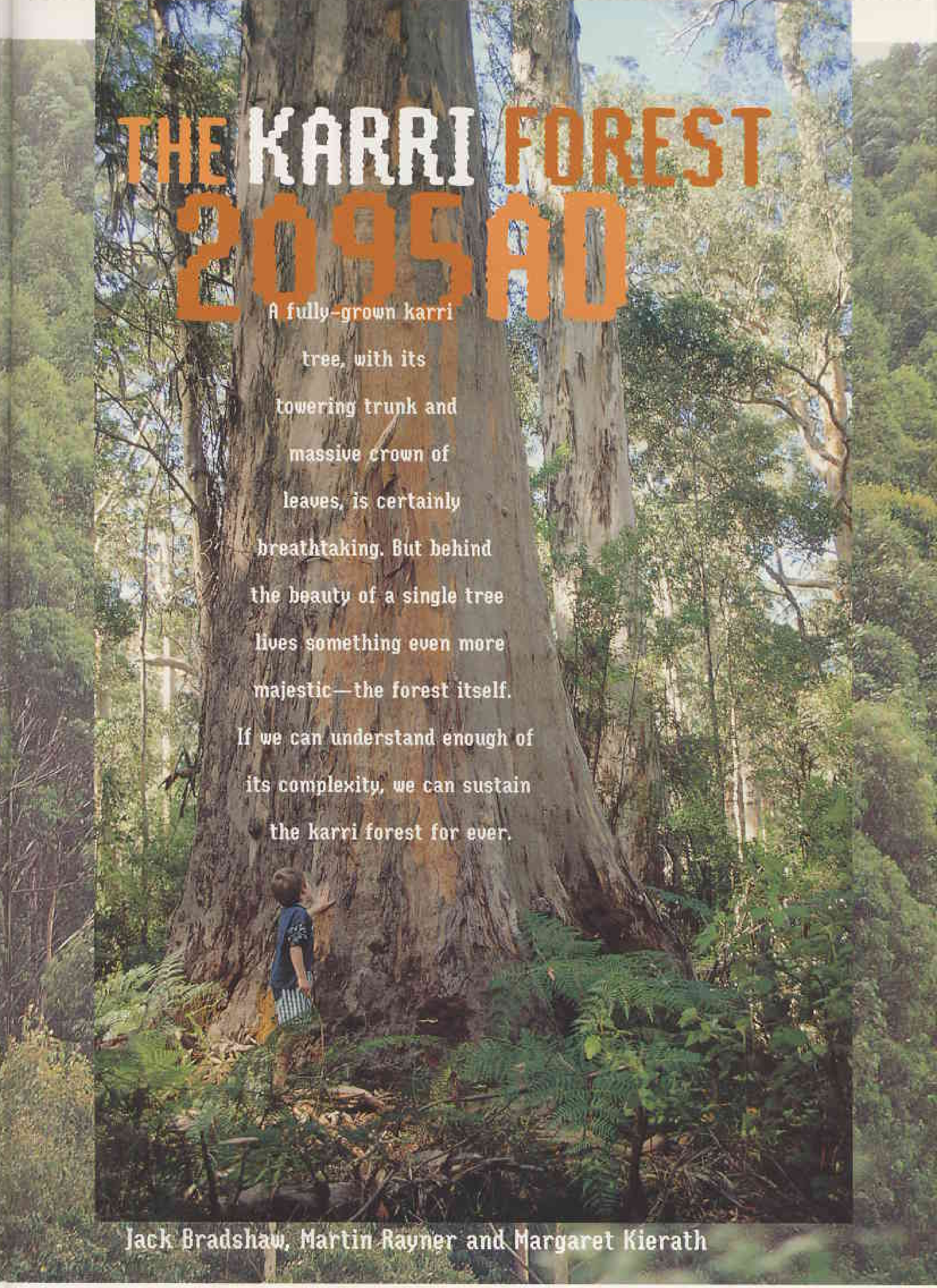


THE KARRI FOREST 2095AD

A fully-grown karri tree, with its towering trunk and massive crown of leaves, is certainly breathtaking. But behind the beauty of a single tree lives something even more majestic—the forest itself. If we can understand enough of its complexity, we can sustain the karri forest for ever.

Jack Bradshaw, Martin Rayner and Margaret Kierath

Birth, infancy, adolescence, maturity, old age. The familiar cycle of human life involves challenge, diversity and change, not only for the individual, but also for the whole community. By overseeing each new generation through to maturity, we ensure the health and survival of the race.

So it is with forests. The individual tree matters, but communities of trees matter more. Forests must remain balanced if they are to survive and remain healthy; they will do so only if groups (stands) of varying generations of trees, not just old growth, are always present. Only if there are younger generations ready to take the place of older trees, no matter where they are in the forest, can there be any certainty of a thriving karri forest in the centuries to come.

To look after a forest properly, management plans must be able to predict the way it is likely to grow over a long period of time. In the case of the south-west karri forest, the main belt, approximately 70 per cent of the total forest that contains karri, has recently been studied for that purpose. The study aimed to develop a way of predicting the karri development stages, based on ageing areas of forest, and finding out how they might change over time. Information about the present forest's composition was fed into a computer program, which then modelled the changes over the next 100 years.

Previous page
Main: The characteristic conical crown of a 'juvenile' stand. It has already reached its maximum growth rate and will soon enter the immature stage.
Photo – Chris Garnett/CALM
Inset: A young child looks up in awe at a giant karri that began its life 300 years earlier.
Photo – Cliff Winfield/CALM

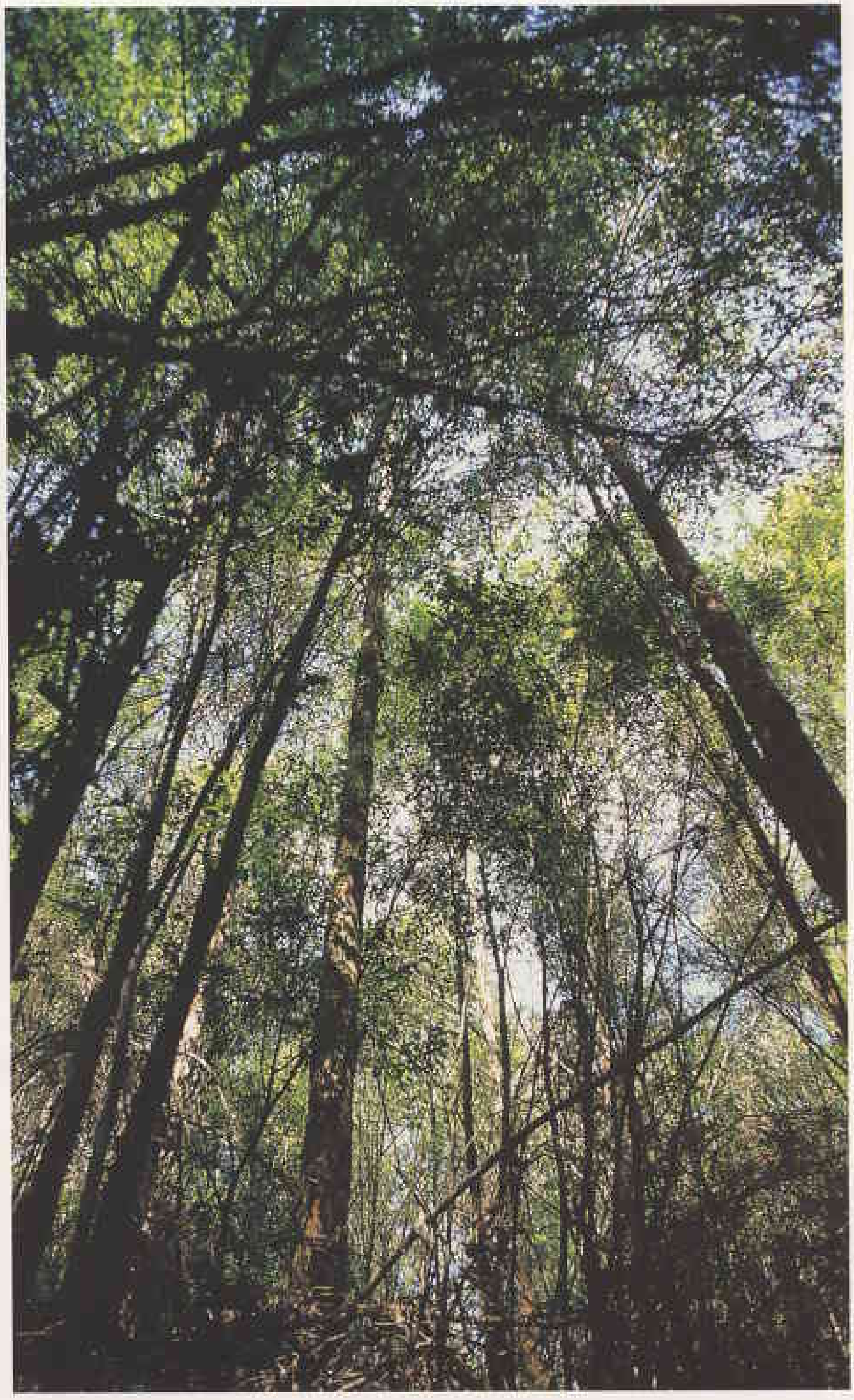
Left: A seedling begins the struggle for survival. In the natural course of events it has less than a 1 in 200 chance of living to old age.

Right facing page: Young saplings in the 'establishment' stage struggle for dominance over the understorey.
Photos – Chris Garnett/CALM

LIFE AND DEATH IN THE FOREST

Trying to predict the forest's future must begin with a knowledge of how karri trees live and die—their natural patterns of birth, growth and decline.

A stand of karri midway through the 'immature' stage. It is already 50 metres in height.
Photo – Chris Garnett/CALM



The natural cycle of birth and death begins when there is a disturbance in the karri forest, usually caused by fire. If mineral soil is exposed, if seed is present, and if there is vacant space in the canopy, a stand of karri trees can regenerate. Competition with all the understorey species is fierce, but after about eight years, the canopy of the surviving saplings is closed and the stand moves into its juvenile stage. The trial of strength resumes, and when the trees are 25–30 years old, there remain perhaps 500 individuals per hectare from an earlier population of 5,000.

The subsequent period—the immature stage—is also a period of competition, although this is less intense than before. The number of trees reduces to about 150 per hectare. Small gaps in the canopy are created by the death of individual trees, but the surrounding vigorous trees quickly reoccupy the spaces. By the time they are 60–70 years old, they have reached about 90 per cent of their final height. Still further on, at about 120 years of age, the immature stage concludes and the mature stage begins; the individual tree crowns have reached the point where they can no longer expand, whether or not there is space available.

The mature stage is relatively stable. The diameters of the trees steadily increase, but individuals can neither occupy more of the site nor increase their crown diameter beyond 20–25 metres. Individuals slowly decline in vigour, but dominant trees maintain their growth rates. When an individual dies, a gap in the canopy results. This is an opportunity for new growth, for a new generation to emerge. When the trees are about 200–250 years old, the mature stage comes to an end.

The final period, the senescent stage, is a story of rapid decline. The crown declines and major branches break, providing entry points for fungi that rot the woodland and further weaken the tree. Between 200 and 280 years of age, the number of trees quickly reduces, followed by a more gradual decline until there remain only a few rare individuals over 350 years old.

As the canopy closes at the beginning of the 'juvenile' stage, the young karri have won the race against the understorey. Now they begin to challenge each other.
Photo – Chris Garnett/CALM

FIRE KILLS—AND REGENERATES

There are about 70 days a year when the karri forest is dry enough to carry a fire. Both the frequency and severity of

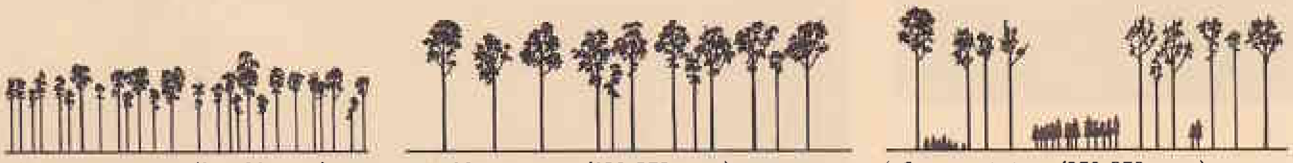
HOW FIRE AFFECTS FOREST STRUCTURE

1 EXTREME FIRE INTENSITY KILLS MOST TREES IN LARGE PATCHES—A STAND-REPLACING FIRE

a. Original stand

b. Establishment stage (approx. 0–8 years)

c. Juvenile stage (approx. 8–25 years)



d. Immature stage (25–120 years)

e. Mature stage (120–250 years)

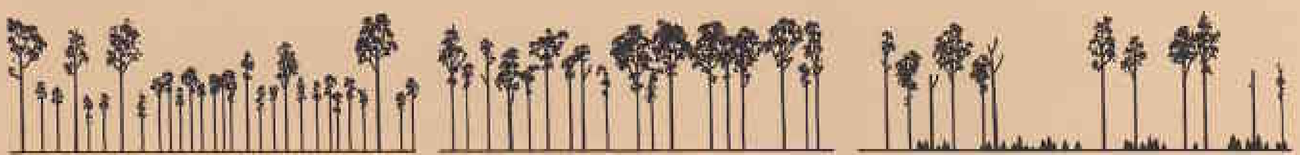
f. Senescent stage (250–350 years)

2 SEVERE FIRE INTENSITY KILLS INDIVIDUAL TREES OR SMALL PATCHES—PARTIAL STAND REPLACEMENT

a. Original stand

b. Two cohorts, mature and establishment

c. Two cohorts, mature and juvenile



d. Two cohorts, mature/senescent and immature

e. One or two cohorts, mature/senescent

f. Senescent

3 LOW INTENSITY FIRE KILLS ONLY THE UNDERSTOREY—UNDERSTOREY DEVELOPMENT DEPENDS ON THE PERIOD BETWEEN FIRES. ITS DEVELOPMENT CYCLE IS INDEPENDENT OF THE OVERSTOREY

the many fires that occur have a profound effect on the structure of the natural forest. If the fire intensity is extreme, many large patches of the trees in the overstorey will be killed and the development cycle will begin again. Extremely intense fires that completely replace the stand are not as common in karri as they are in other forests, such as the boreal forests of Alaska and the mountain ash of eastern Australia. However, multiple severe fires can have the same effect as one very intense blaze.

Less intense fires create smaller gaps in the canopy, as do storms and old age. This is another chance for regeneration, and a stand with trees at different stages of development will eventually result. It may comprise two or more generations (cohorts), of different ages, and the dominant cohort—the one with more than 25 per cent crown cover—will suppress the younger individuals. Younger cohorts with more than 25 per cent crown cover are significant, however; they become the dominant group in the future when the dominant cohort declines.

At any stage, another severe fire may completely halt the cycle, causing it to begin again. Alternatively, it may kill only part of the stand and introduce a new cohort.

Views of the forest from above:
(*Top*) A wildfire in 1951 killed almost all of the original stand. The new stand is now in the immature stage. A few old senescent trees still stand.
(*Right*) As old trees die in this senescent stand, new regenerating trees take advantage of the gaps in the canopy.
Aerial photos – Reproduced by permission of Department of Land Administration under Copyright Licence 565/99.

A fire of almost any intensity will be enough to kill the understorey layer and initiate another shrub cycle. Thus, there may be many cycles of understorey development during the life of the overstorey. For many of the forest vertebrate and invertebrate species, the understorey influences populations more than the overstorey.

The varied stages of karri development exist because of these disturbances and ageing processes. All need to be represented in sufficient proportions to guarantee that the total structure is maintained into the future. Old forest, for example, cannot continue to exist if there is insufficient younger forest to grow old and take its place.

Aiming for such representation is a common feature of northern American forest management plans, but has not been widely used in Australia. One

obstacle has been the difficulty of estimating the age of a stand of trees, particularly where there are different generations within the stand.

HOW VARIED IS THE KARRI FOREST?

The first step in computer-modelling the future forest was to map the present one. Each dominant cohort was categorised and mapped according to one of the development stages. This was done through age records and interpretations of colour aerial photography. From the immature, mature or senescent categories, 121 field plots were selected; the age of both dominant and significant cohorts was estimated by measuring the diameters of trees and by using a previously determined age-diameter relationship.

Within the samples, there are few mature stands older than 230 years. The oldest stands are 370 years, and all stands are senescent by 300 years. However, senescence may occur earlier, usually as a result of damage by fire.

The present virgin (unlogged) forest, approximately half of the total, has a mean age of 170 years, and consists of both single and multiple cohort stands. The secondary cohorts vary in age from 30 to more than 200 years of age.

Left: These 140-year-old trees have won their struggle to early maturity.
Photos (left & below) – Chris Garnett/CALM

Below: The graphs show the present age and the structure of the virgin forest with its preponderance of middle-aged stands, and the present age distribution of the whole of the karri-dominant forest.

The picture that emerges of the virgin forest prompts questions. What is the reason for the distribution of ages? Why is there a low proportion of stands in the 50–150 year age group? Will there be much less virgin forest aged 150–250 years in 100 years time?

The low number of stands aged between 0 and 50 years is partly due to the fact that most of these stands, created by recent severe fire damage, have been salvage-logged. This meant that, for the purposes of the research, they could not be described as virgin stands. The slope at the older end of the graph is due to the rapid mortality of trees older than about 250 years.

Fire in the karri forest also contributes to the overall pattern of age distribution, particularly to the proportion of multi-aged mature stands. Forests that are extremely sensitive to fire, such as the boreal forests of Alaska, often have stand-replacing fires. As a result, they have a very high proportion of young forest with progressively smaller proportions of older forest. The pattern is different in karri, which has a greater resistance to fire. It is true that fire is increasingly likely as a cohort ages, but because stands are less commonly replaced by a single fire, multi-aged stands are more often produced. When the older cohorts die, perhaps of old age, they are replaced by the younger significant cohorts, not by completely new regeneration. This helps to maintain the age pattern we see today.

The age distribution for the whole karri dominant forest (the virgin and the previously harvested forest) shows a much higher proportion of younger stands, reflecting a history of past disturbance. Harvesting in the main karri belt began about 1913, and until 1928, all harvested areas were cleared for agriculture. From 1938 to 1967, selective logging resulted in relatively few stands in the 50–100 year age group.

THE FOREST IN THE FUTURE

Mapping the existing development stages is important, but what about the future? Making reliable predictions entails looking at both the areas set aside for timber production and the conservation reserves that develop naturally.

Under CALM's current management plan, more than half of the future regrowth forest will be managed to a rotation age of 250 years. Most of the remainder will be managed to a rotation age of 100 years. By 2045, existing mature stands set aside for timber will have been harvested. Previously harvested and regenerated areas will be thinned progressively, but not re-harvested for the second cycle of regeneration until after 2045. To arrive at a picture of these stands in 50 and 100 years time, natural ageing and proposed harvesting schedules were factored in to the computer model.

Space doesn't remain vacant for long in the forest. The death of an old tree is life for a new cohort of regeneration.
Photo – Chris Garnett/CALM

The model had to take account of reserved areas, including national parks, nature reserves, road, river and stream zones, and patches of retained mature forest within multiple-use

forest. In these areas, stands between 250 and 400 years of age were assumed to have an attrition rate similar to the existing virgin forest. In the model, stands that 'died' during the projection period were replaced by a second generation or a secondary cohort. The process was repeated for each 50-year period.

By adding together the multiple-use and reserved areas, the model produces a complete picture of the forest a century from now. One of its most interesting findings is that we can expect a relatively stable representation of development stages to be maintained within a robust forest structure. If old stands are depleted more slowly than predicted, the proportion of senescent stands would increase slightly. If severe fires occur more frequently than in the past, there would be an increase in younger ages at the expense of stands of middle age. Less severe fires should have little effect on the overall pattern of development stages.

This study, the first of its kind in Australia, suggests that the present diversity of the development stages can be maintained into the future. Individual stands will, of course, change; some will become older while others will make way for younger generations in a vigorous drama of renewal. The young forest of today will, after all the challenges, become tomorrow's old forest.

Early morning in a mature karri forest in the Warren River valley.
Photo – Chris Garnett/CALM

Jack Bradshaw is the former Manager of the Forest Management Branch in CALM. He is now a forest consultant.

Martin Rayner is a forest scientist and currently is the Acting Manager of the Forest Management Branch.

Margaret Kierath is a freelance writer with an interest in the environment.

The following scientific papers describe the study in more detail:

Bradshaw, F.J. and Rayner, M.E. (1997). Age Structure of the Karri Forest:
1. Defining and Mapping Structural Development Stages. *Australian Forestry* 60(3), pp. 178–187.

Bradshaw, F.J. and Rayner, M.E. (1997). Age Structure of the Karri Forest:
2. Projection of Future Forest Structure and Implications for Management. *Australian Forestry* 60(3), pp. 188–195.

What does the future hold for our karri forest? Research provides some interesting insights. See page 18.

'Growing Gnangara Park', on page 35, continues the story of WA's largest proposed outer suburban native parkland.

Winner of the 1998 Alex Harris Medal for excellence in science and environment reporting.

LANDSCOPE

VOLUME FOURTEEN NUMBER 4, WINTER 1999

The photographic exellence of WA team Babs and Bert Wells was driven by a love of the job. See page 10.

Many WA women have played important roles in the conservation of our natural resources. Some of them feature in our story on page 41.

Partnerships are important. Many private sector businesses and individuals are active partners in protecting our natural heritage. See page 47.

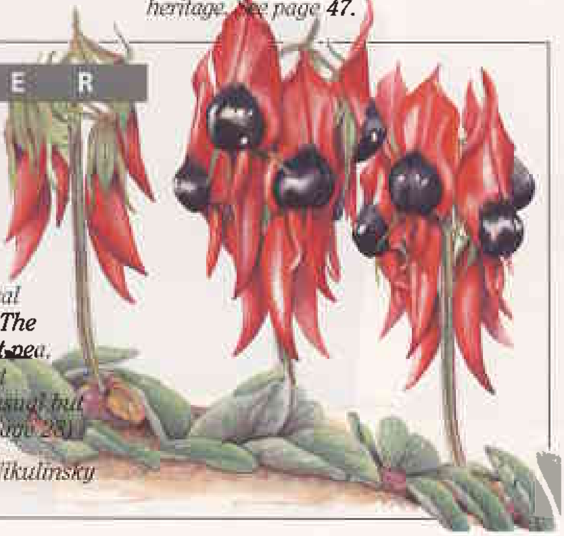
FEATURES

REGULARS

COVER

The Dampier collection returns briefly to Western Australia for an exhibition at the WA Museum. The specimens' scientific interest is limited, but their historical significance is immense. The illustration is of the Sturt pea, and Dampier was the first person to collect this unusual but magnificent plant. (See page 28)

Illustration by Philippa Nikulinsky



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