required to establish jarrah and marri regeneration.

14-2 The proponent shall establish a programme, to the requirements of the Minister for the Environment, to identify and evaluate the environmental implications of the proposed reduction and that the results of that evaluation shall be reported on, at or before the time of the next review of the Forest Management Plans by 2002.

15 Fire management

15-1 The proponent shall ensure that the fire management objectives related to the jarrah forest silvicultural prescription include the minimisation of air pollution in urban areas, to the requirements of the Minister for the Environment.

15-2 The proponent shall inform the public about its fire management on a regional basis each year in its annual report. This shall include but not be limited to the following:

(1) occurrences and causes of wildfires;

(2) purposes of burns;

(3) areas burnt under different regimes of season and periodicity;

(4) escapes; and

(5) the contribution of prescribed burning to reducing wildfire hazard.

15-3 Within 12 months of this proposal being given authority to be implemented the proponent shall initiate a public review of its prescribed burning policy and practices and the wildfire threat analysis. This should be done with the close involvement of the Research and Monitoring Committee. If possible it should be linked with a review of the provisions of the Bush Fires Act.

16 High salt risk catchments

16-1 Within three years, or such other period as the Minister for the Environment shall nominate, the proponent, on advice from the Water Authority of Western Australia, shall identify second order catchments with a high salt risk.

16-2 Within each catchment identified according to the requirements of condition 16.1, the proponent shall retain additional river and stream buffers and locate areas temporarily reserved during phased logging operations to the requirements of the Water Authority of Western Australia

17 Forest Monitoring and Research Committee

17-1 The Minister for the Environment will set up a committee having objectives which include:

(1) identification, prioritisation and approval of monitoring and research programmes and projects on environmental impacts of forestry management,
(2) the granting of funds towards such monitoring and research,
(3) receival of progress reports,
(4) reporting to the Minister for the Environment and
(5) publication of results.

17-2 The Committee shall include the heads (or nominees) of the Department of Conservation and Land Management, the Environmental Protection Authority, the Western Australian Forest Industries Federation, the Conservation Council and the Water Authority of Western Australia, and the Chairpersons of the Lands anf Forests Commission and the National Parks and Nature Conservation Authority.

17-3 The Committee shall appoint working groups of scientists to recommend and report to the Committee on the design and funding of research projects, the identification, prioritisation and review of monitoring and research programmes and projects relating to the environmental impacts of forest management.

17-4 The Committee shall provide brief annual progress reports to the Minister for the Environment, with major reports in 1997 and 2002, at the time of the next review of the Forest Management Plans and Timber Strategy.

18 Reporting on compliance

18-1 The proponent shall prepare "Progress and Compliance Reports", to help verify the environmental performance of this project, in consultation with the Environmental Protection Authority. These shall include brief annual progress reports to the Environmental Protection Authority, and major public reports in 1997 and 2002.

Note

Wherever the term "jarrah forest" is used in this statement it includes both the jarrah and the jarrah-marri forests.

Procedure

Compliance

The Environmental Protection Authority is responsible for verifying compliance with the conditions contained in this statement, with the exception of conditions stating that the proponent shall meet the requirements of either the Minister for the Environment or any other government agency.

If the Environmental Protection Authority, other government agency or proponent is in dispute concerning compliance with the conditions contained in this statement, that dispute will be determined by the Minister for the Environment.

Prior to making determinations as provided for in these conditions the Minister for the Environment may seek advice from the Forest Monitoring and Research Committee.

Jim McGinty, MLA
MINISTER FOR THE ENVIRONMENT

24 December 1992

Appendix 2

"Review of the
New Jarrah Inventory System
and Associated Timber
Estimation Procedures"

as published by

Dr Brian Turner
and
Dr Geoff Wood

ANU, Canberra, ACT
Minister for the Environment

Review of the New Jarrah Inventory System and Associated Timber Estimation Procedures

by

Dr Brian Turner and Dr Geoff Wood

Department of Forestry
Australian National University
Canberra, ACT

8 January, 1993

This report is submitted to the Environmental Protection Act Appeals Committee in response to a request for an independent review of the ability of the new jarrah inventory and associated systems to "provide policy makers, forest managers and informed members of the public with reliable estimates" (FAX from T. Barnett to Professor Bachelard, 11/12/1992) on such matters as gross bole and sawlog volumes, growth rates and allowable cuts.

We wish to emphasise that our check of the new jarrah inventory system (Spencer 1992)[1] and of the growth data base and of the procedures used for modelling growth and yield has, of necessity, been cursory. We have concentrated on matters likely to affect the validity of the estimates derived from both the inventory and the modelling processes.

Inventory Design

Examination of Spencer (1992) indicates that CALM Officers gave considerable thought to a range of options before adopting a sampling design and associated sampling and measurement procedures which would provide the resource data needed to manage efficiently the jarrah forest resource.

The rationales for choosing for inventory a two-phase (double) sampling design in a systematic layout without stratification, and for describing features of tree boles in detail in the 2nd-phase sample as a basis for determining product assortments (rather than relying on the expert knowledge of experienced assessors of timber products within a tree bole), are both sound and justifiable. We are pleased to note that the Department of CALM is conducting sawmill studies to try to develop stronger correlations between the external bole features and internal wood characteristics of trees in an attempt to improve the prediction of product assortments from the inventory.

The assumptions made about the coefficients of variation (CVs) of the estimates in the two phases of sampling, viz. of gross bole volume from the photo samples (70%) and of the ratios of ground estimates to photo estimates (50%) are also reasonable and acceptable. These CVs can now be refined given that the first inventory has been completed. However, it appears from Spencer (1992, p. 11-12) that the desirable size of sample in the two phases was derived using the formula for two-stage rather than two-phase sampling, namely:

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[1] Spencer, R.D. (ed.). 1992. Application of modern inventory techniques in the forests of Western Australia. Occasional Paper 1/92, Department of Conservation and Land Management, West Australia. 85 pp.

$$E = \sqrt{[C_1^2 t_1^2 / n_1 + C_2^2 t_2^2 / n_2]}, \qquad \text{Formula 1}$$

$$\text{thus, } n_2 = C_2^2 t_2^2 n_1 / [E^2 n_1 - C_1^2 t_1^2], \qquad \text{Formula 2}$$

where E = desired precision of estimate (%) of sawlog volume for areas of 10 000 ha
C_1, C_2 = CVs (%) of the 1st- and 2nd-stage samples respectively
n_1, n_2 = size of sample in the 1st- and 2nd-stage respectively
t_1, t_2 = Student's t-statistic for the 1st- and 2nd-stage respectively.

Accepting that $C_1 = 70\%$, $C_2 = 50\%$, $E = \pm 25\%$, and $t_1, t_2 = 2$, the computed sizes of the 2nd-stage sample, n_2, for nominated sizes of the 1st-stage sample, n_1, are:

n_1	n_2	n_2'
10000	16.1 (16)	17.7 (18)
500	17.1 (17)	18.6 (19)
300	17.9 (18)	19.2 (19)
200	19.0 (19)[2]	20.0 (20)
150	20.2 (20)	21.0 (21)
100	23.3 (23)	23.1 (23)

Theoretically, all of the listed combinations of n_1, n_2 in the table above would give a precision of estimate that meets the design criterion. To check the validity of these combinations when the correct formula for two-phase sampling with ratio estimation is used (see Cochran 1977[3]), we rearranged Cochrane's Formula 12.72' as follows:

$$n_2' = [S_y^2 - 2RS_{yx} + R^2 S_x^2] \; / \; \{[V(\bar{y}_R) - S_y^2 / N - [2RS_{yx} - R^2 S_x^2] / n_1\} \qquad \text{Formula 3}$$

where n_2' = number of ground plots in the 2nd-phase sample
n_1 = number of photo plots in the 1st-phase sample
N = number of sample units in the population
R = $\bar{y}_2 / \bar{x}_2$, where $\bar{y}_2$ and $\bar{x}_2$ are the means of y and x, the variables measured in the 2nd-phase sample
S_x^2 = variance of x in the 2nd-phase sample
S_y^2 = variance of y in the 2nd-phase sample
S_{yx} = covariance of y and x in the 2nd-phase sample
$V(\bar{y}_R)$ = variance of the ratio estimate of $\bar{y}$, the population estimate.

We then used real inventory data supplied by CALM (from 'the Ross Block') and substituted them into Formula 3. The results listed under n_2' in the table above indicate that the values have changed only marginally from the n_2 derived using the incorrect Formula 2.

[2] The combination chosen by CALM was $n_1 = 200$, $n_2 = 20$. The exact values of t_1 and t_2 for this option are 1.97/199 dfs and 2.093/19 dfs respectively.

[3] Cochran, W.G. 1977. Sampling Techniques. 3rd ed. John Wiley & Sons Inc. 428 pp.

Thus, the combination of 200 1st-phase and 20 2nd-phase plots chosen by CALM as the basis of the new jarrah inventory is entirely appropriate.

We note that relative costs of the first and second phases of sampling were not known and were not considered in determining the desirable size of sample for the inventory. Although these costs now will be known, they are unlikely to be of consequence in determining the optimum size of sample as the table above demonstrates clearly that n_2 (the costly ground sampling phase) is relatively insensitive to changes in n_1. In any case, a minimum size for n_2 of about 20 ground plots is necessary to ensure that sufficient sample trees are available to provide the information required on product assortments. In any future consideration of improving the design of the jarrah inventory, it would be prudent for CALM staff to review some of the principles contained in the recently published paper of Oderwald and Jones (1992)[4].

It should be clearly understood that the precision of estimate of sawlog volume (±25%) attained by the inventory over a 10 000 ha block of forest will be much better than that attained for the estimates of the other component wood products/log assortments. If better precision is ever required in these latter estimates, n_2 should be increased (while possibly leaving n_1 unchanged) because, as indicated above, it is only from the 2nd-phase sample that volumes of the various wood products can be estimated.

Field Procedures

A key constraint determining the reliability of estimates derived from double sampling is the level of success achieved by field crews in locating accurately on the ground the centres of the 2nd-phase ground plots, matching them with the centres of the 1st-phase photo plots. We are confident that the field procedures described in Sections 3.4, 5.1 and 5.2 of Spencer (1992) meet this constraint. The rest of the procedures applied in the ground-measurement phase of the inventory and described in Section 5 of Spencer (1992) are sound.

A number of the procedures underpinning the new jarrah forest inventory, e.g. the aerial photographic and photo-measurement methods and the new technique developed to estimate product types, are innovative and practical, and will be of considerable interest and benefit to resource scientists. The combined system developed by CALM staff incorporating the forest inventory, GPS receivers, GIS integration of data, and the estimation technique for log products, is indeed a very powerful planning tool of which, justifiably, the Department can be proud.

Bole Volume Function and Basic Data Processing Algorithms

Bole volumes in the first phase of the new jarrah inventory are estimated from an exponential relationship previously established between bole volume and total tree height. The relationship is based on a small sample (data base) of 112 trees drawn from the Collie area (Spencer 1992, p. 8-9). These 1st-phase volumes are then corrected using the more accurate estimates derived from the 2nd-phase ground plots. The restricted sample underpinning the 1st-phase estimate is unlikely to bias this estimate but it will affect its precision. It is recommended that this data base be expanded over time to help improve the efficiency of the inventory.

[4] Oderwald, R.G. and Jones, E. 1992. Samples sizes for point, double sampling. Canadian Journal of Forest Research 22 (7): 980-983.

A matter of concern with any set of photo-measurement data is the possibility of bias on the part of one or more photo interpreters. This problem is well covered in the jarrah forest inventory by the procedures used to monitor the performance of the interpreters (refer Spencer 1992, Section 4.6).

Data Integration and Analysis

Section 6 of Spencer (1992) describes the procedures used to integrate and process the data derived from the jarrah inventory. Parts of this section are difficult to comprehend due to poor English expression and description, e.g. the last paragraph of Sub-Section 6.2.3. Despite this, we are able to follow the gist of the story and are satisfied that the procedures used to process the data are sound.

Area Estimation

Accurate estimation of total volumes in a forest depend as much on the precision of estimation of land areas as on that of current and future volumes per hectare. CALM is justifiably proud of its long involvement in GIS technology and is able to use it effectively to rapidly update areas available for timber production (e.g., Spencer 1992, p. 51-53). Since the inventory has a systematic design, plots which are subsequently designated in non-production areas can be eliminated and the statistics recalculated. Thus, our expectation is that the area statistics are accurate and up-to-date. We note the proposed amendment of the operable area of jarrah/marri to 1.239 million hectares (CALM 1992a[5], p. 27) from 1.324 million hectares (CALM 1987[6], p. 17). Presumably, this reflects recent conversions from state forest to conservation areas and exclusion of stream buffers from production status. However, proposed new silvicultural guide-lines mandate the preservation from logging of additional areas, such as Special Visual Resource Management Areas (permanently) or wildlife corridors (temporarily) (CALM 1992a, App. A, p. 3-5). It is also proposed that areas of very low timber productivity which will be too expensive to adequately regenerate should not be harvested (CALM 1992a, App. A, p. 7). It is not clear how much of these proposed reservations has been taken into account in the reduced operable area.

Growth Data

In order to estimate changes in the jarrah forest resource it is necessary to predict the growth of the forest. Future growth can be estimated from the patterns of past growth. As noted by Abbott and Loneragan (1983)[7], past growth can be measured by: (a) periodic measurement of individual trees over their life; (b) growth ring analysis from destructive sampling of sample trees; or (c) periodic measurement of trees or stands over long enough periods that the patterns of growth can be deduced. Most of the data available on jarrah that can be used for growth analysis come from source (c).

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5 CALM. 1992a. Proposals to amend the 1987 forest management plans and timber strategy and proposals to meet ministerial conditions on the regional plans and WACAP ERMP. Department of Conservation and Land Management, West Australia.

6 CALM. 1987. Timber production in Western Australia. Department of Conservation and Land Management, West Australia.

7 Abbott, I. and Loneragan, O. 1983. Growth rate of jarrah (*Eucalyptus marginata*) in relation to site quality in cut-over forest, Western Australia. Aust. For. 46: 91-102.

Abbott and Loneragan (1986)[8] give an extensive description of growth data (p. 33-51) and the factors which affect the rate of growth. Since the method used for yield regulation is based only on the rate of diameter growth, only this is considered here.

Estimates of diameter growth at breast height range up to about 1.5 cm/yr but " the most recent authoritative estimate for" fully stocked stands of high quality jarrah forest "is 0.17 cm/yr, with a range of 0.09-0.25 cm/yr" (Abbott and Loneragan 1986, p. 35). They point out that "there is a strong negative correlation between stand basal area and diameter growth" (citing Abbott and Loneragan 1983) for high quality stands, although not for low quality forest where the increment averaged 0.10 cm/yr. Standard errors on these means were 0.012 cm and 0.014 cm respectively.

The yield regulation method used by CALM assumes that the primary determinant of diameter increment is the current diameter at breast height (dbh) of the tree. Abbott and Loneragan (1986) developed regressions for estimating dbh under bark (ub) at a second measurement from dbhub at a first measurement for 21 stands scattered over the jarrah region. These stands were first measured in the 1950's or before and remeasured in the early 1980's, thus representing 30 or more years of growth. Correlations were high (r=0.88+ for plots containing from 19 to 65 trees). Average diameter growth for high quality forest as estimated from these models ranged from about 0.3 cm/yr for 10 cm trees to 0.03 cm/yr for 100 cm trees, "indicating that trees of smaller diameters (e.g. poles) grow slightly more rapidly than trees of larger diameter" (Abbott and Loneragan 1986, p. 37), a fact which they attribute "most likely" to the greater age of larger trees. However they assert that "in more or less even aged stands ... the larger diameter classes show faster growth".

Other factors which have been shown to affect diameter growth are *seeding* (production of flowers and seeds) which "reduces the diameter growth of pole-sized jarrah" (Abbott and Loneragan 1986, p. 38); *fire* (mild fires seem to have no effect but "moderate to high intensity fires in some cases accelerate d.u.b. growth" (p. 39)); and *intraspecific competition* which "curtails diameter growth" (p. 40). Thinning increases diameter growth in more or less even aged stands roughly in proportion to the thinning intensity. The pattern and magnitude of diameter growth over time in cut-over stands does not appear to differ from that in virgin stands (p. 41).

Growth Prediction

The growth data which have been used by CALM in their prediction process derive from the 22 stands mentioned above (see Growth Data). We presume that the choice was based on a number of factors including the long period over which measurements were made (30+ years), their geographic spread, and their range in site quality and initial diameters, all important considerations. They also seem representative in terms of diameter growth rates, as indicated above.

The average growth rates for these stands (for high and low productivity forests separately) were calculated for the range of diameter classes and used as a guide to derive the curves shown in Fig 19 of CALM (1992b)[9] (p. 172). The average relationships are linear, a result of the fitted simple linear regressions, but the increments of small trees have been reduced and those of the large trees have been increased somewhat, presumably to fit silvicultural expectations about the species. A curve for average productivity has been estimated between the high and low productivity curves and values are given in Table 1. These are the

[8] Abbott , I. and Loneragan ,O. 1986. Ecology of Jarrah (*Eucalyptus marginata*) in the northern jarrah forest of Western Australia. Bull. 1, Department of Conservation and Land Management, West Australia.

[9] CALM. 1992b. Management strategies for the south-west forests of Western Australia. Department of Conservation and Land Management, West Australia.

diameter growth data used to project the current diameter distribution into the future (Biggs, pers. comm)[10]. How this is done is covered under Yield Regulation.

Table 1. Average diameter growth rates (Di) for given Dbhubs, from Fig 19 of CALM (1992b).

Dbhub (cm)	15	25	35	45	55	65	75	85	95	105	115	125	135	145
Di (cm/yr)	0.22	0.21	0.20	0.18	0.15	0.12	0.10	0.08	0.07	0.06	0.06	0.06	0.05	0.05

We have tried to gain some understanding of how the curves of Fig 19 of CALM (1992b) have been derived from the linear regression models of Table 10 of Abbott and Loneragan (1986, p. 38). Estimates of annual diameter growth rates were calculated from the models for each of the 21 stands listed, for a range of initial dbhub classes. The unweighted averages of these (separately for the 15 high quality stands and the 6 low quality stands) were then calculated and are shown in Table 2.

Table 2. Average diameter growth rates (Di) for given Dbhubs, derived from Abbott and Loneragan (1986), Table 10.

Dbhub (cm) (limits of initial data)	15	25	35	45	55	65	75	85	95
Di (cm/yr) —High quality forest	0.28	0.25	0.22	0.20	0.17	0.14	0.11	0.09	0.06
Di (cm/yr) —Low quality forest	0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.09

When the two Tables are compared it can be seen that the values of Table 1 mostly fit within the upper and lower values of Table 2, but the curvilinear relationship evident in Table 1 is not derivable from Table 2 where the relationships are strictly linear.

Predictions are based on the assumption that conditions which affected the growth of individual trees in the past will continue to pertain in the future. Factors which may change and affect growth rates are:

- higher stocking densities may be retained in future for wildlife habitat
- weather patterns over the period of prediction may differ from those over the measurement period
- climate may change in the long term (but effects are difficult to predict)

Yield Regulation

Prediction of future wood yields from the jarrah forests is predicated on a policy decision that the desirable structure of the forest to be maintained in perpetuity is the current average structure of the forest (CALM 1992a, p. 14). This structure is defined by the frequency distribution of trees by diameter classes given in Table 22 of CALM 1992b, p. 172. The harvestable component of a stand is thus that which is in excess of this desirable distribution.

[10] Biggs, P. Department of Conservation and Land Management, West Australia.

Using the matrix method of Usher (1966)[11] (essentially a modernisation of the stand projection method but applied on an annual update basis), it is possible to determine the cutting pattern which will retain any desirable distribution (i.e., stand table) (Campbell, pers. comm[12]). The gross bole volumes of these harvestable trees by diameter classes are estimated and used to develop the total volumes of removable stems by diameter classes. These are calculated by forest units to allow for geographic variations in tree volumes. Finally the per hectare figures are expanded by the appropriate areas to give total harvestable gross volumes for any specified forest unit.

We were not supplied with information as to how gross bole volumes were ascribed to trees of particular diameters. Presumably, one-way tree volume tables are available to predict volumes from diameters within forest units.

A matrix of species and log product ratios allows the gross bole volume yield in each diameter class to be partitioned into species and log product components. "The ratios were derived from the jarrah inventory and were specific to the forest unit under consideration" (Campbell, pers. comm).

Items Needing Further Consideration or Action

In our review, we have identified a number of items which present current problems or difficulties or about which we had inadequate information but which might require reconsideration or at least, documentation. For convenience, these are gathered together in this section.

1. The formula used to estimate sample sizes for the two-phase sampling scheme should be corrected.

2. Improved precision in estimating product assortments or volumes on areas smaller than 10 000 ha will require a much higher 2nd-phase sampling rate.

3. The database used to relate bole volume to total tree height should be expanded over time so that the efficiency of 1st-phase sampling can be improved.

4. Any bias in photointerpretation has serious consequences and should be continually monitored.

5. Any change in the land base of forest available for timber production will affect inventory levels and thus sustainable yields. Many of the 1992 proposals involve changes in this production base. Care is essential to ensure that all of these changes are accounted for.

6. Most of the growth data have been collected for jarrah species only, presumably because in the past other species were considered non-merchantable. This is no longer the case. For example, almost no information is available on the growth of marri which constitutes a substantial component of many stands and is now considered utilisable for some products. The assumption that other species have the same growth rates as jarrah is highly contestable.

7. The way in which the average diameter growth rates used in yield calculations have been derived from the empirical data needs clarification and documentation.

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[11] Usher, M.B. 1966. A matrix approach to the management of renewable resources, with special reference to selection forests. J. Applied Ecology 3: 355-367.

[12] Campbell, H. Department of Conservation and Land Management, West Australia.

8. The most desirable structure of the forest depends on the management objectives. For example, the optimum structure if timber production is to be maximised will differ from that which will maximise conservation objectives. It seems likely that maintaining the existing structure will offer a compromise between these extremes since the forest is currently a mixture of cut-over and virgin forest. Conservation objectives may be better served by maintaining the structure of virgin forests. It is not clear how different these are and some sensitivity analysis might be illuminating.

9. The practical implications of the proposed approach to yield regulation need careful consideration. For example, a stand table projection of the existing distribution of trees by diameter classes over the next ten years suggests that if the current distribution is to be retained, about 2/3 of the stems to be removed will be in the 20-30 cm dbh class. Although this analysis is not as rigorous as that using the Usher algorithm, it indicates the need for a market for this small material.

10. The critical nature of the new algorithm for defining product assortments from the inventory is evident. This defines what proportion of the sustainable yield is expected to be in sawlogs, by grades. Careful monitoring of this procedure is essential.

Concluding Remarks

We note that the proposed sustainable yield of gross bole volume is substantially higher than the previous accepted projected supply. The latter (CALM 1987, p. 42, 49) projected a generally decreasing supply of sawlogs from the jarrah forests, from 523 000 m^3 in 1992-1995 to 239 000 m^3 in about 2030. The proposed sustainable yield is a constant 1 360 000 m^3 of jarrah and 469 000 m^3 of marri (CALM 1992a, p. 29). These latter figures, however, include significant volumes of non-sawlog material. More comparable figures are 675 000 m^3 of jarrah and 57 000 m^3 of marri sawlogs (1992-2001). Further differences are due to somewhat different definitions of sawlogs and increased utilisation of bole volume resulting in significant increases in the quantity of lower grade logs. (We note that estimated supply of first grade logs for 1992-1995 was previously 400 000 m^3 and the proposed sustainable yield of first grade logs is 459 000 m^3.)

The differences noted above reflect the substantially higher sawlog volumes estimated in the recent inventory (57.2 million m^3) (CALM 1992a, p. 27) compared with the 18.25 million m^3 estimated in the previous inventory (CALM 1987, p. 17). The annual sawlog harvest for the 1992-1995 period would be 2.9% of the sawlog resource according to the 1987 Strategy as compared with 1.3% of the sawlog resource using the recent inventory and the proposed sustainable yield. Thus, the proposed increase in potential sawlog harvest would come from a significant increase in utilisation, not from an increase in proportion of the forest harvested.

In summary, we are very impressed with the care with which the jarrah inventory has been designed and, as indicated by the results, executed. We have suggested a correction to the sampling intensity calculation (which has negligible impact on the results) and possible increases in the 2nd-phase sampling intensity to improve precision if the inventory is to be used at the operational, as opposed to the strategic, level. The significant impact of product outturn estimates on the sustainable yield calculations is noted and this highlights the importance of gaining high precision in these estimates. The approach being used by CALM seems a much-needed advance, but is innovative and thus needs careful monitoring. Precise estimation of land areas is also important to the overall inventory. Frequent updating of the area statistics to account for changes in the production forest base is essential. Fortunately, CALM's extensive experience with GIS means that the ability to make these

rapid updates is available, but care is needed to ensure that all current and anticipated future changes are made.

Successful yield regulation depends on a precise inventory (which we believe now exists, at least at the strategic level) and good growth information. Existing growth information has been extensively reviewed, so we have no doubt that the best possible data set has been used for growth projections. However, this data set has some deficiencies which are not easy to overcome in the short term. For example, little information is available on species other than jarrah. The diameter growth data used in projections, although consistent with other evidence, seem to have been derived from sources (perhaps non-empirical) additional to the data set indicated as the source, and this should be carefully documented. The method of yield projection used by CALM is appropriate to the type of growth data available but more advanced tree growth models should be developed as better data are acquired. The concept of using a steady-state diameter distribution to define a desirable ecosystem structure is an interesting and useful advance in the definition of sustainability, and provides a useful platform for yield regulation. Our spot checks of these calculations indicate that the methodology has been applied correctly.

Assuming the acceptability of the assumptions underlying the sustainable yield approach, we believe that the methodology used by CALM is appropriate and essentially correct. The methodology specifies not only the volume to be removed to achieve sustainability but also the size distribution of removals. This has implications for utilisation, marketing and silviculture which have been mentioned in part but are beyond the scope of this report. However, the success of the yield regulation system depends on its correct implementation. Careful and continuous monitoring of the relationship between predicted and actual distributions and yields will be essential.

Signed: ....

Brian J. Turner
Reader, Dept. of Forestry, ANU

Geoff B. Wood
Reader, Dept. of Forestry, ANU

8 January 1993

Appendix 3

"EPA Recommendations to CALM Outlining Scope and Process of the Assessment"

dated 19 September 1991

APPENDIX C

Acting Executive Director
Department of Conservation and Land Management

Your ref:
Our ref:
Enquiries:

Environmental Assessment of Proposals to Change Forest Management in the South West

Further to the briefing of the Environmental Protection Authority on the Department of Conservation and Land Management's preparation of documents resulting from reviews of nature conservation and forest strategies which will include proposals for change (including addressing environmental conditions set in 1987 by the Hon Minister for the Environment on the Forest Region Management Plans and Timber Strategy and W.A Chip and Pulp Co Pty Ltd), I confirm that the following environmental issues should be included for the purposes of environmental assessment and also confirm agreement reached on the joint process (as attached) to satisfy statutory requirements under the Conservation and Land Management Act and the Environmental Protection Act.

Scope

The following issues have been derived principally from the Ministerial Conditions as already mentioned. Notwithstanding the specific issues, any proposal or issue with the potential to have a significant impact on the environment should be included within the Forest Management Plans Amendments ('Approvals Document') for environmental assessment.

These may emerge during the preparation of the documentation or arise during the assessment phase. The Department of Conservation and Land Management and Environmental Protection Authority should discuss these in the first instance.

Road, River and Stream Zones and High Value Forest Areas

- Objectives and description of existing Road, River and Stream Reserve system
- Discussion of the effectiveness of the existing Road, River and Stream Reserve system in meeting objectives
- Justification for change to existing Road, River and Stream Reserve system
- Objectives of proposed Road, River and Stream Zone system
- Criteria for identification of proposed Road, River and Stream Zone system
- Outline of the predicted effectiveness of the proposed Road, River and Stream Zone system
- Management prescriptions for proposed Road, River and Stream Zones system

- Objectives and criteria used for identification of exceptional scenic or conservation values or high value old growth forest areas
- Identification of areas of exceptional scenic or conservation values within multiple use forest which are proposed to be excluded from harvesting
- Identification of areas of high value old growth forest within multiple use forest which merit flexible harvesting management
- Management prescriptions for selected high value old growth areas and areas of exceptional scenic or conservation values within multiple use forest
- Future monitoring and reporting

Northern, Central and Southern Forest Regions - Jarrah Forest Types

- Objectives of management, and silvicultural procedures for Jarrah forests
- Proposed integrated logging/ silvicultural procedures and the basis of proposals
- Predicted impacts of integrated logging/ silvicultural procedures on Jarrah forest ecosystems, protection from fire and dieback disease, water resource values and the nature of the forest
- Conservation objectives (flora, fauna and landscape outside reserves) and their implementation through multiple use State Forest management, taking account of long term sustainability of ecosystems of Jarrah forest types
- Research directions

Southern Forest EMP

- The Marri resource in the "salt sensitive zone"
- Proposed integrated logging/ silvicultural procedures
- Predicted impacts on forest values
- Proposed monitoring and reporting

Conservation Reserve System

- Any significant alteration to the conservation reserve system as proposed in the Northern, Central and Southern Forest Region Management Plans or CTRC/ EPA Systems Recommendations
- Conservation protection management in multiple use forest adjacent to existing and proposed conservation reserves

Process

The attached chart outlines the joint process for preparation, public review, assessment and finalisation of the strategies and proposals documents.

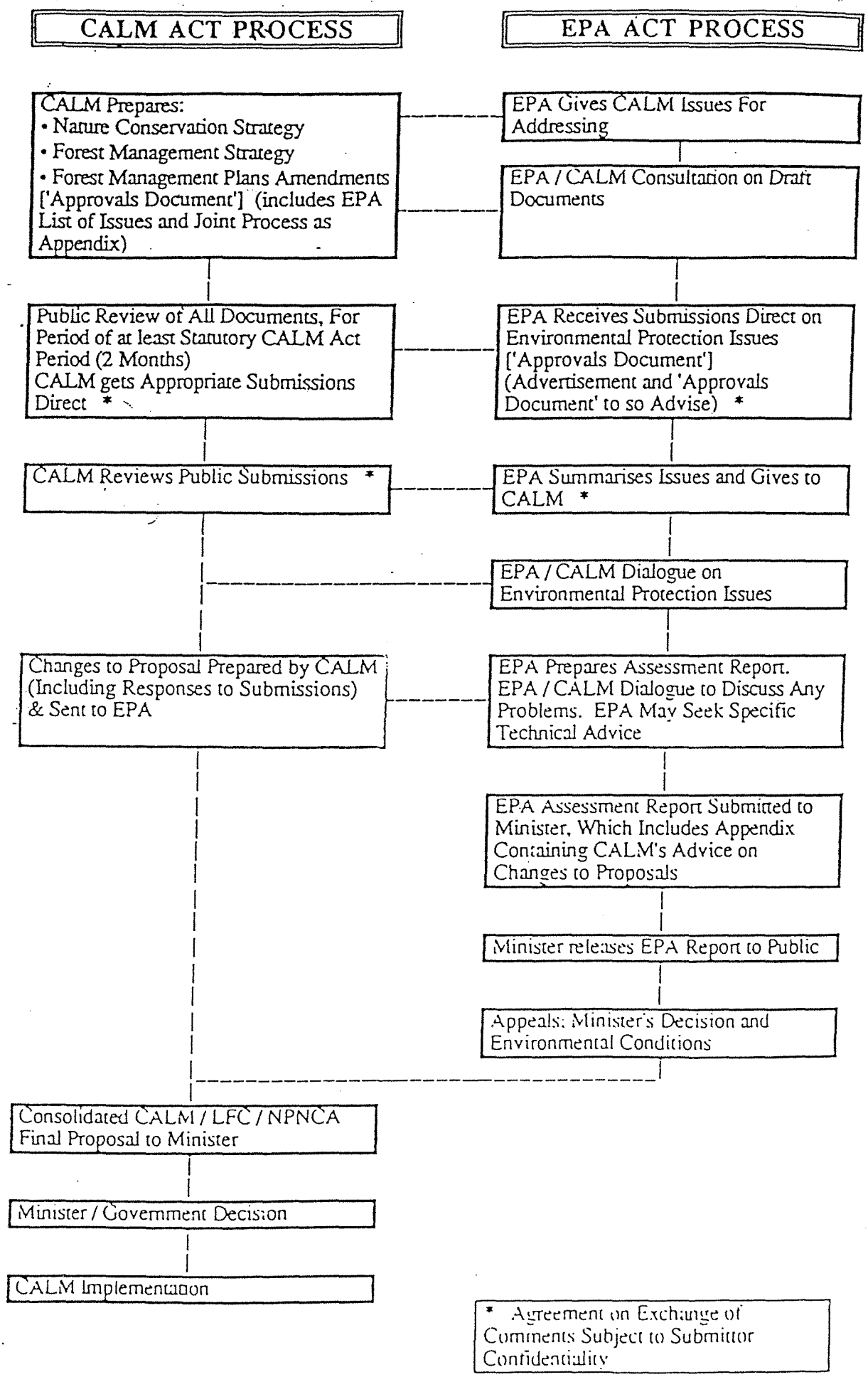
Terminology

One of the areas about which there has been considerable historical debate in the public discussion of forest issues has related to terminology. The Authority considers that these documents and this process provide the opportunity for the use of a commonly acceptable set of terms that can be applied to specific practices or processes. A set of terms and their clear definition incorporated in the documentation would assist understanding and review.

B A.Carbon
CHAIRMAN

19 September 1991

Process



Appendix 4

"Submission from CALM to this Committee Outlining Preferred Harvest Levels for Jarrah"

CALM'S STATEMENT IN RESPECT TO QUESTIONS FROM THE EXPERT SCIENTIFIC AND ADMINISTRATIVE REVIEW COMMITTEE

A *"CALM's preferred level of harvest of jarrah sawlogs for the next 10 years and the forest management rationale for that"*

CALM has no preferred level of harvest *per se* but believes the level should be set -

- to achieve the environmental goals of the Government within the ecologically sustainable limits of the forest; and
- to achieve the social and economic goals of the Government.

Ecological sustainability of the jarrah forest

- The 1992 Draft Review of Jarrah Forest Management included a comprehensive assessment of the effect of forest management practices (including timber harvesting) on fundamental forest processes (nutrient and water cycles etc) and plant and animal species. While there is no evidence that forest management practices were adversely affecting forest processes or species the 1992 Review proposed:
  - a significant expansion of the reserve system, including the provision of extensive stream, river and road reserves throughout the forest. [Note - the last three Management Plans (1982, 1987, 1992) have resulted in more than 420,000 ha of multiple use tenures being proposed for conservation tenures which exclude logging. Of this, in excess of 300,000 ha is jarrah type being almost 20 per cent of the jarrah forest estate)];
  - more sophisticated and flexible silviculture;
  - that the forest structure be sustained to ensure that there would always be a significant representation (>60%) of "old growth forest".
- Sustainability of wood increment is achieved by ensuring that the removal of wood by timber harvesting does not exceed the total increment of wood produced in the forest over prolonged periods of time.

  In a forest which has equal representations of size classes and in a forest where the total bole increment over the forest is relatively constant over time and the relationship between total bole volume increment and sawlog yield is constant, it is relatively easy to derive the sustainable yield of sawlogs from estimates of total bole volume increment. In such a forest, it is also possible to manipulate the sawlog yield so that it remains relatively constant over long time periods. This situation does not apply to the jarrah forest. Both wood increment, and the proportion of bole increment utilisable as sawlogs, will change over time as the structure of the forest changes and as utilisation standards change.

  In a forest which is totally represented by "old growth" the increment will be close to zero as old trees grow very slowly and any increment tends to be lost by mortality. The jarrah forest consists of a mosaic of old growth stands, stands with a partial overstorey of large trees which suppress growth of younger trees, overstocked regrowth stands and vigorously growing regeneration and pole stands.

  Consequently, the total increment in the forest will vary. Based on plot data and projections of increased growth as a consequence of the application of silviculture,

CALM estimates that the average increment of the jarrah component of the jarrah forest which is available for timber harvesting will be within the range of 1.0 m^3/ha/yr to 1.4 m^3/ha/yr.

In the 1992 Draft Forest Strategy CALM used a total bole volume increment of 1,360,000 m^3/yr which was based on an average jarrah increment of 1.24 m^3/ha/yr on an available area of 1.1 million hectares. Using the available area figure of 1.11 million hectares, the total bole volume produced each year as a result of the potential range of increments is shown in the table below:

Table 1

Total jarrah bole volume produced on the forest available for harvesting with a range of jarrah increments

Average jarrah increment m^3/ha/yr	Total bole volume produced m^3/yr
1	1,110,000
1.1	1,221,000
1.2	1,332,000
1.3	1,443,000
1.4	1,554,000

The proportion of the total bole volume that can be utilised as sawlogs is the other principal factor which determines the impact of different levels of sawlog harvest on the sustainability of annual total bole volume increment.

The effect of varying percentage recovery rates of sawlog on total bole volume removed at different harvest rates is illustrated below:

Table 2

Relationship between percentage yield of sawlogs and bole volume harvested

Bole volume (m^3) required to produce the given sawlog level

	% of bole volume which is sawlog				
Sawlog (1st and 2nd) production m^3/year	30%	33%	36%	40%	50%
350,000	1,165,500	1,060,500	969,500	875,000	700,000
450,000	1,490,000	1,360,000	1,277,000	1,125,000	900,000
550,000	1,831,500	1,666,500	1,523,500	1,375,000	1,100,000

CALM, in its 1992 proposals, suggested a potential sawlog yield over the planning period of 675,000 m^3/yr. This assumed that approximately 50 per cent of the annual total bole volume increment could be classified as sawlogs although many would be below current standards. Subsequent field trials (which were also recommended by Turner and Wood) have shown that the estimated standing volume of sawlogs should be reduced by 12.5 per cent as a consequence of the need to retain habitat trees and to exclude trees too dangerous to harvest. These same studies showed that 82.5 per cent of the estimated sawlog volume was marketable as 1st and 2nd grade logs. Thus on the basis of these operational trials the proportion of the estimated total bole increment (1,360,000 m^3) which can be converted to sawlog (1st and 2nd grade) is approximately 36 per cent.

Factors affecting determination of sawlog harvest during the planning period

- The 1982 General Working Plan and the 1987 Timber Strategy recognised (see Figure 1) that there would be significant periods during the next century when sawlog yield would decline to low or non-existent levels, even though total wood increment on the forest would be sustained. This situation occurs because increment is largely occurring on trees too small to yield sawlogs until the forest reaches a "normal" structure.

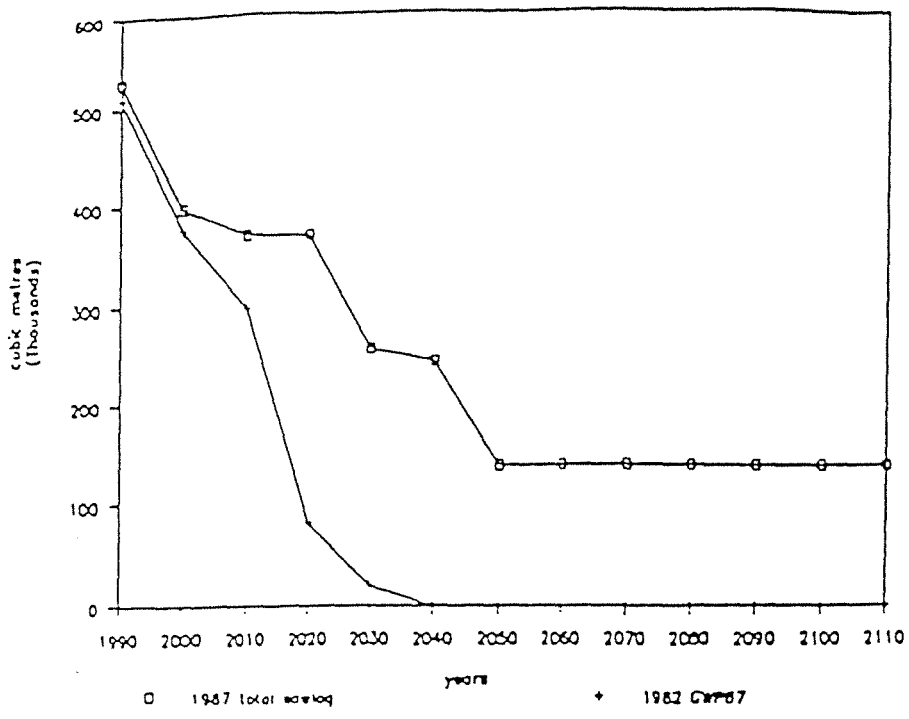


Figure 1:
Long-term yield projections of the 1982 and 1987 plans

- While it is possible to estimate the potential long term yield of sawlogs by simulating growth over the whole forest, the actual sawlogs that can be removed on a sustainable basis beyond the 10-year planning period are affected by a range of additional operational constraints. CALM has developed a scheduling model which estimates long term sawlog yield by applying a range of operational and silvicultural schedules on 33 different forest strata.

  This scheduling model, which assumes that current log utilisation standards and the forest management proposals in the 1992 Forest Management Review apply, predicts that the long term sustainable yield of jarrah sawlogs is approximately 300,000 m^3 per year.

  This represents a significant improvement on the 1982 and 1987 scenarios, but even though changing utilisation standards could result in a significantly higher sustainable yield in the future, current planning must be based on the assumption that the sawlog harvest levels will need to be reduced over time to 300,000 m^3.

  The actual level of sawlog harvest during the planning period can only be determined by considering biological, social and economic factors and how they interact.

1. The effect of sawlog harvest levels on sustainable bole increment

- The total available annual bole increment over the forest will vary as the forest approaches a "normal" structure. The estimated range varies from 1.1 million m^3 to 1.56 million m^3 (Table 1). Similarly, the effect of the level of sawlog harvest on total bole increment will vary according to the proportion of total bole volume that is used as sawlog, which varies according to utilisation standards and forest structure (Table 2).

  A sawlog (1st plus 2nd grade) harvest of between 450,000 m^3 and 550,000 m^3 would result in a removal of 1.36 million to 1.5 million m^3 of total bole volume increment, assuming that the proportion of total bole volume utilised varied between 33-36 per cent (Table 2). This range represents the most likely overall recovery being achieved in the field at present, although in high quality forest a recovery rate of 50 per cent has been recorded. This falls within the range of potential bole volume increment levels of the forest (Table 1). The harvest level over a 10-year planning period of between 450,000 m^3 and 550,000 m^3 would not adversely affect the long term sustainable total bole volume increment levels of the forest.

  The scheduling model has been used to estimate the effect of different levels of harvest during the 10-year planning period on forest structure. The model shows that harvesting levels over the 10-year planning period, ranging from 350,000 m^3 to 550,000 m^3, have comparatively little effect on forest structure. For example, the proportion of forest with significant "old growth" structural elements would exceed 60 per cent in the year 2100 if an annual harvest level of 500,000 m^3 for 10 years, followed by a harvest level of 300,000 m^3 to the year 2100 was applied.

  The scheduling model also showed that the harvest level for the next 10 years of between 450,000 m^3 to 550,000 m^3 of sawlogs would have insignificant effect on the long-term sustainable yield of sawlogs, even if it is assumed that current utilisation levels do not improve.

2. The social and economic effect of the level of harvest during the planning period

- One of the principal objectives of the 1987 Timber Strategy was to provide an incentive for the timber industry to restructure, and to introduce new technology to enable greater utilisation in the forest and to increase the proportion of sawlogs which could be converted to value added products. The principal incentive was to provide a secure resource supply to the industry by providing legally binding long term log resource contracts.

  The 1987 Strategy was successful in that there have been major investments in new plant and equipment which resulted in significant improvements in utilisation in the forest and in the mills, and a major increase in the proportion of sawn timber which is converted to value added product. Whereas the 1987 Strategy aimed to achieve a conversion of 30 per cent of the green sawn timber to value added product, a number of sawmill companies have exceeded this level and have plans in place to increase the proportion of sawn timber converted to value added products to in excess of 60 per cent.

- An immediate reduction of sawlog supply levels to 300,000 m^3 would result in a major disruption of the industry causing significant unemployment in some regional areas. It would also result in a major reduction in planned investments which are required to maximise the conversion of sawn timber to value added products. A level of cut at this level would particularly disadvantage small sawmillers because the 1987 Strategy allocated timber to this sector of the industry (which previously had no formal access to log resource) on the basis of 5-year contracts.

  Maintenance of the level of log supply at the 1992 levels set out in the 1987 Timber Strategy (520,000 m^3 1st and 2nd grade logs) would result in the maintenance of the existing level of industry confidence. However, as a consequence of the severe recession in the previous 3 to 4 years, the actual level of sawlog supply (1st and 2nd grade logs) since 1987 has averaged approximately 480,000 m^3 per annum.

  It could also be argued that the investment that has occurred as a consequence of the 1987 Timber Strategy was predicated on a reduction of the level of cut to 461,000 m^3 in 1993 and 345,000 m^3 in 1996. The industry however, particularly the small sawmill sector whose resource was based on 5-year contracts, were aware that the 1987 resource allocation was based on an outdated inventory and would, to some extent, base their investment on an expectation of a smaller reduction in sawlog supply than that predicted by the 1987 Strategy.

  An additional factor affecting the level of industry investment is the period of time over which log resource contracts are fixed. One of the reasons why there has been less investment by small sawmillers in new technology was that the 5-year contract periods were not sufficient to justify the level of investment required. CALM's 1992 proposals foreshadowed that the contracts would extend over a 10-year period, thus increasing the incentive for investment.

  The economic and social consequences of different levels of sawlog supply over the planning period are not easy to predict because each industry company has its own particular investment environment. Thus a subjective judgement must be made on the effect of harvest levels during the planning

period on the ability of the industry to justify the investment that is required to continue improvements in forest and sawmill utilisation and the proportion of sawn timber converted to value added product.

- The level of industry investment, and consequent improvement in utilisation, will have a significant impact on the long term sustainable yield of sawlogs from the forest. CALM's modelling of the long term sustainable yield of sawlogs assumed that current standards of utilisation were to apply. Improvements in utilisation resulting in an increased proportion of the total bole volume being utilised as sawlogs and major increases in the proportion of sawlogs being converted to value added products, would significantly increase the long term sustainable sawlog yield.

B *"The effect of your preferred harvest on existing sawmill contracts, including those falling due for renewal"*

As stated at the beginning of this document CALM does not have a "preferred" level of harvest, but will manage the forest in accordance with Government objectives.

As from 1 January 1994, when the short-term contracts which have been rolled over expire, the contracted commitment for jarrah sawlogs is:

1st grade = 302,000 m^3
2nd grade = 43,000 m^3

As a consequence, the level of harvest could drop to 350,000 m^3 in January 1994 without the breaking of any jarrah contractual commitment.

However, this level of harvest would have a very significant impact on the sawmilling industry, the south-west towns and people and businesses which rely on them. The small sawmilling sector would virtually disappear and there would be no contracted logs for the larger mills at Jarrahdale, Collie, Walpole and Northcliffe.

There would also be a flow-on effect in marri sawlog and residue production with implications for any existing or proposed industry based on this resource, as it is governed by the area cutover for jarrah and karri sawlogs.

CONCLUSION

- Based on <u>current</u> utilisation standards, the long term sustainable jarrah sawlog yield is approximately 300,000 m^3 per annum.

- A sawlog harvest level of between 450,000 m^3 to 550,000 m^3 during the 10-year planning period would have no adverse effects on biological and wood increment sustainability of the forest. Similarly, harvest levels within this range would not significantly affect the long term sustainable sawlog yield even if utilisation standards did not improve.

- As of 1 January 1994, there are no contractual obligations in excess of 350,000 m^3.

- A marked reduction in the level of timber harvest would have significant adverse social and economic effects throughout the south-west and would particularly disadvantage small sawmillers.

- A level of sawlog harvest within the range of 450,000 m^3 to 550,000 m^3 would minimise adverse social effects and provide sufficient incentive to the industry to continue investment in new technology and marketing which is required to improve utilisation, and similarly increase the proportion of sawn timber converted to value added products. Improvement in utilisation rates and increases in the proportion of sawn timber converted to value added products would result in an increase in the sustainable sawlog yield.

THE CONVERSION OF SAWLOG TO GROSS BOLE VOLUME FELLED

INTRODUCTION

The purpose of estimating the amount of Gross Bole Volume (GBV) felled as a result of a particular level of sawlog cut is to ensure no more GBV is felled than is growing each year.

Detailed below is the rationale for the figures put to the Committee by CALM:

- The jarrah bole growth for a year is 1,360,000 m^3.

- The estimated quantity of sawlogs which this would yield, based on the existing forest structure is -

  - 675,000 m^3 which is 49.6 per cent of the annual bole growth.

- This was estimated to break down into 459,000 m^3 of 1st grade and 216,000 m^3 of other grades -

  - although some of the other grade sawlogs are known to be not saleable in the current economic climate.

- The estimated saleable volume can be calculated by adding to the 1st grade amount (459,000 m^3) the average of the last two years' sales of 2nd grade expressed as a percentage of 1st grade sold. This figure is 29 per cent. Hence -

  - expected 1st and 2nd grade is 459,000 x 1.29 = 592,000 m^3.

- Field trials on 32 plots throughout the south-west, designed to show what happens to estimated available sawlogs in harvesting, showed that only 82.5 per cent of the expected available 1st and 2nd grade sawlogs were actually sold. Left standing was 17.5 per cent comprising habitat trees, trees too dangerous to fall and crop trees.

  - On this basis 488,000 m^3 of grade 1 and 2 sawlogs of the 592,000 m^3 would be realised.

- This is approximately 36 per cent of the estimated annual growth of the forest.

- However, as 104,000 m^3 (17.5 per cent of the expected available 1st and 2nd grade sawlogs) is left standing, the proportion of bole volume felled which is sold as sawlogs cannot be less than 38.8 per cent, ie 488,000 m^3 divided by (1,360,000-104,000) x 100.

- The only trial from which the proportion of bole volume felled can be estimated is that in Ross Block, which showed that 50 per cent of felled bole volume was removed as sawlogs.

  - This is known to be high productivity forest, hence is likely to be higher than the general mean.

- In terms of jarrah it should be noted that the recovery percentage should always be represented by a range because of variation in space and time. The percentage of sawlog realised from bole volume felled by using the calculation -

$$^{(1)}25\% \times \frac{^{(2)}100}{77.5} = 32.25\%$$

where (1) is the percentage of sawlog realised from total estimated GBV
(2) is the (estimated) proportion of GBV actually felled

will be a lower end estimate because it includes the marri component of GBV.

- The 25 per cent is sawlogs as a proportion of jarrah and marri GBV.

  - The percentage of sawlogs which are jarrah would be 90 percent. Hence the jarrah sawlogs as a proportion of GBV would be higher than 25 per cent.

- Another estimate of utilisation percentage using only jarrah GBV may be made using the same process that realised the 32.25 per cent figure such -

$$^{(1)}25 \times \frac{^{(2)}90}{100} \times \frac{^{(3)}100}{75} \times \frac{^{(4)}100}{77.5} = 38.7\%$$

Where (1) = original 25 per cent of total GBV as sawlogs
(2) = 90 per cent of (1) are jarrah sawlogs and 10 per cent marri
(3) = 75 per cent of total GBV is jarrah
(4) = 77.5 per cent of total GBV is felled.

- This may be compared to the Ross Block trial where:

  (1) was 28 per cent
  (2) was 96 per cent
  (3) was 81 per cent
  (4) was 65 per cent

which gives the 50 per cent realised in the trial.

Appendix 5

New Scientist Article, June 1993

"Timber: the beam in Europe's eye"

[3]"And why beholdest thou the mote that is in thy brother's eye, but considerest not the beam that is in thine own eye?

[4]Or how wilt thou say to thy brother, Let me pull out the mote out of thine eye; and, **behold, a beam *is* in thine own eye?**

[5]Thou hypocrite, first cast out the beam out of thine own eye; and then shalt thou see clearly to cast the mote of thy brother's eye.

Matthew 7:1

26 June 1993

Timber: the beam in Europe's eye

Debora MacKenzie, Brussels

IN GENEVA this week European governments, including Britain, are demanding that tropical countries harvest timber only from "sustainably" managed forests by the year 2000. But last week in Helsinki, European governments, led by Britain, refused to make the same pledge for their own forests, despite a surprise announcement by the US that it will adopt the target.

As a result, major tropical timber producers such as Indonesia and Malaysia are unlikely to commit themselves to sustainable forestry. Environmentalists say the standoff will lead to further destruction of both tropical and temperate forests, and make it harder to turn the "forest principles" agreed at the Earth Summit in Rio last year into a binding forestry convention.

The International Tropical Timber Agreement, signed in 1983, was designed to regulate the trade in tropical timber, a market worth some $7·5 billion per year. In recent years it has become a focus for debate on forest conservation. The agreement expires next year, and in April its 51 signatories, all countries that produce or consume tropical timber, met in Geneva to renegotiate the accord (This Week, 3 April).

The meeting ended in stalemate when industrialised countries refused a request by tropical countries for the agreement to be extended to timber cut from temperate forests. This week the signatories are trying again. Nigel Dudley of the World Wide Fund for Nature says European governments avoided a showdown in April by promising to agree a position on this in Helsinki.

Last week, forestry ministers from 37 European countries signed four "general guidelines": for sustainable management of forests in Europe; conservation of biodiversity; help for central and eastern Europe; and strategies for adapting European forests to cope with climate change. But they rejected the target of using only sustainable timber by the year 2000.

Dzsingisz Gabor, the Dutch secretary of state for forestry, called for this target to be written into the resolution on sustainable forestry. But the European Community, Britain and Sweden opposed this and it was defeated.

Kim von Weissenberg, of the Finnish forestry ministry, which organised the conference, said there was no need for a deadline. The guidelines say the resolutions should be implemented "as soon as possible". The guidelines define, for the first time in an international agreement, what "sustainable forestry" means: "use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality" and their "ecological, economic and social functions", while not causing "damage to other ecosystems".

Greenpeace says the definition is too vague, and the qualities that are to be "maintained" should be put in some order of priority. Emphasising productivity rather than biodiversity would lead to "very different types of forestry". Moreover, the resolution calls for unsustainable practices to be actively discouraged, but not prohibited.

Environmentalists also wanted tougher restrictions on plantations of exotic species, such as eucalyptus and pines, which reduce the diversity of Europe's forests. The resolutions simply say that "introduced species may be used when their potential negative impacts have been assessed".

While Europe has signally failed to draw up any binding rules to protect its forests, the US has had a surprising change of heart. Eldon Ross, the head of the American delegation, said: "The US is committed to the national goal of achieving sustainable management of its forests by the year 2000." The US had previously rejected this target. □

Disagreement fells timber treaty

ATTEMPTS to renegotiate the International Tropical Timber Agreement collapsed in Geneva last week, after timber-growing countries in the temperate regions of the world refused to be bound by the same conditions as tropical countries.

The ITTA, signed in 1983, expires next year. Countries that produce tropical timber want its successor to be a comprehensive international Timber Agreement that includes wood from temperate forests. But the countries with temperate forests do not want their own timber subjected to the agreement's controls. This group is led by Canada, the US, Sweden and Germany.

Under the ITTA, tropical producers have agreed that they will manage their forests "sustainably" by the year 2000. But they are threatening to abandon this commitment unless temperate nations adopt a similar line. Temperate countries said in Geneva that their timber is already managed sustainably and does not need to be controlled by international agreement. The US has promised to manage its own forests sustainably by the year 2000 and, last month, criticised European governments for not adopting the same target (This Week, 26 June). □

Glossary of Terms

Bole: the trunk of a tree, usually the portion from which sawlogs are retrieved.

Coupe: an area of forest that is subject to timber harvesting operations as a single unit.

Edaphic: soil characteristics.

Habitat: a component of an ecosystem providing food and shelter to a particular organism.

Hardwood: the timber of broadleaved trees, and the trees themselves, belonging to the botanical group Angiosperms, eg. Eucalypts.

Management plan: a plan, revised periodically, defining forest policy governing management activities within the management plan area, typically includes forest geography and history, land use allocation, objectives and prescriptions for management.

Multiple purpose: the use of land, especially forest land, for several different purposes either concurrently or sequentially.

Native forest: naturally occurring forest, whose current floristic and structural condition may or may not have been influenced by human activity.

Riparian: pertaining to the banks of streams, rivers or lakes.

Softwood: the timber of trees, and the trees themselves, belonging to the botanical group Gymnosperms, eg. Pines.

Sustainability: when applied to forests means, the maintenance of ecological processes, soil, water, etc. so that the forest ecosystem will continue.

Sustained yield: a plan of management which produces a more or less consistent, but not necessarily optimum, output of product being managed, which is within the long-term capability of the ecosystem.

Thinning: a felling made in an immature stand for the purpose of improving the growth of trees that remain without permanently breaking the canopy and encouraging regeneration.

Harvest: removal of timber produce from the forest for commercial utilisation.

Yield: the amount of product produced by the forest as a consequence of a particular management strategy.