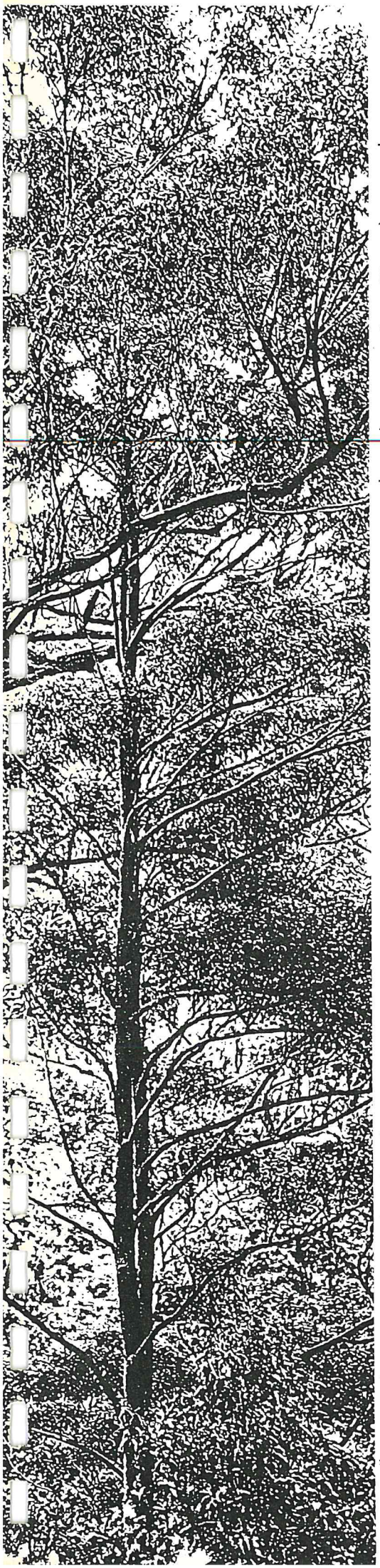


Resource Assessment Commission Forest and Timber Inquiry Draft Report

Response by the Department of Conservation and Land Management

September 1991

RESPONSE TO THE DRAFT REPORT OF THE RESOURCE ASSESSMENT COMMISSION

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
WESTERN AUSTRALIA

INTRODUCTION

The Department of Conservation and Land Management (CALM) has reviewed the Resource Assessment Commission's (RAC) Draft Report, Volumes 1 and 2, on the Forest and Timber Inquiry. Given the status of the RAC, and the importance of the issues at stake, it was reasonable to expect an authoritative statement of the situation in respect of forest management in Australia. This has not been the case.

The Draft Report is a negative, unscientific and superficial treatment of this very complex matter. Both volumes contain many errors of fact and misinterpretations of available information. Delayed publication of Draft Volume 2 and several consultant reports has caused considerable difficulty in reviewing the Draft. It is most disappointing that the Commission failed to recognise regional differences, failed to acknowledge the major changes in recent years in forest management in Australia, and apparently failed to utilise a large amount of published material given to them by CALM staff on a field trip to Western Australia and at the public hearing in Perth.

This response first identifies several major issues of concern to CALM from the Draft Report and examines them in detail. Finally, a detailed review of the Draft Report, Volumes 1 and 2 is undertaken to point out errors of fact and interpretation.

A matter of great concern to CALM is the lack of forestry expertise in RAC for an inquiry of this nature. It was pointed out to RAC staff on their field trip to Western Australia that this was a severe deficiency for this inquiry. The poor quality of the Draft has shown that this concern was well placed. This is a matter to which the Commissioners should give deep consideration for future work. It is inevitable that the subjects of RAC inquiries are complex matters. Complex matters require experienced and professional study. We would suggest that any future Inquiry should be required to include a person with professional qualifications and long experience in the area of study as one of the Commissioners.

The publication of Volume 1 of the Draft was accompanied by several highly inflammatory press releases which bore little relation to the content, or very deliberately played up minor aspects of the report in order to place forest managing agencies in a bad light. Forest management agencies have been severely damaged in the public eye by these actions, and some public recognition of this by the Commissioner would be appropriate.

Notwithstanding the adverse comments above, CALM acknowledges that the Commissioners and RAC staff have been most cooperative since the release of the Draft. There has been most constructive interaction in connection with the development of the INFORM simulation model.

MAJOR ISSUES OF CONCERN TO CALM

1. FOREST CONSERVATION RESERVE SYSTEM IN WESTERN AUSTRALIA

The conservation reserve system is a fundamental element of the nature conservation strategy developed for Western Australia's forests. The present system has evolved over a number of years on the basis of biological surveys, ecological research and extensive practical knowledge of the South-West forests.

Information about the reserve system presented in the Draft Report is superficial and misleading. In particular, CALM is concerned by the following two assertions made by the Inquiry:

- that "only 19% (455 000 ha) of South-West forests are contained in conservation reserves." (Vol. 1, Table 3.5);

- that "In the absence of quantitative information, it is difficult to assess the extent to which the present reserve system in Western Australia is actually representative of all forest communities and species, particularly in relation to understorey plant species and forest fauna." (Vol. 2, Para. G.64).

These two important issues are addressed in the following sections.

1.1 Extent of the reserve system

The conservation reserve estate in Western Australia comprises the following categories of land:

- Nature Reserves - set aside for the preservation of flora and fauna and for scientific study. No logging or other production-related activity, and only limited recreation is permitted.

- National Park - areas of national and international significance, set aside for recreation as well as preservation of wildlife or notable scenery. No logging is allowed.

- Conservation Park - an area of forest or other land set aside for similar purposes as national park but having regional or local rather than national significance. No logging is allowed.

- A small additional component included in other reserve tenures, primarily in the Northern Forest Region.

Since the preparation of the submission to the RAC Inquiry in May 1990 the Western Australian Parliament has passed amendments to the CALM Act necessary for the gazettal of conservation parks.

Major additions to the reserve system were proposed in the Management Plans for the Northern, Central and Southern Forest Regions which were endorsed by the Western Australian Government in 1987.

Under these proposals the area within the conservation reserve tenures will be:

Nature Reserve	161 700 ha
National Park	328 000 ha
Conservation Park	206 900 ha
Other reserves	14 400 ha
Total	711 000 ha

Taken on a percentage basis, land in conservation reserve tenure (711 000 ha) represents 29% of the total CALM forest estate (2 449 900 ha) in the Northern, Central and Southern Forest Regions.

The Draft RAC Report presents a figure of 455 000 ha for the extent of tenured forest conservation reserve in Western Australia (Table 3.4 on P. 144); this should in fact be 457 000 ha based on data supplied to the Forest Resource Survey by CALM. In arriving at this figure the RAC have only considered the net tree covered portion of conservation reserves. Important parts of the forest such as wetlands, riparian zones, and monadnocks were excluded. The figure of 19% of forest reserved in conservation tenures represents the net forested area of conservation reserves (455 000 ha) as a proportion of the net tree covered area of publicly owned (1 898 000 ha) and privately owned (507 000 ha) forests (total 2 405 000 ha).

Forest ecosystems in the South-West consist of a diverse mosaic of communities including open forests, woodlands, shrublands, wetlands, and enclaves associated with riparian zones and rock outcrops. Although lacking the height of tall forests of jarrah or karri, these other communities are in fact of particular significance in view of their high biological richness and specialised environmental characteristics. Such areas also tend to be of importance for the conservation of some rare or restricted species of flora and fauna. For example, the vegetation classification developed for the Walpole-Nornalup National Park (Wardell-Johnson *et al.* 1989) recognised 12 community types on the basis of species representation, of which only 3 were predominantly forested. In the Northern Jarrah Forest only 6 of the 24 vegetation complexes mapped by Heddle *et al.* 1980 were exclusively forest formations.

There is therefore no ecological justification for considering only the net forested area in the assessment of the extent of conservation reserves.

Furthermore, the Draft Report is highly inconsistent in its interpretation and use of the term 'forest', particularly with respect to assessing the possibility of species being adversely affected by management activities such as timber harvesting and silvicultural treatment. For example the list of "threatened plant species in Australian forest environments" (P. N12 of Appendix 2) adapted from Leigh *et al.* 1984 includes a number of species from the Wheatbelt and transitional woodland zones of Western Australia e.g. *Darwinea carnea*, *Adenanthos ileticos*, *Eremophila inflata* which in some cases occur many hundreds of kilometres from the nearest commercial forest operations.

Finally, it is not reasonable to include privately owned forest in the discussion about adequacy of the reserve system developed by the agency. CALM has little opportunity to reserve private land.

1.2 Representativeness of the present reserve system

Systematic reservation of forest areas specifically for the conservation of flora and fauna values commenced in the early 1970's, and the need for additional reserves has been reviewed periodically in the light of improved information and changing perceptions as to the requirements for adequate forest conservation. This process continues up to the present day.

The development of the reserve system has been well documented in both scientific (Havel 1989, Christensen in press) and popular formats (White 1977, Heddle *et al.* 1980, White & Underwood 1989).

The adequacy of the reserve system in the northern forests has been thoroughly reviewed by Havel (1989). Quantitative analysis was undertaken at the level of the vegetation complex which is the highest level of complexity at which the vegetation of the region is mapped. Vegetation complexes were rated according to level of representation in conservation reserves. To quote from Havel's work:

"The situation can be broadly summed up by saying that the adequacy of reservation is inversely proportional to the suitability for conversion to agriculture. This reflects the historical trend, in that alienation for agriculture preceded both conservation and forestry, reducing the scope for subsequent reservation. Within the forested landscape, the adequacy of conservation is generally greater in the east than in the west of the region, and on the extreme and less productive parts of the landscape than on the more productive ones. In the local context, it fortunately also means that those vegetation complexes which are structurally and floristically most diverse are best provided for."

Havel (op. cit.) also commented qualitatively on the representation of individual site vegetation types in reserves, highlighting the fact that types in low topographic positions were particularly vulnerable to dieback infection. Conservation of individual plant species and vertebrate fauna were also reviewed.

A different methodology has been employed for evaluating the reserve system in the southern forests (Christensen in press) because landform and vegetation complex mapping for the region is not yet complete. Christensen (op. cit.) tabulated the presence/absence of plant associations within reserves and identified six associations considered to be poorly represented.

CALM appreciates the need to consider other ecosystem components, eg invertebrates, non-vascular plants in assessing reserve adequacy and has an extensive ongoing program of biological survey and research. Similarly, systematic evaluation of other environmental attributes including landscape and wilderness is being undertaken. However, in the meantime the best available information has been used for making land use decisions. Such an approach is consistent with procedure espoused by the Inquiry for dealing with uncertainty and standards of proof (Vol.1, P.10).

The issue of the development and adequacy of the forest conservation reserve system was addressed in the Western Australian Government submission, and discussed extensively with staff from the RAC during field visit to Western Australia and at the public hearings in Perth (see pages 2896 2897 of Transcripts from Perth Hearings of 14/09/90). Copies of documents describing the reserve system were provided to the Inquiry.

It is clear, therefore that the Inquiry was provided with substantial information on which the present reserve system could be assessed at the plant community level.

2. ENVIRONMENTAL IMPACTS OF FOREST MANAGEMENT PRACTICES

The issue of environmental impacts of current forest management practices is central to the debate over the future management of Australia's forests.

Two of the scenarios examined by the Inquiry in the Draft Report (no further logging of native forests, ACF strategy) are predicated on the assumption that irreversible damage to forest ecosystems is occurring as a result of current forest harvesting operations, and that there is insufficient impact minimisation.

Thorough assessment of information on current forest management practices is therefore of paramount importance in evaluating the validity of alternative scenarios.

Unfortunately the Inquiry has failed to undertake a comprehensive and objective assessment of current information. A considerable amount of relevant information has been overlooked in the Draft Report, and in some instances the information presented does not support the conclusions stated in the Overview or the body of the Report.

CALM therefore considers that the Draft Report does not provide a sound basis on which forest management can be assessed.

2.1 Assessment of evidence by the Inquiry

Throughout the Draft Report, the environmental impacts of forest management activities are generally portrayed in a negative fashion. This is evident in the emphasis on potential adverse impacts of forest harvesting on water quality, soil nutrition and structure, and on fauna. A negative perspective is particularly apparent in the Overview (Vol. 1, P.xliv-xlv) where potential adverse impacts are summarised without due acknowledgement of the existence, and current implementation of prescriptions designed to prevent deterioration in environmental values.

The negative tone of the Draft Report could lead readers to conclude that deterioration in environmental values was an inevitable consequence of forest management. In fact, there is substantial evidence to support the conclusion that well planned and conducted forest harvesting operations do not cause any significant decline in environment values. This evidence comes from studies undertaken by CSIRO, academic institutions and forest management agencies. Disturbance resulting from forest management practices is very often much more localised and less intense than that associated with the periodic natural disturbances of fire, storm and flood with which Australia's forests have evolved.

A second issue of concern in relation to the assessment of environmental impacts in the Draft Report is the repeated emphasis on the inadequacy of currently available information. The statement on P. 169 that "most studies have suffered from poor experimental design, including insufficient replication, unsuitable control sites, and changes in method during the course of the study" is a gross generalisation, and an affront to scientists whose work has been accepted for publication in national and international journals.

Discussion of potential environmental impacts in the Draft Report is deficient in several key respects:

- The review of available literature is not comprehensive and a number of key studies have been ignored; for example, the extensive forest nutrition and hydrology studies undertaken in Western Australia during the past decades. Without thoroughly reviewing the literature, the Draft Report cannot claim to have reached valid conclusions as to the adequacy of current information.

- The Draft Report has failed to critically distinguish between information from substantive primary sources (independently refereed scientific papers and reviews), and propositions espoused in submissions to the Inquiry which naturally enough reflect opinions held by individuals, organisations or government agencies. Statements of fact and interpretation should be referred to original source documents, rather than quoted second-hand by way of submissions.

- Undue reliance has been placed on documents which cannot be regarded as authoritative sources or reviews. In particular, frequent reference is made to the report prepared by Gruen *et al.* (1989) which examined three studies of the impact of forest harvesting on various groups of forest fauna. At most, the report by Gruen *et al.* gives a brief (2 page) opinion on the methodology and interpretation of results employed in these particular studies; unfortunately the report does not even fully cite the references for these studies. In view of the fact that the authors did not attempt a comprehensive review of forest fauna impact studies in Australian forests, or allow their own conclusions to be independently scrutinised, the Gruen report can hardly be regarded as authoritative. Furthermore, the conclusions of Gruen *et al.*, which related specifically to studies of impacts on forest fauna, are cited extensively throughout the Draft RAC Report as evidence of the inadequacy of current information on environmental values *per se*.

  There are in fact a considerable number of well designed studies which have already, or are currently providing comprehensive, quantitative information on the impacts of forest management on a range of environmental values. Subsequent paragraphs outline important contributions for Western Australian forests.

2.2 Environmental Impacts of Forest Management In Western Australia: A Brief Review

2.2.1 Soils And Nutrition

Timber harvesting and fire are the two principal disturbance factors which have potential to influence nutrient dynamics in Western Australian forests. These factors sometimes overlap where fire is employed to reduce accumulated fuels and promote favourable conditions for regeneration following harvesting.

Fire is a long established factor in the South-West forest environment, having been responsible for periodic disturbance over many thousands of years (for a pre-history of fire see Christensen & Abbott 1989). Fire regimes have varied considerably since the time of European settlement in response to prevailing social attitudes, management imperatives, levels of technical expertise and the degree of understanding of the role of fire in forest ecosystems (McCaw & Burrows 1989). Prescribed fire has been an important aspect of fire management since the 1960's, initially solely for fuel reduction, but increasingly for a broad range of management objectives.

In contrast, timber harvesting has been practised for little more than a century; during this period there have been profound changes in the harvesting methods employed, due to changes in technology, and to increased awareness of the need for environmental protection.

Nutrient dynamics have been studied in considerable detail in Western Australian forests. Hingston et. al. (1989) present a comprehensive review of nutrient cycling in the jarrah forest; relevant sections of the review examining fire and timber harvesting are quoted below:

Fire

- *"No evidence has yet been found showing that the current policy of periodic low-intensity burning has caused significant site deterioration in jarrah forest. Some loss of nutrient elements to the atmosphere will occur through volatilisation and ash transport during burning, but most of the ash is transferred to the soil....thus burning resulted in significant quantities of nutrients being redistributed from litter and above-ground vegetation to the soil."*

- *"However, evidence that the growth rates of jarrah on unburnt and prescribed burnt sites do not differ significantly over periods of 30 to 50 years (Abbott & Loneragan 1983) appears to support the contention that there is no long-term site deterioration due to low-intensity burning."*

Timber harvesting

- *"Past and current jarrah forest management involves removal of quantities of nutrients that are small when compared with the stores of readily extractable nutrients in the most common soils (Hingston et al. 1980). However as these soil stores are limited, more intensive harvesting may deplete them to levels low enough to cause an observable decline in site quality.*

Karri forest nutrient cycling has also been investigated in detail during the past decade with important papers published by Grove & Malajczuk (1985), O'Connell (1988) and O'Connell (1989). Work by O'Connell (1989) indicates a need to develop greater understanding of the dynamics of nitrogen in karri forest ecosystems, particularly in relation to recurrent fires.

Detailed prescriptions designed to prevent soil damage, erosion, and spread of dieback disease during roading and harvesting operations are provided in the CALM Manual of Logging Specifications. These prescriptions are enforced routinely in the field during all operations by trained forest officers.

2.2.2 Water

The hydrology of forested catchments in south-western Australia has been extensively studied, in recognition of the important role of forests in preventing the discharge of saline groundwater.

Disturbance associated with logging and fire has the potential to alter hydrological characteristics because of the temporary reduction in vegetation density. In the northern jarrah forest the presence of severe dieback infection in some catchments, and surface mining for bauxite are further important disturbance factors in the high rainfall western zone of the forest.

Studies in the southern forest have focussed on the possible impacts on water quality of the use of more intensive forest harvesting practises associated with woodchipping, specifically clearfelling of karri forest and more intensive selection logging of jarrah forest. Following a review of research conducted over the period 1975-1986 the Steering Committee for Research on Land Use and Water Supply (1987) concluded that:

- In the high and intermediate rainfall zones, logging operations have caused small and temporary increases in stream salinity and/or sediment concentration in many local streams but this presents no significant threat to regional water resources.

- Further refinement of logging practice is possible to moderate local transient effects on stream salinity and sediment concentration.

- With appropriate management, there is no significant stream salinity risk from heavy selection cutting in the low rainfall north-east sector of the Woodchip Licence Area.

The basis for these conclusions is detailed in a series of reports - Stoneman *et al.* (1988), Martin (1987), Borg *et al.* (1987a,b).

A comprehensive review of forest hydrology in the northern jarrah forest is provided by Schofield *et al.* (1989). The emphasis of research has been on catchment responses to bauxite mining (Loh *et al.* 1984) and dieback (Batini *et al.* 1980), with some preliminary investigation of streamflow responses to thinning (Stoneman 1986). Localised site hydrological characteristics have been found to be important in development and intensity of jarrah dieback disease (Shea *et al.* 1983).

2.2.3 Fauna

The forests of south-western Australia have particular significance in relation to the conservation of native fauna because of their remoteness from the forests of eastern Australia, the small proportion of forested land in the state, and the high degree of endemism evident amongst some groups. Furthermore, forest areas are now an essential refuge for a number of once widespread species which have contracted severely in range since the time of European settlement (Burbidge & McKenzie 1989); notable amongst these species are the Numbat (*Myrmecobius fasciatus*) and the chuditch (*Dasyurus geoffroii*). The extensive clearing of woodlands for agriculture in the adjacent wheatbelt zone, and the impact of feral predators have been strongly implicated in this decline.

Further important differences between the South-West forests and those of eastern Australia include the absence of arboreal mammals, and the trend towards greater mammal richness in the low rainfall, slow-growing forests at the eastern margin of the present forest estate (Christensen *et al.* 1985a).

Forest wildlife and habitat management have been studied extensively in Western Australia by CSIRO, tertiary institutions, the Western Australian Museum and by CALM and its predecessor organisations. This work has addressed a number of major themes including:

- The distribution of vertebrate fauna in South-West forests in relation to geographic and habitat factors (Christensen *et al.* 1985a).

- Bird community responses to disturbances associated with forest harvesting and fire (Wardell-Johnson 1984, 1985; Christensen *et al.* 1985b).

- The biology and habitat requirements of individual species (Christensen 1980, Wardell-Johnson 1986, Wardell-Johnson & Roberts 1991, Inions 1989).

- Development of wildlife management programs for vulnerable and endangered species (Serena *et al.* 1991).

Several recent publications have reviewed the current state of knowledge with regard to fauna in Western Australian forests. Nichols & Muir (1989) examined vertebrates in the jarrah forest and provided a general species list, a review of the impact of disturbance factors and a discussion of future management and conservation needs. Nichols & Muir (1989) concluded that "*given the present concern for rare species, the establishment of large reserves, and the fact that conservation is now considered in forest land use planning, the future for conservation of the jarrah forest vertebrates appears encouraging.*" Forest wildlife and habitat management in South-West forests has recently been reviewed by Wardell-Johnson and Nichols (1991) using the themes of biogeography, fauna and disturbance ecology. This review highlighted the large number of studies that have been undertaken, but also indicated the need for ongoing survey work, and the continued commitment to the development and implementation of management programmes for vulnerable flora and fauna.

CALM appreciates the need for continuing research into the impact of forest management practices on fauna, particularly as prescriptions for silvicultural treatment of regrowth forests evolve. Changes to forest harvesting practices associated with greater utilisation of residue wood, eg removal of logs for charcoal production have also required evaluation with regard to possible impacts on forest fauna; in these situations CALM has adopted a policy of seeking support for research from proponent industries.

Conclusion

CALM is committed to the principle of using the best available information as the basis for forest management. A substantial proportion of the department's resources are devoted to research, inventory and monitoring; close liaison is also maintained with other government agencies, CSIRO and tertiary institutions undertaking relevant work.

CALM believes that information currently available supports the contention that well-planned and conducted management operations, including timber harvesting, do not pose a threat to the functioning of forest ecosystems nor the survival of any species of flora or fauna in south-western Australia. The resilience of these forests is illustrated by the fact that areas logged in the early years of this century without the benefit of impact minimisation practices now regarded as routine have in fact been included in some national parks in recognition of their environmental value; with sensitive management there is every reason to believe that forest values can be maintained in perpetuity in multiple use forests.

Management practices will undoubtedly evolve in response to improved information, changing social and economic circumstances and emerging environmental issues.

3. SUSTAINED YIELD AND OVERCUTTING

3.1 Introduction

A major flaw in the Draft Report is the RAC's inadequate understanding of the concepts of sustained yield and the implication that forest services have irresponsibly permitted overcutting.

An important claim made by the RAC in the Draft Report is that it was unable to find any example of sustained yield of timber products in any managed forest in Australia. Much has been made of this claim in the initial press releases by the RAC and subsequently by environmental groups.

RAC did not at any time ask CALM if WA forests had achieved sustained yield. It is incomprehensible that such an important charge could be made without first checking that RAC staff, none of whom could be expected to understand the complexity of the concept, had got it right.

In Western Australia, the RAC is wrong. Its mistake is difficult to understand since the WA Government submission to the RAC (1990) specifically states that overall growth exceeds the level of harvest in the forest. Although this is an oversimplified notion of what constitutes sustained yield (see below), it conforms with the simple definition used by the RAC. The 1987 Timber Supply Strategy (CALM 1987) also presents data which show that the total increment exceeds yield. RAC was given a copy of the Strategy.

From Table 8 in the Strategy, the estimated total annual increment of the native hardwood forest available for timber production in 1987 is given as 1 620 000 m^3 and increasing, while the potential increment, once the forest has been restructured, is given as 2 750 000 m^3.

The planned total annual harvest of live timber from native hardwood forests in 1987 was 1 535 000 m^3 (Tables 14-17). This was planned to reduce to 1 451 000 m^3 in 1990.

3.2 Overcutting

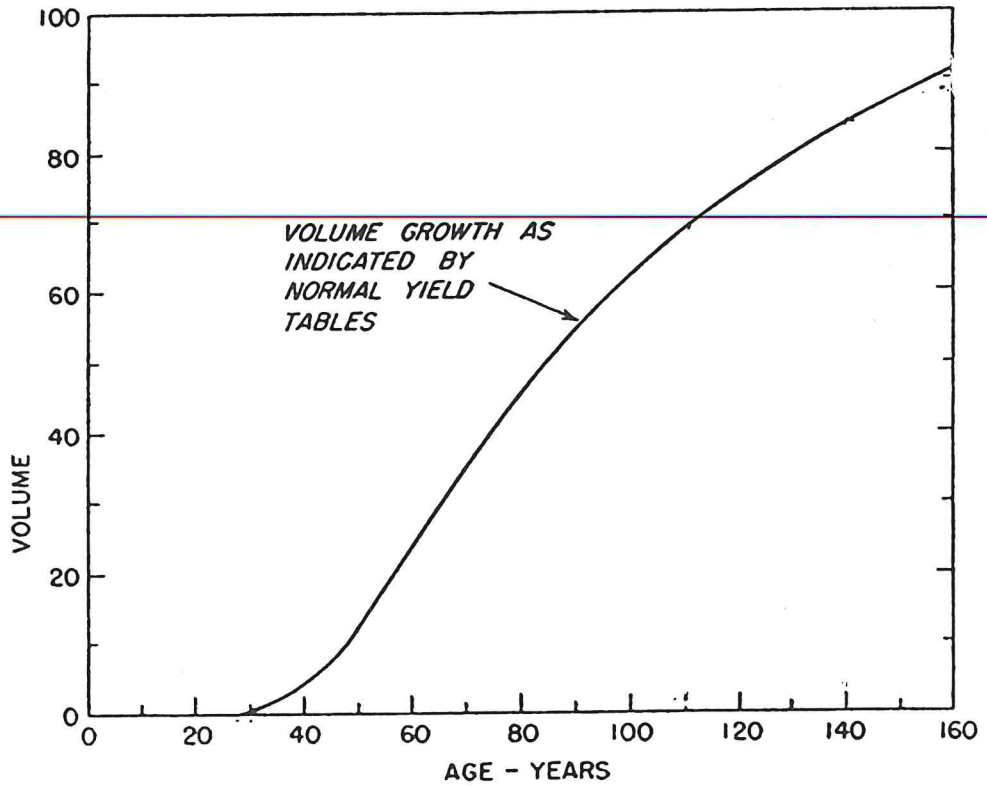
At a policy level it must be appreciated that the level of cut has always been set by State Government decisions. For example, after World War II there was a significant hardwood sawmilling industry in Western Australia based on the private property timber resource. As this resource became depleted about 1960, Government policy was that no sawmill would close for lack of resource and the Forests Department of the day was compelled to absorb all those mills on to State forest.

Any State forest managing agency has to work within the constraints set by Government in this way to try to restructure the forest estate to provide for expected timber requirements, while not compromising other forest values unduly. In Western Australia this need to provide timber resources led to a vigorous State pine planting programme, again, within severe constraints set by Government policy. Restrictions on purchase of cleared land meant that most of the pine plantations in this State were established on publicly owned land.

The theoretical explanation of overcutting is as follows:

A crucial factor in evaluating the growth potential of a forest is its age class distribution. If we take the case of a virgin, mature forest, its net growth is zero. Growth is balanced, regionally, by death when averaged over time. Clearly, there will be periods when the forest as a whole is in an aggrading state following a large scale disaster, but the usual situation is of a system in which gains are balanced by losses. Some areas will be actively aggrading and some will be degrading.

Suppose that harvesting commences and each year 1% of the forest area is cutover and regenerated. That first 1% will commence to grow, but as all forests have a sigmoid growth curve (see figure below), especially in respect of large sized logs, increment is slow at first. Each year a further 1% is cutover and commences to put on increment in the same way. However, the forest is technically being overcut since harvest greatly exceeds growth of merchantable logs.



After 50 years 50% of the forest will have been cut over, but it will not have achieved 50% of its potential maximum growth rate due to the sigmoid growth curve effect. There is a lag period which is determined by the species concerned. It would be quite possible that after 50 years of cutting there would be no trees at all which had achieved merchantable size. Even after 100% of the forest area has been cut over and there is a balanced series of age classes, the lag period will still apply. Therefore, it always takes at least a full rotation to achieve the maximum possible level of sustained yield.

In simple terms it could be argued that the forest was being severely overcut for the majority of the first rotation. By year 60 the first year's cutting area might move into the merchantable size class, and every year after that another cohort will join it, with the result that the apparent growth rate, in terms of merchantable timber, will rapidly increase.

On the other hand, if we look at the position from the viewpoint of total volume growth, the level of harvest might have been greater for the first 30 years, but by 30 years into the cutting cycle the total volume growth (all in sub-merchantable sizes) might exceed the level of harvest. Thus technically the forest had been overcut for 30 years, but after that it would have technically been "undercut", in terms of total volume. The period of overcutting has not in any way harmed the potential of the forest to achieve the maximum possible level of sustained yield, and was, in fact, a necessary phase which the forest had to pass through in being brought under management.

Overcutting in the sense described here, and used as part of a deliberate plan for the restructuring of the forest, is not a matter for concern at all. One cannot make any statement whether cutting is really in excess of the capacity of the forest to sustain it in the long term without access to detailed information about age class distribution, spatial variation in age classes and growth rate in those classes. Where there is a mixture of species and great variation in site quality involved the picture becomes even more complex.

3.3 The Principles of Sustained Yield

The concept of sustained yield management is built on the philosophy that "each generation should sustain its resources and hand them on undiminished to the next generation". The best known and the best developed expression of this is the sustained yield of wood products. But it is not and should not be confined to that alone. In the US sustained yield has a specific definition that includes other values. The Multiple Use Sustained Yield Act of 1960 says "*sustained yield of the several products and services means the achievement and maintenance in perpetuity of high level annual or regular periodic output of the various renewable resources without impairment of the productivity of the land*". In other words, there should be an undiminished flow of goods and services from the forest forever. It has an intuitive appeal as a general principle, but as with so many principles, there are complex problems in its implementation. Not the least of these is the differences that derive from the meaning and the intention of words such as "undiminished" and "forever" in the context of sustained yield.

Before considering the question of the sustained yield of all the values of the forest it is appropriate to look at the apparently simpler principle of sustained yield of wood products.

3.3.1 Sustained Yield of Wood Products

The growth of a forest stand varies according to a number of factors but the most significant is its age. Growth begins slowly, reaches a maximum at about the end of the immature phase of development and then begins to decline. The annual growth on the forest is made up of the sum of the growth on each of the individual age classes. If the area of each age class in the forest is unequal, as it usually is, then it follows that the growth on the whole forest will vary from year to year. There is then a contradiction; if the harvest were to match the growth then the harvest will not be consistent or sustained in the strictest sense. Conversely if the harvest is sustained (or consistent over a long period) then the harvest in any one year may be more or less than the forest growth.

This problem is overcome with the "normal" forest. This is not a normal forest in the sense of being typical but it is the name given to a forest with an equal representation of age classes, from zero to its rotation age. Such a forest, under idealised and stable conditions, would have a growth rate that was consistent from year to year; and thereby allow for a consistent and sustained annual yield that matched the annual growth and the long-term sustained yield. To achieve this idealised condition while starting with a forest with a different age structure, requires the deliberate variation in the annual harvest during the whole time it takes to create such a forest; at least one full rotation. There is therefore no such thing as the sustained yield until a "normal" forest structure has been achieved - there must be several different levels of yield if the "normal" forest is to be achieved in the long run.

The achievement of sustained yield is a long process even in a totally stable environment. Where the products required from the forest change over time, where natural disasters affect the forest resource and when even the area of forest varies dramatically then the ultimate level of the sustained yield will also change; and the current harvest must be varied to accommodate the changing circumstances. The pursuit of a constant level of yield (forever), in the absence of a total stability and suitable age structure in the forest, is technically impossible.

There are a number of other factors and qualifications that must also be considered in determining the yield. These are discussed below.

3.3.2 Sustaining What?

There are a variety of wood products from the forest that could be considered for sustention. If only pulp wood is to be grown then the harvest that could be sustained would be fairly similar to yield of the total volume. If, however, the product to be sustained is conventional large-sized sawlogs, then the yield will be much less than the total yield. This is because the volume that has the size and quality to meet the standards of a sawlog account for only about half the total volume that will grow throughout the life of the stand. Furthermore, the relationship between stand age and the growth rate of these larger products is very different to that for small size products. Early in the life of the stand there is no volume of sawlogs even though the total growth may be reaching a maximum rate. This is because all the trees are small. As the stand ages a growing proportion of the growth is in sawlogs. The more demanding are the characteristics of these products, the more important it is to have an age class distribution in the forest that is closer to the "normal" forest so that the flow of these products is more constant. If the age distribution in the forest is not appropriate, it is quite possible that while the harvest may be well below the total growth it can exceed the growth of these larger products and create a shortage in the future.

In calculating the growth it is therefore necessary to determine not only the total growth but also the growth of different size and quality classes. This is complicated further by the fact that the quality of the trees grown in the future will be different to that in the virgin forest. Furthermore, when estimating the growth of these products many years into the future it must be recognised that the standards of acceptable size and quality will change, and along with it the growth of the various products and their potential yield. Constant adjustment to the expected yield is required.

3.3.3 Geographical Scale

Yield can be regulated within any number of "boundaries". It might be local, regional, state or national. What is appropriate?

One of the original motivations for sustained yield was to provide for community stability at a local level. As society and transport changed so did the concept of "local" and the sustained yield unit is now seen to cover much larger areas than it did, of necessity, in the past. Governments may in fact wish to encourage larger, regional communities at the expense of smaller, less viable centres that may have once been considered the centre of a sustained yield unit. In WA, regulation of the total sawlog resource on a state basis was the practice for many years. There was no separate control of the harvest of hardwood by species and there was a policy to amortise the hardwood over the period it took to be replaced by pine. While this philosophy may have been satisfactory from an industrial viewpoint it did little for social stability in rural areas and was unacceptable from the viewpoint of multiple use because while sustained total yield may have been achieved it could be applied with virtually no consideration of the resulting long-term structure of the forest.

Probably the most acceptable compromise is regional regulation on the basis of forest type, ie karri, jarrah and pine should be regulated separately and summed. It is industrially acceptable, it is based on the individual "growth factories", it partially satisfies rural stability and it is more suitable for sustaining ecological values.

3.3.4 A Hierarchy of Sustained Yield

There are several levels of Sustained Annual Yield SAY that can be considered:

- Sustaining total yield. For wood production the crudest stage in the hierarchy of sustained yield is the level of harvest which does not exceed the total growth, ie the sustained annual yield of total wood volume regardless of its age, size or quality.

- Sustained yield of size and quality classes (in effect the sustained annual yield of products such as particular sized sawlogs) over substantial periods of time, ie the level is sustained for lengthy periods (decades) but with periodic revision. There may be several levels of sustained yield within the one rotation or from rotation to rotation.

- Sustaining yield of size and quality classes over an entire rotation or longer. This degree of sophistication has never been achieved in forestry anywhere. It is an idealised concept that has provided a useful focus for sustainability. However it probably has little real relevance because it is only achievable with absolute stability for very long periods of all the factors which influence it.

The first of these is relatively easy to achieve but is only really relevant if the product to be sustained is pulpwood or a similar product. It will not necessarily sustain industries requiring a more demanding product nor will it necessarily sustain other forest values.

The second level is that which is most commonly aimed at. It provides the necessary resource to sustain particular industries over substantial periods of time but allows for the yield to be varied up or down to alter the distribution of the age classes in the forest, to accommodate changes to the resource base and the changing needs of society and industry. It nevertheless attracts criticism in some quarters because it is not unchanging and immutable.

The most sophisticated of these is probably never feasible and if it were it is almost certainly undesirable. It assumes that the decisions made now are the best and should be binding on future generations; that industry needs will never change; that the area of forest on which the yield is based should never change; and that economic and community stability is based upon the unchanging supply of raw materials. None of these assumptions is true. If decisions of the past were to be held as sacrosanct then it would not have been possible to have converted substantial proportions of the forest to reserves because of the negative effect that it would have on the sustained yield. Ironically some of the strongest proponents of unchanging yield are also the proponents of dramatic changes to the resource base upon which it is derived.

However it is equally clear that a laissez faire approach to yield will not ensure stability or sustainability. How do we provide for essential variation and ensure that it is sustainable to the best of our knowledge? There are a variety of ways to calculate what the future yield could be.

3.3.5 The Calculation of Yield

Growth as a basis of control

There are various ways of using growth as a means of determining yield. Growth is an essential tool to predict future stand volume; as such it is an important tool in the calculation of yield. But it is sometimes used in its own right by assuming that growth (or increment) and yield are the same thing and therefore if the cut is equal to the growth then SAY has been achieved. This is flawed in two ways.

- growth does not equal yield except under very specific conditions;

- growth on the forest is not consistent except under certain critical conditions.

Mean Annual Increment (MAI)[1] is sometimes advocated as a measure of forest yield. Unfortunately its apparent simplicity far exceeds its utility. This is because:

- MAI is not a single figure and varies throughout the life of the stand. Indeed it has no meaning whatever without a specified rotation length.
- MAI varies according to whether it is the MAI of cellulose, certain size classes or product (ie size and quality). The relationships between these are not consistent but vary with rotation length.
- MAI also varies according to whether it is gross, nett or managed MAI. Managed MAI varies according to the management regime and may in more or less than nett yield.
- The MAI of a stand only equals yield if each of the above is specified and if stand age is rotation age. Growth only becomes yield when it has accumulated over the nominated rotation period. If there are no stands of that age, there is no yield.
- A forest is made up of several stands. There will only be consistent yield if all ages are represented (ie a "normal" forest).

MAI is never seriously used as a method of yield calculation.

Growing Stock Calculation

There are another group of methods sometimes used to calculate sustained yield. These are based on controlling the yield by removing a certain proportion of the growing stock each year. This is based on the assumption that the proportion calculated to be removed is the equivalent of the growth on the stand. The von Mantel formula (2*Standing Volume/Rotation) is probably the best known of these. Its initial appeal is simplicity because there is the implication that there is no need to know the growth. In effect, however, you do need to know growth in the form of predicted rotation length. The major failing of these methods is that it is based on the presumption of the "normal" forest. This method only provides a consistent yield if it is a "normal" forest.

There are various modifications of this and related methods designed to account for the conversion of forests dominated by old growth to the "normal" forest and which also incorporates increment (Austrian, Hanzlik, Meyer etc).

Area Control

Area control is sometimes suggested as a means of ensuring sustained yield. It does not really qualify as yield control but is really a method of cutting control. It is based on controlling the annual area cutover. It is usually based on the logging and regeneration of 1/R ha each year. Unless the forest already has an even distribution of age classes, this method will result in a wide fluctuation of the annual yield of different products (but not necessarily in total yield of cellulose). It will not be a sustained yield at least until the second rotation. Depending on the age distribution at the time when this method is instituted it may also result in too much or too little area being cut in the conversion period even to achieve the "normal forest" in the next rotation.

Simulation Methods

There are a number of other techniques for calculating the yield that are based on the prediction of future stand volumes (and by summation, future forest volumes) if they are managed in certain ways. They include the use of yield tables, recruitment methods or a range of sophisticated modelling techniques. The method itself does not aim to produce a

---

[1]Nett MAI is the sum of the existing standing volume of all the trees in the stand divided by the current age. Gross MAI includes the previously harvested yield as well as the previous mortality. It may be calculated for total volume or for various products.

sustained yield but merely predicts the yield that would result from certain management regimes. The effect of various management regimes on future yields can then be determined and alterations made to achieve the most desirable outcome.

This approach shifts the emphasis from attempting to calculate a sustained yield as a fixed number which will never be achievable in the long term, to a consideration of a number of options for the future. Decisions can then be made as to whether the predicted levels of yields of various products are acceptable. They will not necessarily be perfectly consistent.

3.3.6 Sustaining Other Values

It is sometimes implied that forest that is managed for sustained yield of wood will also sustain other forest values. To a larger extent this is true, especially when wood production is in the form of large size trees, because to sustain their production requires long rotations. However as the capacity to use smaller trees increases and with the increasing economic pressures there is a trend towards shorter rotations. Rotations that will sustain wood production will not necessarily sustain other forest values.

There is a need to consider the stand structures, forest conditions and the rotation lengths that suit other values as well. In this respect, the concept of the "normal" forest is just as valid as it is for wood production. If the forest is to sustain any value (ie to be more or less unchanging over time) then there must be a continuous series of age classes in the forest that will progress through time; and as the oldest stands die off they will be replaced by the next younger stands. The most important variable is rotation length which for many values may need to be longer than is the optimum for wood production. However it is not essential that the rotation lengths be the same throughout the entire forest - it may be more appropriate to maintain a mixture of rotation lengths to achieve the optimum result. Indeed it will usually be essential to vary the rotation length of the first cycle to ultimately create a more stable forest structure.

Although it has rarely been done in Australia there is no reason why the "yield" of other values cannot be related to the age of the forest and projected over time in the same way as wood yield. By projecting the impact on the field of all forest values over time under various management options, the opportunity exists to select regimes that give the most acceptable yield of all values. None of these individual values will necessarily be produced at a constant, never changing level, but all values will be sustained to the level that is considered (by today's decision-makers) as being the most acceptable or desirable or achievable.

Sustained yield should not be seen as an unchanging and immutable figure that is maintained forever. Rather it should be seen as the predicted yield from the forest in the future that will best sustain the joint objectives of community, economic and environmental well-being. To determine that requires a prediction of the future yield of all the various values into the future under different management regimes. The best and most sustainable solution will not necessarily provide consistent yields of any of the individual products or values at all times.

4. MULTIPLE USE MANAGEMENT OF FORESTS

4.1 Introduction

Working towards sustained yield of timber products (within the social constraints set by State Governments) and development of practical multiple use management, have been the paradigm of post war forest management in all States and especially in Western Australia.

Multiple use as a management concept is a relatively recent phenomenon despite the fact that it has always occurred in the forests of Western Australia. Until the early 1960's the total demand on the forest was so low that multiple use did not have to be managed, but merely allowed to occur.

Sustaining the yield of a single resource in perpetuity was an acceptable approach when the forests were valued primarily for one or two values (eg, timber and water) but does not fit contemporary circumstances where forests are appreciated for an array of commodity and community values. This is because such an approach tends to lead to multiple use by adjacency, ie, the management of the forest for timber in one part, for recreation in another, for nature conservation in the reserve system, etc. Multiple use by adjacency has been found by experience to be very unsatisfactory, as it institutionalises single use management with associated pressure groups advocating primacy of a single resource and the preferential treatment of it over other uses, thus leading to inefficiency in resource allocation and management. It can also lead to severe adverse impact on some forest values.

CALM interprets multiple use as being more than just the institutionalisation of a variety of single users on adjacent areas of forest. True multiple use involves the integration of many values at the local scale, and over time.

CALM holds that integrated forest resource management is the logical outcome of this and prefers to use this term rather than multiple use because it:

- recognizes the interconnectedness of the system, ie , that the harvesting of a tree will affect wildlife habitat, groundwater levels and water yields;
- treats the forest as a single system;
- emphasises multiple use achievement simultaneously not just by adjacency;
- is efficient in terms of the resources used in management;
- makes most efficient use of the forest estate.

Integrated forest management recognises that the forest is a single biophysical system rather than an aggregation of useful products (wood, water, recreation, etc) and that the overriding objective for its management should be the maintenance of the forest ecosystem and its processes. Within this constraint the management objective will be the simultaneous production of several interdependent and useful products and services over a long time frame rather than the perpetuation of the physical supply of particular products (such as sawlogs) and services. The long time frame recognises that social perceptions of the utility of forest values are volatile, hence are likely to change markedly over time. Therefore, it is necessary that the capacity to provide the services and products from integrated resource management will be able to be sustained in perpetuity. The balance between the various services and products will vary from time to time.

4.2 Structure and Operation of Forest Agencies

The structure and administrative arrangements that apply to forestry agencies have a major influence on the implementation of integrated forest management.

The Inquiry has correctly recognised the need for forest services to be given clear mandates by Government in terms of their responsibilities for efficient wood production, efficient forest use, and the need to meet wider community objectives such as employment (Para. 5.272). The Inquiry has also acknowledged the steps already taken by forest agencies to place wood production on a more commercial footing, provide greater information on economic aspects of forest management, and identify the funding and cross-subsidisation of non-wood values of forests.

In this respect, forestry agencies are responding to contemporary trends in public sector management, in particular the trend towards greater financial accountability. Such developments have considerable implications for the structure of forestry agencies.

Possible future directions identified in the Draft Report are:

- to maintain multifunction agencies but strictly observe commercial principles for revenue-generating activities and cover the costs of non-commercial outputs through state and territory appropriations;

- to corporatise those parts of services engaged in commercial production and place them on a profit-maximising footing, and establish the non-commercial parts as separate agencies;

- to privatise commercially-oriented forest operations through a system of forest rights combined with codes of practice and other regulations, enforceable by agencies dedicated to the non-commercial aspects of forest management.

Clearly, the appropriateness of each of the scenarios outlined above will vary between states and territories according to the nature and extent of the forest estate and the key objectives of forest management, regional economic considerations, and existing agency arrangements.

In the case of Western Australia, the arguments are overwhelmingly in favour of retaining an integrated agency responsible for management of both wood and non-wood values of forests. As detailed in the Western Australian Government's initial submission to the Inquiry, the advantages of integration include:

- commonality of skills, experience and operational procedures required to undertake land management;

- efficiency in the provision of infrastructure and support facilities;

- avoidance of 'territorial imperatives' between government agencies competing for scarce resources.

CALM stands by its record of achievement as an integrated agency in fields as diverse as forest recreation, development of innovative wood utilisation technology, forest planning, wildlife research and management, and restructuring of the timber industry. This record clearly illustrates that a single agency can provide the range of skills, expertise and support necessary for effective integrated forest management.

At the same time, CALM has taken up the challenge of adopting a more commercially-oriented approach to wood production from both hardwood and softwood forests; important initiatives in this area include:

- implementation of a system of CPI-indexed target royalties for a range of wood products;

- introduction of a system of periodic timber auctions to gauge market prices;

- publication of a comprehensive Timber Strategy for Western Australia;

- adoption of target rates of return for both native forests and plantations;

- recognition of the need for improved accounting and financial reporting through program budgeting.

CALM firmly believes that arrangements already in place in Western Australia can ensure complementary and efficient management of forests for both wood-based and non-wood values.

5. SCENARIOS

5.1 Hardwood Plantations

Before addressing the scenarios and the method of assessing them used in the Draft, it is useful to make some comments about the issue of hardwood plantations, as they are a feature of several of the scenarios.

It is the general assumption in all scenarios in the Draft Report that the development of hardwood plantations is required to supplement or replace timber resources from native forests. It is CALM's position that:

- Additional hardwood (or softwood) plantations are not a feasible replacement for timber resources from native forests and there are no rational arguments that this should ever take place.

- Additional hardwood (or softwood) plantations are a supplementary source of timber products to that obtained from native forests.

- Australia needs a vastly increased tree plantation estate:

  - to assist agricultural land use to become more sustainable,
  - to provide wider environmental benefits, such as a reduction in stream salinity,
  - to develop a new cash crop for farmers to diversify and stabilise rural income,
  - to provide a large new, renewable, resource which will replace imports and enable development of new export markets.

Recent research, both in Western Australia and in Victoria, has shown that there is a positive interaction between tree crops and farming such that the first 20% of tree cover, if appropriately distributed, will cause no loss of agricultural production (Bartle, 1989). Such tree plantings would, however, have major beneficial environmental effects. These arise from the microclimate and complementary benefits of mixed tree and crop systems.

It is now quite clear that the major land management problems in Australia, in terms of sustainability, are in the agricultural lands. Taking as a whole the results of all the research undertaken around Australia in the last 30 years, it is a reasonable statement that the land and environmental degradation in forests is minor indeed, compared with that in farmland. There are no forest management problems which cannot be adequately handled by careful planning and control of field operations.

The most important motivation for Australia to expand wood production is to improve the productivity and sustainability of farmland, not to diminish impact on native forests. In achieving this goal, we have the potential to totally remove our reliance on overseas forests, and to become a large exporter of forest products.

This does not necessarily mean the establishment of large scale plantations and a total change in rural land use, with all the adverse community reaction that would cause. It can be achieved at minimal public expense by commercially driven private reforestation as part of better farmland management systems. But this will only happen if there is a clear and consistent national policy that there will be a continuing viable and competitive forest products industry in Australia.

CALM therefore urges the RAC to focus firmly on the problem of ensuring that future national forest policy has this objective and that any such programme has the necessary research and planning support. **It should be noted that the pine plantation programme, which it is now apparent is so important to Australia (and which was previously reviled by environmentalists), required many years of careful research before reliable techniques were developed. The same will apply to the proposed hardwood plantations.**

In the past, the establishment of large blocks of plantation, especially of pines, has attracted considerable community criticism. Apart from an antipathy to "exotic pines" (which was fostered by environmentalists), local government and rural communities saw the advance of plantations as causing depopulation of the countryside and consequent loss of services. While it may be argued that there was an inevitable process of land use adjustment going on, there is no doubt that the loss of rural services was real. In such a situation, the necessity for large block plantations needs careful review.

The alternative is a flexible system of reforestation on farms, preferably by the farmers themselves, along the lines of the various approaches being pioneered by CALM. These approaches range from plantation sharefarming agreements tailored to the particular farmer's needs to a timber-producing shelterbelt system. At present the funding is from Government sources, but there is no reason why external (even overseas) investors should not fund such schemes. In the medium term, there is every prospect that farmers will increasingly want to capture the total financial benefits by funding plantations entirely themselves. This also solves a major problem for State Governments - lack of funds for land purchase or for reforestation.

It is assumed (ACF scenario) that hardwood plantations for sawlogs will produce satisfactory products. The evidence so far is that this cannot be assumed for all species. We know little about matching tree species to site and we have very little information on the silvicultural practices which will be required. Utilisation of fast-grown hardwoods is in its infancy and a great deal of market development is necessary before such plantations can be deemed economically viable.

Furthermore, as in pine plantations, the production of sawlogs will mean the concomitant production of a large amount of pulpwood quality material, the utilisation of which will be crucial to the economic success of a hardwood plantation for sawlog production. Thus, it is necessary to plan and find markets for the very large quantity of pulpwood involved. In a very competitive commercial environment, it must be realised that markets will not be available to a supplier which has a track record of unreliability. ***It is most important that overseas buyers see that Australia has a clear and consistent national policy on forest product exports.***

In view of prospects that overseas funding could drive a large expansion of hardwood plantations for pulpwood production, it is also important that no unnecessary restrictions be placed on future use of any new resource.

5.2 Scenarios Used in the Draft Report

It is understandable that the RAC should seek to use a modelling approach to evaluate the impacts of several future options. The requirement to evaluate the ACF and FAFPIC options virtually made this essential.

Much has been said about the INFORM model and about the predictions it has made in the Draft. It only needs to be recorded here that the INFORM model was crude in the extreme and totally inadequate for the task. Since development and use of such models is the stock in trade of all forest managing agencies, it would have been more efficient if the RAC had approached an agency for assistance in developing a model of the type required.

The predictions of timber yield made by INFORM were highly subjective and based on preconceived notions of the pattern of future yield. The model failed utterly to take account of regional differences. It was used in a crude attempt to compare environmental impacts of the scenarios evaluated, using impact outcomes that were neither objective, scientifically based nor documented.

In view of the limitations of the INFORM model and the resultant scenario outcomes presented in the Draft Report, there is little to be gained from an exhaustive comparison of scenario outcomes.

5.3 Scenarios for the Final Report

CALM understands that INFORM is to be redeveloped to accommodate regional information and data on forest age class distribution, which will greatly improve its utility.

The most important question is which scenarios the RAC should examine in it final report as a way of evaluating national forest policy options. Apart from the ACF and FAFPIC scenarios, what other scenarios is it sensible to test? Although it is totally unrealistic, the "no logging in native forests" scenario should be used again to drive home the impossibility of that option.

The next scenario should be a combination of the current State forest management strategies. In most cases these have been arrived at after a long process of public debate and represent the direction the community as a whole wishes to take. This should be called the State Strategies scenario, not the demeaning "business as usual" scenario which implies there will be no change in the future.

Another scenario which should be evaluated is one which sets out to optimise the use of the timber resource. In this case, the possibilities are:

- Hardwood to be largely phased out of the building market altogether, except for a small proportion used for exposed beams and flooring.
- Good quality hardwood to be used for furniture, joinery, etc, mainly for export.
- Poor quality hardwood to be directed into pulp or other reconstituted material uses.
- The building market to be dominated by softwood.
- 20% of all farmland receiving greater than 750 mm rainfall to be reforested with either hardwoods or softwoods.

This scenario could be seen as one possible, and feasible goal for national forest policy.

CONCLUSION

The final report of the Resource Assessment Commission will be an important document. It is therefore vital that it be an objective and factually correct report which corrects the deficiencies outlined here in the Draft.

CALM believes that the Commission should avoid the temptation to be too prescriptive in its final report. The essential issues should be identified and general principles and options for national policies should be developed. A revised set of scenarios should be evaluated to gain insights into the possible implications of some of the options, but that is the extent of their usefulness. Given the lack of precision of any new version of INFORM which might be developed over the next few weeks, the outcome of the modelling exercise can only be indicative.

A particular case where a prescriptive approach should be avoided is the issue of conservation reserve system selection. It is understood that RAC has commissioned a special study of the representativeness of conservation reserves in Tasmania. In the absence of any clear consensus as to how such an evaluation should be undertaken, and taking account of the great differences in conditions between different regions, CALM believes that RAC should not attempt to prescribe how States should select their reserves.

It is sufficient to conclude that each State should have a representative, scientifically designed reserve system, for all significant ecosystem types (not just forests), amounting to a minimum of, say 10 percent of each type. The matter should be left to States to progress from there.

In line with the accepted division of roles of Commonwealth and State Governments, CALM believes the RAC should confine its deliberations to matters concerning what is to be done, not how things should be done. There should be agreed national policies, which have been developed by the Commonwealth and the States as partners. Unilateral imposition of Federal policies will achieve nothing but further controversy. Unilateral imposition of procedures for forest management, which ignore the real differences between regions, would be disastrous.

The final report is being developed at a time when there are other initiatives, such as the Ecologically Sustainable Development studies, resource security legislation and the proposed Intergovernmental Agreement on the Environment are also reaching finalisation. All could have some impact on the outcomes of the Forest and Timber Inquiry.

CALM urges the RAC to adopt a positive approach in its final report which will, inter alia:

* acknowledge that multiple use of native forests is the most efficient and practical use of Australia's limited forest resources,

* acknowledge that there are no significant threats to the maintenance of ecological processes in managed forests in Australia,

* acknowledge that forest managing agencies are working towards sustained yield of timber products,

* agree that there is no justification for excluding timber harvesting from native forests,

* promote the concept of large scale reforestation of farmland, as part of a farmer-based and commercially-driven plan to improve the sustainability of agricultural land use and to improve the economic stability of rural areas,

* advocate firm long term Commonwealth support for a viable, aggressive and forest products industry, based on a national forest estate managed to sustain all forest values.

The RAC has an opportunity to put forward a framework for constructive Commonwealth-State partnership in the management of Australia's forests. CALM hopes that its review of the Draft Report will assist the RAC to achieve that goal. It is also happy to provide further input to RAC deliberations, for example, in the development of the INFORM model.

REFERENCES

Abbott I & Loneragan (1983) Influence of fire on growth rate, mortality and butt damage in Mediterranean forest of Western Australia. *Forest Ecology and Management* **6**: 139-153.

Bartle, J R (1989) Eucalypt pulpwood: a potential new crop for farmers in the lower South West. In Trees - Everybody Profits. AIAS Occasional Paper 45: 41-50.

Batini F E, Black R E, Byrne J & Clifford P J (1980) An examination of the effects of changes in catchment conditions on water yield in the Wungong catchment, Western Australia. *Australian Forest Research* **10**: 29-38.

Borg H, Stoneman G L & Ward C G (1987a) Stream and groundwater response to logging and subsequent regeneration in the southern forests of Western Australia: results from four catchments. CALM Technical Report **16**.

Borg H, King P D & Loh I C (1987b) Stream and groundwater response to logging and subsequent regeneration in the southern forests of Western Australia: interim results from paired catchments. Western Australian Water Authority Report WH **34**.

Burbidge A A & McKenzie N L (1989) Patterns in the modern decline of Western Australia's vertebrate fauna: causes and conservation implications. *Biological Conservation* **50**: 143-98.

CALM (1987) Timber production in Western Australia: A Strategy to take WA's South West Forests into the 21st Century. Department of Conservation and Land Management, WA, pp. 83.

Christensen P E S (1980) The biology of *Bettongia penicillata* Gray, 1837 and *Macropus eugenii* (Desmarest 1817) in relation to fire. Western Australian Forests Department Bulletin **91**.

Christensen P (in press) The karri forest: its conservation significance and management. CALM.

Christensen P, Annels A, Liddelow G & Skinner P (1985a) Vertebrate fauna of the southern forests of Western Australia: a survey. Western Australian Forests Department Bulletin **94**.

Christensen P E S, Wardell-Johnson G & Kimber P C (1985b) Birds and fire in southwestern forests. In A Keast, H F Recher, H Ford & D A Saunders (eds.) *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management.* Surrey Beatty and Sons, Sydney. pp.291-99.

Christensen P & Abbott I (1989) Impact of fire in the eucalypt forest ecosystems of southern Western Australia: a critical review. *Australian Forestry* **52**: 103-121.

Government of Western Australia (1990) Submission to Resource Assessment Commission Inquiry into Forest and Timber Resources.

Grove T S & Malajczuk N (1985) Nutrient accumulation by trees and understorey shrubs in an age series of *Eucalyptus diversicolor* F. Muell. stands. *Forest Ecology and Management* **11**: 59-74.

Gruen F J, Leslie A J & Smith A P (1989) Inquiry into the proposed trial of the value adding utilisation system, Central and East Gippsland Forest Management Areas under the Environmental Effects Act. Ministry for Planning & Environment, Melbourne.

Havel J J (1989) Conservation in the northern jarrah forest. In B. Dell, J J Havel & N Malajczuk (eds.) *The jarrah forest: a complex mediterranean ecosystem.* Kluwer Academic, Dordrecht. pp. 379-400.

Heddle E M, Loneragan O W & Havel J J (1980) Vegetation complexes of the Darling System, Western Australia. In *Atlas of natural resources Darling System, Western Australia.* Dept. Cons. & Env. West. Aust. Perth. pp. 37-74

Hingston F J, Dimmock G M & Turton A G (1980/81) Nutrient distribution in a jarrah (*Eucalyptus marginata* Donn. ex Sm.) ecosystem in south-west Western Australia. *Forest Ecology and Management* **3**: 183-207.

Hingston F J, O'Connell A M & Grove T S (1989) Nutrient cycling in jarrah forest. In B Dell, J J Havel & N Malajczuk (eds.) *The jarrah forest: a complex mediterranean ecosystem.* Kluwer Academic, Dordrecht. pp.179-202.

Inions G B (1989) Effect of fire on the availability of hollows in trees used by the common bruhtail possum, *Trichosurus vulpecula* Kerr 1792 and the ringtail possum, *Pseudocheirus peregrinus* Boddaerts, 1785. *Australian Wildlife Research* **16**: 449-459.

Leigh J, Boden R & Briggs J (1984) Extinct and endangered plants of Australia. Macmillan, Melbourne.

Loh I C, Hookey G R & Barrett K L (1984) The effect of bauxite mining on the hydrology of the Darling Range, Western Australia. Engineering Division, Public Works Department, Western Australia, Report No. WRB **73**.

Martin M W (1987) Review of the effects of logging on ground water in the southern forests of Western Australia. Project Two: paired catchment study. Western Australian Department of Mines Geological Survey Record **87/6**.

McCaw W L & Burrows N D (1989) Fire management. In B Dell, J J Havel and N Malajczuk (eds.) *The jarrah forest: a complex mediterranean ecosystem.* Kluwer Academic, Dordrecht. pp. 317-334.

Nichols O G & Muir B (1989) Vertebrates of the jarrah forest. In B Dell, J J Havel and N Malajczuk (eds.) *The jarrah forest: a complex mediterranean ecosystem.* Kluwer Academic, Dordrecht. pp. 133-153.

O' Connell A M (1988) Nutrient dynamics in decomposing litter in karri (*Eucalyptus diversicolor* F. Muell.) forests of south-Western Australia. *Journal of Ecology* **76**: 1186-1203.

O' Connell A M (1989) Nutrient accumulation in and release from the litter of karri (*Eucalyptus diversicolor* F. Muell.) forests of south-western Australia. *Forest Ecology and Management* **26**: 95-111.

Schofield N J, Stoneman G L & Loh I C (1989) Hydrology of the jarrah forest. In B Dell, J J Havel and N Malajczuk (eds.) *The jarrah forest: a complex mediterranean ecosystem.* Kluwer Academic, Dordrecht. pp. 179-201.

Serena M, Soderquist T R & Morris K (1991) The Chuditch (*Dasyuris geoffroii).* CALM Western Australian Wildlife Management Program No. **7**.

Shea S R, Shearer B L, Tippet J T & Deegan P M (1983) Distribution, reproduction and movement of *Phytophthora cinnamomi* on sites highly conducive to jarrah dieback in south Western Australia. *Plant Disease* **67**: 970-973.

Steering Committee for Research on Land Use and Water Supply (1987) The impact of logging on the water resources of the southern forests, Western Australia. Water Authority of Western Australia Report WH **41**.

Stoneman G L (1986) Thinning a small jarrah forest catchment: streamflow and groundwater response after two years. Institute of Engineers of Australia Hydrology and Water Resources Symposium, Brisbane.

Stoneman G L, Rose P W & Borg H (1988) Recovery of forest density after intensive logging in the southern forest of Western Australia. CALM Technical Report **19**.

White B J (1977) Southern recreation and conservation management priority areas. Forest Focus **18**.

White B & Underwood R (1989) Conservation in the karri forest. Landscope **4** (2): 32-38.

Wardell-Johnson G W (1984) The effectiveness of a variable circular plot procedure for estimating bird density in the karri (*Eucalyptus diversicolor* F. Muell.) forest of south-western Australia. Proceedings ANZAAS Conference 1983. pp. 25-33.

Wardell-Johnson G W (1985) The composition and foraging ecology of a bird community in south western Australia. M. Sc. Thesis, Oxford University.

Wardell-Johnson G W (1986) The use of nest boxes by Mardos, *Antechinus flavipes leucogaster,* in regenerating karri forest in south western Australia. *Australian Wildlife Research* **13**: 407-17.

Wardell-Johnson G W, Inions G & Annels A (1989) A vegetation classification of the Walpole-Nornalup National Park, south-western Australia. *Forest Ecology and Management* **28**: 259-279.

Wardell-Johnson G W & Nichols O (1991) Forest wildlife and habitat management in south-western Australia: knowledge, research and direction. In D Lunney (ed.) *Conserving Australia's Forest Fauna.* Surrey-Beatty and Sons.

Wardell-Johnson G W & Roberts J D (1991) The survival status of the *Geocrinia rosea* (Anura: Myobatrachidae) complex in riparian corridors: biogeographical implications. In D A Saunders & R J Hobbs (eds.) *Nature Conservation 2: the role of Corridors.* Surrey-Beatty and Sons. pp. 167-75.