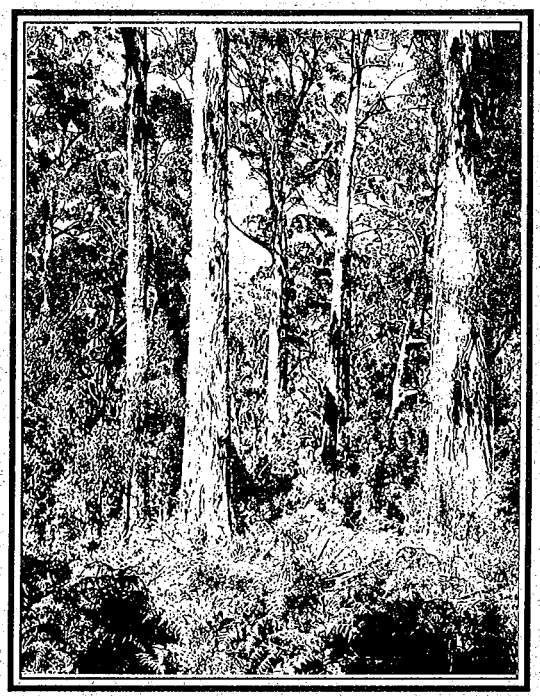
SUBMISSION TO RESOURCE ASSESSMENT COMMISSION

INQUIRY INTO FOREST AND TIMBER RESOURCES



By

THE GOVERNMENT OF WESTERN AUSTRALIA

May 1990

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SUMMARY

This submission to the Resource Assessment Commission from the Government of Western Australia provides an overview of the State's approach to the management of its forests. The present day management objectives and procedures are placed in their historical, economic and biological context. Detailed information on many of the aspects described will be found in the publications referred to in the text.

The publicly owned forests of Western Australia, on all land tenures, are professionally managed by a single agency for the integrated and sustained provision of the full range of forest values: nature conservation, timber and water production, recreation, mineral extraction and minor products, such as apiary and wildflower picking. The combination in one agency, of responsibility for control of "development" activities in the forest as well as responsibility for "conservation" of flora and fauna, has made it possible to plan and administer all forest activities in an integrated way, thus ensuring practical expression of the concept of sustainable development.

There is a small, but growing, involvement by private companies in growing trees on private land for the timber industry in Western Australia. A far larger area of native forest still exists on private land, but this is regarded as having a doubtful future, even where catchment protection legislation has prevented further clearing, due to lack of purposeful management.

The submission outlines the present condition and occurrence of the forests in Western Australia and describes their values and the demands made upon them. As the area of forest is inadequate to accommodate single use of appreciable areas for the whole spectrum of values, it has become important to practise multiple forest use where feasible. Multiple use does not mean all possible uses on every hectare all of the time. Rather, it is a judicious blend of compatible uses which may vary temporarily and spatially across the forest. A significant achievement resulting from this process has been the secure and representative reserve system which has been set in place.

The forests of south-west Western Australia have a long history of research and study, by the managing agency, by CSIRO and by tertiary institutions. They have been managed for 70 years by a well trained professional group who have made many notable technical advances.

A feature of this management is the development of long term integrated land and resource management plans. These plans were developed, with a high degree of public participation, to take account of all forest values, including national estate values. They have been approved by the State Government, accepted by all political parties in the State and have gained widespread community support as a reasonable balance of all competing uses of the forest. Within these overall plans, area management plans are developed for specific areas, such as national parks. Management policies are developed by an interdisciplinary executive group in the managing agency. Particular care is taken to protect rare and endangered flora, and some areas of forest are managed specifically to optimise the habitat requirements of important vertebrate fauna.

The forest-based industries are a very important regional factor in economic and employment stability. They are also viewed, in the case of the timber industry, as a tool for forest management.

In respect of the timber production capacity of the forest, the level of harvest is exceeded by the current increment of the forest, although much work remains to be done to achieve the balanced sequence of age classes which is required for maximum timber volume production in the long term.

Sustainability of the forest is not measured merely in terms of wood production. Great care has been taken in management policies and in-field operational procedures in Western Australia to ensure that all uses of the forest - for recreation, nature conservation, water production and minor forest products - are sustainable under appropriate criteria for each value.

The submission draws attention to a number of important issues for forestry in Western Australia. Foremost among these is a need to determine which agency (Federal and or State) has the right to decide on forest management plans in Western Australia. Other important issues are the management of forest on private land and the question of rural land use balance.

Finally, the submission outlines the long term objectives of forest management in Western Australia and lists the actions planned for the near future to progress toward these objectives.

1. INTRODUCTION

THE PART PLAYED BY FORESTS IN THE HISTORY AND ECONOMY OF WESTERN AUSTRALIA

For over 40,000 years Western Australian forests provided food and shelter for Aborigines. There was also some minor use of timber for implements and for ceremonial purposes. Aborigines regularly used fire in the forest (Hallam, 1975) and this process is believed to have had a marked influence on both flora and fauna.

Western Australia's forests have played an important part in the European history and economy of the State. In the early years of European settlement they were regarded as a "land bank" for eventual conversion to some form of agriculture, as agriculture was the dominant form of rural economic activity, at least in the public mind, until the sustained mineral resource boom which began in the early 1960's.

Forest products, mainly timber, have themselves been a very important component of the State economy. The utilisation of forest resources was for many years regarded by Governments as a method of "opening up the country". This attitude persisted until the late 1950's.

One of the earliest timber exports from Western Australia was sandalwood. Vast quantities of sandalwood have been harvested from what is now the Wheatbelt region and from the Goldfields of the State over the last 150 years. Sandalwood is still a very important export commodity, with a gross return to the State of about $10 million each year.

The main timber harvest of the State is, however, from the south-west part of the State. From about 1860, a number of concessions were granted to entrepreneurs to harvest the jarrah and karri forests in return for the construction of towns, railways and ports. Although reasonably successful in that respect, the concession system caused a great deal of forest degradation, as there were no effective controls over harvesting and no effective provisions for regeneration or protection of the forests. Following a public outcry over the condition of the forests, the Forests Act was passed in 1918, and the Forests Department was formed in 1919.

From the earliest days of settlement forests have played a valuable role in the protection of domestic water catchments.

FORESTRY LEGISLATION AND MANAGEMENT

The Forests Act was a strong piece of legislation, providing for a legally secure forest estate, powers for the control of the industry, which was seen as the main problem of the time, and having a very good goal setting mechanism through its requirement for the production of long term forest management plans. Although it made the Department self funding, the level of funding was inadequate (3/5 of revenue from log royalties) and progress in achieving professional management was slow until the Act was amended in 1953 to give the Department 9/10 of revenue. The achievements over the first 50 years of forestry were summarised by the Forests Department in 1969.

The first objective of the Forests Department was to reserve as State forest as much of the good quality forest as might be saved from agriculture and then defend it from the constant pressure for alienation. There were many bitter battles fought over the alienation of forest land for agriculture, right up until the 1960's.

Once the Department was relatively well staffed, in the 1960's, there were rapid advances in many areas of forest research, inventory, timber utilisation, fire protection and silviculture. In the early 1960's, however, two new and very difficult factors complicated forest management. The first was the realisation of the severity of the impact of jarrah dieback disease, caused by the fungus *Phytophthora cinnamomi*, and the other was the entry of a massive bauxite mining industry into the northern jarrah forest. These factors have greatly complicated forest management in Western Australia.

WILDLIFE AND RECREATION VALUES IN THE FOREST

Over this same period of time, the national park system in Western Australia developed slowly, with little focus on forested areas. Always under-resourced and with frequent changes in policy, the larger parks tended to be concentrated in the more remote parts of the State, with a number of smaller parks in the south west. Several were managed by local national park boards.

The State's wildlife management and nature reserve system tended to develop in the same way, similarly handicapped by lack of resources and by the fact that concern for nature conservation arrived too late in Western Australia to permit the reservation of significant areas in some of the most important areas of the State, such as the Wheatbelt. Nature conservation, did, however, have the benefit of a very powerful Act, the Wildlife Conservation Act of 1960, which provided the means for management of the State's flora and fauna, but not the funds. Although there were quite large areas set aside as nature reserves, mainly in the more remote parts of the State, there was very little on-ground management of them. However, the former Department of Fisheries and Wildlife did carry out excellent biological and biogeographical research, which has subsequently been used in management programs throughout the State.

With the passage of time, and the increasing realisation of the need for viable reserves of representative areas of all vegetation types, the Forests Department moved to provide those reserves from within State forest for the south-west part of the State. Reserves were set aside in a systematic way from the early 1970's, following a series of detailed ecological studies. The validity of these reserves in a scientific sense was confirmed by a number of subsequent inquiries, but did not satisfy concerns about the security of purpose of "reserves" which were still classified as State forest. The principal concern was that the purpose of the reserves could be changed by the Minister without reference to Parliament.

THE FORMATION OF CALM

The management of Western Australia's public lands was reviewed in 1984 and as a result, the Forests Department, the National Parks Authority and the Wildlife half of the Department of Fisheries and Wildlife were amalgamated in 1985 to form the Department of Conservation and Land Management (CALM), responsible for the management of state forests, national parks, nature reserves and marine reserves. The CALM Act provides more definite objectives for forest management than the Forests Act, and those which are relevant to the Commission's Inquiry are as follows:

> "Sect 56 (1) (a) in the case of indigenous State forest or timber reserves, to ensure the multiple use and sustained yield of that resource for the satisfaction of long term social and economic needs;
>
> (b) in the case of State forest or timber reserves planted with exotic species, to achieve the optimum yield consistent with the satisfaction of long term social and economic needs;

(c) in the case of national parks ..... fulfil so much of the demand for recreation by members of the public as is consistent with the proper maintenance and restoration of the natural environment, the protection of indigenous flora .....

(d) in the case of nature reserves ..... to maintain and restore the natural environment, care for, and promote the study of, indigenous flora and fauna ....."

Through the establishment of CALM, the Government has consciously set out to achieve an integrated approach to conservation (in the World Conservation Strategy sense of the word) of the natural resources of Western Australia. This is reflected both in the regional and district structures of the Department, where field managers are responsible for all land (or water) tenures and by the development of its policies by an interdisciplinary executive group. The executive group has the assistance of the statutory bodies, the National Parks and Nature Conservation Authority, the Lands and Forest Commission and the Forest Production Council, which provide for community input. CALM has a very clearly defined mission as set out in its Strategic Plan and is progressively developing regional land management plans which give effect to the requirements of the CALM Act.

In addition the Department of CALM has set up a comprehensive and multi-disciplinary research division, comprising research scientists and other staff. The Director of Research is a member of the Department's Corporate Executive.

CALM is a highly decentralised organisation with a regionalised structure. The 10 regions cover the whole of the State, managing a total of 17,600,386 ha of land and waters which includes every major ecosystem known to occur in Western Australia. Under the Wildlife Conservation Act it is also responsible for the protection of all flora and fauna in the State and its territorial waters. Thus CALM is responsible for marine animals such as dugongs, whales, turtles and dolphins, but not fish. Its powers in relation to the protection of declared rare and endangered flora and fauna extend onto private property as well as the land managed by CALM.

In relation to the forests of Western Australia, CALM has legal powers over matters affecting the tree component only on land managed by CALM. It has no powers over trees on private land, however it does have powers over rare and endangered flora and fauna in private forests.

THE FOREST MANAGEMENT PLANNING PROCESS IN WESTERN AUSTRALIA

The current management plans for the public forests of south-west Western Australia were developed by CALM and its controlling bodies (the National Parks and Nature Conservation Authority, the Lands and Forest Commission and the Forest Production Council) on the basis of Government policy and in a process which incorporated extensive public participation.

The plans were developed over an 18 month period and then released in draft form for public comment. Simultaneously a State Timber Strategy was developed. This covered every aspect of management of the timber industry. This Strategy was also released in draft form for public comment. A communications plan was also developed and implemented to ensure that all stakeholders were exposed to the draft plans.

The communications plan included a variety of communication initiatives, for example, the document "What Future for our Forests?" which was widely distributed with the draft plans. In addition, a video was produced and shown on TV, there were newspaper articles, a story in Landscope, public meetings at four centres, workshops with special

interest groups and meetings with shire councils. 435 letters were sent out to community groups and 90 briefings were given. Comments on every aspect of the plans were invited.

Over 4,000 responses were received. These included proformas from 30 organisations and 565 substantial submissions. Many supported the plans in their entirety, a few rejected them completely, most suggested a myriad of minor changes.

All responses were analysed and summarised. A summary of public submissions was written and published. The plans were then rewritten and resubmitted to the controlling bodies. The final plans were also reviewed by the State Environmental Protection Authority before being submitted by the Minister for Conservation and Land Management to State Cabinet.

The final forest management plans were unanimously endorsed by Cabinet and published. A new pamphlet entitled "Forests for Tomorrow - Your Decisions" was published and widely distributed.

THE ADVANTAGES OF INTEGRATED LAND MANAGEMENT

It is unlikely that the State Government could have developed successful forest management plans and a timber strategy in the absence of an integrated land management agency in Western Australia. The philosophy which underpinned the formation of CALM was that, regardless of the objectives of management of public land, the same skills are required. This is because the achievement of any management objective for an area of land or water is dependent on an understanding of the ecosystem and the way that the system must be managed to achieve the objective. Consequently, the same suite of skills are required to regenerate and harvest forests as to manage national parks and wildlife reserves for conservation. Similarly, the logistical support systems, skills and operational procedures to manage wildfires are the same as those required to rescue whales or to devise and implement strategic burning procedures in the desert to create habitat for rare mammals.

Because it is an integrated agency, CALM can tap into all these skills wherever it operates throughout the State, and in particular in its forest areas.

Where single agencies manage adjacent areas of land, considerable time and resources are wasted on those agencies defending their territories. An integrated agency automatically avoids the phenomenon of the "territorial imperative" which is even more intensely developed in the human species than in animals.

CALM's role in managing industries, such as timber production, wildflowers or kangaroos, does not conflict with its conservation role. This is because of two facts.

Firstly, the agency's role is to implement policies on behalf of the community of Western Australia via the Government of the day. CALM's principal method of ensuring that the management of land is carried out according to the requirements of the community is by the land management plan process. This process involves a statutory requirement for public participation and the plans themselves are submitted to the Minister of the day, not by the Department, but by either the Lands and Forest Commission or the National Parks and Nature Conservation Authority, which has a majority representation of members of the community.

Secondly, the industries with which CALM is concerned are based on renewable resources. Consequently, it is possible to manage them from a conservationist stance - ie, to practise true resource conservation on the ground - and to fully integrate this with the management of all other land values.

2. FOREST RESOURCES OF WESTERN AUSTRALIA

2.1 INTRODUCTION

Western Australia's forests occupy a relatively small portion of the State's vast area. The actual proportion varies according to the definition of forest used. The Annual Report of the Western Australian Woods and Forests Department for 1896-97 estimated that prior to European settlement some 8,621,800 ha or 3.4% of the total area of the State was covered by "timber species". Judging from maps such as that prepared by Beard (1981) a further 25 million ha was an open woodland. One of the distinctive features of this woodland is that it extended into very low rainfall regions in the Goldfields. Woodlands containing trees over 30 m in height were (and still are) to be found in the 250 mm rainfall zone.

The forests and woodlands were, as in the other parts of Australia, dominated by the genus *Eucalyptus*, except in the drier fringe of the woodland zone, where mulga (*Acacia*) is the dominant genus. In the Kimberley region there were savannah woodlands, again dominated by *Eucalyptus*, but with an admixture of other genera such as *Terminalia*, *Atalaya*, *Andersonia* etc. There are relatively small areas around the north coast of rainforest vine thicket.

The flora of the south-western botanical province of Western Australia, a somewhat larger region than the main forest zone being considered here, contains some 2500 species, about 68% of which are endemic (Marchant 1973). The dominant families in terms of biomass are the Myrtaceae, Proteacae and Leguminosae.

North of the Blackwood River and on the drier sites south of it, where the rainfall is less than 1150 mm, the common forest formation is high open dry sclerophyll forest of jarrah (*E. marginata*) and marri (*E. calophylla*) 25-40 m in height. Jarrah is nearly always the dominant species in the mixture, especially on the more harsh sites where it forms pure stands. In most jarrah forest there is a lower storey of sheoak (*Allocasuarina fraseri*) or Bull Banksia (*Banksia grandis)* and blackboy (*Xanthorrhoea*). Within this general area both these species are replaced on fertile lower slope sites by yarri (*E. patens*) and on poor swampy sites by bullich (*E. megacarpa*) and flooded gum (*E. rudis*), often accompanied by *Melaleuca* species.

South of the Blackwood River, where the rainfall exceeds 1150 mm, the better quality soils, which are red forest loams, carry fine pure stands of wet sclerophyll karri (*E. diversicolor*) forest 70-80 m in height. On less fertile yellow podsolic soils the karri grows in association with marri and on even poorer lateritic sands and gravels the forest becomes a jarrah-marri mixture. The karri forest is characterised by a much more dense and more mesophytic understorey. Along the south coast are found small areas of red tingle (*E. jacksoni*) and yellow tingle (*E. guilfoylei*) interspersed with woodlands of yate (*E. cornuta*) and peppermint (*Agonis flexuosa*). Tuart (*E. gomphocephala*) is found in a relatively narrow strip along the Swan coastal plain, reaching its best development at Ludlow, south of Bunbury. Other coastal plain tree species are peppermint and pricklebark (*E. todtiana*) and several species of *Banksia.*

The quality of the high forest declines from west to east as a consequence of declining rainfall. East of the 900 mm isohyet the vegetation of the broad valleys becomes an open woodland of wandoo (*E. wandoo*) and flooded gum, with jarrah and marri on the uplands. Further east still, the wandoo is found higher in the landscape and is joined by powderbark wandoo (*E. accedens*) on the ridges, while the slopes carry York gum (*E. loxophleba*) or brown mallet (*E. astringens*) and jam (*Acacia acuminata*). At this

point the forest grades into a woodland with a wider variety of species - *E. oleosa*, *E. flocktoniae*, *E. salubris*, *E. salmonophloia*, *E. dundasi* and several others, with intervening zones of mulga (*Acacia aneura*) woodland. It is in this area that sandalwood (*Santalum spicatum*) occurs.

2.2 VEGETATION CLASSIFICATION

The vegetation of Western Australia has been extensively studied and generalised maps of vegetation cover the whole State (Beard 1981). The rainforest areas in the north have recently been mapped using satellite remote sensing and have been intensively assessed under the Commonwealth rainforest conservation programme (McKenzie et al 1987). In the south-west there are structural vegetation maps prepared by Smith (1973, 1974) and maps of ecological associations by Heddle (1979). Virtually the entire CALM forest estate is covered by digital vegetation maps using these classifications.

The maps published by Heddle are derived from extensive synecological research by Havel (1975a, 1975b) who divided the vegetation of the northern jarrah forest into a number of site-vegetation types, based on groups of indicator species, using principal component analysis techniques. This work has recently been extended to the southern jarrah forest region by Strelein (1988) and to the karri forest by Wardell-Johnson et al (1989) , Inions (1990) and Inions et al (1990).

Although the techniques have been developed, the field mapping of site-vegetation types of the karri forest has not yet been completed. However, there are well known regional patterns (Bradshaw and Lush 1981) and variations with soil type.

The site-vegetation types identified by Havel are of profound significance for day to day forest management in the jarrah forest, as they are closely correlated with the susceptibility of the forest to development and intensification of dieback disease. Forest type maps are an integral part of planning procedures for any activity in the forest. They have also been used in the design of the original ecosystem reserve system in the jarrah forests

It should be noted this vegetation mapping has been carried out only on lands managed by CALM. There has been no effort to map or classify the natural vegetation which remains on private property, apart from some recent work by the Department of Agriculture in relation to the Remnant Vegetation Retention Scheme. This information is held in digital form by the Department of Agriculture.

2.3 THE FOREST AREA

A large part of the original forest and woodland area of Western Australia has been almost totally cleared of its natural vegetation for agricultural purposes. Up until the mid-1970's there was still intense pressure from agricultural interests for alienation of forest land for agriculture. In the high forest zone there is still a significant area of forest land in private ownership, but it is generally regarded as a vanishing resource, except in certain catchment areas where there is a moratorium on clearing to protect water quality and where there have been recent reforestation programmes on farms. The latter have been funded by the timber industry and by the State Government. The future of this forest on private land is a matter for concern, as there are no provisions for management to ensure that the forest cover is maintained in perpetuity, even though the hydrological benefits of the forest require it to be permanent.

There are about 2.5 million ha of publicly owned forest in the high forest zone in the south-west, held under a variety of land tenures, but all managed by the Department of Conservation and Land Management. Most of this is natural forest but about 65,000 ha is pine plantation. Of the 2.5 million ha about 381,000 ha is classed as very open areas, being rock, swamp or heath, cleared for public utilities or dams. The area classified as very open in the multiple use forest is 188 000 ha.

In addition to this area in the south-west, there are 59,000 ha of timber reserve in the Goldfields and a very large area, about 42 million ha, of pastoral lease covered by mulga and eucalypt woodland in which harvesting of sandalwood has taken place for 150 years.

2.4 FOREST PLANNING IN WESTERN AUSTRALIA

All publicly owned forests in the south-west of Western Australia are managed under State Government approved regional management plans developed with extensive public participation. The plans allocate forested land to nature reserve, national park, conservation park or to State forest. The functions of these different tenures are clearly spelt out in the governing CALM Act. The forests are managed professionally for the full range of forest values including water catchment protection, recreation, conservation of flora and fauna, timber production, honey production, wildflower production and maintenance of visual amenity. They are also required to accommodate large scale open cut mining for bauxite, gold, tin, coal and mineral sands, as well as the supply of gravel, sand and stone for road making and other constructional purposes.

Similar regional land management plans are under development for the South Coast Region, where a large part of the sharefarming tree planting takes place, and for the Goldfields Region. Both these regional plans are likely to recommend reservation of significant areas of forested land as either State forest, national park or nature reserve.

2.5 LAND TENURE AND PURPOSE IN WESTERN AUSTRALIAN FORESTS

The functions allocated to each land tenure are as follows:

Nature Reserve	-	set aside for the preservation of flora and fauna and for scientific study. No productive activity and only limited recreational use is permitted.
National Park	-	areas of national and international significance, set aside for recreation as well as preservation of wildlife or notable scenery.
State Forest	-	multiple use for water, wildflowers, timber, honey production, recreation, protection of scenery, flora and fauna conservation.
Timber Reserve	-	generally forested land in a "holding" condition pending a decision on status or alienation.
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.

* Note that this land classification requires an amendment to the CALM Act which is pending.

Under the CALM Act, State forest is vested in the Lands and Forests Commission, and both nature reserves and national parks are vested in the National Parks and Nature Conservation Authority.

In Western Australia the term vacant crown land is applied to land held by the Crown not alienated nor vested in any other body or authority.

The areas of native forest under each of the land tenures for which CALM has legislative responsibility ie, publicly owned land, are as follows:

TENURE	JARRAH	KARRI	WANDOO	OTHER	NON EUC	PINE
State forest+	1 266	121	59	40	190	65
National park	88	49	2	9	180	
Nature reserve	70	2	2	17	71	
Conservation park*	151	1	44	1	22	
TOTAL ('000 ha)	1 575	173	107	67	463#	65

\+ Includes timber reserves.

* As allocated under the 1987 Regional Management Plans, gazettal requires amendment of CALM Act.

\# About 20% of this area is land which carries trees but has not yet been classified for tree species.

2.6 FOREST-BASED INDUSTRIES

There is a long history of exploitation of Western Australia's forests. Timber cutting has been carried on in the jarrah forests since 1840 and in the karri forests since 1880. In former years much of the cutover forest was alienated for agriculture in accordance with the social pressures of the time. However, while some 95% of the woodland in the wheatbelt zone has been cleared for agriculture only about 50% of the forest in the rainfall zone above 700 mm has been lost. The remainder was set aside mainly as State forest under secure tenure which required approval of both Houses of State Parliament before alienation.

The arid zone eucalypt forests around Kalgoorlie have supported a very large wood using industry (larger than the present woodchip export operation in the south west) for the production of timber for the gold mines, firewood and (before the completion of the Mundaring-Kalgoorlie water pipeline) the distillation of saline water.

Despite this long period of exploitation, the forests remain highly productive and with their conservation values largely intact. This is a tribute to their powers of regeneration and (in the high forest zone) the careful management applied over the last 75 years. Their condition is so good that cutover and regenerated areas of forest, even those clearfelled in the past, are now keenly sought after for dedication as national park. Even the inland forests around Kalgoorlie have regenerated extremely well in that difficult environment.

A feature of eucalypt forests is the wide range of wood quality in the forest. This is partly a consequence of the growth habits of the eucalypts and partly due to the effects of past wildfire damage. There are also major differences between species in their timber quality and applicability for some purposes. For example, jarrah is very durable in the ground, but karri is not, being highly susceptible to termite attack. Marri suffers severely from gum pockets and "ring shakes" and has been very little used for sawtimber as a result.

In most mature eucalypt trees part of the interior of the stem is unusable due to rot or physical breakdown of the wood from growth stresses. There are also frequent gum veins or gum rings and rot pockets which degrade the wood, as does physical damage such as hollow butts or dry sides from fire. The large logs and hard timber require thick, heavy duty saws which produce a high proportion of wasted sawdust. The net result of these characteristics is a relatively poor recovery from sawmilling, compared with pines and a significant proportion of trees in a stand which are not economically usable for sawmilling. In the past, this has led to "high grading" of the forest by sawmillers and progressive decline in timber quality in the forest. In some areas, where jarrah was utilised but marri was not, the species balance has swung in favour of marri.

The current status of the timber industry is as follows:

(a) The sandalwood industry for export

Sandalwood is harvested from vacant crown land and pastoral leases over some 42 million ha of the interior of Western Australia. The industry is very tightly controlled and the harvest is regulated to about 2000 tonnes a year under a long term plan of management (CALM in press). The entire harvest is exported to Asia.

At the present time about 60% of the harvest is dead wood resulting from wildfires and drought over the last 10-15 years.

(b) Sawlog industry in jarrah and karri forests, and in exotic pine plantations, mainly for local and interstate consumption for housing, furniture and joinery

The current level of harvest from Crown land of jarrah sawlogs is 560,000 m^3 annually and that of karri 235,000 m^3. Because of its high degree of defect, only about 20,000 m^3 of marri is used for sawlogs. The cut of pine sawlogs is 120,000 m^3, but this rises rapidly to 420,000 m^3 at about the turn of the century. Under the long term plans set by CALM (1987a), the cut of both jarrah and karri will be progressively reduced as the supply of pine increases.

(c) Veneer industry based on pine, karri and jarrah, for both local and interstate use and export

This industry uses a relatively small volume of high grade timber, about 8,000 m^3 each year, but is likely to steadily expand.

(d) Hardwood residue pulpwood industry for export

This controversial industry has been in operation since 1975, and is licensed to export up to 750,000 tonnes a year of woodchips from karri and marri residues. The proportion of intake from different sources, such as mill waste, karri and marri sawlogs has changed significantly over the last 10 years. Initially there was a high proportion of karri logs, a reflection of a policy of delaying regeneration to save such material from burning to waste for some time before the commencement of the industry. Later the proportion of marri increased and in 1979, karri thinnings commenced and have assumed increasing importance (CALM 1989c, p. 51).

A proportion of the woodchip cut comes from private property. This has varied since 1975 from zero to 15.6%.

(e) Residue jarrah for charcoal for the production of high quality silicon metal for the overseas electronic industry

This is a very new industry which will use dead or moribund jarrah trees which have no other commercial use, green forest residue resulting from sawlog operations and sawmill residue. It provides a long sought residue-using market for the jarrah forest which will enable more efficient regeneration of jarrah and faster forest growth, as well as an improvement in the aesthetics of logged stands. Eventually, it is hoped this plant will accept small green logs from thinnings.

A State agreement guarantees a resource of 150,000 tonnes per year of jarrah to the industry. The company has prepared a submission for a second phase of the smelter and has requested that an additional 75,000 tonnes per year be supplied.

(f) Pine particleboard and medium density fibreboard plants for local, interstate and overseas export

The pine particleboard plant at Dardanup operates exclusively on the exotic softwood forest resource and is one of the largest such plants in the southern hemisphere. It is also highly efficient and innovative technologically. Work is in progress on the construction of a medium density fibreboard plant near Perth which will draw its resource from the *P. pinaster* plantations just north of the metropolitan area.

These processing plants, in addition to being value-adding activities, perform an invaluable function in forest management, as they use thinning material which is an inevitable by-product of the production of pine sawlogs. Thinning is required to accelerate the production of sawlog sized trees in the pine forests and reduce the risk of losses from drought.

The Dardanup particleboard plant has an annual intake of 250,000 m^3 of pine thinnings and sawmill residue. The planned initial intake of the medium density fibreboard plant is 20,000 m^3 rising to 60,000 m^3.

(g) A growing craftwood industry for the tourist trade

This market uses only a small quantity of timber, but it is a highly visible industry with relatively high returns. Turnover in 1990 is estimated to be about $5 million.

(h) Other timber products

In addition to these products, the forest also produces poles for the State Energy Commission. In former years, the SEC used large numbers of long jarrah poles for transmission lines, but there is an increasing trend toward the use of pressure treated karri, pine and marri poles, and compound timber/steel poles.

A wide range of fencing materials, such as posts, strainers and rails is produced from thinning of regrowth jarrah stands as well as from clearing State forest for bauxite mining. Over the last 20 years there has been a strong trend for the split jarrah fence post, the standby for the farmer for over 100 years, to be replaced by longer-lasting treated round pine posts from local pine forests.

There is also a minor market for bridge timbers for Main Roads Department and Shire Councils.

Firewood for rural and metropolitan areas is another important forest product, which has gained increasing attention over the last 10 years with the rising popularity of wood-burning slow combustion stoves. A large area of State forest adjacent to Perth is zoned so that all dead wood from the zone is allocated to either professional firewood cutters or for weekend wood "fossickers". The firewood demand is about 400,000 tonnes per year.

There is also a very wide range of reprocessing industries producing all types of furniture and joinery from local timbers. Jarrah, in particular, has a high reputation for its attractive grain and finish.

Direct employment in forest-based industries in Western Australia is estimated to be about 9,000, and indirect employment related to forest products is in excess of 20,000 (CALM 1987a). Details of the structure of the forest-based industries are also given in that publication.

The timber industry in Western Australia differs from that in other States in that its ownership is highly concentrated, three companies accounting for 90% of the timber harvest.

Most timber harvested in Western Australia is used locally, but there is an increasing concentration on value adding, particularly for jarrah furniture production which is exported interstate and overseas. The bulk of the particleboard is exported interstate or to south east Asia. All the sandalwood is exported to Asia, as is all the pulpwood.

There is a significant level of solid timber imports into Western Australia. In the main these are for further processing into veneer or furniture, but some is used during periods of high demand for house construction. As a generalisation, the level of imports more or less balances the level of export of solid timber products. Virtually all paper products are imported.

The sawmill industry was, until recently, characterised by high efficiency in the timber harvesting process but poor efficiency and backward technology in the timber processing phase. The latter was due largely to uncertainty about security of access to future resources. The Western Australian Government approved the regional management plans and a long term timber industry strategy in 1987. To give effect to the Timber Strategy the Government has entered into long term supply contracts with timber companies which give them security of the resource. Rapid progress and large investments - $200 million current or proposed (Shea, 1990) - have been made in modern sawmill technology. This has been assisted by an innovative CALM/industry timber utilisation research programme, funded jointly by industry, State and Commonwealth Governments.

A feature of forestry in Western Australia has been the use of long term management plans for the forests, backed up by clearly defined goals for the forests and the industries dependent on them. Initially, these plans were internal to the managing agency, but since 1977 they have been publicly available, and since 1987 have involved extensive, systematically organised public participation.

2.7 OTHER IMPORTANT FOREST VALUES

Although the forest-based industries are given prominence in this submission, that is so because of the apparent focus of the Resource Assessment Commission on that aspect. So far as the Western Australian Government is concerned, timber is just one of the values for which the forests are managed. The forests are prime recreational and tourism resource, contain the catchments for a large percentage of the State's harnessed water resources, contain a significant proportion of the State's unique flora and are an important habitat for native fauna. Nature conservation is one of the principal values of the forest. In addition, Western Australian forests provide substantial employment and economic stability in south-west towns.

2.7.1 Recreation and Tourism

There are heavy demands on Western Australian forests for forest-based recreation. Data from CALM's VISTAT programme indicate that the level of visitation to forested recreation sites for 1989/90 was approximately:

Northern Forest Region	.....	990,000 visitors
Central Forest Region	.....	498,000 visitors
Southern Forest Region	.....	267,000 visitors

The data include both tourist visits and day trips. It is likely that visitation to recreation sites in the northern region would fall mainly into the category of day trips, while visits to sites in the other two regions would be mainly of a tourism nature.

In the south, for example the Pemberton, Walpole and Manjimup areas, the forest environment has been a prime tourist attraction for 50 years, and has coexisted with a large timber industry.

Recreational use of the forest tends to be concentrated in particular areas, such as the Murray River in the Lane-Poole Reserve, the Four Aces near Manjimup and the Gloucester Tree (an old fire lookout), which alone receives about 100,000 visitors a year.

2.7.2 Water catchment protection

State forest contains the catchments of the Mundaring Dam, which provides water for the pipeline to the Goldfields region, for the Canning, Serpentine, South Dandalup, Stirling, and Harvey Dams, as well as the catchments for a large number of smaller town water supply schemes. It also provides a high proportion of the catchment of the Wellington Dam and plays a crucial part in maintaining a lower level of salinity than would be the case if the catchment were all under farming use.

Forested catchments provide about 65% of the public water supply for Perth, but their importance is far greater than that figure would indicate. Water from the forested catchments is of high quality, requiring only minimal treatment before use. Extra treatment that would be necessary if the high rainfall forest was converted to agricultural land would cost the Water Authority $450 million in present day values. There would also be increased risks of contaminants entering the water which would not be removed by treatment. If low rainfall forest was cleared and salinity increased, a further $400 million would be required for desalination in the future.

2.7.3 Nature Conservation

The forest ecosystems contain the full range of native flora described from them. On the publicly owned forests, there is no known case of a flora taxon extinction in spite of 150 years of use. There are two well-known areas of particular botanical interest: in the Whicher Range, near Busselton and the Sheepwash area, at the junction of the Hay and Mitchell Rivers, on the south coast. The former is proposed to become a nature reserve and the latter a national park under the 1987 regional management plans.

The situation is rather different in respect of native fauna. There are no forest-dependent mammals or birds in Western Australia, but the extent of agricultural clearing has meant that the forests have become an important refuge for some species which are now of restricted occurrence, such as the numbat, woylie and tammar. The last two were much more numerous in the forests in recent times but are believed to have suffered a decline due to predation from the European fox (Christensen 1980, Kinnear 1990) and to some degree the cat. The forest still contain 27 species of native mammal, 32 reptiles, 15 frogs and 12 native species of fish (as well as some introduced species).

The forests contain a rich bird fauna. Christensen et al (1985) recorded a total of 129 species in surveys in southern forests and listed a further 16 which were known to occur. Of the major vegetation types in the forested area, the richest assemblage of birds occur in the open forest, open woodland and low open woodland.

Compared with flora, vertebrate fauna and birds, research on invertebrates is far less advanced. This is true world-wide and is not simply a Western Australian forest problem.

In the context of fauna habitat, there is a great diversity of vegetation types in what we refer to as the forest area. Some of these types are more important than others for fauna. For example, in the karri forest zone, the flats and open areas contain a much greater diversity of fauna than the karri forest proper.

In a worldwide context Western Australian forests have a very high biodiversity. This is expressed principally in terms of the understorey flora; a very small number of tree species dominate the overstorey in South-West forests.

2.7.4 Landscape

Western Australian forests are an important part of the South-West landscape. The northern jarrah forest provides the backdrop to the city of Perth and the great beauty of the wandoo and karri forests provides sustained pleasure to people living or working in, or visiting forests for recreation.

3. DEMANDS ON WESTERN AUSTRALIAN FORESTS

The main demands on forests in Western Australia are in connection with timber production, water production, recreation, wildlife management and the preservation of representative samples of forest ecosystems.

3.1 NATURE CONSERVATION

The demand for wildlife management in forests varies according to the importance of the fauna or flora in a particular area and any threats to wildlife which may arise. In respect of fauna, there are no forest dependent animals in Western Australia, although some species, such as the woylie (*Bettongia penicillata*), the tammar and the numbat have had their former ranges so diminished by agricultural clearing that forests are now important to their survival. In these cases specific action must be taken in forests to ensure the correct habitat for them is maintained (Christensen 1980). Nature conservation requirements are clearly spelt out in regional and area management plans.

A great deal of research has been carried out on forest fauna ecology in Western Australia. This has focussed not only on the larger vertebrate fauna (Christensen et al 1985) but on the birds (eg, Abbott and van Heurck 1985), fish (Christensen 1982, Pusey 1981) and frogs (Roberts et al 1990, Wardell-Johnson and Roberts 1990). Only the invertebrate fauna is not well studied, as in all other ecosystems in Australia. There has been some research on invertebrates, mainly in relation to the biology of the leaf miner insect (Wallace 1970), the gum leaf skeletonizer (Abbott 1989), soil and litter fauna (Abbott 1984) and earthworms (Abbott 1985).

As CALM is responsible under the Wildlife Conservation Act for the protection of declared rare flora, it is able to ensure that all field activities are undertaken in such a way as to conserve any known occurrences of rare flora. In the three forest regions, for example, detailed manuals covering location and management prescriptions for all known rare flora in the region are held in regional and district offices. All operational planning takes this information into account in the preparation of job prescriptions. A copy of the CALM policy and management guidelines for conservation of endangered flora is attached.

3.2 TIMBER PRODUCTION

Western Australians have demanded timber from their forests since the first days of settlement. To a very large extent the early economic development of the State was tied to timber production.

Long term forest planning began in the 1920's. By the early 1930's a future deficiency of timber resources was foreseen. At the same time forest managers became concerned with improving the efficiency of timber use in the State. High quality timbers such as jarrah were at the time being used for fruit cases and sleepers instead of furniture. Further, the native eucalypt timbers are not ideal for many common uses such as house construction. A continuing problem with the utilisation of the timber resource was efficiency in use. Due to the high proportion of defect in logs coming from the native forests, it was economically possible for the industry to use only high grade material. A large amount of material was just wasted, with adverse effects on industry economics and on forest management. In effect, it was possible only to high grade the forest, so it became progressively degraded in a productive and structural sense.

The State began over 50 years ago to build up a softwood forest resource based on exotic conifers to supplement the native timber resource and replace it for some purposes. After a great deal of careful research, two species were used for large scale plantings: *Pinus radiata* on the more fertile and wetter soils in the lower south west and *P. pinaster* on the drier, more infertile soils on the coastal plain.

Following the results of the first complete inventory of the State forests in 1960, efforts were made to reduce the level of cut of the native forests and to accelerate the softwood forest establishment programme. A reduction in the level of cut was rendered impossible by the then Government's policy that no sawmill would be closed. At the same time pressure was put onto the industry to improve its utilisation of the resource. This pressure was largely nullified by inability of the industry to use low quality residue material and by economic circumstances of the time.

Another inventory completed in 1973 reinforced the need for all these initiatives and the 1977 Forests Department General Working Plan was made a public document to outline the Department's long term plan for a marked reduction in the hardwood cut and a further increase in pine planting. As part of this process the first real attempts at econometric analysis (Forests Department 1983) were made to establish the likely future requirements for forest products in Western Australia, and to explore options for fulfilling them. Extensive consultations also took place with forest-based industries to explain the need for reductions in sawlog allocations and to impress on the industry the need to adapt to the marked changes foreseen. Government support for a restructuring of the timber industry was also finally gained and significant reductions in the level of cut were commenced. The 1977 General Working Plan was notable for the formal setting aside of a significant proportion of the forest area as a scientifically designed ecosystem reserve system known as Management Priority Areas (MPAs) for conservation of flora, fauna and landscape and for recreation. In these areas timber cutting was either prohibited or subservient to other values.

In the mid-1970s the Department began to use economic analysis as a routine tool in the examination of investment alternatives, and in the evaluation of plantation silvicultural systems. This was expanded into econometric analysis of projections of State and regional timber requirements, as a basis for long term plantation programmes and the consequent budgeting requirements.

This process of resource projection and analysis was expanded and increased in sophistication for the 1982 General Working Plan, and, following the incorporation of the Forests Department into CALM, was further developed in the 1987 timber supply strategy and accompanying documents (CALM 1987a, 1987b, 1987c, 1987d, 1987e).

The timber supply strategy also represented a departure from previous practice in that a graded log royalty system was introduced, lower quality logs attracting a lower level of royalty in order to stimulate their use and high quality logs attracting a higher royalty to reflect their real market value. The differential in prices for different log grades has also been a significant factor in improving timber utilisation.

Target royalty levels were set by detailed economic analysis. The following table shows how royalty values have been increased since 1984, and the target royalty figures.

LOG GRADE	HARDWOOD ROYALTY 1984-85 *	1990	TARGET **
Jarrah Sawlogs			
Premium	-	73.20	78.80 + CPI
Grade 1	12.72	28.48	30.66 + CPI
Grade 2	12.92	18.27	19.00 + CPI
Grade 3	-	12.00	12.00 + CPI
Karri Sawlogs			
Premium	-	72.97	85.12 + CPI
Grade 1	11.76	34.00	38.50 + CPI
Grade 2	11.96	24.23	27.53 + CPI
Grade 3	-	12.00	12.00 + CPI
Woodchip Logs	3.15	10.29	15.00

* Weighted averages
** Target royalties will be achieved by 1 January 1992

The Timber Strategy comprehensively describes the anticipated future demands for forest products in Western Australia and outlines how the demand is proposed to be met. In essence this will be by a judicious mixture of careful husbanding of native forest resources and establishment of intensively managed plantation forests.

A profound change in timber use efficiency came about with the inception of a woodchip export industry in 1976. Since then there has been a progressive improvement in the utilisation of the resource to the extent that in the karri forest an additional 20 percent of timber volume has become available for sawlogs.

These forest management benefits really only applied to the karri and karri-marri forests. The jarrah forests, which have been cut for a far longer period of time and at a much greater level, are in a quite different condition. Regrowth jarrah forests are generally overstocked with small and medium sized regrowth trees to the extent that stand development is adversely affected. This comes about from the tendency of jarrah regrowth stands to "lock", ie, effectively to stagnate. As it is expensive to thin such stands to waste, and the loss of raw material would be prohibitive, some industrial use is required to permit these forests to regain vigour. Woodchipping has not been possible as the jarrah timber contains too much tannin and polyphenols for economic pulp production. It is this need to utilise small jarrah logs which has driven the innovative timber utilisation research at the Harvey Utilisation Research Centre.

More recently, forest planning in Western Australia has moved further than catering merely for local requirements. It has been realised that the State has many unique advantages for commercial forest growth which should be exploited for their long term social and economic advantage.

These advantages are: adequate land for forest establishment, a good climate for growing trees, low harvesting costs due to generally easy topography, a stable social and political environment, a high degree of technical expertise in forest management, and an already established infrastructure. All these add up to low timber production costs and reliable supply, both crucial requirements for industrial development.

Added to this favourable situation is an opportunity to use a tree planting programme to ameliorate two severe environmental problems in Western Australia - stream salinity resulting from excessive forest clearance for agriculture and eutrophication of estuaries due to the leaching of nutrients from pasture land, piggeries and feed-lots.

A programme which aims to achieve a total of 100,000 ha of eucalypt plantations of mainly *E. globulus* has been commenced (Shea and Bartle 1988) and about 4,800 ha have already been established. A feature of the programme is its use of funds from the private sector through the innovative Tree Fund concept. This was developed after the realisation that Government finances cannot be expected to carry the burden of all reforestation programmes, especially where the enterprise is clearly profitable enough to attract the private investor.

The *E. globulus* plantations are being grown on a 10-year rotation for pulpwood (although there are promising indications from recent timber utilisation research in Western Australia that some could be used for furniture manufacture). Genetically improved seed is used to maximise the wood quality and productivity of the plantations and very sophisticated site selection procedures have been developed. During the last two years approximately 4,800 ha of *E. globulus* plantation have been established on private property in Western Australia.

All the plantations are established on farmland under a sharefarming agreement with the landowner whereby the owner receives an annuity and a share of the profits at final felling. Plantings will be spread over the entire south-west, including the Peel-Harvey catchment. The latter is part of a long term plan to drastically reduce the input of phosphatic and nitrogenous nutrients into the Peel-Harvey estuary. Several other estuaries in Western Australia which have similar, or developing, problems of this nature may have the programme extended to their catchments. For example, some of the plantations will be established in the Collie River catchment as part of another long term plan to reduce river salinity. Some 15 years of research in this area has proved that reforestation will permanently lower groundwater tables which are the key to reduced stream salinity.

3.3 WATER PRODUCTION

The production of potable water is another important role of forests in the northern and central jarrah forest. Extension of the harnessed catchments to the karri forest zone is envisaged in the long term by the Western Australian Water Authority. Action has been taken to ensure that southern catchments are protected from further degradation by strict constraints on forest clearing for agriculture and an active reforestation programme.

The crucial protective role of forests in maintaining low salinity levels in runoff was recognised in the early years of this century following misguided clearing by the then Public Works Department of part of the Helena River catchment to promote runoff into the Mundaring Dam. The very first Forests Department area management plan for the Mundaring forest in 1926 specified that the protection of catchment values was the first objective of forest management.

Since that time there has been a steadily increasing area of forest encompassed by harnessed catchments. Further, in catchments such as that for the Collie river, where a severe stream salinity problem had been caused by excessive clearing for agriculture, CALM has been taking part in a wide scale tree planting programme which will restore the water quality in this large water resource.

As a result of concern over the possible adverse impacts of water resources of large scale open cut mining for the production of bauxite in the northern jarrah forest, and the woodchip harvesting operation at Manjimup, a very large programme of research into forest hydrological processes was initiated in the early 1970's. This massive effort, which

was also driven by the need to understand the processes of soil salinisation under agriculture, has given us a profound knowledge of hydrological processes in Western Australia which has been summarised recently by Borg et al (1987) and Schofield et al (1989).

3.4 RECREATION AND TOURISM

Recreation demands in forest areas have increased rapidly since 1970. In both national parks and State forests, managing agencies were initially slow to devote resources to recreation infrastructure development, mainly due to financial stringency. Funding for such developments has improved, but remains inadequate in relation to public demand. Recreation demand surveys have been carried out in the northern jarrah forest in the past and plans to provide the required facilities drawn up (Forest Department 1982). CALM has a sophisticated programme of visitor recording at national parks and forest recreation sites, which is used operationally as guide for directing investment in facilities. Recreation in forests is actively encouraged by a wide range of leaflets and other publications (eg, CALM 1986, 1988a, 1988b, 1989). It is true to say, however, that the provision of recreation facilities lags behind requirements.

On a wider picture, forests as a backdrop are a vital part of the tourist industries of the lower south-west. The industry originally grew up in the Pemberton area on the beautiful regrowth stands along the Rainbow trail. CALM has incorporated appropriate visual resource management techniques into its timber harvesting operations, and in certain key tourist drives, such as along the Manjimup-Pemberton road, the prescribed burning regime is deliberately manipulated to optimise the wildflower display.

3.5 MINING

There are a number of major mining operations in State forests in Western Australia. The largest is the three open cut bauxite mines operated by Alcoa Ltd at Jarrahdale, Dwellingup and Willowdale. These result in the clearing of about 500 ha each year of high quality jarrah forest. The whole mined area is rehabilitated and returned to forest cover. Alcoa, in particular, has been prepared to direct considerable resources to research and takes great care to achieve satisfactory rehabilitation. For a number of years the tree species planted were mainly from the Eastern States as there was concern that dieback disease would intensify in the pits, but under modern rehabilitation techniques this is much less of a problem and native species are increasingly used.

Other major mining operations are for bauxite at Mount Saddleback, coal at Collie, gold at Boddington, tin at Greenbushes and mineral sands in the lower south-west. To date, forest rehabilitation after coal, tin and mineral sands mining has not been up to the standard of the bauxite and gold miners.

3.6 HONEY AND OTHER MINOR FOREST PRODUCE

In State forest, there are about 1,200 registered apiary sites. The number actually utilised in any one year depends on whether the karri (which produces the most desired nectar flow) is flowering heavily and to what degree other nectar sources are having a good season. Honey production is a moderately important industry in Western Australia, with an annual turnover of about $3 million. The industry is not dependent on the south-western forests for its livelihood, but forests provide an important source of nectar and pollen.

Apiary sites are currently not permitted in many national parks or nature reserves in order to minimise possible adverse effects of the introduced honeybee on native flora.

There is also a significant wildflower harvesting industry which draws its supplies from either State forest or timber reserves as well as areas outside the forest. This is largely an export-oriented industry.

Western Australia's infrastructure development provides a continuing demand for release of forest for various public utilities such as powerlines, dams and roads.

4. MANAGEMENT POLICIES IN WESTERN AUSTRALIA

4.1 PRIVATE LAND

There is a considerable area of forest and woodland remaining on private land in Western Australia. In general, farmers have not opted to manage this forest as a sustainable resource. It has more often been regarded as an opportunity to expand the agricultural pursuit. Indeed, the income from the sale of timber has always been an important part of a farmer's financial planning.

There has been concern by some that the woodchip market would lead to faster losses of forest on private land in the high rainfall zone. To some extent this can happen. However, if a farmer's intent is to expand his crop land or pasture, he will dispose of the trees in one way or another. If he cannot find a market for the low quality material for woodchips he will simply burn it, and a valuable resource will be wasted. The choice is not whether the private forest is to remain or not, it is whether it is used or wasted.

In recent years there has been a heartening change of attitude by farmers. Many now accept that forests can be managed as a valued timber resource which can help to rectify environmental problems such as soil and stream salinity.

CALM has maintained a small rural advisory service which provides advice to farmers on tree species selection and tree establishment techniques. This service is now severely stretched because of the greatly increased tree planting activity in rural areas. Assistance in this respect has been gained through the activities of other organisations such as Greening Australia (which the State Government supports financially and with senior staff time), but there is still much research needed in this important area. Tree planting in rural area as a valuable way to improve fauna habitat as well as a contribution to the amelioration of soil degradation. The Department of Agriculture also provides advice to farmers. In the past this advice was principally directed to means of increasing agricultural production and returns. More recently the Department of Agriculture has increasingly been providing advice on tree planting and vegetation conservation.

Within the high rainfall zone, timber processing companies have been active in creating their own resource of either pine sawlogs or pulpwood. There has also been a boom in investment plantings, mainly of pines, although the quality of some of the plantings has been dubious. More recently CALM has been strongly promoting sharefarming schemes with farmers, firstly with pines and lately with short rotation *E. globulus* for pulp. There is clearly great interest among farmers in the latter in particular, and there is every prospect that the present target of 100 000 ha will be realised.

By early 1990, approximately 75 hardwood sharefarming agreements covering approximately 4,800 ha of new forest, have been settled between CALM and landowners.

For about 20 years CALM (and to a lesser extent the CSIRO and Department of Agriculture) have been carrying out research on the integration of agriculture and forestry (agroforestry) and is now at the stage of actively promoting this method of land management among farmers. Agroforestry encompasses a wide range of activity from shelterbelts (which can be managed to provide a useful source of timber), through spatially integrated commercial tree growing in association with grazing to farm woodlots. It is believed to be an essential component of sustainable agricultural systems outside the high rainfall zone in Western Australia.

CALM is also involved in the administration of a Remnant Vegetation Scheme in Western Australia and actively promotes the linking up of remnant vegetation patches within private property and to existing CALM reserves to provide corridors for fauna movement. The scheme protected a total of 7,000 ha in 1988/89 and is anticipated to cover a further 10,000 ha in 1989/90.

4.2 FORESTS MANAGED BY CALM

4.2.1 Introduction

The bulk of the publicly owned forests in south-western Western Australia are vested either in the National Parks and Nature Conservation Authority or the Lands and Forest Commission and are managed by CALM.

In the native forests allocated for multiple use and in pine forests managed by CALM, a complex set of management procedures has grown up over the years. These procedures fit into a well defined legislative and planning hierarchy. They begin with legislative requirements in the CALM Act for sustained yield of all forest values and long term resource management policies (eg, Bradshaw and Lush 1982, CALM 1987a), and land use policies (eg, the CALM regional plans and the Forests Department General Working Plans). They then progress down through issue or species management policies, such as silvicultural guidelines (eg, Bradshaw 1986), issue policies (such as retention of fauna habitat) to prescriptions for each forest operation.

Forest conservation and resource management requires a very detailed inventory of the forest condition, information on forest growth rates, a good scientific basis for management, a broad view of the social and economic values of the forest and the ability to project these for long periods into the future. Out of such a broad view of the situation comes a series of action plans for, eg, fixing the level of permissible cut, forest inventory, and research on timber utilisation to solve both forest management problems and resource availability problems.

CALM has a large and long-standing commitment to research on forest ecosystems (CALM 1989) over a wide range of matters. Current research programmes include forest fire ecology, native and pine forest silviculture, forest pathology, forest entomology, timber utilisation, forest fauna ecology, hydrology (in cooperation with the Western Australian Water Authority), agroforestry, tree breeding and forest establishment on farmlands. Close contact is maintained with external organisations such as CSIRO and tertiary institutions who also carry out research in forest areas. CALM periodically funds external research in areas of interest to its functions.

4.2.2 Forest policy

It is essential that the State's goals for forest management are acceptable to the community at large. A high degree of public consultation is therefore required at that level of planning. This is also a requirement of the CALM Act. Once the goals have been decided through public participation and democratic processes, it is the role of the Department to work towards them using the appropriate management procedures. These procedures are regarded as largely an in-house matter, except when a management action could impinge on the rights and interests of neighbours. In the latter case consultation with those affected is necessary.

In Western Australia the 1987 regional management plans and the Timber Strategy, which are now State Government policy, lay out a clear set of goals for forest management. Periodic reports are prepared to indicate how much progress is being made (CALM 1988).

Since the publication of the timber supply strategy, the sandalwood industry has been reviewed and a long term management plan developed (CALM in press). The plan provides for the continuation of the sandalwood harvest at approximately the current level for at least 60 years, the use of income from the present industry to purchase pastoral leases to improve the representation of sandalwood in secure reserves, a programme of re-establishment of the species in the wheatbelt and funding for research on alternative sandalwood species for the very long term future, or even expansion, of the industry.

In essence, the 1987 forest plans and timber supply strategy have fully allocated Western Australia's forest resources to the range of demands outlined above. Furthermore, the pressures on land use are such that a radical change in the balance which has been struck for forests in Western Australia could have adverse consequences for the social and economic values of Western Australian forests.

A policy issue is the continued use for timber production of native forests outside parks and reserves. Social, economic and technical analysis over many years indicate that the commercial use of forests can be fully sustainable. It is the Western Australian position that all the forest values set out in its regional plans are legitimate uses of the forest. All have been catered for in a balanced way which is believed to optimise the overall benefit to the State.

The balance which has been achieved in Western Australia is a practical implementation of the spirit of the National Conservation Strategy for Australia and of the principle of sustained development. The concept of a balance in forest use has recently been re-affirmed by the Commonwealth Government (Hawke 1989).

4.2.3 Conservation policy

The State Conservation Strategy for Western Australia sets out five key objectives for conservation. These are:

* to maintain essential ecological processes and life support systems;

* to preserve genetic diversity;

* to ensure the sustainable utilisation of species and ecosystems;

* to maintain and enhance environmental qualities;

* to optimise the quality of life for Western Australians.

The strategy recommends that the following principles be adopted to achieve the objectives:

* integrate conservation and development;

* retain options for future use;

* focus on causes as well as symptoms;

* accumulate knowledge for future application;

* educate the community;

* recognise community aspirations and the need for involvement in the planning process.

These objectives and principles are used as the basis for all forestry planning and operations. They are developed into an organisational mission statement for CALM and a series of primary objectives encompassing management, conservation, production, recreation and knowledge. These are set out in published documents (CALM 1987e). The basic principles are elaborated into Departmental policy statements which provide guidance for field operational staff over the whole spectrum of factors affecting land management.

4.2.4 Recreation policy

Part of CALM's legislated responsibility is to provide for recreation those lands (and waters) it manages where recreation is a compatible activity. Recreation is interpreted broadly to mean both active and passive activities. Management policies concerning recreation development are developed and promulgated in the same way as conservation policy, and the two aspects often are combined in the one document.

In the development of policies, the following principles are followed:

* a natural system must be able to sustain the form of recreation proposed;
* the recreational activity must be compatible with the vesting purpose of the land, or the established land use priority;
* the widest range of activities should be allowed, but uses which impair other forms of use to an unreasonable extent will be controlled or eliminated;
* where appropriate, fees will be charged to offset management costs;
* commercial concessions will be granted in appropriate circumstances;
* visitor information and interpretation of natural systems will be provided.

The importance accorded recreation by the Department is reflected in the concentration of management plan development in the last five years in national parks and conservation reserves.

4.2.5 Native forest silviculture

The silvicultural systems in use are determined by the nature of the species concerned, the condition of the forest and the degree to which the timber industry can be used as a tool to achieve silvicultural objectives. For many years the industry was able to use only a proportion of the previous crop and as a consequence it was not possible to treat the forest in a way which foresters would desire. In Western Australia this is still the situation to some extent in the jarrah forest, except in limited areas where a residue-using industry (low quality timber for charcoal) is available.

In the area of timber harvesting, there is a rigidly enforced Code of Logging Practice (CALM 1988d) and Manual of Hardwood Logging Specifications (CALM 1989d) which contain comprehensive specifications for all aspects of the harvesting process. It particularly focuses on the forest hygiene requirements to contain dieback disease and to ensure avoidance of soil damage. Soil damage and compaction are avoided by monitoring rainfall and soil moisture content, and halting all in-forest operations when critical levels are reached.

Contractors are obliged to establish log stockpiles to enable continuity of production due to bush closure for soil damage and the regular seasonal closure to avoid wet soil movement for dieback disease management.

A feature of logging operations in Western Australia is the coordination of all forest harvesting operations by CALM as the prime contractor. The actual logging is still performed by private contractors, but as they are responsible to CALM for their in-forest activities it is much easier to impose CALM environmental protection requirements and to control the utilisation of the forest produce.

Silviculture in Western Australia starts from the premise that society requires certain values from the forest (eg, timber, water, recreation, wildlife conservation) and it is the task of the forester to make these available in such a way that the long term integrity of the forest ecosystem is not impaired. In respect of timber production, the approach taken is that the industry is a tool to rehabilitate and improve the forest. The production of timber is not seen as the end of forest management: the end is the achievement of a "normal" forest where there is a balanced sequence of age classes, all healthy and fully stocked, with the desired range of tree species and with the full complement of other components of the forest ecosystem.

Karri forest silviculture

In the karri forest a range of silvicultural systems has been tested. After much experience and research a clearfelling regime has been adopted and brought to a very high level of efficiency. The reasons for this system and the role of the woodchipping industry have been outlined by Bradshaw and Lush (1982). The clearfelled coupes are dispersed as far as possible in line with visual resource management considerations and regional fire management plans, and located within a network of road, river and stream buffer zones. These buffer zones are designed to protect visual amenity, catchment values and to facilitate the survival and movement of forest fauna. The fact that the karri forest lies in a region where tourism is of great, and increasing importance, is a major factor in management procedures.

Most karri forest is regenerated using a seed tree system, but it is not always possible to do this due to karri's erratic seeding habits. A proportion of the harvested areas is regenerated by hand planting seedlings raised in a nursery in order to ensure prompt renewal of the forest.

There is now a considerable area of karri forest regenerated in past years which is undergoing thinning. Karri regenerated in 1930 is now being thinned and yielding peeler logs, sawlogs, SEC poles and pulpwood. The latter is very efficient operation using logs down to a small diameter of 5 cm bark included. Research has shown that it is possible to thin karri forest as early as 15 years of age, and then several times more before the nominal rotation age of 100 years.

A long term plan for karri forest management was developed in 1981 (Bradshaw and Lush 1982) and remains the basis of planning, although minor amendments were made in the 1987 Timber Supply Strategy. Under this plan the level of harvest is to remain constant until the year 2067, at which point a decision can be made to either continue at the same level of cut and lengthen the rotation to 200 years, or maintain the present rotation length of 100 years and greatly increase the annual cut.

Jarrah forest silviculture

Jarrah forest silviculture is very different, since the forest has been subjected to a wider range of treatment in the past from clearfelling to light selection cutting (Stoneman et al 1989), resulting in a very diverse structure. Virtually every hectare of the jarrah forest has to be treated on its merits.

The silvicultural system now in use in the jarrah forest perpetuates an uneven-aged structure in most jarrah forest, or a mosaic of small even-aged stands varying in size

according to past treatment. In the groups of pole-sized forest, thinning to remove the poorer stems is used to promote growth on the better retained trees. The treatment varies markedly over short distances according to the current condition of the forest.

Logging operations in the jarrah forest are directed towards removing groups of trees containing marketable logs in a way which will facilitate subsequent regeneration (Bradshaw 1986, 1987). A specified number of "habitat" trees is retained per hectare. The fundamental principle of the jarrah silvicultural system is to use the timber industry, in combination with other tools such as fire, to promote a healthy, vigorous new forest which in the future will be capable of yielding a better class of wood product, as well as provide a diverse wildlife habitat, be visually attractive and yield the optimum amount of high quality water.

4.2.6 Pine forest silviculture

Since 1970, pine forest silviculture in Western Australia has taken a rather different course from the other States, as it has concentrated on the production of sawlog-sized trees at the earliest possible time. This has implied much lower tree stockings than used elsewhere. In other States the approach has been to maximise plantation productivity. The Western Australian approach has been driven by a desire to expand pine sawlog production as rapidly as possible, for reasons explained elsewhere in this submission, and by a desire to achieve maximum economic benefit from the plantation enterprise.

A vital consideration for pine forest management is the capacity to market small logs from the first thinnings. Here the level of activity of the particleboard industry and to a lesser extent, the treated fence post industry, is especially important. There have been severe plantation losses from moisture stress caused by the combination of drought and overstocking.

4.2.7 Special management for water production

In some forest areas the requirements for water production are a major influence on silvicultural practices. For example, research by Butcher (1980) showed that the level of stocking of the *P. pinaster* forest on the coastal plain north of Perth determined the amount of recharge to the underlying sub-artesian aquifers. Thinning the forest to maximise sawlog production also gave high aquifer recharge. The management practices for this forest reflect the need to optimise groundwater recharge (CALM 1987b).

In the harnessed catchments in the northern jarrah forest a heavy thinning has also been found to greatly increase water yield. Where there is no risk of increased stream salinity, ie, the western half of the northern jarrah, forest thinning is a feasible and more cost effective method of producing more water than the construction of new dams. However, it has not been applied in practice due largely to lack of markets for the material produced by such a thinning operation.

In the eastern half of the jarrah forest, where there is a known risk of increased stream salinity after clearing for agriculture, there are strict guidelines for minimum basal area retained after a harvesting operation. These guidelines have been worked out in consultation with the Water Authority.

4.2.8 Forest protection

Fire management is a vital part of forest management in Western Australia. The role of fire in forest ecosystems and fire behaviour have been very extensively researched (Christensen and Abbott 1989) and the research results have

been incorporated into operational procedures for fuel reduction burning (Underwood and Christensen 1981, Wardell-Johnson et al 1989). Western Australia has for many years been in the forefront of research and operational use of fire as a management tool to achieve a wide range of management objectives from protection of forest and community from wildfire (Underwood et al 1985), to fauna habitat management and wildflower display manipulation along tourist routes.

Forest disease, in the form of the root rot fungus *Phytophthora cinnamomi*, is a serious forest management problem in jarrah forests. It is a unique problem not faced by any other forest managing agency in Australia. It is not only a serious pathogen of the jarrah tree itself, but it has a severe effect on many other plant species in the south western part of the State and is the principal flora protection problem as it has the potential to eliminate some groups of native flora.

Over the last 20 years there has been a great deal of research into the biology and control of the pathogen, and very complex management procedures have been developed and applied over large areas of forest and other vegetation types (eg, Fitzgerald River National Park). In fact the dominant consideration in jarrah forest management is disease management (McKinnell 1981, Shearer and Tippett 1989). One of the significant early benefits of the formation of CALM was the rapid extension of the Forests Department's expertise in disease management to national parks and nature reserves.

4.2.9 Environmental protection

An important aspect of environmental protection is the control of feral animals and weeds in forest areas. In the lower south-west, feral pigs are a management problem as they are suspected of being a vector for the spread of dieback disease. Various pig control programmes have been undertaken but the problem remains. Both pig control and control of declared weeds are carried out in cooperation with the Agriculture Protection Board of Western Australia.

Environmental protection also encompasses setting conditions on the use of forested areas by mineral explorers or mining companies. Under the Western Australian Mining Act, consultative procedures are required before any mining activity may take place on land for which CALM is responsible. This provides an opportunity to specify conditions which will minimise environmental impact.

4.2.10 Management for nature conservation

Nature conservation has been an explicit objective of management since the early-1970's, when detailed ecological and fauna surveys were carried over the whole forest estate. as a consequence, large areas of forest have been withdrawn from timber production for that purpose (Heddle et al 1980, White 1977, White and Underwood 1989).

In forests managed as nature reserves, for example the Perup forest near Manjimup, a complex management plan has been in place for 15 years to use fire, the dominant factor of the environment, to manage forest habitat to favour the small marsupials, woylie and tammar. Similarly the Dryandra State forest demonstrates a unique blend of timber utilisation and management for numbat habitat. For such areas, specific area management plans are drawn up, using the results of extensive departmental research to guide management. Nature conservation requirements are also spelt out in regional land management plans.

CALM has prepared a number of species management plans for important species of flora and fauna. In some cases there are fauna re-introduction programmes to spread particular species of restricted occurrence eg, woylie, numbat, and

noisy scrub bird, back into areas from which they have disappeared.

A factor of potential concern in nature conservation in Western Australia is the possible impact of adverse climate change. At the present time the emphasis is on gathering biological data on the current situation and monitoring changes.

4.2.11 Management for recreation

CALM has promoted a professional approach to recreation management in State forests. This involves specially trained staff developing regional and site plans in advance of installation of facilities or recreation programs.

For forested national parks, a similar approach is taken, using area management plans to determine on-ground management procedures. As many national parks are the subject of intense sectional interest, CALM has developed a range of procedures to ensure all groups are consulted in plan development, and in some cases, ongoing management (CALM 1987, CALM 1989c). The usual approach taken is to zone the park into areas where a particular management objective, such as recreation or nature conservation has priority, and then set out a series of management guidelines designed to achieve stated management objectives.

A programme of monitoring visitor numbers has been instituted at all major recreation areas. The information is collated and returned to local managers to aid them in day to day planning of activities. The information is also used to guide specialist branch work programmes for training in recreation site development. Formerly, recreation site planning and development was centralised, but the expertise has been spread down to field level by intensive training. Great stress is laid on consistency and quality in both site development and in signs.

5. THE STATUS OF FOREST MANAGEMENT IN WESTERN AUSTRALIA

Over 70 years of professional management of forests in Western Australia has produced some notable achievements in both forest policy and in technical advances. The most important of these are the setting aside of a secure forest and a representative forest conservation system, the development of multiple use management, public participation in planning and the protection of forests from fire and disease. These features and many others are discussed in more detail below.

5.1 A SECURE FOREST

The important forests of the south-west of Western Australia are now securely reserved. This means they are allocated to tenures such as State forest, national park or A Class nature reserve. These tenures cannot be changed without the approval of both Houses of State Parliament.

The secure status of State forest as established in the 1919 Forests Act has been retained in the CALM Act. This means that for all practical purposes it will be forest in perpetuity. Apart from some minor boundary adjustments which are constantly being made, and relatively small areas yielded for special purposes at the instruction of Government, or transferred to national park or nature reserve under the regional management plans, the area of State forest has not changed for many decades. Thus the oft-repeated claim that our forests are diminishing is patently false for public forests in Western Australia. The agreement of both Houses of Parliament is necessary before any tenure changes may take place.

The total area of land under forest is actually growing due to the active programmes of softwood and hardwood establishment on cleared private property. In the last two years, for example, a total of 5,000 ha of pines and 6,000 ha of *Eucalyptus globulus* plantations has been established.

5.2 A REPRESENTATIVE SCIENTIFICALLY BASED FOREST CONSERVATION SYSTEM

All major forest types in Western Australia are represented in secure conservation reserves. In the jarrah and karri forests of the southwest the reserve system was scientifically designed to further ensure that the range of major vegetation sub-types also was included. The best areas of old growth forest are included in reserves.

Areas classified as A Class nature reserve, or as national park or conservation park may not be logged. Nature reserves and national parks may only be mined after agreement by both Houses of Parliament.

With the exception of the Shannon River and the Tuart Forest National Parks (which were created in the mid-1980s) the reserve system in the forests has been in place since the early 1970s.

5.3 PROTECTION OF NATURE CONSERVATION VALUES IN FORESTS

Through the establishment of a secure and representative reserve system and by implementing policies for flora and fauna management, a high level of protection for nature conservation values has been achieved.

Management programs for endangered species of flora have been put in place and programs have been developed for some mammal species which are rare or threatened.

Research into nature conservation values of forests is ongoing. CALM has research programs which look at both fauna and flora conservation and has scientists allocated to these programs located in the forest regions.

5.4 MULTIPLE USE OF FORESTS

It was long ago realised that the area of forest in Western Australia was totally inadequate to permit single use for purposes such as water catchment. Multiple use was found to be the only realistic approach to forest planning. This does not mean that all possible uses must be permitted on every single hectare at the same time. In some areas one use will have priority and others will be permitted to the extent that they do not adversely impinge on the prime use.

In a harnessed water catchment, for example, water yield and water quality are the prime objectives of management. This is normally quite compatible with nature conservation and timber harvesting.

In particular parts of the forest where there is a special focus on recreation, timber harvesting is excluded or modified for a distance related to the viewshed of the recreation site.

5.5 CONTROL OF FOREST HARVESTING OPERATIONS

All forest harvesting operations are controlled and prompt and effective regeneration takes place after all final fellings. A Code of Logging Practice was developed nearly a decade ago and is strictly applied.

A range of silvicultural methods are applied, depending on the situation of the individual stand. Silvicultural prescriptions are written and available to the public. These prescriptions are approved by the Corporate Executive of CALM, which includes staff with a wide range of scientific disciplines.

5.6 SUSTAINED YIELD

Timber harvest is below the sustainable level - ie, harvest levels have been so regulated that the volume of timber removed in any year is exceeded by the volume which grows in the forest (CALM 1987a).

A clear plan has been put in place to ensure that there will be a more even distribution of age-classes in the karri forest by the middle of the next century.

5.7 RECOGNITION OF ALL FOREST VALUES

CALM has a comprehensive set of policies (CALM 1987e), developed by an interdisciplinary executive group, which ensure that all forest values are taken into account. A monitoring programme provides a check that policy directions are implemented in the field.

5.8 DEVELOPMENT OF LONG TERM FOREST MANAGEMENT PLANS

Both the former Forests Act and the CALM Act contain requirements for the production of long term forest management plans. These have helped ensure consistency in management over a long period. Their publication has greatly assisted public appreciation of where forest management is going in Western Australia. The CALM regional plans (which cover all land tenures) and timber supply strategy are not library documents. They are on the desks of every regional and district manager and are constantly referred to.

All these documents have had very extensive public consultation through explanatory publications in laymans terms, workshops, briefings and consultations with all forest user groups and organisations. As such they are a real reflection of community attitudes and requirements of the forests of Western Australia.

5.9 PUBLIC PARTICIPATION

Public participation takes place at all levels, from the membership of the National Parks and Nature Conservation Authority down to on-ground management.

The application of the requirement in the CALM Act for public consultation has developed rapidly in the last five years. In the development of area management plans, it was the practice initially to produce a draft plan and then take outside input from written submissions or from workshops. In more recent times the intent to produce a plan has usually been advertised first and concerns of the stakeholders taken into account from input received at special workshops and briefing sessions. This also gives CALM the opportunity to air its concerns about forest management problems.

In some areas there are local "Friends of the Forest" groups who are a great aid in minimising rubbish dumping problems and preventing the theft of forest produce. In the larger forested reserves there are management advisory committees to assist CALM staff in devising management strategies.

5.10 PROTECTION OF FOREST AND USE OF FIRE AS A MANAGEMENT TOOL

Since 1961 there have been no huge uncontrolled bushfires in Western Australian forests, or serious bushfires burning out of the forests and causing substantial damage in the community. This is largely due to the professional levels of fire detection, prevention and suppression which have been developed, and successfully incorporated into management and operational plans.

In addition to successful fire protection programmes, major advances have been made in the use of fire as an environmental and silvicultural tool. Fire research is on-going and changes to plans in the light of research findings is regarded as part of normal management.

A notable achievement in the 1970's was the development of the aerial ignition technique for prescribed burning and the use of spotter aircraft for fire detection. CALM is currently breaking new ground again in linking the results of its fire behaviour research to a computer-based geographic information system, which will enable fire fighters to make vastly better and faster decisions, especially in multi-fire situations.

5.11 DISEASE MANAGEMENT

In response to the unique problem of jarrah dieback, a systematic approach to disease management in forests has been developed. This approach includes the quarantining of

large areas of forest (with legislative backing) and the application of "hygienic" forest planning and operations which are well in advance of anything elsewhere in Australia. Detection of the disease required the development of a unique large format shadow-free aerial photography technique, whereby individual dying indicator species in the forest can be detected. All disease management is supported by a major scientific research program, and is applied to all forests, especially forested conservation reserves.

5.12 RESEARCH BACKING FOR MANAGEMENT

Forest research has been conducted since before the second World War, and continues to have a high priority. Research continues to be conducted into silviculture, fire protection and ecology, hydrology, pathology, economics, fauna ecology, soils, tree breeding, entomology and rehabilitation, and research scientists have carried out biological surveys throughout the forest regions.

This work provides the scientific basis for all reserve planning and day-to-day operations. Research is continuing, and in conjunction with a newly adopted approach to monitoring, will allow plans and procedures to be constantly upgraded.

5.13 INNOVATIVE TIMBER UTILISATION RESEARCH

CALM has carried out highly successful and innovative research into log use and storage, and timber utilisation and drying. This has culminated in the development of the Valwood (TM) Process, a brilliantly innovative method of converting low grade logs into high grade product.

5.14 INNOVATIVE SILVICULTURE

Silvicultural practices have been constantly refined in all forest types. In softwood forests they are designed to produce timber of defined characteristics with maximum efficiency and within certain economic constraints (in respect of internal rate of return of the forest enterprise).

In the native forests the silvicultural regimes are designed to rebuild the forest after the (necessarily) high grading practices of the past. The timber industry is used as a tool to work towards the desired balance of age classes and to put the forest into a more productive condition, taking into account the nature of the species concerned.

In some areas the regime may be designed to maintain scenic amenity or fauna habitat values or creation of regeneration for conservation purposes, for example of tuart in the Tuart National Park. The priority is varied to fit the local management objectives. The multiple use philosophy covers the single use of localised areas, eg, for recreation, within a matrix of forest where timber may be cut, to extensive areas where several uses may coexist at the one time.

5.15 EFFICIENCY OF RESOURCE USE IN TIMBER HARVESTING

All logging operations in the native hardwood forests are fully integrated to ensure optimum segregation of logs to the highest value market, and maximum utilisation of timber from cut-over areas and felled trees. Log distribution is controlled by CALM, not by the timber industry. Royalties are so arranged to encourage the best use of logs, as far as is possible.

Further, CALM's assumption of responsibility for timber harvesting operations means that the forest manager determines what is to be removed from the forest. At all times efficiency of use of the resource is a prime consideration.

5.16 OPERATIONAL GEOGRAPHIC INFORMATION SYSTEM

Western Australia was the first Australian forest management agency to become involved in the use of computer-based geographic information systems (GIS). An operational need for such a system was seen in the late 1970's to carry out the complex planning associated with forest harvesting in southern forests. As no commercially available system was able to perform the required tasks, CALM developed its own system (FMIS). This has been refined over the years and supplemented by two commercial systems, but there is still nothing else which suits a forest manager for some purposes. CALM has more experience than almost any other forest managing agency in the world in the practical application of GIS technology to forestry.

A recent step has been to integrate GIS with the new forest inventory system (Biggs et al 1990). The latter uses large scale aerial photography taken from a helicopter flying at low altitude, the position of each photograph being fixed from a satellite navigation system (Bailey 1989) and recorded on an on-board laptop computer. Suitable computer software selects a proportion of the photo plots for ground truthing and the field data is combined with photo data to produce estimates, with confidence limits, of gross bole timber volume and for a wide range of forest products, depending on a range of conversion factors. The latter are derived from monitoring industry standards of log acceptability or from special utilisation studies. A feature of the system is its ability to rapidly recalculate timber resources whenever there is a change in markets or a change in log acceptability standards. This innovative system is far in advance of anything else used in Australia.

5.17 CREATION OF A SOFTWOOD FOREST RESOURCE

The creation of a softwood forest resource in Western Australia encountered problems which did not exist in other States for many years. From the beginning, severe nutrient deficiencies in both species of pine were evident and this required research which, in its time, was the most advanced in the world.

The use of the very poor coastal sands near Perth for pine planting required selection of a different species from that used elsewhere in Australia. Both its nutrition and subsequent improvement by a tree breeding programme were landmarks in Australian forestry.

There are now about 70,000 ha of softwood forest in the State, which are playing an increasingly important part in relieving the pressure for sawlogs from the native forest estate. They are, in fact, a vital link in the State's timber supply strategy.

5.18 LEADERSHIP FOR CHANGE IN TIMBER USE

For many years the Department has had a conscious policy of providing leadership for the forest-based industries. When the utilisation of softwood was introduced to Western Australia, the Department had its own sawmills and set out to ensure that all pine sold in the State was treated and graded according to national standards so that a consistent and guaranteed material was produced.

It pioneered research on high temperature seasoning in softwoods and has carried out contract research on seasoning for other States. This work lead to CALM's world-leading research on utilisation of small eucalypt logs which has so much potential for both economic output from young trees and benefit for forest management.

5.19 COORDINATION BETWEEN STATE GOVERNMENT AGENCIES

Effective links have long been established between all relevant agencies (eg Agriculture, Water Authority) to ensure an integrated approach to land use and conservation issues in respect of forests for example, forest development has been an accepted and very successful measure adopted in water catchment rehabilitation for nearly 15 years.

5.20 CATCHMENT REHABILITATION PROGRAMMES

Major research programmes have been undertaken to evaluate the role of reforestation in catchment rehabilitation. Since the inception of the rehabilitation programme in the Collie River catchment CALM has carried out the reforestation on contract to the Western Australian Water Authority. The Departments of CALM and Agriculture are also active in planning an integrated approach to rehabilitation of the Denmark River catchment, where a blend of changed agricultural practice and judicious reforestation is being used to reverse a developing salinity problem arising from the clearing for agriculture of only 15% of the area of the catchment.

The Western Australian Government has a strong integrated catchment management programme in which the activities of all Government agencies are coordinated to achieve positive and cost-effective results.

5.21 PLANNING CATERS FOR ALL FOREST VALUES

Long term, comprehensive forest plans have been written, published and revised for decades. Since 1987 plans have been subjected to public review in draft form. Final plans are approved by Cabinet.

Plans are regionally based and address all forest uses and user concerns, including visitor safety.

In addition to regional plans, individual management plans for forested parks and reserves are prepared. The management plan for the Shannon River national park is now being implemented; draft plans for Walpole-Nornalup National Park, Lane Poole Reserve and John Forrest National Park are all in various stages of completion. All "area" plans, like all regional plans, involve full public participation.

5.22 PUBLIC INFORMATION PROGRAM

The Government has long been committed to providing public information about forestry. Initially, this was carried out by the publication of the Forests Department's FOREST FOCUS, and continued and greatly expanded by CALM's LANDSCOPE magazine. Landscope is widely sold in the State and sent all over the world to subscribers. In addition, there is a wide variety of special publications and leaflets to inform and encourage the public to use and appreciate Western Australia's unique and beautiful forests.

CALM also provides extensive programs in community education in other fields. This includes the installation of interpretive signs at sites visited by the public and running field stations at the Perup, Dryandra, Mundaring Weir and Jarrahdale to which the public is invited.

The management planning processes which CALM has developed play a major role in providing public information. All management plans are released as drafts and are accompanied by public workshops and other interactive sessions designed to involve and educate the public about management issues.

6. KEY ISSUES IN FOREST MANAGEMENT

6.1 RESPONSIBILITY FOR PLANNING IN FOREST MANAGEMENT

For some 70 years planning for forest management has been the exclusive responsibility of the relevant State management agency, operating within the directions imposed by State Government policies. This has changed in recent years with the intervention of the Commonwealth Government into the arena through its control of export licences. To gain approval for an export licence it must be shown that the relevant Commonwealth environmental protection legislation has been complied with.

Although there have been some difficulties with this situation, negotiation has achieved reasonably satisfactory outcomes. At the very least, the legislation is clear and the lines of authority are undisputed.

In Western Australia the State has developed, with very wide public participation, a comprehensive set of regional forest management plans and Timber Supply Strategy which take into account all demands on the forest estate, including national estate values. The plans have been endorsed by all political parties on the State scene and have wide community support. They are a delicate balance in the use of a scarce resource. This has been accomplished by means of a professional and integrated agency (CALM) who are directly accountable to the elected State Government. The planning processes which have been developed and the carefully balanced plans which have been put in place, with community support could be jeopardised if decisions on the planning and management of forests were made outside that process.

6.2 TIMBER HARVESTING IN "OLD GROWTH FORESTS"

An issue of concern to the Government is the question of timber harvest from old growth forests. Part of the problem with this issue is the question of definition. From the West Australian perspective "old growth forest" is synonymous with virgin forest - ie, forest which has been largely unmodified by timber cutting or agricultural clearing since the time of European settlement.

It is essential that a proportion of virgin uncut forest should be set aside from harvesting as examples of the primeval forest. In Western Australia this has already been done. A forest reserve system was developed by the Forests Department in the early 1970's and modified by CALM in 1987. The question is what proportion. It is not possible to preserve all virgin forest, as to do so would cause unacceptable dislocation to an important regional industry because of the distribution of age classes in the forest. The balance which has been decided in Western Australia under the 1987 regional plans is that which is the best overall compromise which could be reached. It has been accepted by the timber industry and endorsed by the community at large.

In the main forest types in Western Australia a preliminary assessment of the area of virgin forest, ie, forest in which there is no record of any timber harvesting having taken place, is as follows:

FOREST TYPE*	AREA	(IN ,000 HA) VIRGIN	NOT VIRGIN	% VIRGIN
Karri	173	87	86	50
Jarrah	1,575	322	1,253	20
Wandoo	107	3	104	3

* Note, includes all tenure types.

In karri forest, 46% of the virgin forest is in national park, or forest to become national park, conservation park or nature reserve under the regional management plans. For the jarrah forest the equivalent figure is 30% and for the wandoo it is 70%. For the karri an additional 24% of the virgin forest is in stream or road buffer zones, where there are severe restrictions on timber harvesting. Harvesting normally takes place in these areas only to thin regrowth areas, and virgin forest is not cut unless badly fire-damaged. Bearing in mind the other demands on the forest, as outlined elsewhere, this is considered a satisfactory balance by the Western Australian Government.

6.3 REFORESTATION ON CLEARED LAND

The WA Government is promoting the use of cleared agricultural land for forest resource development. However, there are difficulties in obtaining sufficient suitable land to enable full replacement of the Western Australian forest-based industries by a private property resource.

The Government has been involved in land purchase for pine planting since 1956, and has encountered strong resistance from the agricultural sector to conversion of land to tree crops. To deflect this opposition, an innovative sharefarming programme has been developed. This has had a measure of success, but there is still a real problem in convincing a farmer that he should, in effect, lose the control of his own land for a period of time. There is also marked, and increasing, opposition from local Government which sees reforestation leading to depopulation of the countryside. Planning schemes have been designed in some cases to make it virtually impossible to establish plantations in some shires, or to relegate plantations to the poorest marginal soils. There has even been pressure in Western Australia for Right to Farm legislation, which would, *inter alia*, be used to exclude commercial tree planting from "farming" areas.

It is CALM's view that the best outcome is one where tree planting is integrated onto farms and silviculture enhances, but does not completely replace agriculture.

A basic problem is the reconciliation of national and local interests. Suitable processes for this are generally lacking.

6.4 MANAGEMENT OF PRIVATE FORESTS

A management problem of steadily increasing importance in Western Australia is the management of forests on private land. There is no concern for forests on private land established by or for timber companies, such as Bunnings Tree Farms, since they have clear objectives for management and professional advice and input.

There is, however, cause for concern at the management of all other forest remaining on private land. Farmers in the high rainfall zone generally have no immediate incentive to maintain forest. Farmers in the wheatbelt, on the other hand, where the adverse effects of the loss of the native woodlands are now obvious to them, are now generally protecting remnant forests. But even where there is no short term intent to actually clear the forest, it is normal practice to graze the area so that regeneration is prevented. This is of particular concern in forest on private land within declared catchments where there is a moratorium on clearing for agriculture. Although good forestry is slowly being introduced in this area, in general in Western Australia greater emphasis is needed on sustaining native forests on farms.

In addition to the need to ensure that forests in important catchments remain effective hydrologically, forests on private land can make a very important contribution to the State's timber production, as well as a very important contribution to the provision of habitat for native wildlife, and farmer income.

Local governments could play a far more positive role in encouraging retention of tree cover. At present they tend to see it as a loss in potential rate income and not a beneficial economic activity.

Although it would no doubt help the position if an education campaign were undertaken, a far more positive step would be the development of a range of positive incentives by State and Commonwealth Governments working in partnership. Action at both levels of government is required as taxation incentives are likely to be an essential part of an incentive package.

Further Commonwealth Government actions to encourage the productive uses of forests are needed. The Billion Tree Programme, for example, expressly forbids the use of its funds for tree planting for any productive use. It might be easier to achieve a great increase in the rate of tree planting, with all the attendant environmental and social benefits by establishing a partnership with the private sector to mobilise private capital.

6.5 SUSTAINABILITY OF WESTERN AUSTRALIAN FOREST ECOSYSTEMS IN RELATION TO USE

The sustainability of forests subjected to various forms of use is a matter of frequent debate. Sustainability is a complex matter, covering a range of specific concerns. The position varies according to the management objectives of a particular piece of land. For example, for a national park set aside to preserve a particular stand of trees, it could be argued that it has become non-sustainable if a severe wildfire destroys that stand, and no seed was available to naturally regenerate it. Even if the seed were there, is the stand still sustainable if the value for which it was set aside will not be there again for 200 years? In other words, in what time frame, and by what criteria should sustainability be measured?

To avoid debates of this nature, which can degenerate into pointless semantics, the approach taken in Western Australia on forest sustainability is that the crucial factors which must be protected are:

* the productivity of the soil;
* the assemblage of wildlife, in terms of diversity;
* the genetic diversity of all components of the ecosystem;
* the diversity of forest structure, so that all age classes from zero to the oldest will always be represented somewhere in the forest;
* the health of forest ecosystems.

In respect of timber harvesting, the future productivity of the forest is safeguarded by an understanding of nutrient recycling patterns (eg, Hingston et al 1988, O'Connell 1988), the enforcement of procedures designed to avoid excessive soil compaction, the complex procedures designed to prevent the further spread of dieback disease, and by an effective wildfire prevention system. Long term planning procedures ensure that the level of harvest is within the productive capacity of the forest, at least in the overall sense of total growth versus level of harvest.

The gradual creation of a full range of age classes in the multiple use forests is essential for sustained wood production as well as for the stabilisation of the production of all other forest values.

The sustainability of the flora under present forest management practices has been confirmed by research and biological surveys. For example, 150 years of timber harvesting in the northern jarrah forest has not resulted in the known extinction of any species of flora, whereas there are many documented instances of plant extinctions in the wheatbelt. This is not to say that the biological requirements of every plant species is optimised. We simply do not, and perhaps never will, know enough about the precise requirements of every single species. We do know from research that all the tools of forest management, timber harvesting and prescribed fire, do not have adverse effects in this regard.

The one point of concern over sustainability of flora is in relation to the long term effects of *Phytophthora cinnamomi*. It is generally believed that we have now seen the main impact of the disease in the jarrah forest. Certain site-vegetation types have been decimated by the disease and may never recover their former diversity and structure. This can only be assessed by long term monitoring. The disease may still have a major impact on other vegetation types outside the forests. Within the forest area it has already caused a marked decline in the populations of some susceptible species, such as *Banksia grandis*, and forest management practices have contributed to this in an attempt to reduce the potential for disease intensification.

Sustainability of forest mammals and bird fauna is believed to be adequately catered for in Western Australia. Suitable habitat is provided by the extensive reserve system in a matrix of multiple use forest, combined with active fox control programmes. In fact, the greater structural diversity of the forest with the progressive development of the "normal" forest will optimise the diversity of fauna niche. In this respect rotation length is considered more important than the silvicultural system which is adopted.

One disturbing factor at the present time is feral pigs. Despite active control programmes, they are continuing to spread, aided by irresponsible members of the community who actively seed them into new areas of forest. It is hoped this attitude will diminish with the community education programmes now in place. Although the purpose of this deliberate seeding is hunting, hunting is not a significant factor in the survival of native fauna in the forests.

Sustainability of the scenic value of forests in relation to tourism is adequately catered for by complex landscape planning procedures. The overall position is very sound, and will improve with better technology in the future.

The sustainability of popular recreational sites is a matter for concern. The techniques for ensuring their long term sustainability are well understood, but the funding for their application are a continuing problem. In national parks there is at least a source of income from park entrance fees which could be directed in this way, but there is a major dilemma in State forests. Traditionally, free access to State forests has been regarded as a right. However, the rapidly increasing demands for recreational use have stretched the capacity for funds available to provide the necessary facilities and management.

6.6 MINING IN FOREST AREAS

The mining industry is an important economic activity in Western Australia. Most mining activity takes place outside the main forest area, but there are some significant mines in the forest. Bauxite mining is the most important of these, in terms of area of forest affected. In the long term (say, 70 years) it will have covered a very significant proportion of the northern jarrah forest. Gold is a relative newcomer to the forest and other minerals may be exploited in the future.

In national parks and nature reserves, there is a State Government policy (Anon 1989) under which any proposal to develop a mine must be approved by both Houses of State Parliament. This ensures the widest possible consideration of the community economic interests in relation to conservation interests before a decision is made. Despite the acknowledged importance of some national parks and nature reserves, the Government policy is that it would be unwise to permanently sterilise any resource without full consideration of the implications.

A different approach applies to State forests in Western Australia. Mining proposals may approved by the Minister for Conservation and Land Management without reference to Parliament. A uniform approach to mining in forests, parks and reserves across Australia is desirable.

6.7 REGIONAL ECONOMIC STABILITY

Long term planning procedures are also needed to protect the sustainability of employment in forest-based industries. There will, of course, be continuing technological change in industry which may have an impact on employment levels, which requires monitoring. Not all reductions in employment due to technological change are necessarily negative. Many jobs in sawmills prior to 1960 were dangerous, with "gut-busting" work practices being common. Mechanisation has reduced employment in the mills, but it has greatly improved safety and the quality of life of those still working in them. At the same time, greater processing of forest products and a wider range of work in the forest has opened new and safer employment opportunities. A key factor in any social change is to try to ensure that impacts on individuals are minimised or avoided. Changes in the forest-based industries in Western Australia over the last two to three decades have achieved this.

7. FUTURE DIRECTIONS

The future directions of forest management in Western Australia are determined by our vision for the future of our forests. Our vision is:

* A secure publicly owned forest estate which ensures a balance of land uses, including conservation, production, recreation and catchment protection.

* A forest professionally managed by a well trained, interdisciplinary staff, in touch with community requirements of the forest.

* Balanced provision for all forest values.

* Integrated long term planning for all forest values.

* Carefully controlled timber harvest which provides the maximum economic and employment benefit to Western Australians and stability to regional economies.

* Maximum efficiency in use of timber resources

* Commitment to ongoing research and monitoring of all activities in the forest.

* A vastly increased tree cover in agricultural areas, which will ameliorate land degradation and link up CALM reserves to improve fauna movement.

* A forest ecosystem which has retained the full range of wildlife and the full range of genetic diversity of plant life.

* Careful management of all forest activities to provide the optimum balance of benefits in a sustainable way.

In the short term, the measures by which this vision will be pursued are as follows:

7.1 REFINEMENT OF FOREST MANAGEMENT PLANNING

A far greater level of precision in planning is now possible, using CALM's GIS capabilities. For example, the system of stream buffer zones in the Southern Forest Region could be redesigned to make them function more efficiently. This system could also now be expanded to other areas of State forest. There have also been changes in karri, jarrah and marri utilisation practices and new research results which can be incorporated into the forest management plan.

In the jarrah forest more complete information is available from a major new forest inventory. Also an assessment of the final impact of jarrah dieback disease and of mining in jarrah forests is now possible.

7.2 CONTINUED PROMOTION OF TECHNOLOGICAL CHANGE AND IMPROVED EFFICIENCY IN RESOURCE USE

The Government will continue to give high priority to promoting technological change and improved efficiency in the use of forest resources. The innovative program at the Harvey Wood Utilisation Research Centre will continue to look at all aspects of recovery from logs and value-adding to timber products.

A good example of the results already achieved is the Valwood process. This process offers massive improvements in resource use and availability. It is currently being commercialised with a local company. The same technology will then be licensed to an Eastern States firm, provided Commonwealth funds for commercialisation are forthcoming. The present cooperative research programme with industry will be continued, subject to the availability of funds.

7.3 PROMOTION OF VALUE ADDING FOREST-BASED INDUSTRIES

The woodchip industry has provided a residue-using market for low quality timber which has not only provided an economically beneficial use for a material which would have been burnt to waste, or left to obstruct the proper regeneration of forests harvested for sawlogs, but it has also permitted the use of much lower quality logs for sawmilling than would otherwise be possible. In the karri forest, for example, it is estimated that sawlog standards have changed to the extent that 20% more sawable material is obtained from areas cut-over than were obtained a decade ago. This is one of the explanations for the steady decline in the area of karri forest cutover, over recent years (as shown in CALM 1989a).

The silicon charcoal market has provided similar benefits, but on a smaller scale, for the jarrah forest. CALM will continue to seek outlets of residue material from the forest which both benefit forest management by removal of stand components not required and provide an economic return. In this context it should be noted that there is still a large quantity of low quality material in the forest which has no present use. This applies especially to marri in the central and northern forest regions, which has very poor sawmilling potential. To maintain the present species balance it is essential to utilise the marri along with the jarrah.

Residue markets are essential, not only to assist with regeneration and thinning, but to help improve the aesthetics of sawlog harvesting.

The most obvious means to add value to marri and karri residues and thinnings is to pulp them locally. Studies on pulping options have been in progress for some time but as yet a viable proposal acceptable to Government has not been forthcoming. The situation may change over the next 10 years with current research on effluent treatment and new pulp processes for eucalypts. The opportunity for local pulping will also be enhanced by the addition, toward the end of this decade, of substantial quantities of pulpwood from plantations on private property.

The Government will continue to monitor and assess trends and options in this industry.

The Government will also continue to provide incentives, for example through the log royalty system, which will encourage industry to devote more of its output to value-added uses.

7.4 CREATION OF A LARGE EUCALYPT PULPWOOD RESOURCE

The Tree Fund sharefarming project will be expanded to attract more private sector funding for this programme which, in addition to creating a high quality pulpwood resource, will make an important contribution toward the solution of pressing land use problems in the catchments of several rivers and estuaries.

The pulpwood resource can be used either for export, or for supplying a pulpmill in Western Australia. A decision will be made as the plantations approach harvestable age. It is also possible that a proportion of the material can be used as solid wood with Valwood technology.

From the viewpoint of maximisation of economic and employment benefit to Western Australia, it would be preferable to devote the plantation resource to a local pulpmill. Broad export income figures of $200 million a year and an extra 1,200 jobs give an indication of the potential benefits which could be derived from a pulp mill. However, such a development would have to satisfy stringent environmental safeguards before gaining approval.

However, the new resource cannot be considered as a replacement for the pulpwood resource in native forests. The harvest of this resource will provide an essential means for utilising thinnings, sawlog residues and non-millable logs. The removal of this material is essential to ensure efficient forest regeneration and maintenance of forest growth.

7.5 GREATER EMPHASIS ON VISUAL AMENITY MANAGEMENT IN THE FOREST

At present the visual resource management system is applied only in the southern forest region. It will be extended to all other regions where timber harvesting takes place as the professional and technical staff resources become available. It will also be used in assessing the impact of other developments, such as powerline construction, on visual amenity.

7.6 CONTINUE TO WORK TOWARDS THE GOAL OF A NORMAL FOREST IN THOSE AREAS AVAILABLE FOR TIMBER PRODUCTION

A "normal" forest is one in which there is an even distribution of age classes - ie, all ages of trees are represented in the forest, thus allowing a relatively even yield of timber and maximum diversity of wildlife habitat.

Effective progress in this area requires a stable planning environment. The conflicts of recent years have been very damaging in this respect. Nevertheless, CALM will continue its programme of reconstruction of the forest to a balanced distribution of age classes. The principal benefit of this to the State will be greatly increased timber productivity from the present area of State forest at a level which can be maintained in perpetuity, given no deterioration in climatic conditions. If there is a deterioration in climate, there will be sufficient scope for at least the present level of productivity.

7.7 FASTER DEVELOPMENT OF FOREST RECREATION FACILITIES AND OPPORTUNITIES

As discussed above substantial progress has been made over the last five years in the development of recreation facilities in forest areas. However, there is still a backlog of sites in parks and State forests which require upgrading and there is a major unfulfilled demand. For example, a new development to integrate recreation and water production in State forest in the Mundaring-Jarrahdale area is planned, where these two values become the dominant objectives of management. The plan, which is now under active development, will require large investments in facilities and the development of a range of privately operated concessions to cater for public needs. Such concessions may include shuttle bus, "bush skills", historical artifact presentation and provision of catering services.

7.8 COMPLETE COVERAGE OF FORESTED RESERVES BY SPECIFIC MANAGEMENT PLANS

At present only a few national parks and nature reserves in the forested zone are covered by specific area management plans. This coverage will be expanded as rapidly as resources permit. This will result in on-ground management tailored to the specific requirements of each area.

7.9 POSITIVE STEPS TO PROMOTE BETTER MANAGEMENT OF FORESTS ON PRIVATE LAND

It is a natural extension of CALM's involvement in pine and eucalypt sharefarming to actively promote and encourage, by provision of advice and even financial incentives, better management of forests on private land. Improved management should be for a range of objectives, such as catchment protection, timber production and nature conservation. CALM is promoting the link up of forest areas both public and private to provide corridors for fauna movement and habitat. Ideally, incentives of this nature should be a national initiative.

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