CONSERVATION OF THE KARRI FOREST

FORESTS DEPARTMENT

WESTERN AUSTRALIA

OCTOBER 1981

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by F.J. Bradshaw and A.R. Lush

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"the forest has one singular and providential advantage over most of the earth produced elements of our industries. When we have exhausted an iron mine, a gold mine, an oil well ... it is finished. Not so with the forests. It is in our hands to improve or impair them, to keep them or make them live."

J.J. Jusserand 1905

B.J. Beggs
Conservator of Forests

Western Australia
October, 1981

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PREFACE

The aims and processes of forest management have never been well understood by the Western Australian public, nor even by those who have taken a special interest in forestry activities. In particular, this misunderstanding has focused on the karri forest in the far south-west of the State, where controversy has surrounded such projects as the Group Settlement Scheme in the 1920s and the commencement of a woodchipping project in 1976.

The karri forest region consists of a variety of land tenures, including private property, State forest, National Park and uncommitted crown lands. Recent public interest has been mainly directed toward the State forest, with special attention to such issues as woodchipping, the harvesting of timber resources, provision of areas for recreation and the preservation of flora and fauna, the use of fire in the forest, the level of sawlog cut and the impact of forest operations on water quality.

Proposals on each of these issues have been put forward by sectional interests. The Forests Department, as the managing authority for State forest, has the responsibility to plan for the reasonable requirements of all valid forest uses in the area in such a way that intrinsic forest values are not diminished in the long term. This conforms with the Department's overall management objective for State forest, viz: "the conservation, through planned use and management, of forest land and resources for the greatest long-term social and economic benefit".

This publication traces the history of the various uses of the forest and explains Forests Department management policies and practices in the karri forest. It shows how the reasonable needs of all users can be met with a comprehensive multiple land use planning and long-term stability of forest policy. It also illustrates, by reference to the Shannon River Basin, how pressure for a single forest use over an extensive area can have profound effects on other valid forest uses and the social and landscape values in the region.

The issues concerning the karri forest considered in this publication must of course be seen in the larger context of the whole forest area of south-west Western Australia. The matter of long-term timber yield for example, should include a consideration of the future trends in production of softwoods from the State's pine plantations as well as production of the State's other main native hardwood, jarrah.

The conservation of the karri forest is an ideal case study of the nature of forestry in Western Australia and will provide Western Australians with a clearer understanding of the complexities involved, of the background to the options that have been chosen, and of the multiple use policy which is being practised.

INTRODUCTION

The karri ranks with the giant redwoods and Douglas firs of North America and the mountain ash of eastern Australia, as among the largest living things on earth. Ironically, it is not the beauty and grandeur of the karri forest which have assured its existence as we know it today, but its capacity to produce a valuable commercial timber. Its future security is best assured by a management programme which recognizes and assures the continued provision of both these values and the many other forest values present. Only through this can the karri forest be assured of the support of the entire community for its security and maintenance.

This report describes the management for conservation of that part of the karri forest which is controlled by the Forests Department. It describes the occurrence of the karri forest and the factors which influence it; the history of its use, early plans to convert it to agriculture and the final dedication of part of the forest to secure tenure. The report considers the policy of multiple use management, the strategy of management priorities and the effects of this policy on the long established sawmilling industry in the area. Because of the public interest in the watershed of the Shannon River as a potential reserve area, its implications are discussed in a separate section.

One of the greatest natural threats to any forest, particularly in the Australian environment, is the potential damage and destruction caused by inevitable wildfires. The report discusses the implications to forest management of the fire protection strategy for the karri forest.

Since Europeans first entered the karri forest, various groups have attempted to devote the whole of or a large part of the karri forest to their particular interests. Extreme viewpoints, ranging from clearing for agriculture to preservation for posterity, have failed to recognize the validity of the multitude of other forest uses. The karri forest does not cover an extensive area and cannot cater for the extreme desires of each group. It can, however, provide for the reasonable needs of all users. Forest management is clearly a long-term responsibility

and requires stable policies. This publication describes a scheme of management aimed at providing for the needs of all forest uses for both present and future generations. This policy conforms with the World Conservation Strategy, developed by the International Union for the Conservation of Nature and Natural Resources which defines conservation as "*the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. Thus, conservation is positive, embracing preservation, maintenance, sustainable utilisation, restoration and enhancement of the natural environment.*"

It is in the context of the World Conservation Strategy definition that this publication is entitled "Conservation of the Karri Forest."

KARRI OCCURRENCE

Endemic karri *(Eucalyptus diversicolor)* forests are found in the extreme south-west of Western Australia, largely south of a line drawn from Nannup in the north-west through Manjimup to the Frankland River in the south-east. It extends further eastward to Denmark, Torbay and Albany, but in these areas is confined to the coastal environs and rarely extends more than 15 kilometres inland.

Outlying karri forest occurs on the west coast at Karridale, Yallingup and Margaret River, on the south coast at Black Point and inland near Rocky Gully, Mount Barker, the Porongorups and Mt Many Peaks (Map 1).

The native vegetation of an area is simply an expression of that area's capacity to support growth. The area's capacity is determined by its soil and climatic conditions, which allows karri, and many of its associated species, to reach a massive size. It is the tallest tree in Western Australia and among the tallest in the world, exceeding 85 metres in a few instances, but commonly 70 metres, with butt diameters of 1.5 to 2.7 metres. Most of the virgin forest ranges in age between 150 and 400 years.

Soils

The main karri occurrence is on granite-gneiss bedrock with scattered intrusions of basic rock giving rise to a reddish-brown to yellowish-brown podsolic loamy sand. It occurs where the lateritic cap has been eroded through, or where soil has formed on large residual granite-gneiss outcrops. These soils contain a high silt fraction on the surface, are mildly acidic and have a structure that favours root growth and moisture penetration.

Because of these characteristics and because of the magnificent forest supported by them, the karri soils were considered by the early settlers to be fertile and eminently suited to agriculture. This did not prove to be the case, and two separate attempts at agricultural land settlement were largely unsuccessful. Karri soils are deficient in phosphate and such minor elements as zinc and copper, and only with the appropriate application of fertilizer are able to support intensive agriculture.

Climate

Climate appears to be the overriding factor in the karri distribution, being generally mild with a well defined wet winter and dry, warm summer. Extremes of temperature are uncommon and although the summers are described as dry, average summer rainfall is about 25 mm per month. Mean annual rainfall exceeds 1000 mm per annum.
D.M. Churchill (1967), working on pollen counts in cores from peat swamps, suggested that karri was more widespread in times of heavier rainfall and it may be this climatic variable that has the greatest influence on karri distribution.

Occurrence

Within the main belt, karri does not occur in large continuous tracts but in discrete stands where favourable soils occur. The stands of karri are interspersed with jarrah *(E. marginata)* and jarrah-marri *(E. calophylla)* forests and treeless flats and swamps (Table 1).

TABLE 1

VEGETATION TYPE IN THE MAIN KARRI BELT

	Crown Land Hectares	Private Property Hectares
Pure karri	59 000	2 500
Karri mixed with other species	104 000	7 500
Cleared land (Previously karri)	2 500	33 000
Cleared land (Previously other type)	2 000	26 000
Other forest	200 000	14 000
Other native vegetation	135 500	15 500
Mobile dunes	10 500	150

The karri belt is dissected by the Donnelly, Warren, Gardner, Deep, Shannon and Frankland Rivers, and their tributaries, and karri can be found in all topographic situations from ridge top to mid slope and gully. Its occurrence in the topography follows a logical and fascinating trend from the north-west to the south-east, and is virtually dependent on the presence of the younger reddish-brown to yellowish-brown podsolic loams. Depositional sands support swampy heath and scrub, with jarrah occurring in the transition to karri soils. Jarrah also occurs on the lateritic duricrust (Figure 1), with mixtures of jarrah, marri and karri on the transition from laterite to karri soils.

In the Donnelly River area west of Manjimup, karri is typically found in the deeply incised valleys (Figure 1A), with increasing mixtures of marri on mid slopes. It gives way to jarrah and marri on the upper slope and jarrah on the laterites. As the lateritic duricrust becomes more dissected further south and south-east, numerous smaller tributaries to the major rivers develop shallower gullies and karri extends from the gully onto mid and upper slopes. The Warren-Dombakup area illustrates this situation and it is in such areas that the largest contiguous occurrences of karri can be found (Figure 1B).

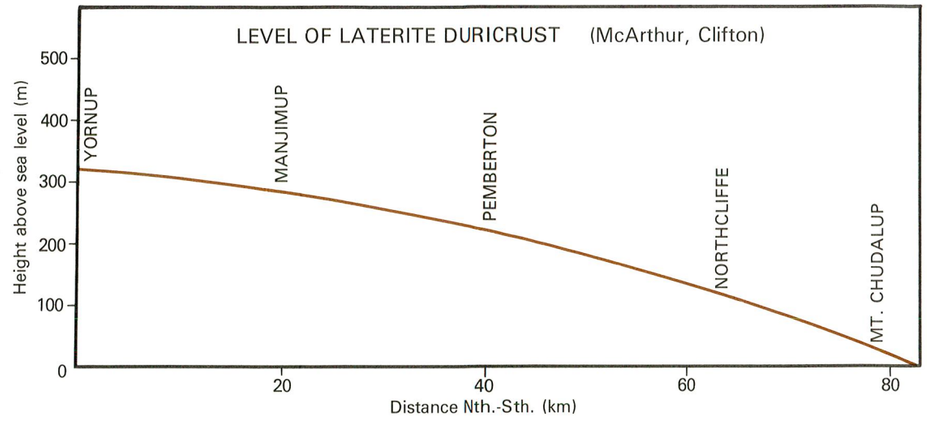
Still further dissection occurs to the south and south-east, and at some time in the past these areas have been inundated by the sea. Subsequent depositional podsolic soils are now supporting extensive flats of swampy heath and scrub, and karri is found where remnants of the older land surface protrude. In this situation karri is located on the low hills standing above the flats. It is also found in river courses where erosion, following inundation, has dissected the podsols and once again exposed karri soils (Figure 1C). Jarrah has also developed wherever the original lateritic duricrust remains and on the fringes of the flats.

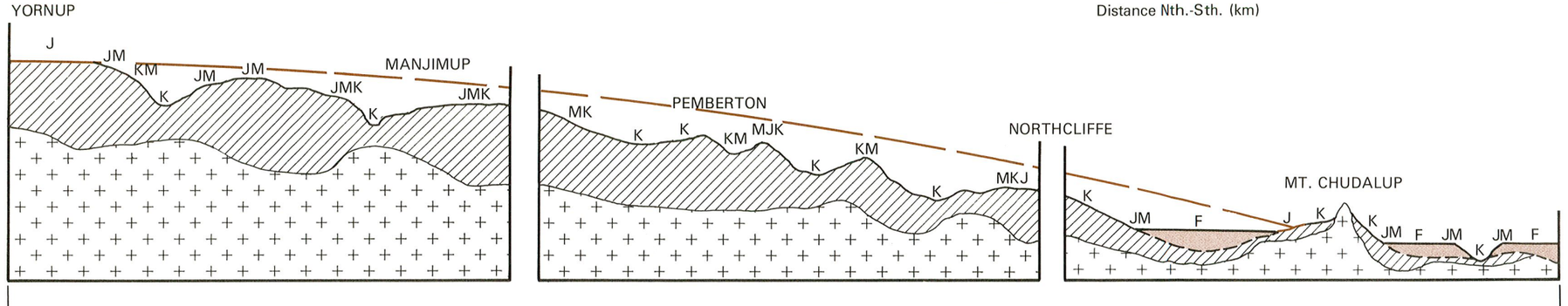
Mt Chudalup is of particular interest for two reasons. Firstly

FIGURE 1

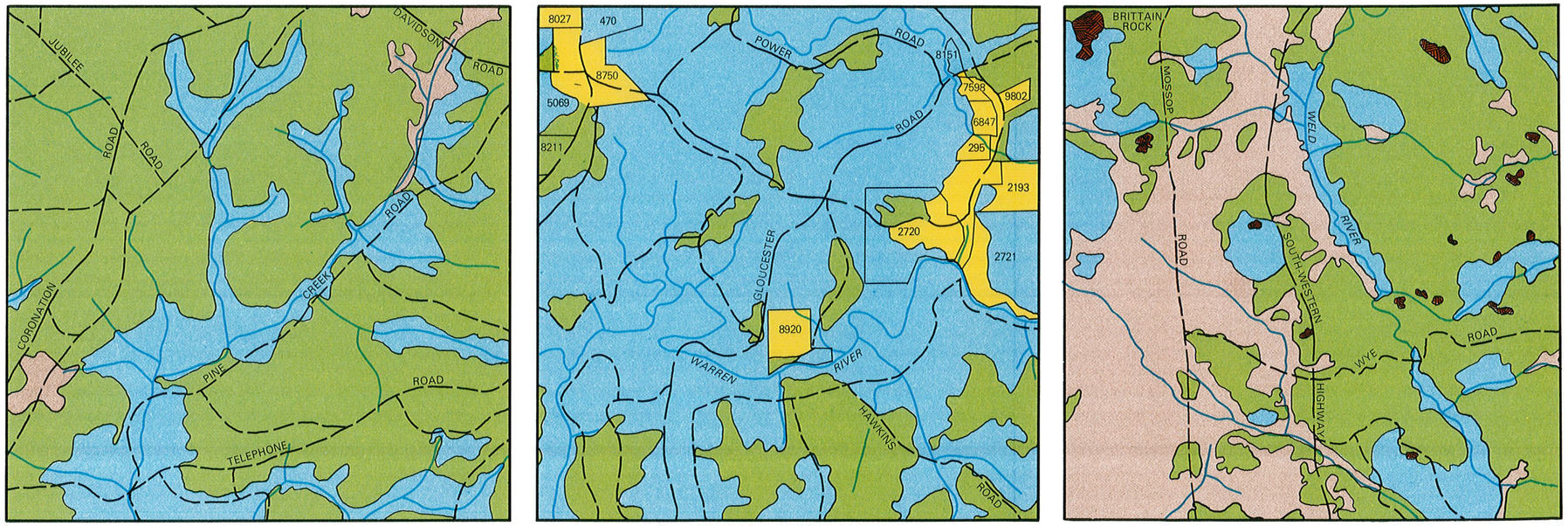
RELATIONSHIP BETWEEN KARRI, LANDFORM AND SOIL

Not to Scale





SCHEMATIC PROFILES



A DONNELLY TYPE B WARREN/DOMBAKUP TYPE C GARDNER/CHUDALUP TYPE

THE NATURE OF KARRI OCCURRENCE ACCORDING TO THE PROFILES

LEGEND

Lateritic Duricrust	Cleared P.P.	Karri —K
Lateritic Duricrust removed by erosion	Flats and non-forest	Jarrah—J
Current land surface	Karri	Marri—M
Depositional Podsols	Jarrah	Flats —F
Granite Gneiss Bedrock	Rock	

it contains remnants of the lateritic duricrust so obvious further north, and secondly it is one of the most westerly occurring outcrops of the granite-gneiss bed rock, called inselbergs.

As dissection of the lateritic duricrust increases from north to south, so does the occurrence of igneous outcrops increase from west to east. Inselbergs become more common east towards Walpole, and hills and ridges become more and more prominent. The highest point is Mt Frankland at the eastern end of the main karri belt. In the north-eastern part of the main karri belt, prominent hills and ridges appear to have disrupted old drainage lines, which have in turn been filled with deposition. This has given rise to extensive flats north of Mt Burnside, Mt Mitchell, Mt Roe and Mt Frankland, to name a few, and particularly north of the Beardmore Ridge. These flats exist at different altitudes and are all above the extensive coastal flats. Again karri is found on karri soils protruding above these flats, and in the few river valleys that dissect them.

The transition from pure karri to jarrah-marri forest is often abrupt, giving the impression of a patchwork forest constantly changing from karri to jarrah and back to karri again.

Karri forest ecosystems

In a limited area near Walpole, karri occurs in association with red tingle *(E. jacksonii)* and yellow tingle *(E. guilfoylei)* and with Rates tingle *(E. brevistylus)*, a recently described eucalypt of even more limited occurrence.

There is considerable variation in the karri forest ecosystem from north to south and from east to west. The dominant species in the shrub layer in the Donnelly River Valley is netic *(Bossiaea laidlawiana)*, whereas in the Shannon River Valley it is karri wattle *(Acacia pentadenia)*. Near Walpole the karri wattle is interspersed with sword grass *(Lepidosperma effusum)*. Zamia palm *(Macrozamia reidlei)*

is a dominant species in the ground flora in the lower reaches of the Warren River and *Acacia urophylla* becomes an impenetrable thicket in certain limited localities, almost to the exclusion of other species. Hazel *(Trymalium spathulatum)* tends to dominate where the karri reaches the height of its development and tree hovea *(Hovea elliptica)* is a strong component of the ground flora in mixed stands, particularly along the northern periphery of the karri forest.

The karri forest today

Management for all karri forest on crown land is vested in either the Forests Department, the National Parks Authority or various other government authorities (Table 2, Map 3).

Today some 168 000 hectares of karri forest remains on crown land, of which 163 000 hectares lies within the main karri belt, with an additional 13 000 hectares on private land.

TABLE 2

KARRI ON CROWN LAND - MAIN KARRI BELT

	Hectares
Land managed by the Forests Department	145 500
National Park and proposed National Park	13 000
Other crown land	4 500
Total	163 000

The only significant area of karri forest on crown land which does not enjoy permanent security of tenure occurs within the proposed D'Entrecasteaux National Park. Originally recommended for vesting as National Park by the Institute of Foresters of Australia in 1972, it was subsequently accepted by the Environmental Protection Authority (E.P.A.) and endorsed by Cabinet in 1976. The formal dedication of the area is yet to be completed (1981).

Early settlement, in particular the Group Settlement Scheme of the 1920s, was responsible for the ringbarking and clearing of substantial areas of karri forest in the Denmark, Walpole, Manjimup, Pemberton and Northcliffe areas.

The Conservator of Forests, C.E. Lane-Poole, in his first inspection of the karri forest in 1917 wrote:

"On this journey we came upon the first karri trees, but unfortunately most of them had been ringbarked. It appears that a few years back an attempt was made to settle this part of the country, and many thousand acres of glorious karri, running up to 60 and 100 loads to the acre, were ringbarked. The settlement did not come, and today the forest is recovering the country."

Dead karri still remain in some areas as a stark reminder of this period.

A survey of cleared areas that originally supported karri forest was carried out in 1981 and it is estimated that 35 000 hectares of karri forest have been lost to clearing for agriculture.

But for the efforts of Lane-Poole and his successors, the majority of the karri forest is likely to have been cleared and Map 2 illustrates the additional areas that had been surveyed for alienation by 1927. Included within this area is 65 000 hectares of karri forest.

DEVELOPMENT OF FOREST POLICY AND PRACTICE IN THE KARRI FORESTS

Present forest policy and practice can only be fully appreciated when its development is considered along with the development of the State and the attitudes that prevailed at the time.

For almost the first 100 years of W.A. settlement, forests were, in general, looked upon either as a valuable source of export earnings or a hindrance to land settlement.

In his annual report of 1917 Lane-Poole bitterly recorded that, *"Forests, instead of being regarded as assets, were looked upon as irritating excrescences on the face of the earth, to be sawn up, ringbarked or otherwise destroyed to make room for the settler."*

Whilst these attitudes are not difficult to understand, in that era of early development of the State, the consequences to the forest were devastating. Uncontrolled sawmilling ranged over the best of the accessible forests, cutting the best trees for a demanding export trade and burning the remaining wood because there was no market for the smaller or poorer quality material. Sleeper hewing was also widespread and was even more wasteful. Permanent loss of forest and forest land occurred through alienation for agriculture wherever the soil was considered suitable. Accompanying both were frequent devastating forest fires that followed in the wake of cutting and settlement, repeatedly burning and damaging any regrowth that did develop. There was neither the interest nor the facilities to prevent these wild fires and indeed fires were encouraged to assist with access and provide fresh foliage for livestock.

Although a Forests Department was formed as a branch of the Lands Department in 1896, it was little more than a revenue collecting organization having neither funds, staff, nor public or legislative backing to effect any degree of control. Regrettably, for 17 years, it was without a trained forester to lead it.

With the exception of Karridale and Denmark, the karri forest remained relatively unscathed because of its inaccessibility. However, preparations were in hand for its virtual annihilation. There was no doubt in the minds of policy makers of the time, that the future of the State lay in a strong rural economy. The karri forest with its high rainfall and apparently fertile soils was seen as able to support a large rural population. In 1909 six survey parties began work to survey the Frankland, Gardner and Warren rivers, among other general surveys. Chief Surveyor Brockman reported that:

"I found all through the country traversed to this date, that a large proportion consists of fine soils. The good soil areas are, however, broken up by most irregular karri forests, and by the mingling of karri and red gum and other trees in such heavy proportion of karri that it would be unwise to sell the areas until the timber has been marketed, unless some means can be devised to prevent its waste."

By the following year, subdivision surveys in the Manjimup and Pemberton areas were well advanced and the use of contract surveyors was recommended to speed up the work. The opinion was voiced that *"land should not be devoted to the production of timber when it is capable of producing other items required on the world market."*

Forest Rangers had the duty of inspecting blocks applied for, to determine whether they should be released immediately or held as timber reserves. To prevent unnecessary survey work, a classification was begun to demarcate those areas that carried little timber and could be surveyed for immediate alienation.

To assist settlement and also tap the karri wood resources, the railway was extended to Jardee in 1911 and mills were

established at Deanmill, Pemberton and Jardee. In 1913 Surveyor Brockman reported *"no mill has been in operation during the year. I still anticipate that as soon as these are in full swing they will have a marked effect on selection if the adjacent areas, free from marketable timber, are made available for mill employees and others."*

The concept of a scientifically managed forest providing a perpetual yield for future generations was relatively new in the English speaking world, though well established in Europe. It must be remembered that W.A. was settled predominantly by the British who, in the 19th century at least, had no forestry tradition. Britain had been largely deforested by the middle ages and timber was always available in cheap and plentiful supply from Scandinavia and the colonies.

In 1914, Hutchins, a professional forester from South Africa engaged to report on forestry in Australia said:

"Public opinion on forestry is nearly absent in Australia ... there is nothing more remarkable than the attitude of the people with regard to modern scientific forestry. Australia is paying out £10,000 a day for imported timber ... the country in its most fertile parts is losing its beauty and its perennial waters, owing to the destruction of its forests, and yet its workers, its public men and its men of letters, with few exceptions, know little of what modern forest science is doing for other countries."

While he recognized the full range of forest values, the main thrust of his argument was firmly based on the advantages of the "managed" forest providing a continuous supply of products at a higher rate than the present virgin forests and with social benefits and an economic return at least equal to agriculture. This contrasted sharply with what he called the "backwoods" mentality of cut out and hope for the best, which was the philosophy till then.

Following this report C.E. Lane-Poole, an Englishman trained in the Foresters School at Nancy in France, was appointed Conservator of Forests in 1916. His first task was to draft a Forests Act that would enable forest areas to be permanently dedicated as State forest (revokable only by resolution from both Houses of Parliament), without which any idea of long-term forestry was futile. The Act provided powers to control the industry and made provision for funds for management. Much of the debate during the passage of the Forests Act concerned the power of the Conservator. Stability of policy was and still is essential for long-term forest management and the Act was designed to minimize the influence of sectional interests. So concerned was he with this, that Lane-Poole sought to have the Conservator directly responsible to Parliament but this was not accepted. Despite the fact that the initial emphasis of the Act was on the control of the timber industry, it was far sighted enough to include as the first objective of the Forests Department "the exclusive control and management of all matters of forest policy."

Although the classification of land suitable for agriculture had been practised throughout the south-west since the turn of the century, detailed classification of the karri region did not begin until 1920. This classification differed in that the objective was to determine which areas were best suited for both agriculture and permanent forest. Detailed ground surveys were carried out by foresters and surveyors and agreement reached between the Conservator and the Surveyor General. In this early example of land use planning, forests dominated by karri were to be reserved and mixed stands dominated by marri were to be alienated to provide land for the settlement of returned soldiers and British migrants. However, the adoption of the Group Settlement Scheme in 1921 put further pressure on karri areas, and all areas cut over to 1924, including pure karri stands, were alienated. Further substantial areas were ringbarked instead of being logged, as the sawmilling industry was unable to keep pace with the requirements for

land clearing.

Lane-Poole resigned in 1921 as a protest against lack of government support for forestry. Evidence given before the Royal Commission of 1922 which followed his resignation gives an interesting insight into the attitudes of the times. Much of the evidence concerned an area of pure karri north of Pemberton known as Eastbrook. The government planned to alienate this area contrary to promises that such areas would be permanently dedicated as State forest. The past practice of sawmills cutting over an area and moving to the next site, left behind a series of abandoned settlements. The new settlers, anxious to see permanent towns and facilities established, were pressing for consolidation of agriculture on land cut over by the mills. Even accepting that a karri forest could be regrown, 100 years to the next crop of trees could not compare with an agricultural return in perhaps three years.

The sawmillers also preferred farm development to follow rather than precede their logging operations. The primary reason was to ensure maximum utilization of the resource, but the millers also remained apprehensive that farm settlements would restrict future access for logging railways.

As a result of these pressures, the Eastbrook was alienated. However, the foresters' arguments eventually prevailed, and in 1925 the first karri forest was dedicated as State forest: an area of 2900 hectares at Big Brook. Until that time the only permanent reserves of karri forest were the Warren and Beedelup National Parks, gazetted as "timber for Government requirements" in 1901 and as National Park in 1915. In 1929 the area of karri in State forest was increased to 61 000 hectares, but it was not until 1955 that the bulk of the karri areas now in State forest were finally dedicated. The struggle to secure dedication of State forests was long and hard and as late as 1959 the Conservator wrote:

"This is an urgent matter. Without real security of tenure, forest management cannot be practised, nor expenditure justified. It is a matter of apprehension that after 40 years since the passing of the Forest Act, this basic principle has to be continually stressed and fought for, and the erosion of forest areas still goes on."

Development of silviculture

Immediately following the dedication of Big Brook, regeneration work began. A working plan was prepared in the same year and a settlement established. The silvicultural system employed was the clear felling method. The mill having removed most of the trees, regeneration preparation was carried out and the area burnt in the following seed year in 1928, with a further 1800 hectares burnt in 1929/30. The cull trees that had been used to provide seed were then ringbarked.

Clear felling was an accepted silvicultural technique which was advocated by most Australian forest services and strongly recommended by Hutchins. He saw it as ideal for eucalypts and saw selective cutting as an interim system till full utilization of the smaller and poorer components of the stand could be effected. Prolific regeneration following clear felling at Denmark and Karridale showed every reason for confidence. The importance of demonstrating the ability of the karri forest to regrow was not overlooked by Lane-Poole when, on a tour of inspection in 1917, he saw the 40-year-old regrowth on the area now known as the 100 Year Forest. He immediately arranged for measurement plots to be established and for its subsequent inclusion in State forest. This head start to demonstrate the management potential of karri regrowth was no less important then than it is now.

The clear felling system was maintained until about 1938 when for a variety of reasons it gave way to the selection system. The clear felled areas, apparently devastated and finished with, were under continued pressure for release for

agriculture. The selection and retention of groups of trees gave the layman an impression of continuing productivity and significantly reduced the pressure for the alienation of the cut over stands. There was also the problem of waste. Standards of utilization adopted at the time were based mainly on the production of quality items for an export trade. Logs from smaller or defective trees could not be used and therefore had to be burnt during the regeneration operation. Added to this was the growing awareness, as more forest was inspected and assessed, that substantial quantities of old growth timber were deteriorating due to fire damage and old age. A lighter selection cut would enable this wasting resource to be salvaged sooner and speed up the provision of access to remote areas of the forest to facilitate fire protection. All of these factors contributed to the change from clear felling to selection cutting in the 1940s.

The abundance of labour available for regeneration work during the Great Depression changed dramatically at the start of the Second World War and forest management was reduced to little more than fire protection of the new karri regrowth. The post-war population and building boom brought about a great increase in activity in the karri forest region. Production of timber for housing was given top priority by the government and its use for other purposes was strictly controlled. A reduction in the level of cut timber from the northern jarrah forests was offset by increased production from the south, and in 1951 new mills were opened at Donnelly River, Quininup, Northcliffe and Shannon River.

The Conservator of Forests continued to express concern at the level of cutting and the long term capacity of the forest to sustain it, particularly since much of the production was coming from areas destined for alienation. This led to a greater impetus for pine plantations to meet the State's need for timber, for improved fire control measures to reduce the loss of the resource and for the

permanent dedication of more State Forest. The option to reduce the level of cutting at a time of national need was unacceptable.

During the 1950s and early 1960s, the emphasis of karri forest management focused on the regulation of the timber industry and the improvement of a regional system of fire control.

The silvicultural system again came under review in the mid 1960s. There were a number of inherent problems with selection cutting and regeneration of karri forest. Among these were the difficulties of burning for regeneration in small gaps in the forest, with a fire that was intense enough to produce good seed bed conditions but not hot enough to damage the remaining trees; the decline in health of the retained trees due to either fire damage or their sudden exposure after partial cutting; and the depressive effect of the retained trees on the regrowth. However, of even greater importance was the problem of carrying out the second cut, inherent in any selection system. This involved the felling and removal of large heavy trees, amongst groups of regeneration, followed by another hot regeneration burn. This was an impractical proposition, causing excessive destruction of the regrowth so carefully secured and nurtured up to this time.

Furthermore, by the 1960s, dedication of State forest in the karri region had been completed and the need to retain groups of trees as a barrier to alienation was no longer important. For these reasons the selection system was discontinued in favour of clear felling in 1967.

The next major change in management practice occurred in 1975 with the establishment of the woodchip industry. Although the industry was new, the idea was not. From the very beginning of forestry in this State, the need for a pulp industry to utilize non-millable trees was

realized. Non-millable trees were left to be burnt following sawmill operations or left standing to inhibit regrowth and degrade the forest for future generations.

The biggest single barrier to the sound management of any forest for wood production is the inability to market the poorer components of the stand. In order to ensure full regeneration after cutting it is necessary to remove trees that are unsuitable for sawmilling but that, if left standing, will compete with the new regrowth. To do otherwise and repeatedly remove the best trees in the stand will inevitably lead to the degradation of the quality of the forest.

However, trees unsuitable for sawmilling can often be used for the manufacture of the wood pulp used in paper making. A pulp industry in W.A. was first suggested in 1899 and was recommended by the Royal Commission of 1922. A pilot plant had produced paper from karri in 1920 at the Perth headquarters of what was later to become the Division of Forest Products of the C.S.I.R.O. Feasibility studies by an Australian paper company in the 1950s came to nothing, but improved paper making technology made the export of woodchips to Japan for pulp and paper manufacture a reality in 1975. This made it possible to improve the regeneration operations in pure karri stands and to satisfactorily regenerate mixed karri and marri stands for the first time. Until this time, such forests had been avoided where possible, but where this was not practicable, the marri was ringbarked, poisoned or bulldozed to make way for new regeneration.

Other forest values

From about 1970,a growing public demand for recreation in the karri forest was accompanied by a greater emphasis being given to this aspect of forest management. A growing public interest in forests co-inciding with an increased demand for wood products, necessitated the formalization in

1976, of the multiple use policy of management for State forest. The strategy for the implementation of this policy is a combination of zoning and multiple use, embodied in the concept of priority uses.

The impact of the acceptance of the multiple use policy on the potential yeild of the karri forest for wood products has been dramatic. To counter the reduced yield brought about by the designation of areas for uses other than wood production,and take into account the latest inventory and yield data, a programme of reductions in sawlog cut was introduced with the General Working Plan of 1977, and is now in the process of implementation.

The advent of the woodchip industry has again focused public interest on karri forest. The challenge facing the forester of today is the same challenge faced by his predecessors over the last 50 years: to ensure that, the resolution of the conflict between sectional interest groups is not at the expense of the forest and those who inherit it.

MANAGEMENT PRIORITIES

The World Conservation Strategy defines conservation as *"The management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations, while maintaining its potential to meet the needs and aspirations of future generations. Thus, conservation is positive, embracing preservation, maintenance, sustainable utilisation, restoration and enhancement of the natural environment."*

When applied to forests, this definition conforms with the long held fundamental principle of forestry. It includes the inherent belief of foresters that with sound management, forests may be used without causing their destruction. It is regrettable that the observation by Hutchins in 1916 is still true today,
"there is a popular idea that to work a forest is to destroy it; .. the man in the street sees the forest as a thing of beauty, and he sees a section of forest which is in course of working, temporarily bereft of its beauty; so he jumps to the conclusion that to work the forest is to destroy it! Where there is no scientific forestry, working the forest tends to destroy it, but that is the result, not of use, but of abuse."

Conflict over karri forest management is not new. During the period that the Forests Department has been responsible for the management of State forest, public opinion has gone from one extreme to another, from a desire to remove the karri forest in favour of agriculture to an expressed concern for total preservation.

Neither extreme does justice to the potential of the karri forest which, with sound, stable management can provide the full range of forest values and products in perpetuity. Balanced multiple use management is seen as the best means of achieving this.

Multiple use management of the forest may be considered in several ways:

(1) to provide a full range of uses on all forest areas at the same time;

(2) to be a zoning of exclusive uses on different parts of the forest for all time;

(3) to provide for different uses of the forest at different times in its life cycle.

The adoption of any one of these strategies in isolation is considered to be neither desirable nor practical and the concept of "priority uses" recognizes and incorporates all of these strategies.

Management by priority uses means:

(1) any use may take place in an area, provided it does not conflict with the priority use;

(2) a priority use is not a zone of single use, though some priorities may be less compatible with other uses, for example, flora, fauna and landscape priority areas will be more restrictive of other activities than would a wood production priority area;

(3) the management scheme for a priority use will be designed to provide the maximum opportunity for other uses, for example, maximum recreational opportunity should be allowed for in a wood production priority area, provided it is not to the overall detriment of wood production;

(4) the priority uses have been nominated in the broadest sense and the principal activity may vary from these at different times, for example, logging activities in a wood production area will, in fact, dominate only a part of the forest area at any time and for a comparatively short period in the forests rotation. Therefore, it has a high value for a variety of other

uses before cutting and after regeneration, and its value for specific purposes will change with age;

(5) a priority use over a broad area does not preclude the use of small, specific areas for an entirely different use, for example, road verges, stream sides and scientific plots may be located and used for preservation, recreational use or scientific study within an overall production area.

Further, the complementary nature of adjacent land management areas should be recognized, for example, National Parks and some Forests Department management priority areas complement one another and should not be regarded as entirely separate entities,or in competition.

The priority use areas recognized in the management plan (Map 4) that apply to the karri zone are:

Flora, Fauna and Landscape,
Wood Production,
Catchment Protection,
Protection of Forest Values,
Scientific - Research,
- Silvicultural,
Recreation,
Road, River and Stream Reserves.

TABLE 3

SUMMARY OF MANAGEMENT PRIORITIES AND NATIONAL PARKS IN MAIN KARRI BELT

Allocation	Percentage		
	Karri forest	Other	Total
1 Flora, fauna, landscape, recreation, road, river and stream reserves	25.0%	19.0%	20.9%
2 Wood production	57.5%	45.5%	49.7%
3 Forest values, catchment protection, scientific	8.0%	9.0%	8.7%
4 National Park and proposed National Park	8.0%	22.4%	17.5%
5 Other crown land	1.5%	4.1%	3.2%
Total	100%	100%	100%

Flora, Fauna and Landscape Priority Areas

These areas have been selected to represent the range of major forest communities that occur within the area and were approved by the Environmental Protection Authority in 1976. While they include some of the more impressive areas of karri forest, they have also been chosen on an ecological basis to represent the range of forest and other natural vegetation communities which occur in the area, the protection of which is equally important. With the exception of parts of one area, all areas are virgin forest and in general, only sparsely roaded. The management objective for these areas is to retain them in as near natural conditions as possible.

In a forest system which is a living, dynamic and diverse entity, and subject to a wide range of natural influences,

a problem arises in defining what is natural. The very existence of man in the environment makes it no longer possible to leave the forest's fate to chance and positive management is required. Fire occurrence provides a good example of this. Fires are a natural part of the forest environment and in pre-settlement times fires burned throughout the whole forest area with different frequencies and intensities, dictated by chance ignition, fuel quantity and weather conditions. It is no longer an option to allow this to happen, because man has an influence on fire frequency and there are other values that require protection.

It is also debatable whether having selected, for example, a fine stand of karri worthy of preservation, that it should be allowed to be killed by a wildfire in order to seem natural. If this were to occur, then at least part of its original reason for selection would have been lost. In pre-settlement times, if one area were damaged by a wildfire there were always others that were not. It must be realized that these areas have been selected at only one point in time.

In order to simulate natural processes as far as possible, management will include a burning regime aimed at producing a variety of fire frequencies, tending to longer cycles than is the case elsewhere, but consistent with the protection of the area and neighbouring areas from devastating fire. The variety of fire frequency is intended to neither favour nor disfavour particular elements of the flora and fauna populations, each of which has a particular niche in a constantly changing system.

Activities that would be detrimental to the management objective will not be permitted. Recreation will be encouraged but would be of a low key variety such as bush walking. Additional facilities for vehicles or intensive recreation would not be permitted. Flora, fauna and landscape use is therefore the closest there is to a

single use zone. The area designated in this category is 38 500 hectares and its locations and proximity to other use areas are shown in Map 4.

It has sometimes been commented that these areas are too small to be a viable ecosystem and that a minimum of 20 000 hectares of karri forest type is required for viability. This observation appears to have been made on the basis of areas that are totally surrounded by an alien environment, and should not be extrapolated to the situation under discussion here. The argument for a large, compact reserve considers the reserve to be an "island", and has in mind the long-term survival of the bigger, more mobile mammals. In a multiple use forest whose character may be modified in parts, but not essentially changed, this argument does not apply.

Furthermore,karri and many other forest types do not naturally occur in such large contiguous areas (the total area of red tingle forest, for example, is only about 5000 hectares).

Wood Production Priority Areas

These areas have a priority for the production of wood for community use based primarily on the native karri forest and with the objective of long rotations (length of time between regeneration and harvest). It has already been described how wood production has a long association with the karri forest, having begun in the Karridale area 100 years ago and been active in the main karri belt for about 70 years.

By world hardwood standards, the growth rate and the capacity of karri to produce sawlogs is high.

However, the adoption of a formal multiple use policy as expressed here has had a dramatic effect on the capacity

of the karri forest to produce sawlogs at the level previously possible. The strategy required to restore this balance is described in a later section.

There are two main objectives of long rotations. Firstly, they provide a continuing high level of other forest values, and secondly, they maximize the options available in the future. It is quite possible, for example, that large sized sawlogs resulting from long rotations may not be required by future generations, but by planning for them now, the options remain open. Should succeeding generations choose to adopt shorter rotations and perhaps re-constituted wood technologies, then they can do so. If, however, that assumption were made and planned for now, they would be committed to this strategy. On the other hand, should there be no future requirement for these products, the forests may be allowed to grow on and in time would be indistinguishable from the virgin forests.

Although 100 years has been chosen as the initial rotation, present planning strategy makes it possible to shorten or extend this in subsequent rotations according to the needs at that time. We cannot dictate the needs of future generations, but we can and should provide choices. In planning of this kind, even the adage *"we have not inherited the earth from our parents, we have borrowed it from our children"*, seems rather too short term.

Although this is the largest single priority use in the main karri belt and has the most dramatic short-term effects, it is one of the least restrictive priority uses and the actual production phase on any given area occupies a relatively short period.

Its suitability for other uses before and soon after this phase is substantial, as is evidenced by existing regrowth forests which provide a wide range of forest uses, including recreation and conservation of the flora and fauna.

Following clear felling, production activities may only disrupt other uses for perhaps two periods of two years during the next 100 years. If we take recreation as an example and assume that, for say 20 years after clear felling and regeneration, the area is not ideal for recreation, then at any one time 80 per cent of the wood production priority areas have high recreation value.

Catchment Protection Priority Areas

This designation is currently given to only one area in the karri forest, namely the catchment for the Manjimup water supply. An additional area is expected to be included when a suitable additional dam site has been located. Most of the karri forest lies within the high rainfall zone where salt problems are not serious, although there are some anomalous areas. The major consideration in this particular catchment is the control of activities to minimize siltation. There are no recreation pressures on the area.

Although a portion of the karri forest is in the zone affected by clearing restrictions imposed on the Warren River catchment, normal forestry activities do not conflict with these requirements.

Protection of Forest Values Areas

Areas in this category have a priority use for the maintenance of forest cover for general protection of the environment and provide for a full range of forest activities and values.
The normal range of forest based activities may occur within these areas.

Scientific Study and Education Priority Areas

These are areas of significant size which are the subject of a specific research programme or are required for long-term observation and demonstration. The management of these

is governed by the requirement of the study. When the study has been completed,the priority use may change. Conversely, other priority use areas may change to scientific study, provided that this did not conflict with the original priority use designation. Those which currently exist in the area include a series of paired catchments used for hydrological research, a dieback disease observation area and silvicultural demonstration areas.

In addition to these, smaller experimental sites occur throughout a number of other priority use areas and are subject to similar constraints and uses, but because of their number and small size they are not specifically designated.

The objective of silvicultural demonstration areas is to create, within a relatively small region, a forest that represents all stages of its life cycle. In order to create new age classes at various times, logging will be required, but only for this purpose. The areas will therefore not be regarded as part of the normal wood resource. Within the main karri belt there are three examples of such areas: in the red tingle forest, the yellow tingle forest and the karri forest respectively.

Two other small areas, one clear felled and one selectively cut, have been included in this broad category but do not share the same management concept, as they are specific areas for long-term observation and demonstration.

Recreation Priority Areas

Recreation means different things to different people and may require a variety of forest environments. The karri forest provides the usual range of forest based recreational interests, including sightseeing, picnicking, bush walking, canoeing and fishing.

Apart from the recreational potential common to any forest, the spectacular nature of the karri itself and its associated vegetation are a prime attraction. Recreation and tourism in the area are recognized as a growing and potentially important industry and one in which forest areas have an important, though not exclusive role.

Because of its distance from centres of population, are area is not subject to the influx of large numbers of day visitors. Touring and sightseeing constitutes 36 per cent of the forest visitors at present, and 20 per cent of all the visitors are from the Eastern States. Forest recreation patterns are focused on the main roads or particular sites of interest for day visitors or those interested in a longer stay. Even bush walking falls into this category and because of the dense nature of the forest understorey, requires the use of old tracks or developed trails. The few large recreation priority areas are therefore located around areas with a particular feature. The management of these areas will be directed towards the maintenance and enhancement of their recreational potential, but will remain forest oriented.

The majority of recreation usage is and will continue to be catered for along major roads and at points of special interest within other designated use areas. Only 23 per cent of the currently developed picnic sites are in recreational priority areas. This allows for the maximum use of diverse and widely separated features of recreational value which do not exist and cannot be catered for in fewer larger areas. The adjacent National Parks, which include the capacity for coastal recreation, complement the recreational values of State forest.

Although the presence of large karri trees will continue to be a major stimulus for recreational interest in this area, pristine areas are not a necessity for recreational enjoyment, as shown by the popularity of the regenerated forest along

the Rainbow Trail near Pemberton.

It seems likely that major expansion of recreation in this area will be limited more by the availability of complementary recreation facilities than by suitable areas of forest. Recreation within State forest will continue to be developed on the basis of forest orientated activities and the provision of facilities for people to improve their understanding and enjoyment of the forest. Supplementary facilities and development need to be provided outside State forest.

Road, River and Stream Reserves

These areas have been selected for a variety of purposes and consist of designated areas along major roads (800 metres in width), rivers (400 metres in width) and nominated streams (200 metres in width). They have been established to maintain vistas along major roads and rivers, as corridors for fauna movement and repopulation following adjacent disturbance, and general protection of rivers, streams and their environs.

These corridors provide a diverse fauna habitat throughout the entire area and for this purpose are considered better than fewer larger reservations that cater for these needs only in selected areas. Because of their position and distribution throughout the main karri belt, these areas also make a significant contribution to recreation and conservation in general.

Central to the management scheme outlined here is the consideration of the forest as a whole and not as separate units that have no value for other activities. The concept of preserved forests and industrial forests is inappropriate and exclusive in nature and reflects a lack of appreciation of the capacity of forests to produce a wide range of benefits and a lack of understanding of forests as dynamic

systems. Multiple use management aims to recognize and cater for the special requirements of each forest value while at the same time maintaining the viability and the capacity of the forest to produce a full range of forest values over its entire area.

WOOD YIELD FROM THE KARRI FOREST

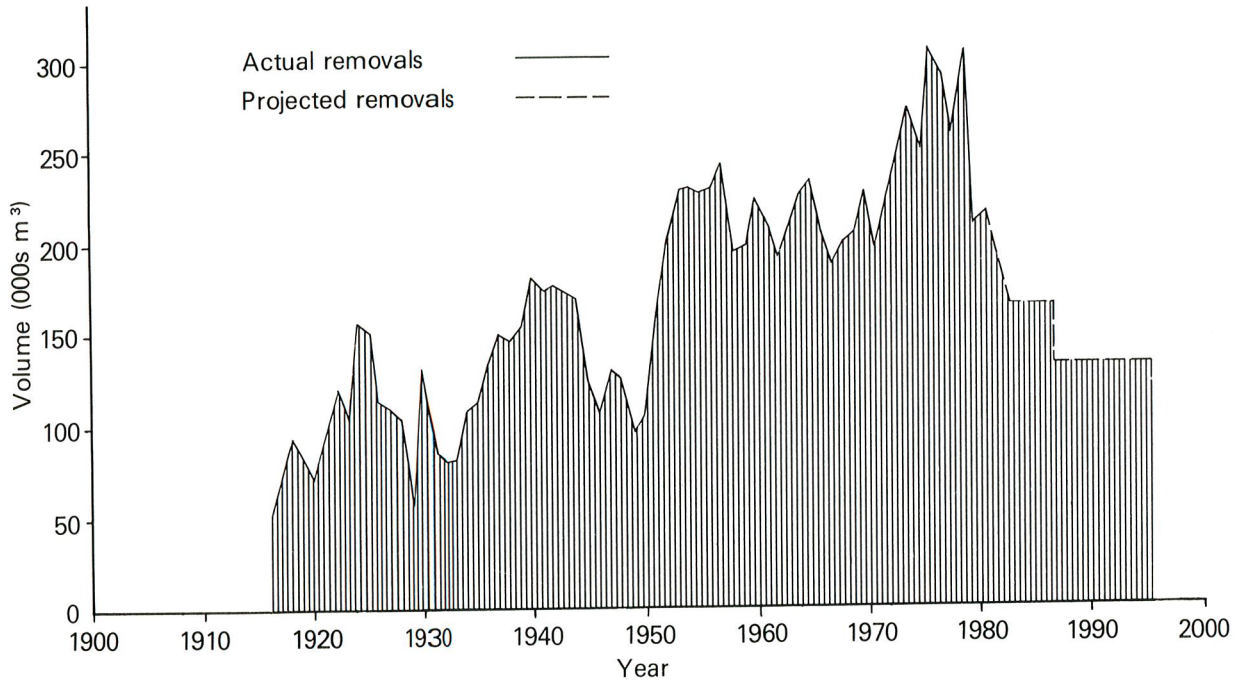
Determination of an appropriate level of sawlog yield from State forest could not effectively begin until 1955 when the last of the significant dedications of State forest were made. Without this security of tenure, a stable resource base on which to establish a level of sustainable production did not exist. By this time new mills had been established in the karri forest area to relieve the pressure of cutting on the northern jarrah forest at a time of heavy demand for wood from the post-war building boom.

Until about 1970, there was a substantial volume of timber available from private property and from land about to be alienated, and milling activity was encouraged to enable this resource to be utilized. When this resource became depleted, the burden of maintaining these historically established cutting levels fell almost entirely on State forest. Until 1976, the cutting levels allowed for each mill were total levels regardless of species, and the rate of cutting of any one species dependend on market preference. These factors, co-inciding with a boom in the demand for sawn karri timber in the 1970s, saw by 1976 an established karri cutting level higher than the karri forest's capactiy to sustain it (Figure 2).

Concurrent with this increase in karri cutting was renewed emphasis for multiple use forestry. The Forests Department's working plan of 1972 first stressed the need for selected forest reserves and focused attention on flora and fauna conservation, catchment management, amenity values, recreation and mining. Consequently, significant areas of karri were assigned priorities for management other than timber production, and this was formalized in the working plan of 1977.

FIGURE 2

KARRI SAWLOG REMOVALS FROM CROWN LAND



In fact, the area of crown land karri unavailable for timber production increased from the five per cent that was National Park in 1972, to 40 per cent in 1977. Such a reduction of the available resource had the inevitable consequence of requiring a corresponding reduction in the level of cut.

While the objective for total sawlog production is to meet the State's needs, it must be considered in the form of softwood, and hardwood (jarrah and karri). Since the management requirements for each forest are different, the

yield of each must be determined separately and then combined, as necessary, to meet the total requirements.

Wood Production Options

In 1976, when the government accepted the multiple use policy, karri forest managers were faced with a dilemma. On the one hand there was an established industry with its social and community infrastructure and on the other a severely reduced resource base. Three principle options were identified.

The first option was to allow the existing permissible cut of 300 000 m^3 per annum to continue until the resource was exhausted. This would have occurred around the year 2000. Given that an objective for karri is to establish a minimum rotation of 100 years, this would mean a complete absence of karri sawlogs for several decades until the regenerated forests were old enough to meet this requirement. Whilst this option would satisfy the needs of the present generation, succeeding generations would inherit only immature stands.

A second option was to reduce the level of cut immediately to that which could be sustained. Appendix 1 explains some of the complexities involved in the determination of this level. A reduction in the level of cut can only be achieved by the closure of sawmills. This means an inevitable reduction in the amount of timber available for housing and other uses, the loss of jobs, and in an area whose economy is based on sawmilling, considerable upheaval to the local economy and social structure.

Therefore, a third option was chosen. This meant reducing the cut at a gradual rate to provide for a continuous supply of sawlogs but allowing time for the community to adjust to these changes. It will be clear that the sooner these changes can be made, the higher will be the yield avaialble during the remainder of the first rotation. This proposal was accepted by Government and put into effect from 1976 by the

introduction of permissible levels of cut of species, and the setting of new levels of permissible cut. These new levels reduce over a period of time so that by 1987, the 1976 levels will have been reduced by 44 per cent.

Karri Forest Wood Production Plan 1976-2076

The objectives of management for wood production from the karri forest are:

(1) to achieve a minimum rotation length of 100 years;

(2) to ensure a continuous supply of large size karri sawlog at a minimum level of 50 000 m^3 per annum during the period of conversion to a sustainable yield.

A rotation of 100 years allows the karri to develop to a size suitable for normal sawmilling. Such a forest also has a very high value for a full range of other uses.

A continuous supply of karri sawlog is essential to maintain a hardwood component in the market and to retain stability within the timber industry and community. The maximum volume that can be sustained while satisfying the initial rotation objective is 100 000 m^3 per annum, made up of clear fellings and thinnings.

Today's karri forests used for wood production can be clearly separated into four different categories:

(1) the virgin old growth;

(2) the original old growth forest, partly cut between 1940 and 1967 under the group selection system;

(3) regrowth forest, in areas clear felled and regenerated before 1940;

(4) regrowth forest, in areas clear felled and regenerated after 1967.

Each category of forest has a special role in achieving the above objectives, requiring different management procedures and having the capacity to supply sawlog differing in both quality and quantity.

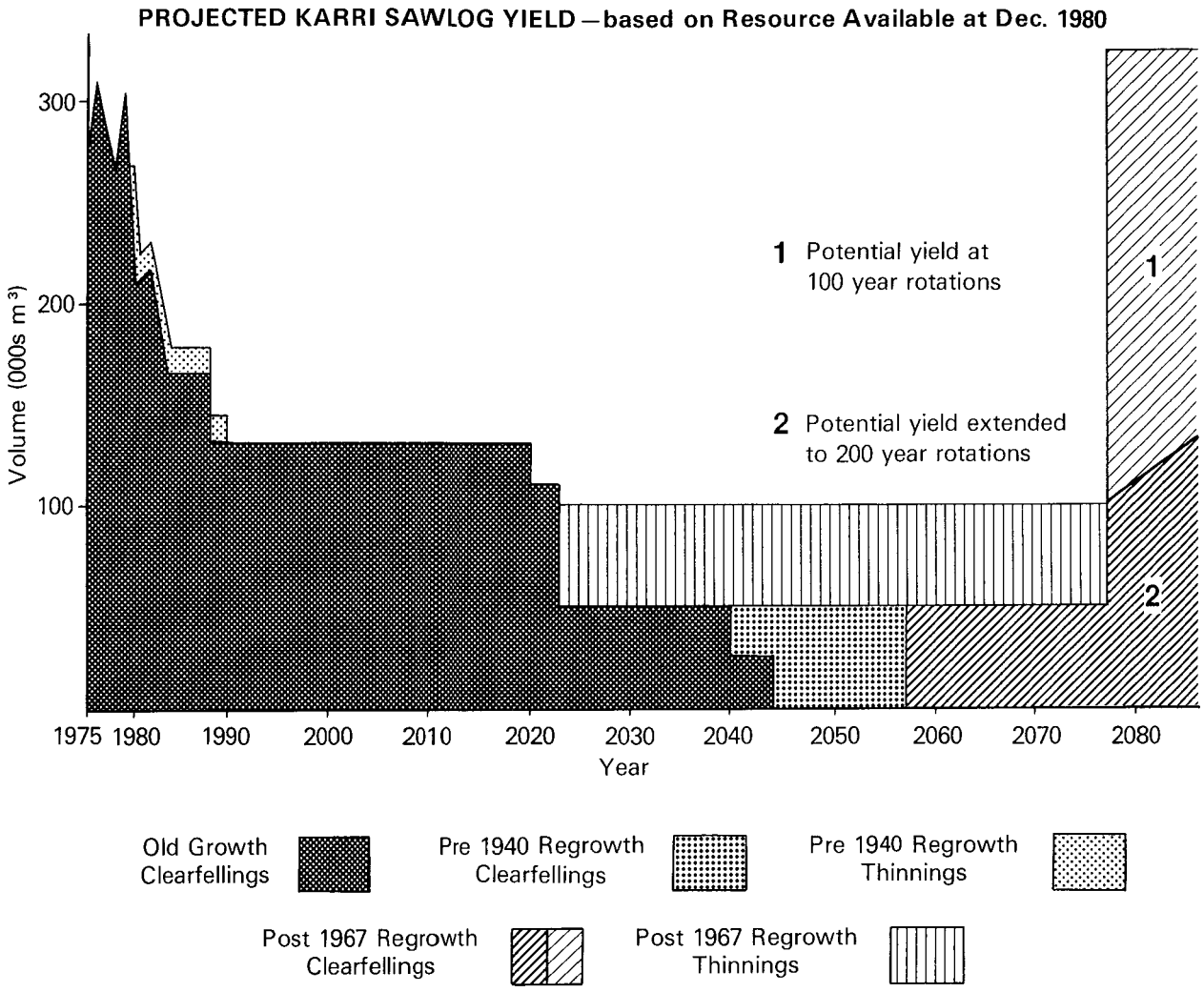
The first of the post-1967 regrowth forest will reach rotation age in the year 2068 (Figure 3), at which time clear fellings may begin again.

In order to meet the objectives of management it is therefore necessary to select a level of production from the virgin and selection cut old growth forests and the pre-1940 regrowth forests to provide the large sawlog supplies, until such time as the post-1967 regrowth is old enough to provide these requirements. Thinnings from the post-1967 regrowth will supplement this supply, bringing the total minimum level of supply to 100 000 m^3 per annum.

Old growth stands, both virgin and selection cut forests will be treated in the same way to produce new even aged forests of maximum productivity. Substantial areas have been selectively cut in the past and are producing at below their productive potential, therefore causing in part, lower levels of yield in the conversion rotation. Urgent reductions to the 1976 level of cut were required to extend this old growth supply and some reductions were prescribed for in the Forests Department's Working Plan 86 of 1977. Additional reductions will be foreshadowed in Working Plan 87 of 1982.

Under this scheme of reductions however, there is insufficient alternative karri available to maintain supply during the intervening years and it is estimated that 2800 hectares of 90-100 year-old regrowth would have to be clear felled to meet the supply objective from 2057 to 2077. A realistic alternative however, is to carry out further second thinnings to supply the sawlog requirements and delay the clear felling.

FIGURE 3



The next production forest category is the regrowth forest on areas clear felled and regenerated before 1940. This forest is providing its first commercial thinning and will have reached a rotation age of 100 years by 2030, and therefore be available for clear felling from this point onwards. Because of its limited area, its contribution to the total karri yield is relatively small. Nevertheless, it is vital to bridge the gap between supply of old growth sawlog and the eventual sustainable yield of regrowth sawlogs. Although sawlogs from the stands regenerated prior to 1940 are shown in Figure 3 as being available *in toto* immediately after the old growth forests have been completely cut over, the option exists to rearrange cutting to allow it to be cut concurrently with old growth forests, and thus extend both over a longer period.

Thinnings are a major component of the yield of a managed forest and it is appropriate to explain the purpose and value of this type of treatment.

A forest begins its life with a huge number of seedlings which grow and compete with one another for available nutrients, moisture, space and light. The faster growing individuals begin to dominate and suppress their neighbours which eventually stop growing and die.

Such competition is natural selection, which continues throughout the life cycle of the forest. With karri, competition map produce only 150 mature trees per hectare from as many as 100 000 seedlings over 100 years.

Thinning is the removal of some of the trees during the life of the stand for two purposes:

(1) to remove and utilize logs from those trees that would otherwise die, thereby adding to the forest yield;

(2) to provide more nutrients, moisture, space and light for the selected remaining trees to encourage their growth.

The intensity and frequency of thinning can be varied in numerous ways to suit differing sites, promote growth on different numbers of trees, or to provide different products.

So far, only the yield which is possible to the year 2077 has been discussed. This is based on sawlogs acceptable by today's standards and on the resource base which is now available. Technological changes and the ability to use lower grade material would have the effect of allowing a higher mid-term yield to be achieved, or an extension of the rotation. Any further reduction in the resource base would of course have the opposite effect.

The potential yield of sawlogs that would be possible after 2077, is shown in Figure 3. At this point future managers will have a full range of options:

(1) they could increase the level of cut to its former level of 300 000 m^3 per annum which could be sustained;

(2) they could retain the existing lower level, and make available the remainder of the forest for other purposes;

(3) they could gradually increase the level of cut and with it the rotation length to eventually achieve rotations of the order of 200 years.

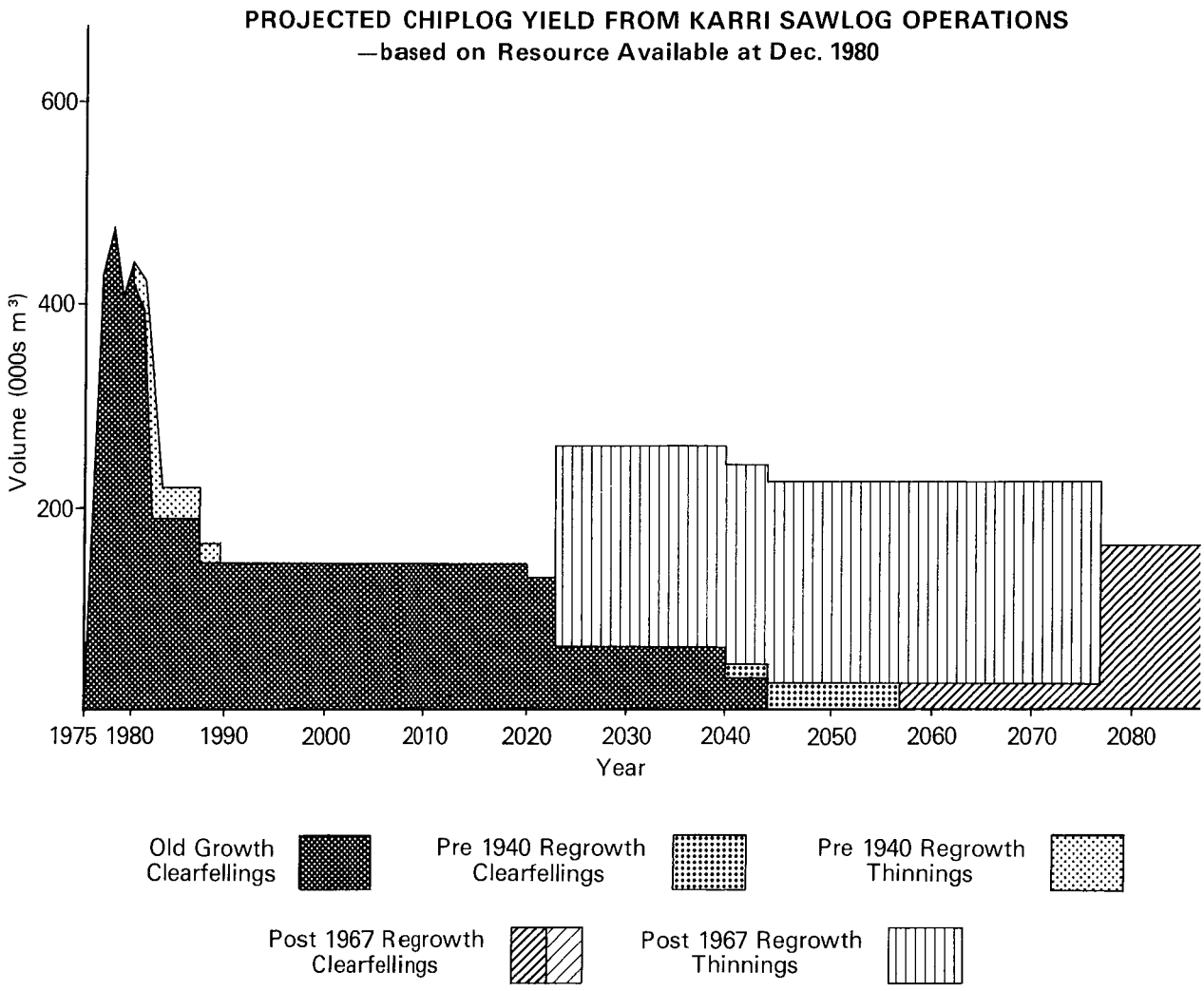
These decisions, as with all decisions of the future are not ours to make, but will be made by future generations. The decisions made now however, will affect the options that are available to them.

The discussion so far has involved sawlogs only. In order to achieve these yields from fully regenerated forests it is necessary to remove trees that are unsuitable for sawlogs but that, if left standing, would compete with the new regrowth. Otherwise, repeated removal of only the best trees in the forest would lead to the inevitable deterioration of the forest. The removal of this lower grade material is the function of the woodchip industry. Since the rate at which the production forest is cut is determined by the level of the sawlog cut, and chipwood logging is required for regeneration, it follows that the level of chipwood cut from the karri forest must be at a level that matches the yield of chipwood from the areas cut over for sawlogs.

The chipwood yield therefore follows a similar trend to the sawlog yield (Figure 4), but will vary slightly depending on which category of the production forest is being cut at the time. Until 1990, the commitment for chipwood under the Woodchipping Industry Agreement Act 1969-73 is higher than these projected levels. However, a marri chipwood yield is also available from jarrah-marri forest types both within and outside the main karri belt. The yield prediction

(Figure 4) indicates the level of chipwood cutting which is required from the karri forest to complement its future sawlog yield (Figure 3).

FIGURE 4


PROJECTED CHIPLOG YIELD FROM KARRI SAWLOG OPERATIONS
—based on Resource Available at Dec. 1980
600
400
200
Volume (000s m³)
1975 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070 2080
Year
Old Growth Clearfellings
Pre 1940 Regrowth Clearfellings
Pre 1940 Regrowth Thinnings
Post 1967 Regrowth Clearfellings
Post 1967 Regrowth Thinnings

STRATEGIC FIRE PROTECTION

Uncontrolled forest fires during the hot dry months that typify the summers of the south-west have the capacity to cause immense damage. Each year, values at risk in the forest are increasing. These values include life and property within forest communities and farms, National Parks and recreation facilities, areas of historical or scientific importance and, of course, the karri forest itself. Increasing values need a compensating level of protection. The fire protection system is therefore one of the key elements of forest management in the karri area.

To simple exclude fire is impossible. Even if the accidental or deliberate incendiarism of man could be eliminated, lightning strikes from summer thunderstorms are a regular occurrence. This was demonstrated during the Dwellingup fires of 1961, when 150 000 hectares of prime jarrah forest were burnt and a considerable area of forest was severely damaged. Massive quantities of dry litter, together with highly flammable undergrowth had been allowed to accumulate for up to 20 years before being ignited by numerous separate lightning strikes under severe weather conditions. Similar lightning strikes and disastrous fires occurred in the karri forests at Karridale, Pemberton and Shannon River in the same year.

The evolution of forest fire control measures in W.A. has been described elsewhere (see bibliography) and need not be elaborated here. Suffice it to say that over 60 years of experience and research has developed a policy which is built upon the basic cornerstone of fuel reduction through rotational prescribed burning in the forest.

The three fundamental elements causing a bushfire are the weather, the fuel and the source of ignition. Of these three, only the fuel can be effectively manipulated to minimize the combined effects of the other two. A prescribed burning programme therefore aims to deliberately burn the

fuel on the forest floor, under controlled conditions, regularly enough to prevent an unmanageable situation building up. The aim is not to prevent forest fires, but to make their control easier and thus reduce damage. This policy has been extremely effective since it became a routine operation in the karri forest after about 1970. The adoption of this policy was made possible by the developments of aerial ignition.

Fuel reduction burning cannot be applied over all areas of forest since, although low intensity fires are prescribed, they will still damage young regrowth, particularly karri. The practice for fire protection within the karri forest is therefore a combination of fire exclusion and fuel reduction by prescribed burning.

Following logging, regeneration is established in numerous small, discrete coupes spread throughout the karri forest. Each is an area of young, vigorously growing forest that may be damaged by even low intensity fire until such time as the tree crowns have risen beyond a height subject to scorching, and the bark developed to a thickness that will withstand fire. It takes at least 15 years for karri regrowth to pass through this fire sensitive stage. To allow the effective application of prescribed fuel reduction burning and to exclude fire from sensitive areas requires detailed advanced planning of both logging, subsequent regeneration operations, and prescribed burning.

The protection strategy for the karri forest is therefore based upon: firstly, fuel reduction through prescribed burning in strategically located buffer strips designed to minimize major fire runs; secondly, the exclusion of fire from young regrowth stands and other special areas; thirdly, regular fuel reduction in other areas whereever feasible; and fourthly, the maintenance of effective fire prevention, detection and suppression systems.

The strategic buffer strips (Map 5) average three to four kilometres in width and in some cases are up to six kilometres wide. Ideally they are large enough to be burnt using the relatively inexpensive aerial ignition technique and are orientated across the direction of dangerous summer winds. Their location is determined with the objective of confining potential fires to a maximum area of 1500 hectares or a run of five kilometres.

Logging and regeneration operations are confined to forest outside the buffer strips. Once the regenerated areas are old enough, they can sustain fuel reduction burning. The original strategic buffers are then no longer needed and may be logged and regenerated. This new regeneration will in turn require protection by the establishment of new buffers. In the main, the new buffer system will consist of strategically located belts of older karri regrowth. Logging and regeneration of the present buffer strips should not commence until the regeneration in the new buffer is old enough to withstand fuel reduction burning.

The above reveals some of the complexities of forestry planning. Not only is it necessary to cater for current constraints of coupe dispersal and sawmill cutting levels, but also to anticipate and provide for the fire protection of the forest now and 20 years in the future.

SIGNIFICANCE OF THE SHANNON RIVER BASIN

The Shannon River drainage basin, generally known as the Shannon basin or the Shannon, is an area of about 59 900 hectares lying between Manjimup and Walpole (Map 1). It comprises some 22 300 hectares of karri forest, 20 900 hectares of jarrah-marri forest and about 16 700 hectares of treeless flats, swamps and rocky areas. For some 20 years there was a large sawmill at the former town of Shannon River, which worked the forest in this area. Since the closure of the mill in 1970, the forest in the Shannon basin has continued to be cut by other mills. As well as the townsite and a dam on the Shannon River, there was a railway line into the town and the forest was extensively roaded.

The Shannon basin first received public attention in 1974 when the Conservation Through Reserves Committee, which had been appointed by the Environmental Protection Authority (E.P.A.) to assess the need for biological reserves in Western Australia, recommended that the Shannon basin or a substantial part of it be set aside from logging as a single large reserve of wet sclerophyll forest, to supplement existing National Parks.

Various reasons were presented for its preservation, including the primary need to preserve a substantial part of the karri forest in an untouched condition. The Shannon was chosen because it was one of the least disturbed river catchments in the main karri belt.

A review committee reporting to the E.P.A. subsequently recommended a series of areas in the karri forest as alternatives to the Shannon to represent the range of variation in karri forest ecotypes that could not be represented in a single large reserve. These alternatives were accepted by the E.P.A. and have been incorporated into the Forests Department's multiple use management plan for the karri forest. Three of the alternative areas (two flora, fauna and landscape priority areas and a portion of the proposed D'Entrecasteaux National Park) are within the Shannon basin.

The Forests Department's land use management plan for the karri forest (together with the proposed D'Entrecasteaux National Park) therefore already provide for the reservation from cutting of some 40 per cent of the Shannon basin. The remainder of the basin has been allocated for wood production.

The questions to be considered now are: firstly, from a preservation viewpoint, is the remainder of the Shannon a better alternative to the areas incorporated in the multiple use programme described earlier; secondly, if this is not the case, is it a necessary addition to these areas; and thirdly, what would be the consequences of withdrawal of the Shannon from wood production on the management of the karri forest as a whole?

The Shannon as an Alternative Reserve

The Shannon has already been considered by the E.P.A. review committee and the E.P.A. as being an unsuitable alternative to the other reserves that have been set aside. It has been shown that the karri forest is not a single, uniform ecosystem but varies throughout its range. The selection of any single area cannot be considered as representative of the whole from an ecological viewpoint. The Forests Department's flora, fauna and landscape priority areas are designed to cover representative karri forest ecosystems throughout the whole range of the forest.

A similar argument applies to the value of the Shannon for the majority of the recreating public. The selection of one large area at the expense of the rest of the forest cannot include the wide variety of recreational features and opportunities that exist over the entire forest and does not conform with normal patterns of forest recreation. Despite the fact that the area is far from pristine, it does have the long-term potential for the creation of a large near-wilderness area by the closure of all road access. To do this however, would eliminate access to most parts of the Shannon for the majority of the recreating public, and would make fire control in the area most impossible.

It must also be remembered that at the time of its recommendation the Conservation Through Reserves Committee was concerned to reserve a representative area of karri forest and the alternative areas did not formally exist.

It is clear that from a preservation and recreation viewpoint, the Shannon does not provide a suitable alternative to the areas already provided for in the multiple use programme.

The Shannon as an Additional Reserve

The second question to examine is whether the Shannon would add significantly to those areas that have already been set aside in the karri forest as flora, fauna and landscape priority areas and other priority areas which will not be logged.

If the only consideration were to maximize the area of forest preserved, the proposal could be accepted. It must be remembered that the alternative areas were chosen throughout the range of the forest (including two areas in the Shannon) for the very purpose of representing the natural range of karri. In this context, the addition of the remainder of the Shannon would not add to this representation.

A commonly held notion by the public is that the Shannon is a large contiguous belt of pure virgin karri forest. This is not the case and although 37 per cent of the Shannon basin is karri, only 9 per cent of the total area is pure virgin karri. Areas already reserved from logging under the multiple use programme will, when added to the proposed D'Entrecasteaux National Park, amount to 40 per cent of the Shannon basin. This 40 per cent includes 60 per cent of the pure virgin karri in the Shannon.

The value of a large contiguous and relatively undistrubed area to provide some sense of wilderness is acknowledged, but it must be recognized that it would be an experience shared by very few people. Wilderness values are almost certainly better represented in the proposed D'Entrecasteaux National Park, and the flora, fauna and landscape priority area which stretches from the Wattle to Soho area immediately east of the Shannon (Map 1 and 4). This latter area was selected to include the maximum possible range of ecotypes within the karri belt in a single contiguous area.

The alternative areas do not incorporate the notion of an entire river catchment as does the Shannon. However, this does not appear to have been a compelling motivation of the Conservation Through Reserves Committee's recommendation. Satisfactory hydrological benchmark areas have been designated elsewhere by the Steering Committee for Research into the Effects of the Woodchip Industry on Water Resources.

It has been concluded that preservation of the remainder of the Shannon basin is not necessary for ecological representation, is not needed for hydrological research, and if converted to a wilderness area would restrict its use for recreation.

Implications of Reservation

The replacement of existing flora, fauna and landscape areas by the Shannon would be inimical to the multiple use management of the whole forest and is not considered by the Forests Department to be a valid or responsible planning option.

If the remainder of the Shannon basin is set aside from timber harvesting, there will be serious effects on the level of timber yield, long-term production planning, regional fire protection, and on the communities of the region. These points are explained below.

The level of wood yield from the karri forest is founded on a resource base that includes the wood production portion of the Shannon basin. The total wood resource base of the karri forest has already been reduced by 35 per cent since 1976 by the allocation of forest to non-wood production uses in the multiple use plan. The remainder of the Shannon represents a further 20 per cent of the total wood resource.

If the wood resource of the Shannon is made unavailable, several alternative courses of action are possible. One could simply sacrifice the road and stream reserves to replace the volume of timber foregone. However, the road and stream reserves are considered a vital feature of the multiple use programme and this option must be rejected.

Two other options would be:

(1) to continue with the planned levels of cutting, as set out in Figure 3 ; or

(2) to immediately reduce the level of cut by the equivalent of the timber yield from the Shannon.

The first of these options would for a time prevent further disruption to the industry, the wood user and the local community already severely affected by the planned reductions in yield. However, if this course were followed, the supply of large karri sawlogs would be exhausted by the year 2020 and there would be no replacement volume from regrowth for many years. The supply of karri sawlogs could only be maintained by commencing to clear fell the regrowth stands at about 64 years of age (Figure 5). Concentration of the whole cut in the lesser area available would also affect both fire protection and coupe dispersal. Because of the reduced resource available, logging and regeneration would need to take place within the strategic burning buffers before alternative buffers were old enough to replace them. This would result in an unacceptable decline in the standards of fire protection for the forest and the region.

Further, there is the question of cutting coupe dispersal. Karri cutting coupes average about 120 hectares in size. In the detailed planning of each area, an attempt is made to provide the widest possible dispersal of the coupes. The object is to minimize the immediate impact of felling on the hydrology of a single catchment and on fauna and aesthetic values. It is already difficult to meet these objectives because of existing constraints. The withdrawal of the Shannon would further reduce the area in which cutting coupes can be dispersed.

The far reaching effects which this option would have on the sound management of the remainder of the karri makes it an unacceptable alternative.

The second option is to further reduce the planned level of cutting by closing another sawmill. This would retain the planned 100 year rotation but only at a reduced level of yield (Figure 6). From the viewpoint of long-term stability of forest management and

FIGURE 5

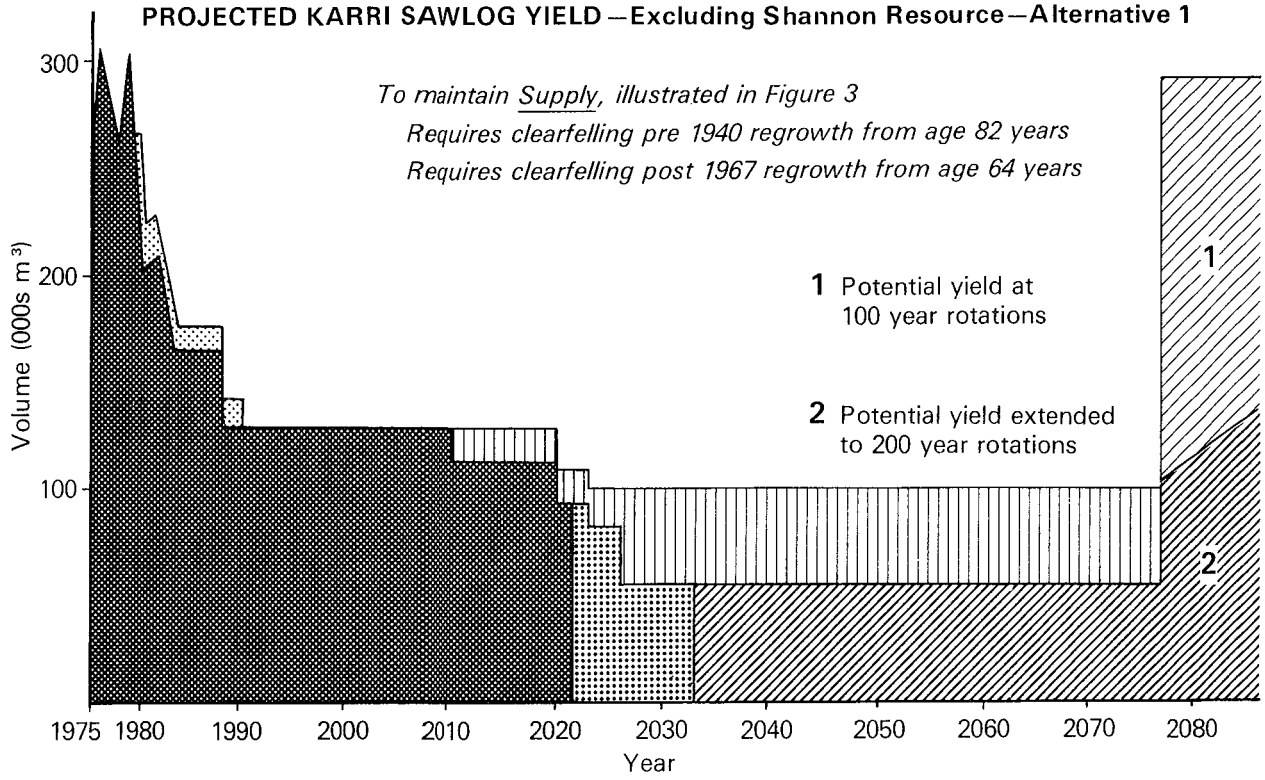
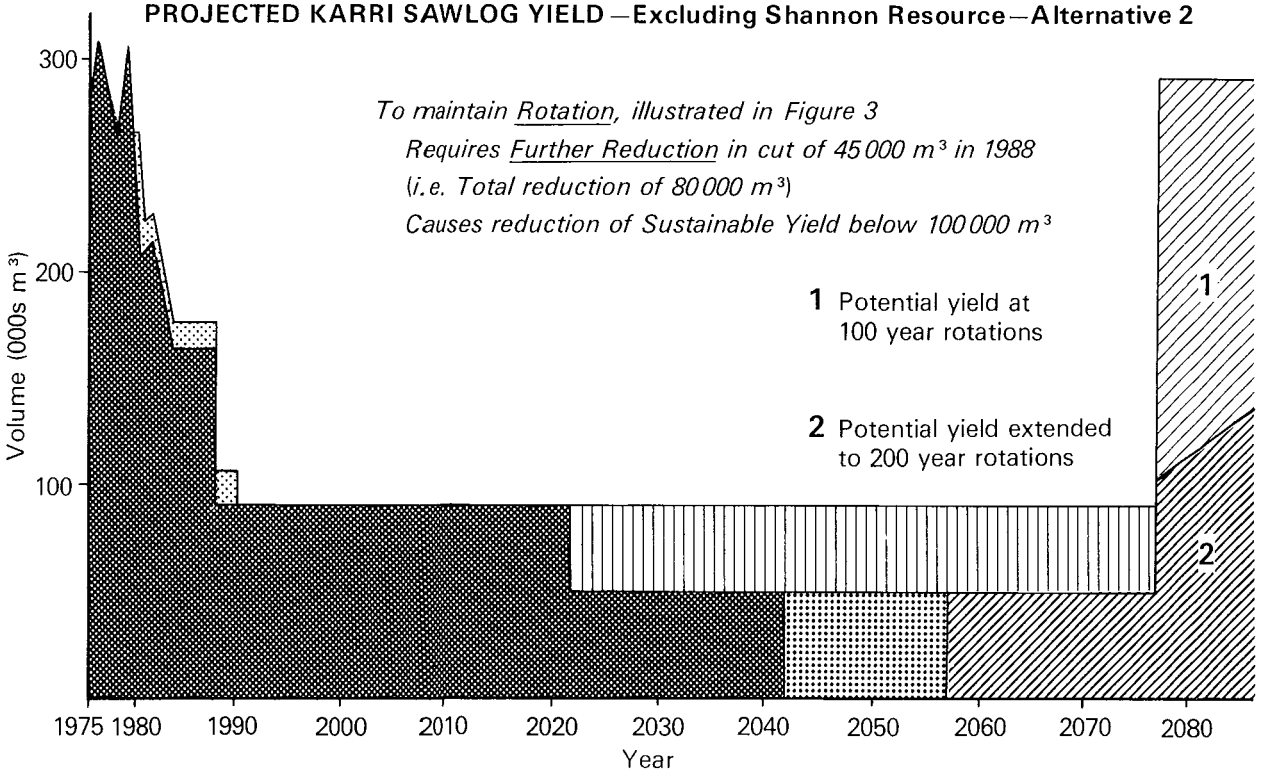
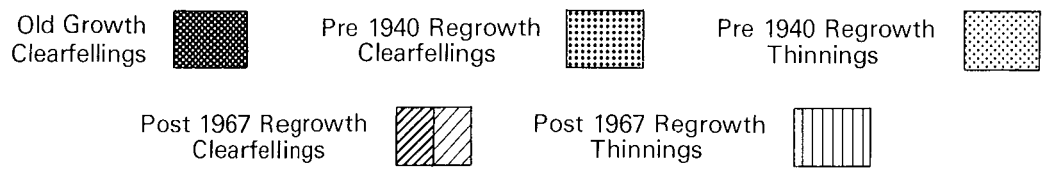


FIGURE 6





protection this is the only acceptable alternative, but such a reduction would have to be implemented immediately.

Because of the substantial area of jarrah forest in the Shannon, there would also be a reduction in the capacity to produce jarrah sawlogs. This would require reductions in the yield of this species as well. Such a strategy would have obvious effects on both short- and long-term wood supplies and the socio-economic stability already considerably affected by the currently planned reduction in cut. Alternative strategies exist, but share the same problems as above. The yield of chiplogs would be similarly reduced.

It is sometimes suggested that loss of employment and social disruption caused by reservation of the Shannon would be readily offset by increases in employment opportunity from recreation and tourism. Recreation and tourism activity are certainly expected to increase in the karri forest region as time goes on, but in the context of the whole forest it cannot be assumed that the status of the remainder of the Shannon will have any significant effect. In the short term, the withdrawal of the entire Shannon from production is unlikely to provide any compensating employment for those whose jobs were lost through sawmill closure.

In conclusion, the Forests Department believes that the benefits of reserving the remainder of the Shannon are not sufficient to outweigh the effects that this would have on the social stability of the local community, wood supply to meet the State's needs or the sound management and protection of the remaining karri forest.

Any decision that attempts to satisfy all the demands for additional reservation in the Shannon, maintenance of wood supply and short-term socio-economic stability will only be made at the expense of long-term stable management and protection of the whole karri forest. Such a course would deny future generations their rights to use the karri forest as they choose. It would also render futile the work of those in previous generations whose efforts provided us with a choice.

CONCLUSION

This paper has described how karri forest management has evolved over the years, from the early battles to save the forest from destruction for agriculture to present day conflicts over adequacy of management aims. It has also explained some of the complex web of forestry, ecological, social and fire protection issues which the forester must consider in developing appropriate management policies.

In explaining how the Forests Department approaches the questions of long-term yield control and multiple land use planning of State forest, the need for stability of purpose has been emphasized and the implications of acceptance of demands for large-scale single use of the forest have been pointed out.

The Forests Department has the responsibility for managing the karri forest on behalf of both present day Western Australians and the generations of the future. The very nature of forestry involves complex and dynamic communities of plants and people. The finite nature of the forest in relation to the demands made upon it underlines the need for carefully balanced long-term planning. Planning should be reviewed periodically as new information becomes available. Important factors such as population trends, community attitudes and requirements can and do change. The challenge of good forestry management is to provide for the widest possible range of present day demands without foreclosing on options for the future.

The Department believes it has met this challenge successfully in the karri forest. It has secured the forest estate in the face of opposing community attitudes of the day, it has developed successful management procedures and programmes of timber harvesting and regeneration that will allow long-term sustainable timber production, and it has made provision for a soundly based series of ecological reserves.

Recreation is encouraged and provided for over the forest as a whole. The Department has also developed an efficient and economical regional fire protection system taking into account the protection of both the forest and the towns and farmlands of the region.

As our population increases, creating increasing demands on our limited forest estate, it is to be expected there will be continuing controversy over forest management policies and procedures. It is hoped this paper will contribute to a better informed public discussion and thereby help to ensure the conservation of the karri Forest.

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APPENDIX I

THE CONCEPT OF SUSTAINED YIELD

Sustained yield is perhaps the most widely accepted but least understood concept of forest management. This seems to have arisen because of attempts to explain a complex concept in over-simplified terms. This section does not attempt to deal with the subject in great depth, but will hopefully provide a better understanding of how the concept applies to forests and the factors that affect its determination.

From the point of view of wood production, sustained yield means the yield that can be obtained from a forest at a consistent level for an indefinite period. For this statement to mean anything in practical terms, the "yield" must be expressed in terms of the type of product (e.g. sawlog) and the size of the product. To achieve the yield at a consistent level forever, the forest must then be structured in a particular way. Figures which are quoted for sustained yield frequently fail to meet all of these requirements.

A common oversimplification is to say that for sustained yield the amount removed should be equal to the growth. Again this is true only if certain qualifications are made. For example, a virgin forest which is in a state of equilibrium has no nett growth. The growth of some trees is equalled by the death of others. On the other hand, a forest consisting entirely of young regrowth is growing at a very rapid rate, yet its yield of sawlogs may be zero because all the trees are too small.

To determine a sustained yield for a forest therefore, it is first necessary to define the type of product required (e.g. sawlogs or pulpwood) and the size of those products (e.g. 10 cm or 100 cm diameter). It is then possible to determine for a particular forest, species and

site quality,how much of this product is growing into, or has the potential to grow into these categories and how long it will take. The time required for this is the rotation length.

Whether the yield so determined is consistent and sustainable depends on the age structure of the forest.

A forest capable of sustained yield has certain characteristics. In its simplest terms this means an equal area of each age class, from age one to the rotation age. Thus each year the oldest area is cut and regenerated, during which time each class moves on one step. The wood removed each year at rotation age equals the sum of the growth on each age class. Under this situation the yield equals the growth. The actual cutting may be done selectively or by clear felling and may or may not be supplemented by thinnings. This is the ideal situation however,and is rarely achieved.

A virgin forest has quite different characteristics. It has a preponderance of mature and overmature trees and therefore no even gradation of age classes. The yield of a particular product from such a forest may bear little relationship to the eventual sustained yield from the managed forest and depends on the time over which conversion from virgin to managed forest is required, the initial imbalance of age classes, and the degree of damage and deterioration present in the original forest compared with the managed and protected forest.

It is evident, therefore, that to quote a single sustained yield figure during this period of conversion can be both inaccurate and misleading. These principles apply to any forest but the karri forest provides some good examples of the misunderstandings which have arisen. Take the statement "The karri forest is being overcut for sawlogs". This is true in the sense that because of an imbalance in age classes, at the present rate of cutting sawlogs of

present day quality and size, they will run out before the next crop is of similar size. However, it is not true in the sense that the cut exceeds growth or potential growth. To correct the imbalance it is necessary to reduce the cut of sawlogs for a period, after which the balance can be restored at a level close to the present cut.

Another common statement is "Given that the sawlog cut is too high, removal of logs for chipwood exacerbates the problem". This is not true in that the yield of sawlogs from the present forest is only a part of the total available yield. The remainder is in the form of karri and marri logs which are unsuitable for sawmilling. The important thing is that the level of cut of sawlogs and chiplogs is balanced to suit the forest condition. This can be achieved in the short term and in the long term by setting levels of cut of both products to suit the forest conditions available at that time.

As the karri forest is still being converted to a managed forest with an appropriate distribution of age classes, and because the resource base has been significantly altered in recent times, no consistent yield figure can be quoted. Yield will vary over time as illustrated in Figures 3, 4, 5 and 6.

MAPS

MAP 1

KARRI DISTRIBUTION

LEGEND

MAIN KARRI BELT

KARRI OCCURRENCE

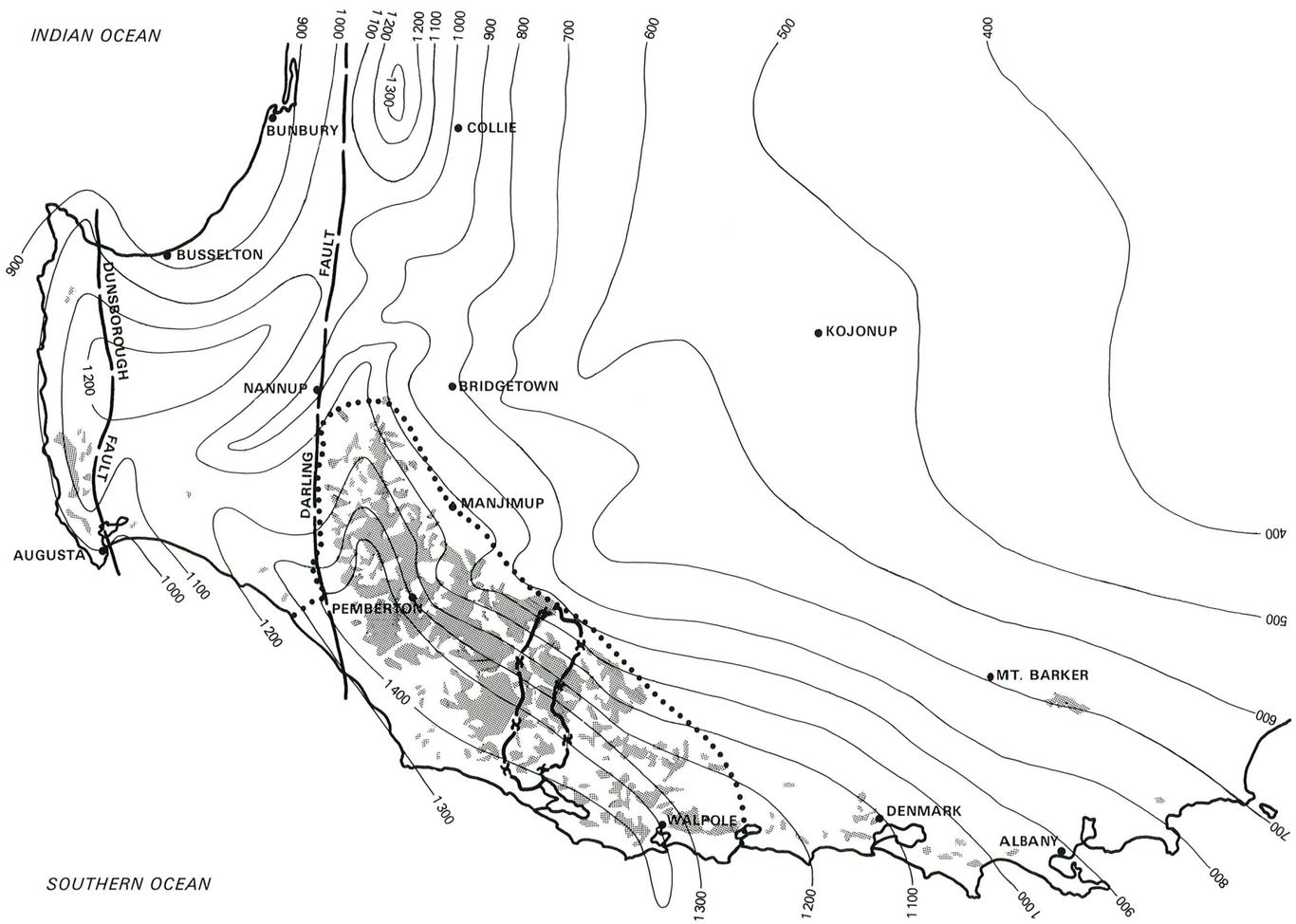
SHANNON WATERSHED

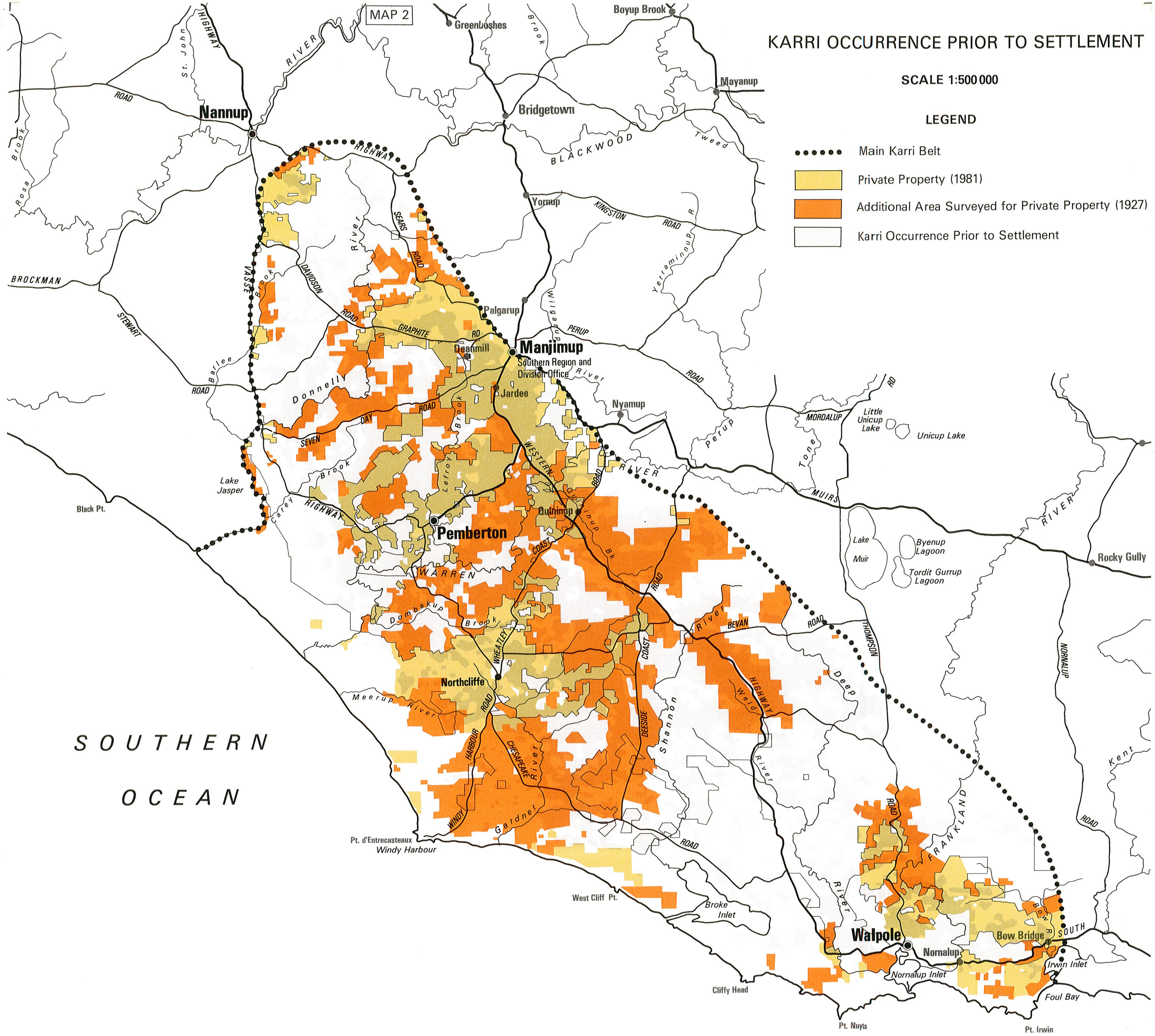
ISOHYET (mm) — 400

N

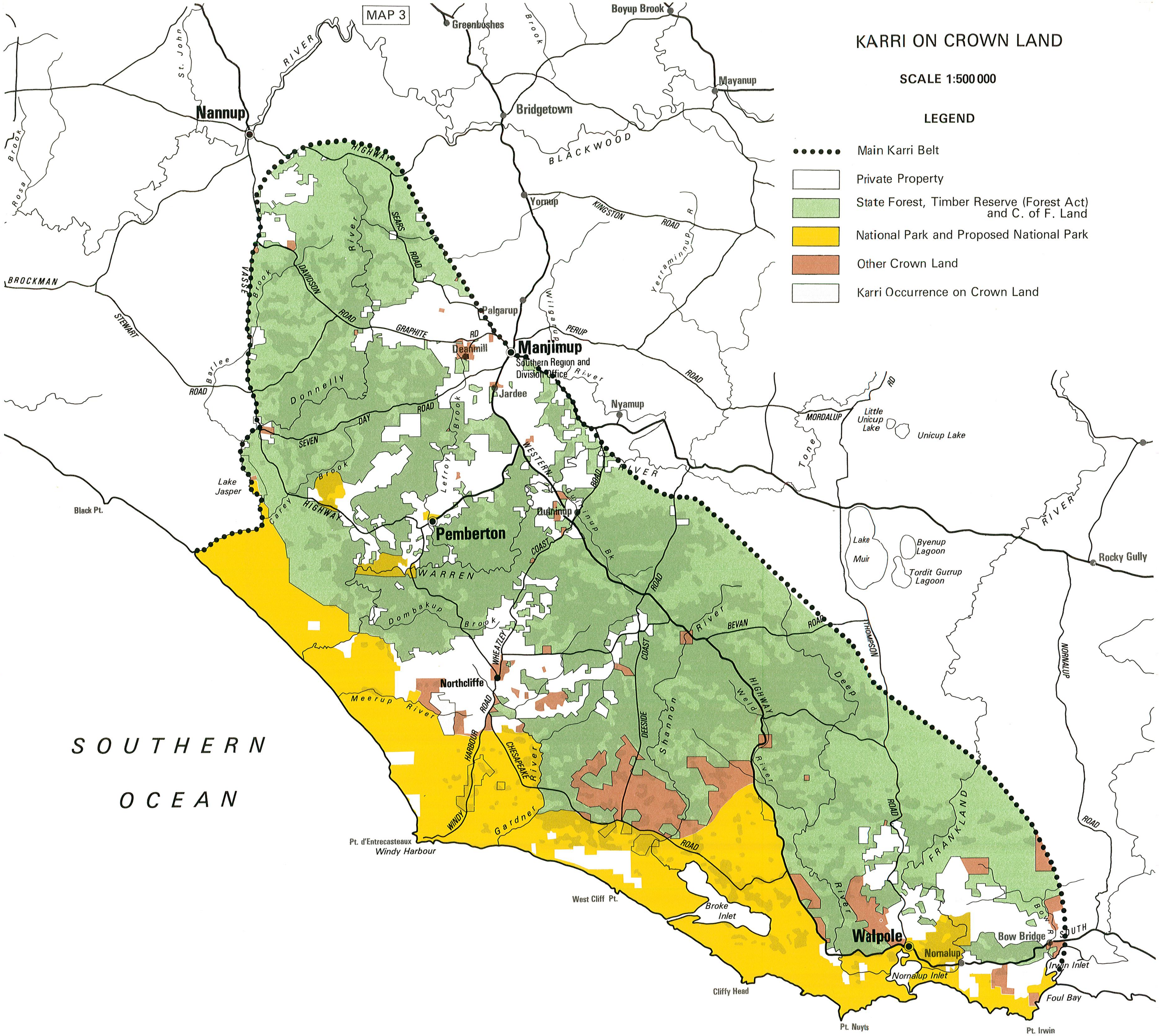
SCALE 1:1 500 000

0 10 20 30 40 50 60 kms





MAP 2
KARRI OCCURRENCE PRIOR TO SETTLEMENT
SCALE 1:500 000
LEGEND
Main Karri Belt
Private Property (1981)
Additional Area Surveyed for Private Property (1927)
Karri Occurrence Prior to Settlement
Nannup
Bridgetown
Greenbushes
Boyup Brook
Mayanup
Yornup
Palgarup
Deanmill
Manjimup
Southern Region and Division Office
Jardee
Nyamup
Pemberton
Quinninup
Northcliffe
Walpole
Nornalup
Bow Bridge
Rocky Gully
Lake Jasper
Black Pt.
Pt. d'Entrecasteaux
Windy Harbour
West Cliff Pt.
Broke Inlet
Cliffy Head
Pt. Nuyts
Nornalup Inlet
Irwin Inlet
Foul Bay
Pt. Irwin
Lake Muir
Byenup Lagoon
Tordit Gurrup Lagoon
Little Unicup Lake
Unicup Lake
SOUTHERN OCEAN


MAP 3
KARRI ON CROWN LAND
SCALE 1:500 000
LEGEND
Main Karri Belt
Private Property
State Forest, Timber Reserve (Forest Act) and C. of F. Land
National Park and Proposed National Park
Other Crown Land
Karri Occurrence on Crown Land
Nannup
Greenbushes
Boyup Brook
Mayanup
Bridgetown
Yornup
Palgarup
Deanmill
Manjimup
Southern Region and Division Office
Jardee
Nyamup
Pemberton
Quinninup
Northcliffe
Walpole
Nornalup
Bow Bridge
Rocky Gully
Little Unicup Lake
Unicup Lake
Lake Muir
Byenup Lagoon
Tordit Gurrup Lagoon
Lake Jasper
Black Pt.
Pt. d'Entrecasteaux
Windy Harbour
West Cliff Pt.
Broke Inlet
Cliffy Head
Nornalup Inlet
Irwin Inlet
Foul Bay
Pt. Nuyts
Pt. Irwin
SOUTHERN
OCEAN

MAP 4

FOREST MANAGEMENT PRIORITIES

SCALE 1:500 000

LEGEND

- Catchment Protection
- Protection of Forest Values
- Flora, Fauna and Landscape
- Recreation
- Scientific and Education
- Wood Production
- Road, River and Stream Reserves
- Main Karri Belt
- Private Property, Reserves and Vacant Crown Land
- National Park and Proposed National Park
- Karri Occurrence on Crown Land

Boyup Brook
Greenbushes
Mayanup
Nannup
Bridgetown
Yornup
Palgarup
Manjimup
Southern Region and Division Office
Deanmill
Jardee
Nyamup
Pemberton
Quinninup
Northcliffe
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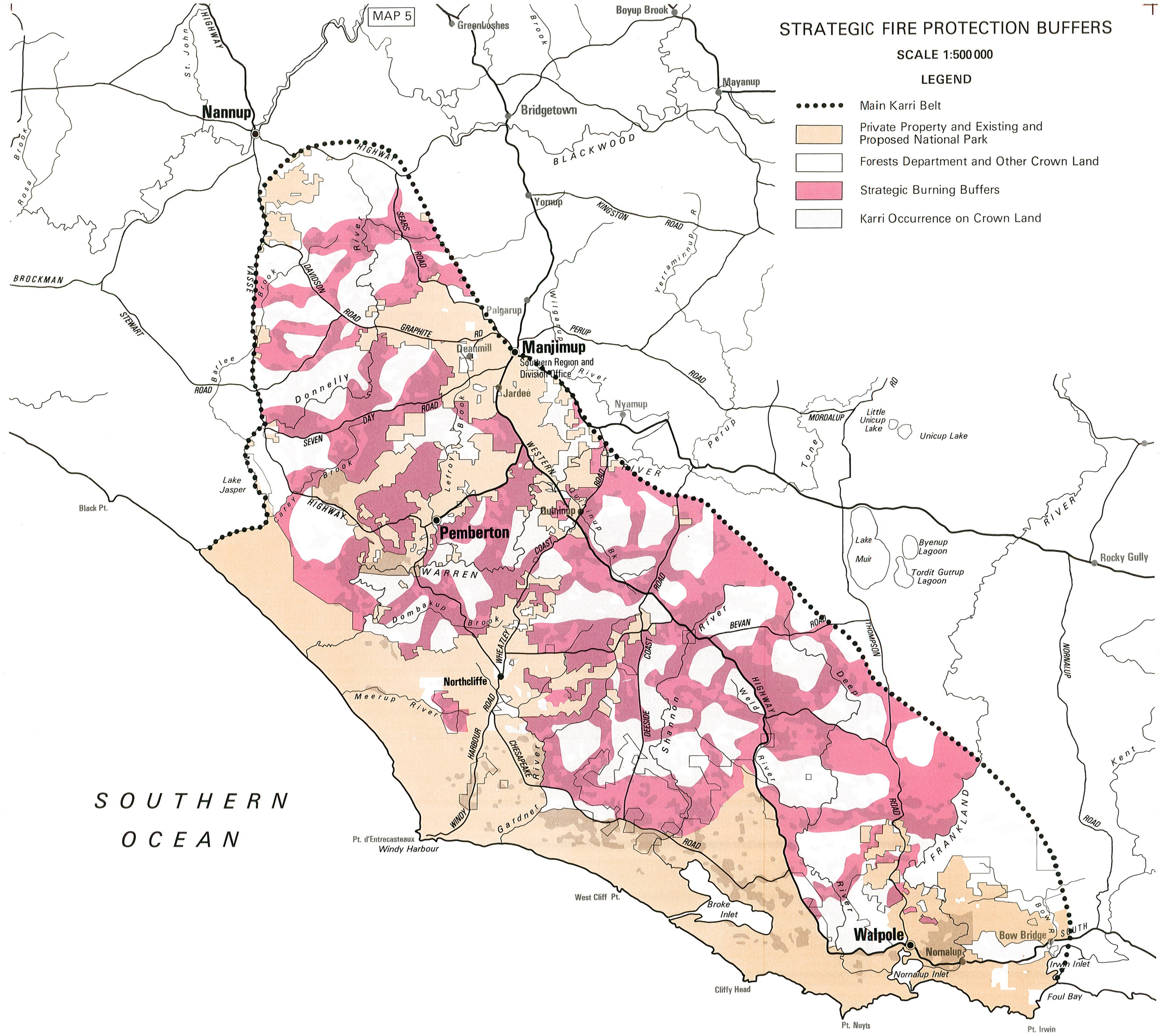
Pt. d'Entrecasteaux
Windy Harbour
West Cliff Pt.
Broke Inlet
Cliffy Head
Pt. Nuyts
Nornalup Inlet
Irwin Inlet
Foul Bay
Pt. Irwin

SOUTHERN OCEAN


MAP 5
STRATEGIC FIRE PROTECTION BUFFERS
SCALE 1:500 000
LEGEND
Main Karri Belt
Private Property and Existing and Proposed National Park
Forests Department and Other Crown Land
Strategic Burning Buffers
Karri Occurrence on Crown Land
Nannup
Greenbushes
Boyup Brook
Mayanup
Bridgetown
BLACKWOOD
Yornup
KINGSTON ROAD
Palgarup
Manjimup
Southern Region and Division Office
Deanmill
Jardee
Nyamup
BROCKMAN
STEWART
GRAPHITE RD
DAVIDSON ROAD
SEARS ROAD
VASSE
HIGHWAY
Donnelly
SEVEN DAY ROAD
PERUP ROAD
MORDALUP
Little Unicup Lake
Unicup Lake
Lake Jasper
Black Pt.
Pemberton
Quinninup
WARREN
WESTERN
COAST ROAD
Lake Muir
Byenup Lagoon
Tordit Gurrup Lagoon
Rocky Gully
BEVAN
THOMPSON
NORNALUP
Northcliffe
WHEATLEY
Meerup River
HARBOUR ROAD
CHESAPEAKE
DEESIDE
Shannon
Weld
HIGHWAY
Deep River
FRANKLAND
Kent
SOUTHERN OCEAN
Pt. d'Entrecasteaux
Windy Harbour
Gardner
West Cliff Pt.
Broke Inlet
Cliffy Head
Walpole
Nornalup
Nornalup Inlet
Bow Bridge
Irwin Inlet
Foul Bay
Pt. Nuyts
Pt. Irwin